A Water Quality Improvement Plan for Cripple Creek (Smyth & Wythe Counties, VA) and Elk Creek (Grayson County, VA)

Cripple Creek, between Cedar Springs and Speedwell

A plan for achieving *E. coli* water quality standards

January 24, 2014

Prepared by:
Virginia Department of Environmental Quality

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New River Soil and Water Conservation District

Evergreen Soil and Water Conservation District

Big Walker Soil and Water Conservation District

Grayson County

Grayson Landcare

Local Residents and Landowners

National Committee for the New River

New River-Highlands Resource Conservation and Development Council

USDA - Natural Resources Conservation Service

Virginia Department of Conservation and Recreation

Virginia Department of Forestry

Virginia Department of Health

Virginia Cooperative Extension

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Big Walker Soil & Water Conservation District

New River Soil & Water Conservation District

Elk Creek Rescue Squad

Speedwell Volunteer Fire Station

Speedwell Elementary School

Summerfield Community Clubhouse

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List of Acronyms

BMP	Best Management Practice
CREP	Conservation Reserve and Enhancement Program
CWA	Clean Water Act
DCR	Virginia Department of Conservation and Recreation
DEQ	Virginia Department of Environmental Quality
EPA	Environmental Protection Agency
EQiP	Environmental Quality Incentive Program
FTE	Full Time Equivalent
GM	Geometric Mean
IP	Implementation Plan
NPS	Nonpoint Source Pollution
NRCS	Natural Resources Conservation Service
SSM	Single Sample Maximum
SWCD	Soil and Water Conservation District
TMDL	Total Maximum Daily Load
VCE	Virginia Cooperative Extension
VDACS	Virginia Department of Agriculture and Consumer Services
VDH	Virginia Department of Health
WQMIRA	Water Quality Monitoring, Information, and Restoration Act

EXECUTIVE SUMMARY

This document outlines a plan for improving water quality in the Cripple Creek watershed located in Smyth and Wythe Counties and the Elk Creek watersheds located in Grayson County. Figures 2 and 3 in this document display a map of these watersheds.

This plan serves as a guide for local stakeholders to the achieve the goal of eliminating impairment by *E. coli* bacteria pollution to the primary contact recreation use (swimming, bathing, kayaking, etc.) of Cripple Creek and Elk Creek. The plan represents a balance among the fecal bacteria load reductions needed to achieve water quality standards, the management practices that are socially and economically acceptable for stakeholders to implement, and measurable goals that are reasonable for stakeholders to achieve in the watershed during the foreseeable future.

E. coli Pollution Budgets (i.e. Total Maximum Daily Loads, or TMDLs) for Cripple Creek and Elk Creek

Segments of Cripple Creek and Elk Creek are listed by the Commonwealth of Virginia as having their primary contact recreation use (e.g. swimming, wading, & kayaking) impaired by elevated levels of fecal bacteria on Virginia's 303(d) List of Impaired Waters. The Commonwealth of Virginia has developed Total Maximum Daily Loads (TMDLs) for fecal bacteria that address the following segments of Cripple Creek and Elk Creek.

- **Cripple Creek**, from its headwaters downstream to the confluence with Blue Spring Creek (Segment ID: VAS-N09R-01-BAC_CPL01A04)
- **Cripple Creek**, from the Dry Run confluence downstream to Francis Mill Creek confluence (Segment ID: VAS-N09R-01-BAC_CPL02A98)
- **Cripple Creek**, from the Dean Branch confluence downstream to the mouth (Segment ID: VAS-N09R-01-BAC_CPL01B04)

The uppermost segment of Cripple Creek (Segment ID: VAS-N09R-01-BAC_CPL01A04) is not addressed separately in this plan since it was removed from Virginia's 2010 list of impaired waters based on a finding that is was attaining the single sample maximum criteria for *E. coli* levels. This issue is further addressed in the section titled *"Review of Water Quality Monitoring, Assessment, and Pollution Budget Development for E. coli".*

For the Elk Creek watershed, there is a single E. *coli* TMDL pollution budget that covers three segments of Elk Creek:

- **Elk Creek**: Comers Rock Branch confluence downstream to Turkey Fork** confluence (Segment ID: VAS-N05R_EKC03A02)
- **Elk Creek**: Turkey Fork confluence downstream to the Knob Fork confluence (Segment ID:VAS_N05R-EKC02A00)
- **Elk Creek**, Knob Fork confluence downstream to mouth (Segment ID: VAS_NO5R_EKC01A00)

The TMDL studies for Cripple Creek and Elk Creek identified the following non-point sources of fecal bacteria in the watersheds that contribute to the fecal bacteria impairments: agricultural runoff from cropland and pasture; direct deposition of fecal matter by livestock; human sources from straight pipes and failing septic systems; pet waste; and wildlife. The TMDL studies established pollution budgets for each impaired water body segment based on the pollution reductions needed to meet water quality standards and the pollutant loads estimated to be coming from each type of land use (e.g. forest, agriculture, residential, urban) in the watershed.

Stakeholder Participation

Individuals representing agricultural, residential, commercial, environmental, and government interests on a local, state, and federal level contributed substantial amounts of their time towards meetings held to address the development of this plan. The input from these individuals is greatly appreciated. Public meetings were held to inform the stakeholders about the purpose and need for the plan and to provide an overview of plan components such as the types and amounts of best management practices that are needed to improve water quality. Several agricultural/ residential and government workgroup meetings were held to discuss details of the plan components. A steering committee meeting was held to review the input from the workgroups and provided recommendations for using the input to inform the content of the plan.

Implementation Actions

The management practices associated with Stage 1 of *E. coli* TMDL implementation are expected to improve water quality sufficiently enough to remove the identified impaired segments of Cripple Creek and Elk Creek from Virginia's list of waters for impairment by *E. coli* within 10 years. The endpoint for Stage 2 of TMDL implementation as described in this plan is the *E. coli* water quality standards violation rate that would occur within the identified segments of Cripple Creek and Elk Creek if soil, water, and vegetation conservation practices were implemented to their maximum practicable extent. Table 53 displays the current E. coli standard violation rate and the modeled violation rates that are projected to occur after completion of Stage 1 and Stage 2 of TMDL implementation in the segments of Cripple and Elk Creek addressed within this plan.

Below are the most consequential types of practices and estimated amounts needed for achieving the Stage 1 *E. coli* load reductions; Stage 2 would generally consist of a continuation of Stage 1 practices, except that a considerable number of retention ponds on upland pasture would be needed. Complete estimates of the types and amounts of practices that will achieve water quality goals are presented later in this document.

Primary Stage 1 Practices for the Elk Creek watershed:

- Replace **97 straight pipes (i.e. raw sewage discharges)** with septic systems
- Repair or replace **42 septic failing septic systems**
- **12.1 miles** of stream exclusion fencing
- **12,443 acres** of improved pasture management
- **184 acres** of reforestation on highly erodible pasture

Primary Stage 1 Practices for the Cripple Creek watershed:

- Replace **116 straight pipes** (i.e. **raw sewage discharges)** with septic systems
- Repair or replace **146 failing septic systems**
- **17.8 miles** of stream exclusion fencing
- **23,235 acres** of improved pasture management
- **520 acres** of reforestation on highly erodible pasture
- **535 acres** of conversion from tall fescue or cool-season grasses on hay land and pasture to native warm-season grasses

Cost of Implementation

The estimated costs for implementing the actions outlined for Stage 1 are listed below. More detailed estimated costs for implementing this plan are provided later in this document. The completion of this plan makes the watershed eligible for certain state and federal grant funds (i.e. through the Virginia Agricultural Cost-Share program and the federal Clean Water Act Section 319h grant program) that are specifically intended to support the achievement of the actions within a TMDL IP. Please see the section titled *Funding for Implementation* for further information about potential sources of funding for implementing this plan.

Table ES-1: Total Costs to Implement Stage 1 for the Cripple and Elk Creek Watersheds

Watershed Planning Unit	Agricultural BMPs	Residential BMPs	Technical Assistance	Total Cost
Upper-Middle Cripple Creek	**$3,254,252**	**$1,034,250**	**$600,000**	**$4,888,502**
Lower Cripple Creek	**$1,053,023**	**$639,425**	**$300,000**	**$1,992,448**
Elk Creek	**$1,962,413**	**$1,003,250**	**$600,000**	**$3,565,663**

The Benefits of Efforts to Improve Water Quality

The primary water quality benefit of implementing this plan in the Cripple and Elk Creek watersheds is a reduced risk of people becoming sick as a result of swimming in streams. Additionally, the implementation of this plan is anticipated to have multiple complementary benefits to agricultural producers, residents, and local communities, for example:

- Cleaner water results in greater public appreciation and support of soil and water conservation efforts by farmers.
- Agricultural management practices that improve water quality, such as improved pasture management, help keep essential raw materials (soil, water, nutrients, and organic matter) on-farm rather than exporting them off the farm in water run-off.
- Cleaner water in streams results in decreased exposure of livestock to waterborne disease.
- Certain agricultural practices in this plan would lead to increased vegetation along streams, which results in less stream bank erosion and reduced property loss and safety hazards, and reduced risk of flood damage.

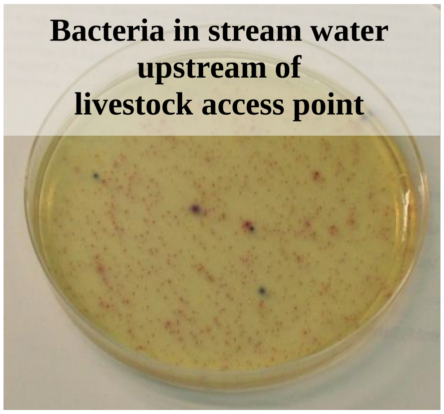
Additional information on the benefits of efforts to improve water quality in the Cripple and Elk Creek watersheds are provided later in this document.

Three Practical Ways for Watershed Residents to Protect Water Quality in Cripple Creek and Elk Creek from *E. coli* Pollution

Improved pasture management

Improved pasture management consists of: dividing a farm tract into multiple pastures through fencing; managing soil nutrient and pH levels to optimize forage production; periodic chaining of pastures to break-up manure; and adjusting the timing, intensity, duration of livestock grazing to the life cycles of forage plants. Improved management of pastures not only helps improve water quality, it also helps retain essential raw materials (soil, water, nutrients, and organic matter) on-farm rather than exporting these resources off the farm in water run-off. The increased retention of raw materials and increased resource utilization improves soil fertility and increases vegetation productivity. This translates into increased forage yields, reduced feed and fertilizer bills, and greater profitability.

Controlling livestock access to streams



Controlling livestock access to streams, either through complete exclusion and providing off-stream water, or exclusion and hardened access points for watering is one of the most effective livestock management practices for improving water quality. Controlling livestock access to streams greatly reduces fecal bacteria inputs and increases the density and vigor of streamside vegetation. Increased streamside vegetation slows the rate of stream bank erosion, which reduces the amount of soil that washes into streams. When less soil washes into streams, pools are deeper and the stream bottom is cleaner, resulting in better feeding, resting and spawning habitat for fish & wildlife. Better habitat results in healthier populations of aquatic insects and the sport fish they feed. Increased streamside vegetation also provides better habitat for terrestrial wildlife such as birds and mammals, more food for aquatic animals, and more shade which helps keep streams cooler during the summer.

Septic System Inspection, Maintenance, and Repair

The most important thing that homeowners can do to reduce residential sources of bacteria is to ensure that their septic system is properly operated and maintained. Proper operation and maintenance includes:

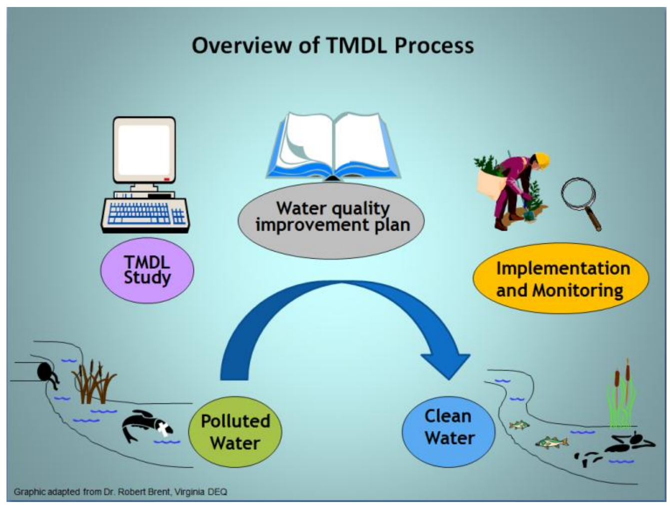
- knowing the location of the system components and protect them (e.g., not driving or parking on top of them, not planting trees where roots could damage the system)
- keeping hazardous chemicals out of the system
- pumping out the septic tank at an interval no more than once every five years
- periodic inspection of the ground surface around the system to see if there is any evidence of septic system failure.

The local Virginia Department of Health is a primary source of information regarding the proper operation and maintenance of septic systems.

Introduction

The Clean Water Act (CWA) requires that all of our streams, rivers and lakes meet state water quality standards.

The federal CWA of 1972 assigns responsibility to the state to evaluate surface water bodies (e.g. streams, rivers, and lakes) to determine if water quality is sufficient to support designated uses. Most inland water bodies in Virginia have the following designated uses: recreation, aquatic life, wildlife, and drinking water. The Commonwealth of Virginia compares the chemical, physical, and biological characteristics of each water body to water quality standards and criteria to determine if each designated use is being supported. Water quality standards and criteria establish conditions for chemical, physical, and biological characteristics of water bodies that need to be met in order for a water body to support a particular designated use. For example, Virginia has water quality standards for how much *E. coli* bacteria can be present in streams without impairing their use for recreational activities such as swimming.



If a water body does not meet one or more standards, it is placed on the state's list of waters having impaired water quality. This list is reported to the U.S. Environmental Protection Agency every even-numbered year. Virginia is required to develop a Total Maximum Daily Load (TMDL) for each pollutant that contributes to water quality impairment. A TMDL is a pollution budget that quantifies the maximum amount of each pollutant that can be delivered to a stream without surpassing water quality standards. In order to develop a TMDL, background pollutant concentrations, point source pollution loadings, and non-point source pollution loadings are considered. Non-point source pollution occurs when pollutants such as sediment, nutrients, or fecal material reaches streams from run-off from the land surface or contaminated groundwater. Point source pollution occurs when pollutants are directly discharged into a stream (e.g. from a pipe). Through the development of TMDLs and plans for implementing TMDLs, states determine the types and amounts of land use practices that are needed to reduce pollution to a level at which water quality standards are met and designated uses are fully supported.

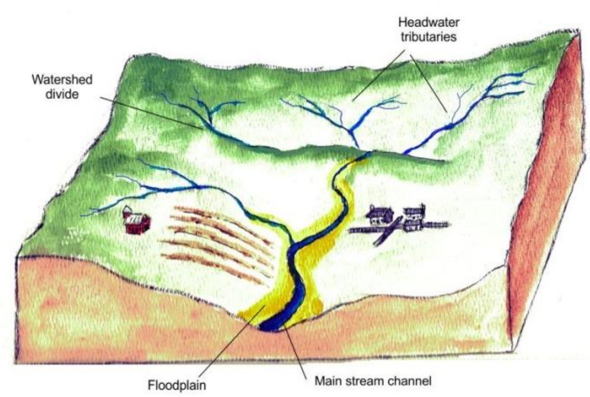
The goal of this water quality improvement plan is to describe the collaborative stakeholder actions and resources needed to eliminate impairment by *E. coli* bacteria pollution to the designated primary contact recreation use (swimming, bathing, kayaking, etc.) of Cripple Creek and Elk Creek. Although several of the tributaries in these two watersheds also have elevated levels of *E. coli*, only the mainstem of Elk Creek and Cripple Creek have established pollution budgets (i.e. TMDLs) for *E. coli*. Therefore, this plan provides estimates of the types, numbers, and associated costs of land management actions needed throughout the two watersheds to meet water quality standards in the mainstem of Cripple Creek and Elk Creek. Restoring water quality in the mainstem of Cripple Creek and Elk Creek will require improved residential and agricultural management practices in the watersheds of tributary streams; in this regard, it is expected that water quality in the tributaries would also be substantially improved.

The plan represents a balance among the fecal bacteria load reductions needed to achieve water quality standards, the management practices that are socially and economically acceptable for stakeholders to implement, and measurable goals that are reasonable for stakeholders to achieve in the watershed during the foreseeable future. As such, this plan serves as a guide for local stakeholders to improve water quality in the Cripple and Elk creek watersheds such that the segments impaired by fecal bacteria can be removed from the Virginia's list of impaired waters for the identified pollutants.

Watershed Characteristics

The term "watershed" describes an area of a landscape that drains to a single location.

The Cripple Creek watershed is located predominately in Wythe County, Virginia, although a substantial portion of the watershed is within Smyth County. The headwaters of Cripple Creek begin in Smyth County near Cedar Springs, Virginia and flows east approximately 32 miles before joining the New River east of Porter's Crossroads and Pierce Mill. The Cripple Creek watershed is approximately 88,885 acres, predominately forest, constituting approximately 60% of the total watershed area. The remaining land uses are divided between pasture (35%), residential (3.3%), and cropland (0.7%). The segments of Cripple Creek that are impaired by *E. coli* are within Wythe County. A map of this watershed is displayed in Figure 2 (pg. 12).



The Elk Creek watershed is located entirely within Grayson County, Virginia. The Elk Creek watershed is approximately 53,700 acres, predominately forest, constituting approximately 59% of the total watershed area. The remaining land uses are divided between pasture (35%), residential (5%), and cropland (<1%).The segment of Elk Creek that is impaired by *E. coli* begins at the confluence of Comers Rock Branch (near the intersection of SR 663- Caty Sage Rd and SR 658- Comers Rock Rd) and flows approximately 24 miles southeast and where it empties into the New River approximately 4 miles west of Galax, VA. A map of this watershed is displayed in Figure 3 (pg. 13).

Review of Water Quality Monitoring, Assessment, and Pollution Budget Development for *E. coli*

Fecal Bacteria Impairment Status for Cripple Creek and Elk Creek

The Virginia Department of Environmental Quality (DEQ) has assessed water quality in Elk Creek, Cripple Creek, and several of their tributary streams. Several stream segments in these watersheds do not meet the water quality standards for *E. coli,* a type of fecal bacteria that inhabits the intestines of warm-blooded animals. The amount of *E. coli* in surface water is used as an indicator of the level of risk that humans will have an illness or infection from pathogens such as bacteria, viruses, parasites as a result of direct contact with the affected water. This risk to human health from pathogens is the basis of the state's water quality standards and associated assessment criteria, which specifies that *E. coli* should not exceed 235 colony forming units (cfu) per 100 mL of water at any time and average levels should not exceed 126 cfu/100mL during any given month. Tables 1 and 2 below summarize recent results of E. coli bacteria monitoring in Cripple Creek and Elk Creek. Figure 1 displays the recent *E. coli* data for the monitoring site at the mouth of Elk Creek as an example of how bacteria concentrations vary at a single station. Appendix D contains the E. coli monitoring data collected in Cripple and Elk Creeks since the year 2000.

Table 1. Recent *E. coli* monitoring results in Cripple Creek

DEQ Monitoring Station	Station Description	Monitoring Period	# samples in violation of SSM / total # of samples (% violation)
9-CPL001.03	near Ivanhoe Ford off Rt 639 off Rt 94	Feb.2007 – Sept. 2007	2/8 (25%)
9-CPL002.82	@ Pierce Mill, Rt 641 of Rt 94	Feb. 2007 – Jan. 2008	1/12 (8%)
9-CPL008.68	@ Eagle Furnace Rt 642 off Rt 619	Mar. 2007 – Jan. 2008	1/11 (9%)
9-CPL018.47	@ Simmerman, bridge #6193 on Rt 619	Mar. 2007 – Jan. 2008	5/11 (46%)
9-CPL022.99	@ Andrews Hollow upstream of Speedwell	Mar. 2007 – Jan. 2008	5/11 (46%)
9-CPL028.10	near Cedar Springs, bridge #6057 Rt 692	Mar. 2007 – Jan. 2008	0/10 (0%)

Table 2. Recent *E. coli* monitoring results in Elk Creek and Knob Fork

DEQ Monitoring Station	Station Description	Monitoring Period	# samples in violation of SSM / total # of samples (% violation)
9-EKC000.11	Elk @ Bridge # 1009 on Rt 274 off Rt 94	Jan. 2008-Nov. 2010	4/15 (27%)
9-EKC010.47	Elk @ Bridge # 6031 on Rt 654 off Rt 660	Jan. 2009-Nov. 2010	6/12 (50%)
9-EKC012.13	Elk @Wooden bridge on Rt 696 off Rt 21	Jan. 2009-Nov. 2010	8/12 (67%)
9-EKC017.51	Elk @ Bridge # 6041 on Rt 663 off Rt 658	Jan. 2008-Nov. 2010	13/24 (54%)
9-KNB000.03	Knob Fk @ Bridge # 6028 on 650 off Rt 660	Jan. 2008-Nov. 2010	12/24 (50%)

Figure 1: Recent levels of E. coli levels at the mouth of Elk Creek

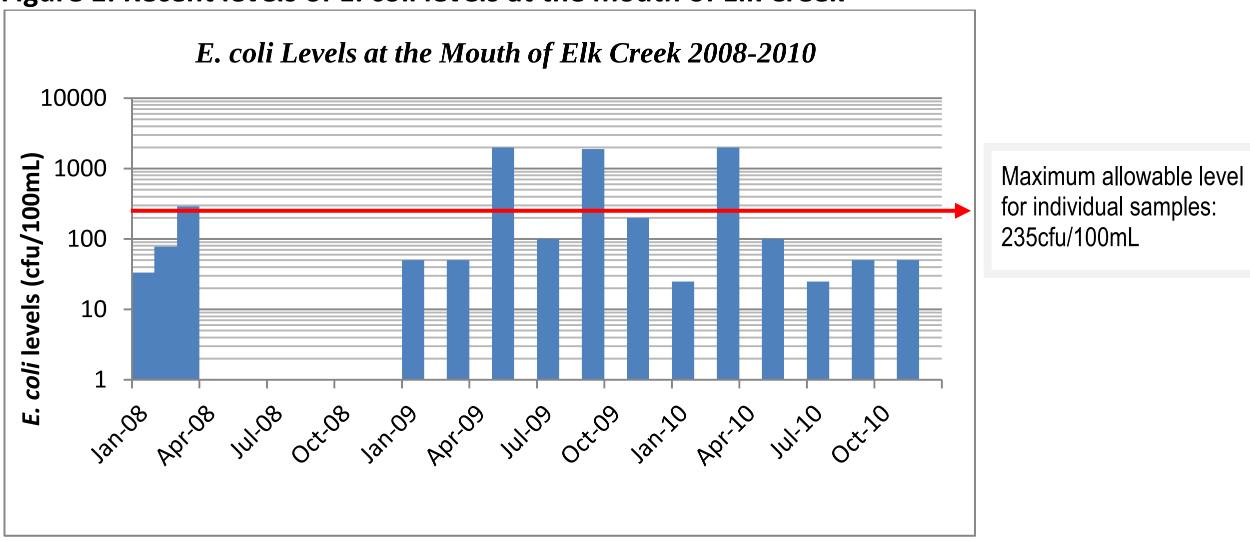


Table 3 below indicates the fecal bacteria assessment history and impairment status for the mainstem segments of Cripple Creek and Elk Creek. This information is based on Virginia's 303(d)/305(b) Integrated Report, which is the Commonwealth's official water quality assessment report, required by the U.S. Environmental Protection Agency to be updated every two years. Appendix A contains tables of the fecal bacteria impairment status and history for all stream segments in the Cripple and Elk Creek watersheds that have been monitored for fecal bacteria.

Table 3. Fecal Bacteria Assessment History & Impairment Status for Cripple Creek & Elk Creek

Stream Segment	Contact Recreation Impaired by Fecal Bacteria? †‡					
	2002	2004	2006	2008	2010	2012*
Cripple Creek: Headwaters downstream to Blue Spring Creek confluence (Segment ID: VAS-N09R_CPL01A04)	N/A	Y	Y	Y	N	N
Cripple Creek: Blue Spring Creek confluence downstream to Dry Run confluence (VAS-N09R_CPL02B04)	N/A	N	N	N	Y	Y
Cripple Creek: Dry Run confluence downstream to Francis Mill Creek confluence (Segment ID: VAS-N09R_CPL02A98)	N/A	Y	Y	Y	Y	Y
Cripple Creek: Francis Mill Creek confluence downstream to Dean Branch confluence (Segment ID: VAS-N09R_CPL01A98)	N/A	N	N	N	N	N
Cripple Creek: Dean Branch confluence downstream to the mouth (Segment ID: VAS-N09R-01-BAC_CPL01B04)	N/A	Y	Y	Y	Y	Y
Elk Creek, from confluence of Middle Fork Elk Creek and Carico Branch downstream to Comers Rock Branch confluence (No segment ID)	N/A	N/A	N/A	N/A	N/A	N/A
Elk Creek: Comers Rock Branch confluence downstream to Turkey Fork** confluence (Segment ID: VAS-N05R_EKC03A02)	N/A	N/A	Y	Y	Y	Y
Elk Creek: Turkey Fork confluence downstream to the Knob Fork confluence (Segment ID:VAS_N05R-EKC02A00)	Y	Y	Y	Y	Y	Y
Elk Creek, Knob Fork confluence downstream to mouth (Segment ID: VAS_NO5R_EKC01A00)	Y	Y	Y	Y	Y	Y

†Prior to 2006, the impairment listings were based more broadly on fecal coliform bacteria levels, from 2006 onward impairment listings were based on *E. coli* bacteria, a specific type of fecal coliform bacteria

‡N/A indicates that the segment was not assessed during a particular period of time

*2012 impairment listings are considered to be *draft* at the time this document was prepared (12/20/2013)

E. coli Pollution Budgets for Cripple Creek and Elk Creek

The Commonwealth of Virginia develops pollution budgets (known as Total Maximum Daily Loads, or TMDLs) for stream segments in which pollutants exceed water quality standards. **Electronic copies of the *E. coli* TMDL studies for Cripple Creek and Elk Creek can be acquired from the DEQ website a at:** http://www.deq.virginia.gov/Programs/Water/ WaterQualityInformationTMDLs/TMDL/ TMDLDevelopment/ApprovedTMDLReports.aspx

For the Cripple Creek watershed, separate *E. coli* pollution budgets have been established for the following segments:

- **Cripple Creek**, from its headwaters downstream to the confluence with Blue Spring Creek (Segment ID: VAS-N09R-01-BAC_CPL01A04)
- **Cripple Creek**, from the Dry Run confluence downstream to Francis Mill Creek confluence (Segment ID: VAS-N09R-01-BAC_CPL02A98)
- **Cripple Creek**, from the Dean Branch confluence downstream to the mouth (Segment ID: VAS-N09R-01-BAC_CPL01B04)

For the Elk Creek watershed, there is a single E*. coli* TMDL pollution budget that covers three segments of Elk Creek:

- **Elk Creek**: Comers Rock Branch confluence downstream to Turkey Fork** confluence (Segment ID: VAS-N05R_EKC03A02)
- **Elk Creek**: Turkey Fork confluence downstream to the Knob Fork confluence (Segment ID:VAS_N05R-EKC02A00)
- **Elk Creek**, Knob Fork confluence downstream to mouth (Segment ID: VAS_NO5R_EKC01A00)

The TMDL pollution budgets for these stream segments o three main things. First, they characterize the watershed, such as the acreages of agricultural land, forest land, and urban land. Second, they estimate the amount of fecal bacteria coming from each type of source. The two main categories of sources are point sources (bacteria being discharged in wastewater treatment plant effluent) and non-point sources (e.g. run-off from pasture land, or bacteria from failing septic systems). The estimates of fecal bacteria "loading" to streams from each type of source include a characterization of the natural or background level of bacteria (i.e. from wildlife). Third, the pollution budgets estimate the amount that each fecal bacteria source would need to be reduced by in order to meet water quality standards. In general, even though wildlife contributes to fecal bacteria levels in streams, the pollution budgets do not prescribe bacteria reductions from wildlife. The reason is that because fecal bacteria from wildlife is considered to be part of naturally occurring conditions whereas state and federal laws require pollution budgets to focus upon controllable human-related sources of pollution.

The uppermost segment of Cripple Creek (Segment ID: VAS-N09R-01-BAC_CPL01A04) is not addressed individually in this plan since it was removed from Virginia's 2010 list of impaired waters based on a finding that is was attaining the single sample maximum criteria for *E. coli* levels. However, additional land use practices are needed within the watershed that drains to the upper segment of Cripple Creek in order to meet the pollution budget (i.e. TMDL) for this segment. Furthermore, such practices in the upper segment of Cripple Creek are needed to help achieve the pollution budget for the middle segment of Cripple Creek (Segment ID: VAS-N09R-01-BAC_CPL02A98). The TMDL for the upper segment of Cripple Creek is therefore implicitly addressed by the Stage 1 & 2 objectives set for the Upper-Middle Cripple Creek watershed, which also contains the impaired middle segment of Cripple Creek. There are tributaries to Cripple Creek that are impaired by *E. coli* (see Appendix A), but because these tributaries do not have established pollution budgets they are not addressed separately in this plan.

Since there is a single TMDL that addresses all three segments of Elk Creek, the segments and their associated watersheds are not addressed individually within this plan. There are tributaries to Elk Creek that are impaired by *E. coli* (see Appendix A), but because these tributaries do not have established pollution budgets they are not addressed separately in this plan.

The associations between watershed planning units addressed in this plan, sub-watersheds used during the TMDL pollution budget development, and stream segments contained within the watershed planning units are shown in Table 4 below. Figures 2 and 3 display maps of the two watersheds that showing which stream segments have established TMDL pollution budgets for *E. coli.*

Table 4. Association between watershed planning units, sub-watersheds delineated during the TMDL study, and stream segments.

<table>
<tr><th>Watershed Planning Unit</th><th>TMDL Study Sub-Watersheds</th><th>Associated Stream Segments</th></tr>
<tr><td rowspan="2">Elk Creek, entire drainage</td><td rowspan="2">ELC1 through 15</td><td>Impaired Segments with a TMDL*:
Elk Creek: Comers Rock Branch confluence downstream to Turkey Fork** confluence (Segment ID:VAS-N05R_EKC03A02)
Elk Creek: Turkey Fork confluence downstream to the Knob Fork confluence (Segment ID:VAS_N05R-EKC02A00)
Elk Creek, Knob Fork confluence downstream to mouth (Segment ID: VAS_NO5R_EKC01A00)</td></tr>
<tr><td>Segments that have not been assessed:
Elk Creek, from confluence of Middle Fork Elk Creek and Carico Branch downstream to Comers Rock Branch confluence</td></tr>
<tr><td rowspan="3">Upper-Middle Cripple Creek, entire drainage upstream of Francis Mill Creek confluence</td><td rowspan="3">CRC 1 through 10</td><td>Impaired Segments with a TMDL:
Cripple Creek, from Dry Run confluence downstream to Francis Mill Creek confluence (segment ID: VAS-N09R-01-BAC_CPL02A98)</td></tr>
<tr><td>Impaired Segments that do not have a TMDL:
Cripple Creek, from Blue Spring Creek confluence downstream to Dry Run confluence</td></tr>
<tr><td>Non-impaired Segments:
Cripple Creek, from its headwaters downstream to the Blue Spring Creek confluence (Segment ID: VAS-N09R-01-BAC_CPL01A04)</td></tr>
<tr><td rowspan="2">Lower Cripple Creek, entire drainage from Francis Mill Creek confluence to the mouth</td><td rowspan="2">CRC 11 through 19</td><td>Impaired Segments with a TMDL:
Cripple Creek, from Dean Branch confluence downstream to the mouth</td></tr>
<tr><td>Non-impaired Segments:
Cripple Creek: Francis Mill Creek confluence downstream to Dean Branch confluence</td></tr>
</table>

*The TMDL was established for the lowermost segment of Elk Creek although it addresses all three impaired segments

Figure 2. Cripple Creek Watershed, showing the impaired segments with an established TMDL and associated monitoring stations

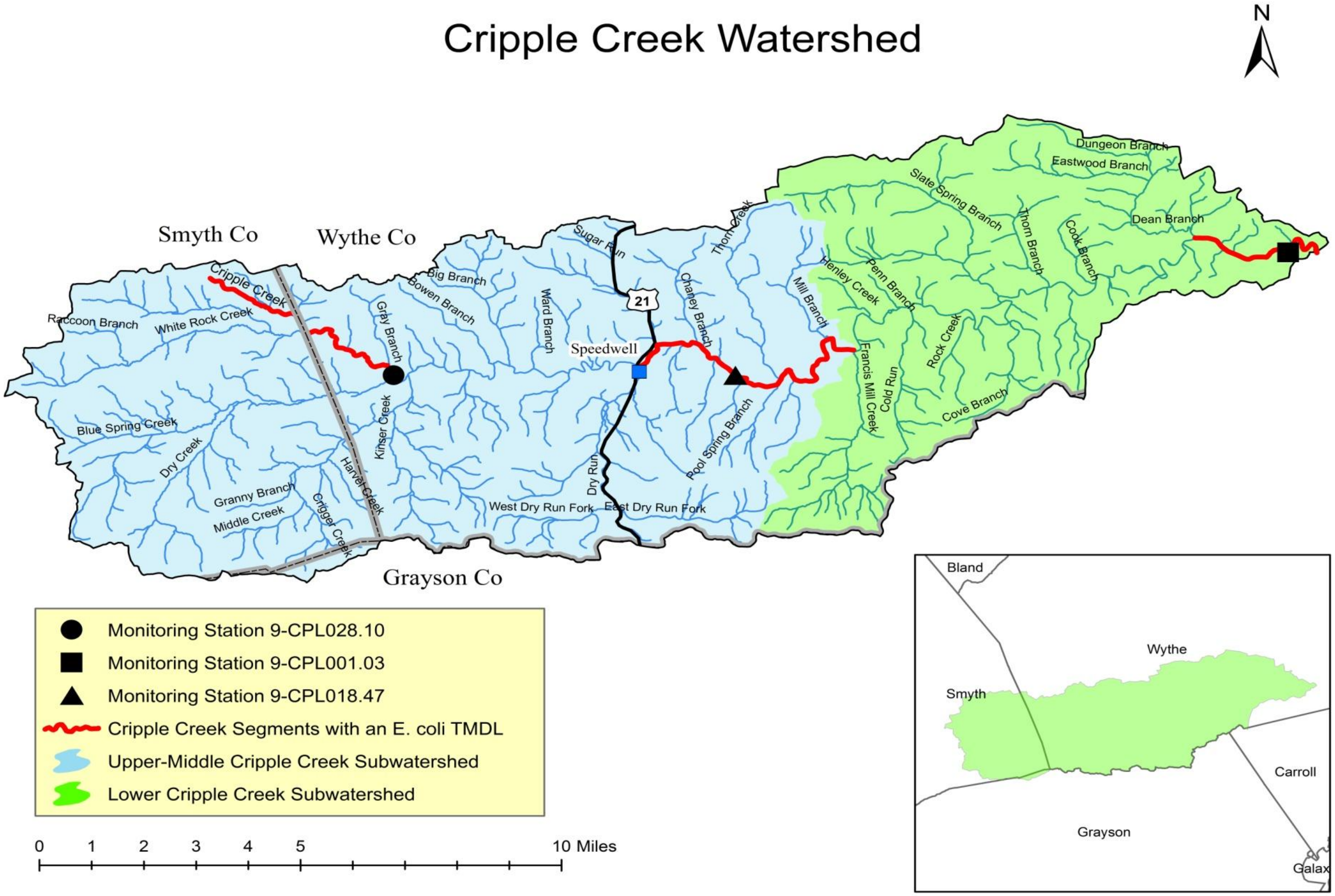
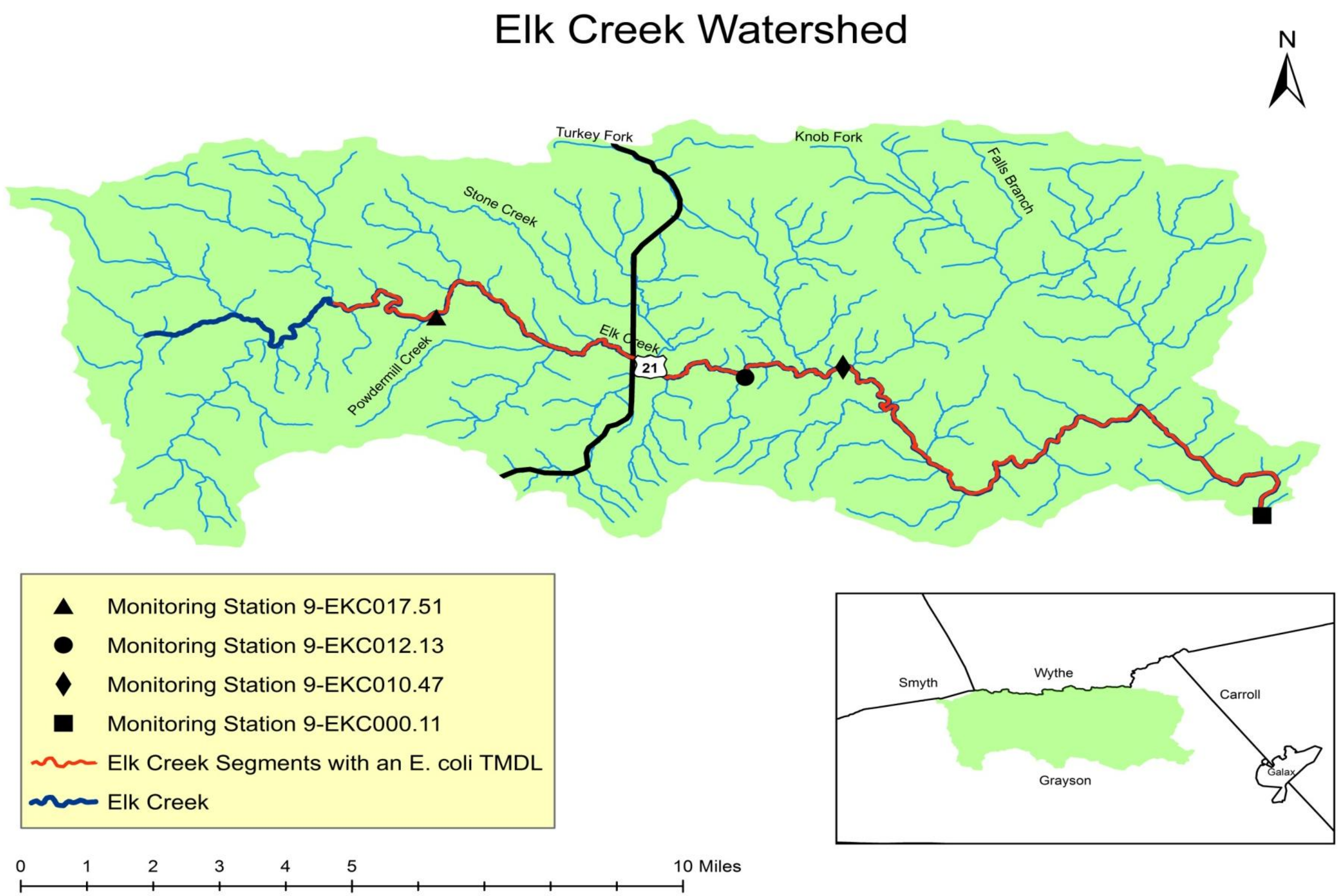


Figure 3. Elk Creek Watershed, showing the impaired segments with an established TMDL and associated monitoring stations



Sources of Bacteria in Cripple Creek and Elk Creek

The TMDL studies for Cripple and Elk Creeks identified the sources of *E. coli* bacteria that need to be reduced in order to improve water quality. There are currently no point sources permitted to discharge bacteria into Elk Creek or Cripple Creek. Since there are no point sources of bacteria to either Elk Creek or Cripple Creek, the presence of human bacteria in the creeks as indicated by the Bacteria Source Tracking Data (Appendix C), means that the source of the human bacteria is from failing septic systems and straight pipes.

Non-point sources of bacteria in the Cripple and Elk Creek watersheds include failing septic systems, domestic pets, livestock manure (either deposited into streams directly or in pasture run-off), and wildlife. Straight pipes are also treated as a non-point source of bacteria in this plan. Pasture runoff is the primary source of bacteria in Cripple Creek and Elk Creek. Bacteria from failing septic systems and straight pipes contribute a small percentage of the total load, but these sources need to be addressed since they are illegal under Virginia law. Wildlife populations continually contribute bacteria to these streams, but the total amount of bacteria that wildlife contributes is insignificant in comparison to the amount contributed from grazing livestock. Figures 4 & 5 illustrate the relative amounts of *E. coli* that are produced from different sources in the watersheds that drain to the impaired segment of Elk Creek and two impaired segments of Cripple Creek that have pollution budgets.

Figure 4. Sources of *E. coli* in Cripple Creek

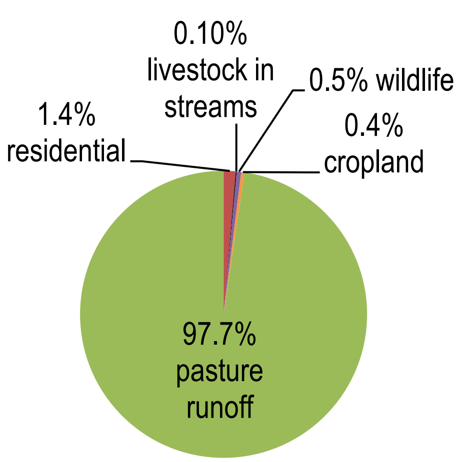
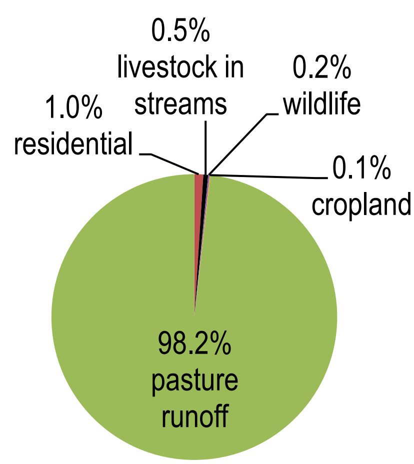


Figure 5. Sources of *E.coli* in Elk Creek



Developing a Plan to Implement the Pollution Budget

After a TMDL is developed for a stream, Virginia state law requires development of a plan that identifies how the pollutant reductions identified in the TMDL can be achieved. In this regard, there are nine components that need to be included in this water quality improvement plan for Cripple Creek and Elk Creek:

1. The causes and sources of *E. coli* that need to be controlled to meet water quality standards
2. The reductions in *E. coli* loads needed to achieve water quality standards
3. The agricultural and residential practices that need to be implemented to achieve the *E. coli* reductions
4. The technical and financial assistance needed, associated costs, and the stakeholders that will be relied upon to implement the plan
5. A description of education and outreach approaches that can be used to communicate the need for a coordinated effort to reduce *E. coli* pollution and encourage participation in the implementation of improved agricultural and residential practices
6. Goals, objectives, and milestones for implementing the agricultural and residential practices
7. A schedule for implementing the practices identified in the plan
8. A monitoring component for evaluating the effectiveness of the implementation effort
9. Criteria for determining if progress is being made towards meeting water quality standards for *E. coli*.

Stakeholder Participation

Multiple stakeholder meetings were conducted to facilitate the water quality improvement planning process. A list of these meetings is provided in Table 5 below. Individuals representing agricultural, residential, environmental, and government interests on a local, state, and federal level contributed substantial amounts of their time towards meeting attendance. The input from these individuals is greatly appreciated.

Public meetings were held to inform the stakeholders about the purpose and need for the plan and to provide an overview of plan components such as the types and amounts of best management practices that are needed to improve water quality. A public meeting to kick off the development of this implementation plan was held in the Elk Creek watershed on April 11th and in the Cripple Creek watershed on April 30th.

Agricultural, Residential and Government working groups were held during the plan development process in order to discuss implementation and outreach strategies suitable for differing land uses in the watersheds. The working groups provided input on: the selection of control measures and their associated costs; prioritization of implementation activities; funding/partnering opportunities; regulatory programs related to plan implementation; existing resources for implementing the plan; potential obstacles for implementing the plan; and potential opportunities for facilitating plan implementation. A representative from DEQ coordinated and facilitated each working group.

In both Cripple and Elk Creek watersheds, combined Residential and Agricultural workgroups were held. These groups discussed stakeholder roles and responsibilities for water quality management, discussed watershed characteristics that would facilitate or constrain water quality improvement efforts, discussed approaches and methods for reducing residential and agricultural sources of bacteria, reviewed practices and associated costs, discussed outreach and BMP targeting strategies, and discussed potential citizen monitoring efforts.

A Steering Committee was formed with representation from the workgroups. The committee reviewed the input from the working groups and provided comments and recommendations on the draft public document.

A final public meeting was held at the Summerfield Community Clubhouse on January 28th, 2014 to conclude the implementation planning process. These public meetings served as opportunities for local residents to learn more about the creeks, and to work together to come up with new ideas to protect and restore water quality in their community. A draft implementation plan and presentation was distributed to attendees at the final public meeting.

Appendix B contains a summary of the Agricultural & Residential Workgroup, Government Workgroup, and Steering Committee discussions.

Table 5. Meetings held during the TMDL IP development process

Date	Meeting	Location	Attendance
4/14/2013	Elk Creek (EC) Public Meeting	Elk Creek Rescue Squad Bldg.	15
4/30/2013	Cripple Creek (CC) Public Meeting	Speedwell Elementary School	17
5/30/2013	EC Agricultural & Residential Workgroup #1	Elk Creek Rescue Squad Bldg.	13
6/11/2013	CC Agricultural & Residential Workgroup #1	Speedwell Vol. Fire Station	5
7/22/2013	CC Government Workgroup	Big Walker SWCD Office, Wytheville	10
7/30/2013	EC Government Workgroup	New River SWCD Office, Galax	9
8/8/2013	EC Agricultural & Residential Workgroup #2	Elk Creek Rescue Squad Bldg.	14
8/15/2013	CC Agricultural & Residential Workgroup #2	Speedwell Vol. Fire Station	5
9/18/2013	EC Agricultural & Residential Workgroup #3	Elk Creek Rescue Squad Bldg.	12
1/8/2014	Steering Committee	New River SWCD Office, Galax	12
1/28/2014	Public Meeting	Summerfield Community Clubhouse, Elk Creek	

Types of Practices for Reducing *E. coli* in Streams

Since this plan is designed to be implemented by landowners on a voluntary basis, the identified approach for improving water quality needs to be financially, technically, and socially acceptable for the local communities. The water quality improvement actions compiled in this document were formulated through the input of stakeholders including: residents of the watersheds, the New River Soil and Water Conservation District (NRSWCD), the Big Walker Soil and Water Conservation District (BWSWCD), the Virginia Department of Conservation and Recreation (VADCR), the Virginia Department of Environmental Quality (VADEQ), the Virginia Department of Health (VDH), the USDA Natural Resources Conservation Service (NRCS), Grayson County, the National Committee for the New River, and Grayson Landcare.

Table 6 below lists the recommended management practices, their associated bacteria reduction effectiveness, and their estimated costs. These practices correspond to the specifications for agricultural and residential practices administered the through DCR, DEQ, and NRCS cost-share programs. The practices and their associated costs were compiled based on their utility for achieving water quality objectives and their suitability for the local watersheds based on discussions with local stakeholders.

Table 6. Bacteria Reduction Efficiencies and Estimated Costs for Best Management Practices (BMPs). Practice codes are listed in parentheses.

Best Management Practice	Unit	Bacteria Reduction Efficiency	Bacteria Reduction Reference	Estimated Cost per Unit
Residential Control Measures				
Septic System Pump-out (RB-1)	System	5%	1	$275
Septic System Repair (RB-3)	System	100%	1	$3,500
Septic System Replacement (RB-4, RB-4P)	System	100%	1	$5,000
Alternative Waste Treatment System (RB-5)	System	98%	1	$15,000
Agricultural Control Measures				
Grazing Land Management System (NRCS-EQiP 528, SL-9)	Acre	50%	2	$75
Livestock Exclusion System (LE-1T)	System	100%	3	$32,800
Livestock Exclusion System (LE-2T)	System	100%	3	$20,000
Livestock Exclusion system (SL-6T, CRSL-6)	System	100%	3	$32,800
Stream Protection System (Livestock Exclusion) (WP-2, CRWP-2)	System	100%	3	$1,500
Animal Waste Control Facility (WP-4)	System	75%	4	$150,000
Heavy Use Area Protection (NRCS Practice 561)	System	92%	4	$12,000
Sediment Retention, Erosion, Or Water Control Structure (WP-1)	Acre-Treated	60%	5	$138
Conservation Tillage (SL-15)	Acre	70%	5	$20
Cover Crop (SL-8B, SL-8H)	Acre	10%	5	$25
Permanent Vegetative Cover on Cropland (SL-1)	Acre	land use change	6	$330
Reforestation of Erodible Pastureland (FR-1)	Acre	land use change	6	$82
Field Borders / Wildlife Option (WL-1)	Acre	land use change	6	$250
Fescue Conversion / Wildlife Option (WL-3)	Acre	land use change	6	$350

1 – VADCR Cost-Share Program
2 – VADCR, 2003. Guidance manual for TMDL Implementation Plans.
3 – By definition.
4 - EPA-CBP nutrient effectiveness, 2011. (Bacteria efficiency assumed equal to nutrient efficiency.)
5 - EPA-CBP sediment effectiveness, 2011. (Bacteria efficiency assumed equal to sediment efficiency.)
6 – These practices result in 100% reduction of agricultural bacteria loads but an addition of wildlife bacteria loads.

Stage 1 Water Quality Objectives

The objective for Stage 1 in both the Cripple and Elk Creek watersheds is *to reduce E. coli loads by the year 2024 to a level that will allow the impaired mainstem segments of Cripple Creek and Elk Creek to be removed from Virginia's list of impaired waters.*

The Stage 1 Objective applies to the following impaired segments of Elk Creek and Cripple Creek:

- **Cripple Creek, from its confluence with Dry Run downstream to its confluence with Francis Mill Creek**
- **Cripple Creek, from its confluence with the downstream to the mouth**
- **Elk Creek from its confluence with Comers Rock Branch downstream to the mouth**

To attain the Stage 1 objective for the single sample maximum (SSM) criteria *for E. coli* must be met. The SSM criteria specifies that no more than 10.5% of samples collected in a month can have counts that exceed 235 (cfu) per 100mL. Meeting the Stage 1 Objective will allow the impaired segment of Elk Creek and Cripple Creek to be removed from the State of Virginia's list of impaired waters.

Water quality modeling was used to investigate different bacteria load reduction scenarios for meeting the Stage 1 Objectives described above. The models are based on a variety of data for Cripple Creek and Elk Creek (e.g. flow data, bacteria data, topography, land use, soils, etc.). Based on modeling, it is clear that *E. coli* bacteria loads need to be substantially reduced from residential and agricultural sources in order to meet the Stage 1 Objectives. Stakeholder input was used to adjust the load reduction scenarios to the local characteristics of the Cripple Creek and Elk creek watersheds. Tables 7, 8, and 9 below display the final load reduction scenarios that can be used to achieve the Stage 1 Objectives and are recommended for use in guiding water quality improvement efforts in the two watersheds. All scenarios call for a 100% reduction in E. coli from straight pipes since they are illegal in Virginia. The modeled violation rates in the last two columns of the tables represent the percentage of the time that *E. coli* levels in Elk Creek and Cripple Creek would be expected to exceed either the GM and SSM criteria if bacteria levels were reduced from all sources combined, as indicated by the percentages listed in the columns two through six.

Table 7. Scenarios for Meeting the Stage 1 Objective in Elk Creek

Watershed Planning Unit	% Reductions in E. coli Loads					Modeled Violation Rates (%)	
	Straight Pipes	Septic Systems	Livestock-direct deposition	Upland Pasture	Cropland	GM criteria	SSM Criteria
Elk Creek, entire watershed	100	10	10	40	5	0*	10.1*

*these are the modeled violation rates that would occur at the monitoring station located at the mouth of Elk Creek, the location where the TMDL has been established.

Table 8. Scenario for Meeting Stage 1 Objective in Upper-Middle Cripple Creek

Watershed Planning Unit	% Reductions in E. coli Loads					Modeled Violation Rates (%)	
	Straight Pipes	Septic Systems	Livestock-direct deposition	Upland Pasture	Cropland	GM criteria	SSM Criteria
Upper-Middle Cripple Creek	100	45	15	45	5	0.0	10.4

Table 9. Scenario for Meeting Stage 1 Objective in Lower Cripple Creek

Watershed Planning Unit	% Reductions in E. coli Loads					Modeled Violation Rates (%)	
	Straight Pipes	Septic Systems	Livestock-direct deposition	Upland Pasture	Cropland	GM criteria	SSM Criteria
Lower Cripple Creek	100	40	10	35	5	0.0	10.4

Achieving Stage 1 Water Quality Objectives

The identification of preferred actions was used to estimate the number of practices needed to achieve the target *E. coli* load reduction scenarios displayed in Tables 7, 8, and 9. Since the land uses contributing to excess loads of fecal bacteria are distributed throughout the land area draining to the impaired streams, it follows that actions necessary to improve water quality need to be distributed throughout the land area draining to each impaired segment. The following tables display the number and distribution of management practices needed to meet the Stage 1 Objectives for the Cripple and Elk Creek watersheds.

Practices for Achieving the Stage 1 Objective for Elk Creek

It is estimated that two-thirds of the residential sources of *E. coli* in the Elk Creek watershed other than straight pipes comes from failing septic systems and one-third comes from pets. The implementation actions for residential sources focus on straight pipes and failing septic systems because workgroup attendees did not think that efforts to implement pet waste BMPs would be successful in this rural watershed. The *E. coli* reductions from residential sources needed to meet the Stage 1 Objective can be achieved by: replacing 100% of the estimated number of straight pipes in the watershed with septic systems or alternative waste treatment systems; and repairing or replacing approximately 28% of the failing septic systems in the Elk Creek watershed. The distribution of residential practices is listed in Tables 10 and 11. There are an estimated 1479 houses in the Elk Creek watershed without sewer. Although septic pump-outs do not result in substantial bacteria reductions, they are a necessary maintenance practice and serve as a check on the functionality of a system. It is estimated that a minimum of 25% of these systems (i.e. 370) will need to be pumped out during Stage 1 in order for them to be properly maintained.

Table 10. Stage 1 practices for correcting straight pipes in the Elk Creek watershed

Impaired Segment	Estimated Number of Straight Pipes	Replaced with	
		Conventional Septic System (80%)	Alternative Treatment System (20%)
Elk Creek	97	77	20

Table 11. Stage 1 practices for correcting failing septic systems in the Elk Creek watershed

Watershed Planning Unit	Estimated # of Failing Septic Systems	# of Failing Septic Systems to be Addressed	Septic System Repair (70%)	Replaced with	
				Conventional Septic System (20%)	Alternative Treatment System (10%)
Elk Creek	151	42	29	8	5

It is estimated that the reduction in *E. coli* from direct deposition by livestock needed to meet the Stage 1 Objective can be achieved through the installation of fencing systems that prevent uncontrolled access to perennial streams by livestock and provide controlled stream access points or alternative sources of water. The total length of stream exclusion fence that would be needed is estimated to be 12.1 miles for the entire Elk Creek watershed. The fencing estimate is based on fencing both sides of live stream channels that flow through or adjacent to pasture. Table 12 below shows an estimate for the number of livestock exclusion systems in each sub-watershed that would be needed in order to achieve the *E. coli* reductions from direct deposition of manure into streams and on stream banks. It is anticipated that SL-7 practices (extension of CREP livestock watering systems) may be needed to complement the installation of livestock exclusions systems. However, since the SL-7 practice does not directly reduce bacteria pollution, estimates for the total number of SL-7 systems and the associated cost have not been provided. A cumulative amount of 5.9 miles of livestock exclusion fencing has been installed through the VACS program between January 1st, 2009 and Dec. 31st, 2013 (i.e. since the TMDL study). The fencing length in Table 12 is the amount that remains to be fenced after subtracting out the recent practices.

It is estimated that the reduction in *E. coli* from cropland needed to meet the Stage 1 Objective for the Elk Creek watershed can be achieved by applying Permanent Vegetative Cover (SL-1) to 2% of cropland and Conservation Tillage (SL-15) to 5% of cropland. This equates to an estimated 8 acres of the SL-1 practice and 20 acres of the SL-15 practice. Since the completion of the TMDL, there has been 36 acres of the SL-1 practice installed within the watershed; therefore, no additional SL-1 acreage are necessary to achieve the cropland bacteria load reductions and the practice is not included in Table 13.

It is estimated that the reduction in *E. coli* from upland pasture needed to meet the Stage 1 Objective can be achieved by: applying Reforestation of Erodible Pastureland to 1% of pastureland; applying Grazing Land Management to 66% of pasture the entire Elk Creek watershed; installing one Animal Waste Control Facility and one Heavy Use Protection Area; and by accounting for an estimated 4% of pastureland that will be converted to tree farms during the next 10 years. The distribution of these additional agricultural practices is listed in Table 13. Note that since the completion of the TMDL, 5 acres of the FR-1 practice (re-forestation of erodible crop and pastureland) have been installed and that this acreage has been subtracted from the acreage of FR-1 shown in Table 13.

Table 12. Stage 1 livestock stream exclusion practices for Elk Creek

Watershed Planning Unit	Estimated Stream Exclusion Fence Length Needed (miles)	Approximate # of VA Agricultural Cost-Share Livestock Exclusion Systems*			
		SL-6T/ CRSL-6 (60%)	LE-1T (20%)	LE-2T (10%)	WP-2/ CRWP-2 (10%)
Elk Creek	12.1	18	6	3	3

*Assumes one system includes 2,122 feet of livestock exclusion fencing, as based on recent fence length in livestock exclusion systems installed in Grayson County; the percentage in parentheses is the estimated proportion of systems out of 100% that would be installed based on practice popularity; the number of systems was derived by: dividing the length of fence needed per sub-watershed by 2122, multiplying by the percentage in parentheses, and rounding to nearest whole number.

Table 13: Stage 1 upland agricultural practices for Elk Creek

Watershed Planning Unit	Pasture (acres)	Cropland (acres)	Conservation Tillage [SL-15] (acres)	Pasture to Christmas Tree Farm Conversion (acres)*	Reforestation of Erodible Pastureland [FR-1] (acres)	Grazing Land Mgmt.[EQiP 528, SL-10] (acres)	Animal Waste Control Facility† [WP-4]	Heavy Use Protection Area‡ [NRCS 561]
Elk Creek	18,898	400	20	756	184	12,443	1	1

*The conversion of pasture land to Christmas tree farms is not a proposed practice for reducing *E .coli*, but instead reflects an ongoing change in land use that is occurring within the watershed and results in *E. coli* reductions since the land is no longer used as livestock pasture.
†assume 60 dairy/system; 40% of daily production transferred to storage
‡assume 90 beef/system; 20% of daily production transferred to storage

Practices for Achieving the Stage 1 Objective for Cripple Creek

It is estimated that about three-quarters of the *E. coli* from residential areas (other than straight pipes) comes from failing septic systems and about one-quarter comes from pets. The implementation actions for residential sources focus on straight pipes and failing septic systems because attendees at the workgroup meetings did not think that efforts to implement pet waste BMPs would be successful in this rural watershed.

The *E. coli* reductions from residential sources needed to meet the Stage 1 Objective can be achieved by: replacing 100% of the estimated number of straight pipes in the watershed with septic systems or alternative waste treatment systems; repairing or replacing approximately 62% of the failing septic systems in the upper-middle Cripple Creek sub-watershed; and repairing or replacing 54% of the failing systems in the lower Cripple Creek sub-watershed. The distribution of residential practices is listed in Tables 14 through 17 below.

Table 14. Stage 1 practices for straight pipes in the Upper-Middle Cripple Creek watershed

Watershed Planning Unit	Estimated Number of Straight Pipes	Replaced with	
		Conventional Septic System (80%)	Alternative Water Treatment System (20%)
Upper-Middle Cripple Creek	71	57	14

Table 15. Stage 1 practices for straight pipes in the Lower Cripple Creek watershed

Watershed Planning Unit	Estimated Number of Straight Pipes	Replaced with	
		Conventional Septic System (80%)	Alternative Water Treatment System (20%)
Lower Cripple Creek	45	36	9

Table 16. Stage 1 practices for failing septic systems in the Upper-Middle Cripple Creek watershed

Watershed Planning Unit	Estimated # of Failing Septic Systems	Estimated # of Failing Septic Systems to be Addressed	Septic System Repair (70%)	Replaced with	
				Conventional Septic System (20%)	Alternative Water Treatment System (10%)
Upper-Middle Cripple Creek	153	95	66	20	9

Table 17. Stage 1 practices for failing septic systems in the Lower Cripple Creek watershed

Watershed Planning Unit	Estimated # of Failing Septic Systems	Estimated # of Failing Septic Systems to be Addressed	Septic System Repair (70%)	Replaced with	
				Conventional Septic System (20%)	Alternative Water Treatment System (10%)
Lower Cripple Creek	95	51	36	10	5

Approximately 2133 houses in the Cripple Creek watershed have septic systems. Although septic pump-outs do not result in substantial bacteria reductions, they are a necessary maintenance practice and serve as a check on the functionality of a system. It is estimated that a minimum of 25% of these systems (i.e. 533 pump-outs arbitrarily divided equally among the two watersheds) will need to be pumped out during Stage 1.

It is estimated that the reduction in *E. coli* from direct deposition of manure into streams by livestock needed to meet the Stage 1 Objectives can be achieved through the installation of fencing systems that exclude livestock access to live streams and provide alternative sources of water. The total length of fence that would be needed is estimated to be 14.8 miles in the upper-middle Cripple Creek sub-watershed and 3.0 miles lower Cripple Creek sub-watershed. The fencing estimate is based on fencing both sides of perennial stream channels that flow through or adjacent to pasture. It is anticipated that SL-7 practices (extension of CREP livestock watering systems) may be needed to complement the installation of livestock exclusions systems. However, since the SL-7 practice does not directly reduce bacteria pollution, the estimated number of SL-7 systems and associated costs have not been provided. In Tables 18 and 19 the estimated number of livestock exclusion systems that would be needed to achieve the *E. coli* reductions from direct deposition of manure into streams and on stream banks is displayed. A cumulative amount of 4.6 miles of livestock exclusion fencing has been installed in the Cripple Creek watershed through the VACS program between January 1st, 2009 and Dec. 31st, 2013 (i.e. since the TMDL study). The amounts in Tables 18 and 19 are the fence length that remains after subtracting out the recent practices.

Table 18. Stage 1 livestock stream exclusion practices for the Upper-Middle Cripple Creek watershed

Watershed Planning Unit	Estimated Stream Exclusion Fence Length (miles)	Equivalent # of VA Agricultural DCR Cost-Share Livestock Exclusion Systems *			
		SL-6/ CRSL-6 (60%)	LE-1T (20%)	LE-2T (10%)	WP-2/ CRWP-2 (10%)
Upper-Middle Cripple Creek	14.8	35	12	6	6

Table 19. Stage 1 livestock stream exclusion practices for the Lower Cripple Creek watershed

Watershed Planning Unit	Estimated Stream Exclusion Fence Length (miles)	Equivalent # of VA Agricultural DCR Cost-Share Livestock Exclusion Systems *			
		SL-6/ CRSL-6 (60%)	LE-1T (20%)	LE-2T (10%)	WP-2/ CRWP-2 (10%)
Lower Cripple Creek	3.0	7	2	1	1

*Assumes one system includes 1,348 feet of livestock exclusion fencing, as based on recent fence length in livestock exclusion systems installed in Wythe County; the percentage in parentheses is the estimated proportion of systems out of 100% that would be installed based on practice popularity; For each sub-watershed, the number of systems was derived by: dividing the total length of fence by 1,348, multiplying by the percentages in parentheses, and rounding to nearest whole number.

It is estimated that the reduction in *E. coli* from cropland needed to meet the Stage 1 Objectives for Cripple Creek can be achieved by applying Permanent Vegetative Cover to 1% of cropland, Conservation Tillage to 5% of cropland, and Cover Crop to 6% of cropland in the Cripple Creek watershed as indicated in Tables 20 and 21 below.

The amounts listed in Table 20 below account for 8 acres of SL-1 completed since the TMDL in the Upper-Middle sub-watershed. Also, it was estimated that 204 acres of the SL-8B and SL-8H practice would be needed to help meet the cropland bacteria load reductions. Since the completion of the TMDL, there has been 1368 acres of the SL-8B and SL-8H practices installed within the watershed; therefore, no additional acreage of these two practices are necessary to achieve the cropland bacteria load reductions and the practice is not included in Table 20.

Table 20. Stage 1 cropland practices for the Upper-Middle Cripple Creek watershed

Impaired Segment	Sub-Watershed	Cropland (acres)	Permanent Vegetative Cover [SL-1] (acres)	Conservation Tillage [SL-15] (acres)
Cripple Creek, from Dry Run confluence downstream to Francis Mill Creek confluence	Upper-Middle Cripple Creek	3,444	27	169

The amounts listed in Table 21 below account for 5 acres of SL-1 completed since the TMDL in the Lower sub-watershed. Also, it was estimated that 127 acres of the SL-8B and SL-8H practice would be needed to help meet the cropland bacteria load reductions. Since the completion of the TMDL, there has been 1196 acres of the SL-8B and SL-8H practices installed within the watershed; therefore, no additional acreage of these two practices are necessary to achieve the cropland bacteria load reductions and the practice is not included in Table 21.

Table 21. Stage 1 cropland practices for the Lower Cripple Creek watershed

Impaired Segment	Sub-Watershed	Cropland (acres)	Permanent Vegetative Cover [SL-1] (acres)	Conservation Tillage [SL-15] (acres)
Cripple Creek, from Dean Branch confluence downstream to the mouth	Lower Cripple Creek	2,133	16	106

It is estimated that the reduction in *E. coli* from pasture lands needed to meet the Stage 1 Objectives for Cripple Creek can be achieved by: installing two Animal Waste Control Facilities and two Heavy Use Protection Areas; Reforestation of Erodible Pastureland, Field Borders, and Fescue Conversion to 4% of pastureland in the upper-middle Cripple Creek watershed and 3% of pastureland in the lower Cripple Creek watershed; and by applying Grazing Land Management to 85% of pasture in upper-middle Cripple Creek watershed and 65% of pasture in the lower Cripple Creek watershed. The distribution of these practices is listed in Tables 22 and 23 below. The amounts listed in Table 22 below account for 30 acres of FR-1 installed since the completion TMDL in the Upper-Middle sub-watershed. The amounts listed in Table 23 have been adjusted to account for 0.4 acres of WL-1 and 15 acres of WL-3 installed in the Lower Cripple Creek sub-watershed since the TMDL study was completed.

Table 22. Stage 1 upland agricultural practices for the Upper-Middle Cripple Creek Watershed

Watershed Planning Unit	Pasture (acres)	Reforestation of Erodible Pasture [FR-1] (acres)	Field Borders [WL-1] (acres)	Fescue Conversion [WL-3] (acres)	Grazing Land Mgmt. [EQiP 528, SL-10] (acres)	Animal Waste Control Facility* [WP-4]	Heavy Use Protection Area* (NRCS 561)
Upper-Middle Cripple Creek	20,416	366	25	396	16,580	1	1

Table 23. Stage 1 upland agricultural practices for the Lower Cripple Creek Watershed

Watershed Planning Unit	Pasture (acres)	Reforestation of Erodible Pasture [FR-1] (acres)	Field Borders [WL-1] (acres)	Fescue Conversion [WL-3] (acres)	Grazing Land Mgmt. [EQiP 528, SL-10] (acres)	Animal Waste Control Facility* [WP-4]	Heavy Use Protection Area* (NRCS 561
Lower Cripple Creek	10,574	154	10	139	6,655	1	1

* assume 60 dairy/system; 40% of daily production transferred to storage
** assume 90 beef/system; 20% of daily production transferred to storage

Stage1 Implementation Costs and Benefits

The estimated costs for achieving the Stage 1 Objectives for Cripple Creek and Elk Creek are listed in Tables 24, 25 and 26 below. The completion of this plan makes the watershed eligible for certain state and federal grants (i.e. through the Virginia Agricultural Cost-Share program and the federal Clean Water Act Section 319h grant program) to undertake collaborative efforts to implement actions within the plan. This plan will also serve as a valuable tool for sustaining funding for implementation efforts through a variety other federal, state, local, and private grant and loan programs. The section titled *Funding for Implementation* provides information on common sources of funding that stakeholders in Virginia utilize to implement residential and agricultural practices that improve surface water quality.

Table 24. Elk Creek Stage 1 BMP Costs

Best Management Practice	Unit	Estimated Cost per Unit	Units Needed	Total Cost
Residential Practices				
Septic System Pump-out (RB-1)	System	$275	370	$101,750
Septic System Repair (RB-3)	System	$3,500	29	$101,500
Septic System Replacement (RB-4, RB-4P)	System	$5,000	85	$425,000
Alternative Waste Treatment System (RB-5)	System	$15,000	25	$375,000
Total Cost of Residential Practices				**$1,003,250**
Agricultural Control Measures				
Grazing Land Mgmt. System (NRCS-EQiP 528, SL-9)	Acre	$75	12,443	$933,225
Livestock Exclusion System (SL-6T, CRSL-6)	System	$32,800	18	$590,400
Livestock Exclusion System (LE-1T)	System	$32,800	6	$196,800
Livestock Exclusion System (LE-2T)	System	$20,000	3	$60,000
Stream Protection System (WP-2)	System	$1,500	3	$4,500
Animal Waste Control Facility (WP-4)	System	$150,000	1	$150,000
Heavy Use Area Protection (NRCS 561)	System	$12,000	1	$12,000
Conservation Tillage (SL-15)	Acre	$20	20	$400
Reforestation of Erodible Pastureland (FR-1)	Acre	$82	184	$15,088
Total Cost of Agricultural Practices				**$1,962,413**

Table 25. Stage 1 BMP costs for the Upper-Middle Cripple Creek sub-watershed

Best Management Practice	Unit	Estimated Cost per Unit	Units Needed	Total Cost
Residential Control Measures				
Septic System Pump-out (RB-1)	System	$275	267	$73,425
Septic System Repair (RB-3)	System	$3,500	66	$231,000
Septic System Replacement (RB-4, RB-4P)	System	$5,000	77	$385,000
Alternative Waste Treatment System (RB-5)	System	$15,000	23	$345,000
Total Cost of Residential Practices				**$1,034,425**
Agricultural Control Measures				
Grazing Land Mgmt. System (NRCS-EQiP 528, SL-9)	Acre	$75	16,580	$1,234,500
Livestock Exclusion System (SL-6T, CRSL-6)	System	$32,800	35	$1,148,000
Livestock Exclusion System (LE-1T)	System	$32,800	12	$393,600
Livestock Exclusion System (LE-2T)	System	$20,000	6	$120,000
Stream Protection System (WP-2)	System	$1,500	6	$9,000
Animal Waste Control Facility (WP-4)	System	$150,000	1	$150,000
Heavy Use Area Protection (NRCS 561)	System	$12,000	1	$12,000
Conservation Tillage (SL-15)	Acre	$20	169	$3,380
Permanent Vegetative Cover on Cropland (SL-1)	Acre	$330	27	$8,910
Reforestation of Erodible Pastureland (FR-1)	Acre	$82	366	$30,012
Field Borders / Wildlife Option (WL-1)	Acre	$250	25	$6,250
Fescue Conversion / Wildlife Option (WL-3)	Acre	$350	396	$138,600
Total Cost of Agricultural Practices				**$3,254,252**

Table 26. Stage 1 BMP costs for the Lower Cripple Creek sub-watershed

Best Management Practice	Unit	Estimated Cost per Unit	Units Needed	Total Cost
Residential Control Measures				
Septic System Pump-out (RB-1)	System	$275	267	$73,425
Septic System Repair (RB-3)	System	$3,500	36	$126,000
Septic System Replacement (RB-4, RB-4P)	System	$5,000	46	$230,000
Alternative Waste Treatment System (RB-5)	System	$15,000	14	$210,000
Total Cost of Residential Practices				**$639,425**
Agricultural Control Measures				
Grazing Land Mgmt. System (NRCS-EQiP 528, SL-9)	Acre	$75	6,655	$499,125
Livestock Exclusion System (SL-6T, CRSL-6)	System	$32,800	7	$229,600
Livestock Exclusion System (LE-1T)	System	$32,800	2	$65,600
Livestock Exclusion System (LE-2T)	System	$20,000	1	$20,000
Stream Protection System (WP-2)	System	$1,500	1	$1,500
Animal Waste Control Facility (WP-4)	System	$150,000	1	$150,000
Heavy Use Area Protection (NRCS 561)	System	$12,000	1	$12,000
Conservation Tillage (SL-15)	Acre	$20	106	$2,120
Permanent Vegetative Cover on Cropland (SL-1)	Acre	$330	16	$5,280
Reforestation of Erodible Pastureland (FR-1)	Acre	$82	139	$11,398
Field Borders / Wildlife Option (WL-1)	Acre	$250	10	$2,500
Fescue Conversion / Wildlife Option (WL-3)	Acre	$350	154	$53,900
Total Cost of Agricultural Practices				**$1,053,023**

Technical and Administrative Assistance Costs to Implement Stage 1

The estimated cost of technical and administrative staff assistance needed for managing and implementing projects to install the identified practices was quantified based on 1.0 full-time equivalent (FTE) being equal to one forty-hour per week position. It is estimated that it would require $60,000 per year to support the salary, benefits, travel, and training expenses for 1.0 FTE. For Upper-Middle Cripple Creek, it is estimated that during each year of implementation, .75 FTE would be needed for implementing the agricultural BMP component and 0.25 FTE would be needed for implementing the residential BMP component. For Lower Cripple Creek, it is estimated that during each year of implementation, .25 FTE would be needed for implementing the agricultural BMP component and 0.25 FTE would be needed for implementing the residential BMP component. For Elk Creek, it is estimated that during each year of implementation, 0.75 FTE would be needed for implementing the agricultural BMP component and 0.25 FTE would be needed for implementing the residential BMP component.

Tables 27, 28, and 29 below display the estimated cost of staff assistance needed for achieving the Stage 1 Objectives for Cripple and Elk Creek.

Table 27. Estimated technical assistance costs for Stage 1 in Upper-Middle Cripple Creek

Watershed Planning Unit	Agricultural Component FTEs	Residential Component FTEs	Estimated Cost per FTE	Stage 1 Period (yrs)	Total Stage 1 Staff Cost
Upper-Middle Cripple Creek	0.75	0.25	$60,000/yr.	10	$600,000

Table 28. Estimated technical assistance costs for Stage 1 in Lower Cripple Creek

Watershed Planning Unit	Agricultural Component FTEs	Residential Component FTEs	Estimated Cost per FTE	Stage 1 Period (yrs)	Total Stage 1 Staff Cost
Lower Cripple Creek	0.25	0.25	$60,000/yr.	10	$300,000

Table 29. Estimated technical assistance costs for Stage 1 in Elk Creek

Watershed Planning Unit	Agricultural Component FTEs	Residential Component FTEs	Estimated Cost per FTE	Stage 1 Period (yrs)	Total Stage 1 Staff Cost
Elk Creek	0.75	0.25	$60,000/yr.	10	$600,000

Table 30 below displays the total estimated costs for achieving the Stage 1 Objectives for Cripple Creek and Elk Creek.

Table 30. Total Costs to Implement Stage 1 for the Cripple and Elk Creek Watersheds

Watershed Planning Unit	Agricultural BMPs	Residential BMPs	Technical Assistance	Total Cost
Upper-Middle Cripple Creek	**$3,254,252**	**$1,034,250**	**$600,000**	**$4,888,502**
Lower Cripple Creek	**$1,053,023**	**$639,425**	**$300,000**	**$1,992,448**
Elk Creek	**$1,962,413**	**$1,003,250**	**$600,000**	**$3,565,663**

The Benefits of Efforts to Improve Water Quality

Efforts to improve water quality in the Cripple and Elk Creek serve as a long-term investment in the natural resource "infrastructure" of these two watersheds. The conservation of natural resources in these watersheds helps to preserve a quality of life that is strongly valued and appreciated by the local communities.

The implementation of actions in this plan will benefit diverse sectors of the local economy including agriculture, forestry, tourism, recreation, construction, and real estate. **The primary water quality benefit of implementing this plan is a reduced risk illness or infection for people who have direct contact with water in Cripple Creek and Elk Creek.** Several complementary benefits to agricultural producers and residents in the local communities which are anticipated to occur as a result of plan implementation are highlighted below.

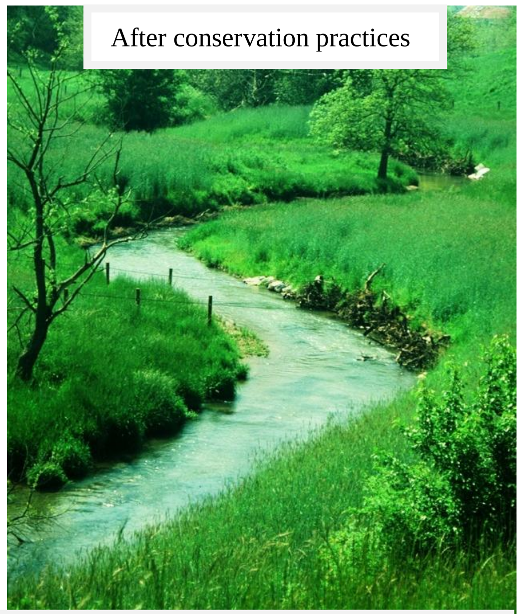
Benefits to Agricultural Communities

There are multiple reasons why agricultural producers implement practices that benefit water quality. Some want to see improved wildlife habitat and populations. For others, conservation practices result in greater farm income. But oftentimes, a primary reason that a farmer will implement conservation practices is because the farmer wants to invest in actions that will have longstanding benefits for his or her community. Cleaner water results in greater public appreciation of agricultural producers and support for further soil and water conservation efforts by farmers. For example, in some places, certification programs have been established to provide recognition for farm products that have been produced using particular practices that conserve soil, water, and wildlife. Through this type of certification value is added to farm products that can be marketed as being "sustainably grown" and/or produced using agricultural practices that are water quality or fish "friendly". This type of certification commands higher prices for products thereby offsetting the costs of implementing the additional practices and then some.

Stream water commonly serves as the primary or sole source of water for livestock on a farm. Livestock that are provided with an off-stream source of water have decreased exposure to waterborne disease, which has been shown to improve herd health. Improved herd health can result in lower veterinarian bills and higher weight gains. Beef producers in several Virginia counties have reported weight gains in cattle after providing alternative water sources. Studies also show increased milk and butterfat production from dairy cattle drinking from a clean and reliable source.

When livestock are given a choice between watering in a stream or an off-stream source (e.g. a trough serviced by a well and pump), they tend to use the off-stream source more than the stream. In this regard, simply providing an alternative source of water for livestock can result in significantly improved water quality because livestock will congregate less (and therefore defecate less in and near streams). A more intensive management approach is to implement a system for an entire farm tract that combines fencing to exclude livestock from streams, off-stream water, and improved pasture management. The strategic placement of off-stream water sources in upland areas can be highly effective in achieving a more even utilization of forage in pastures. This helps to mitigate the problem of over-utilization in forage near streams and under-utilization in upland areas distant from streams. When forage is over-utilized near streams, streamside areas not only lose their ability to filter water and trap sediment, nutrients, and bacteria from upland runoff, but the streamside area itself becomes a source of these pollutants.


Before conservation practices


After conservation practices

Photos courtesy of the Holston River Soil and Water Conservation District

Improved pasture management not only decreases fecal bacteria in pasture runoff, but can also allow a producer to feed less hay in winter months, increase stocking rates and consequently, improve the profitability of the operation. Standing forage utilized directly by the grazing animal is always less costly and can be of higher quality than the same forage harvested with equipment and fed to the animal. In addition to reducing forage costs to producers, intensive pasture management can boost profits by increasing the quality and amount of forage and productivity per acre.

Benefits to homeowners

Many practices that reduce fecal bacteria pollution in streams have complementary benefits. For example, management practices that promote vigorous native vegetation growth in streamside areas result in decreased streambank erosion. Decreased stream bank erosion reduces property loss and safety hazards. Preventing livestock from having uncontrolled access to stream banks is an excellent way to reduce erosion. Oftentimes, there is a connection between flooding and erosion. Streamside areas with dense, vigorous vegetation are able to better withstand the force of flood flows in streams. Also, it is well known that increased sediment supplies to streams (e.g. through soil erosion) can exceed the ability of the stream to transport the increased sediment load. This results in sediment accumulation on the stream bottom and a reduction in the capacity of the channel to hold water. When the capacity of a stream channel is reduced, the severity of flooding is increased because a given amount of flow that once filled the stream channel without overtopping the banks will consequently overtop the banks and potentially cause property damage. Although the effect on flooding by fencing livestock out of streams on a single farm tract is insignificant, when the majority of farms throughout a watershed participate in the same management practice, the cumulative effect on erosion, flooding, and flood damage can have a large cumulative benefit.

The actions for decreasing residential sources of fecal bacteria will also have economic benefits for homeowners. An improved understanding of private sewage systems (including knowledge of what steps can be taken to keep them functioning properly and the need for regular maintenance) will give homeowners the tools needed for extending the life of their systems and reducing the overall cost of ownership. The cost of proper maintenance is relatively inexpensive in comparison to repairing or replacing the entire system.

Benefits to aquatic life

The exclusion of livestock from stream channels for the purpose of decreasing fecal bacteria loads to streams also results in aquatic habitat improvement. The vegetated buffers that are established serve to decrease stream bank erosion, which reduces the amount of sand, silt, and clay in the stream bottom and helps the stream channel to become narrower and deeper. In addition, as trees and shrubs in vegetated buffers grow, they increase shading of the stream. This helps keep water temperature lower during the summer and allows for a greater amount of dissolved oxygen in the stream. A lower amount of fine sediment, improved water temperatures, and higher levels of oxygen lead to a substantial increase in the types and numbers of aquatic life, such as aquatic insects that live in the stream. Improving the health of aquatic life often results in improved fish populations, which leads to better fishing.

Stage 2 Water Quality Objectives

The Total Maximum Daily Load studies completed in 2009 for Cripple Creek and Elk Creek identified goals for reducing bacteria from the different land uses in the watersheds. The water quality endpoints of the TMDL studies were quantified as the *E. coli* bacteria loads that would result in a 0% violation rate of both the geometric mean (GM) and single sample maximum (SSM) water quality criteria for *E. coli* in the impaired segments of Cripple Creek and Elk Creek. Achieving the TMDL endpoints would result in water quality that is substantially better than meeting the Stage 1 Objectives described earlier because the Stage 1 Objective is to improve water quality to the minimum acceptable level as defined by the *E. coli* water quality standard. In order to maintain consistency with the TMDL studies, this water quality improvement plan includes Stage 2 Objectives, which represent the *E. coli* load reductions that could be expected through the implementation of management practices at the full extent of social, technical, and financial feasibility in the Cripple Creek and Elk Creek watersheds. Note: *The practices for meeting Stage 2 objectives are the quantities needed in addition to those previously listed for meeting the Stage 1 Objectives*.

Cripple Creek Stage 2 Objective: *To achieve the E. coli Total Maximum Daily Loads for the impaired segments of Cripple Creek to the greatest practicable extent by the year 2034.*

Elk Creek Stage 2 Objective: *To achieve the E. coli Total Maximum Daily Load established for the impaired segment of Elk Creek to the greatest practicable extent by the year 2034.*

Table 31. Scenarios for Meeting the Stage 2 Objective for Elk Creek

Impaired Segment	% Reductions in *E. coli* Loads					Modeled Violation Rates (%)	
	Straight Pipes	Septic Systems	Livestock-direct deposition	Upland Pasture	Cropland	GM Criteria	SSM Criteria
Elk Creek, from Comers Rock Branch confluence downstream to the mouth	100	65	80	80	5	0*	3.7*

*these are the modeled violation rates that would occur at the monitoring station located at the mouth of Elk Creek, the location where the TMDL has been established.

Table 32. Scenario for Meeting the Stage 2 Objective for Upper-Middle Cripple Creek

Impaired Segment	Watershed Planning Unit	% Reductions in *E. coli* Loads					Modeled Violation Rates (%)	
		Straight Pipes	Septic Systems	Livestock-direct deposition	Pasture	Cropland	GM Criteria	SSM Criteria
Cripple Creek, Dry Run confluence downstream to Francis Mill Creek confluence	Upper-Middle Cripple Creek	100	75	80	80	5	0	4.8

Table 33. Scenario for Meeting the Stage 2 Objective for Lower Cripple Creek

Impaired Segment	Watershed Planning Unit	% Reductions in *E. coli* Loads					Modeled Violation Rates (%)	
		Straight Pipes	Septic Systems	Livestock-direct deposition	Pasture	Cropland	GM Criteria	SSM Criteria
Cripple Creek, from Dean Branch confluence down to the mouth	Lower Cripple Creek	100	75	80	80	5	0	5.4

Practices for Achieving Stage 2 Water Quality Objectives in the Elk Creek Watershed

Additional *E. coli* reductions would be needed from residential lands beyond those needed during Stage 1 in order to achieve the Stage 2 Objective. Cumulatively, this would result in the correction of approximately 100% of the failing septic systems in the Elk Creek watershed, which is required by state regulations. Table 34 below displays the residential practices that would need to be completed in addition to the practices already listed during Stage 1. It is estimated that 50% of the 1480 septic systems (i.e. 740) will need to be pumped out during Stage 2.

Table 34. Stage 2 septic system practices for the Elk Creek watershed

Watershed Planning Unit	Estimated Number of Failing Septic Systems to be Addressed	Septic System Repair (70%)	Replaced with	
			Conventional Septic System (20%)	Alternative Waste Treatment System (10%)
Elk Creek	109	78	22	9

It is estimated that in order to achieve the Stage 2 Objective, 56.1 miles of stream exclusion fencing would need to be installed along perennial streams beyond the amount needed to meet the Stage 1 Objective for Elk Creek. Table 35 below displays the estimated number of livestock exclusion systems that would be needed in the Elk Creek watershed during Stage 2. Unlike Stage 1, the livestock exclusion systems for Stage 2 are heavily weighted towards the relatively inexpensive WP-2 practice in order to keep costs down.

Table 35. Stage 2 livestock exclusion practices for Elk Creek

Watershed Planning		Estimated Stream Exclusion Fence Length (miles)		# of VA Agriculture Cost-Share Livestock Exclusion Systems*		
			SL-6, CRSL-6, (10%)	LE-1T (5%)	LE-2T (5%)	WP-2, CRWP-2 (80%)
Elk Creek	Total	56.1	14	7	7	112

*Assumes one system includes 2,122 feet of livestock exclusion fencing, as based on recent fence length in livestock exclusion systems installed in Grayson County; the percentage in parentheses is the estimated proportion of systems out of 100% that would be installed based on practice popularity; the number of systems was derived by: dividing the length of fence needed per sub-watershed by 2,122, multiplying by the percentage in parentheses, and rounding to nearest whole number.

Table 36 below shows the agricultural practices that would be needed to meet the Stage 2 Objective for Elk Creek in addition to the practices that are needed to achieve the Stage 1 Objective. Modeling indicates that increasing the load reductions from other sources (i.e. septic systems, direct deposition, & cropland) beyond those reductions indicated in Table 36 will not result in the achievement of the Stage 2 objective because the vast majority of the bacteria load in the watershed is derived from pasture run-of. Meeting the Stage 2 Objective depends upon the ability to eliminate most of the bacteria load (i.e. 80%) coming from pasture. Furthermore, modeling indicates that the required level of bacteria reduction from pastures would not be fully achieved solely through improved pasture management. In order to attain the load reduction from pasture that is needed to achieve the Stage 2 objective, it would likely be necessary to construct a large number of retention ponds within pastures in order to capture pasture run-off and prevent bacteria from reaching streams by allowing the contaminated water to evaporate or be filtered through the soil.

Table 36. Stage 2 upland agricultural practices for Elk Creek

Impaired Segment	Sub-Watershed	Conversion of Pasture to Christmas Tree Farm† (acres)	Reforestation of Erodible Pastureland [FR-1] (acres)	Grazing Land Mgmt. [EQiP 528, SL-9] (acres)	Animal Waste Control Facility* [WP-4]	Heavy Use Protection Area** (NRCS 561	Retention Ponds [WP-1] (acres treated)
Elk Creek	Total	756	183	4,566	1	9	14,457

*assume 60 dairy/system; 40% of daily production transferred to storage
**assume 90 beef/system; 20% of daily production transferred to storage
†The conversion of pasture land to Christmas tree farms is not a proposed practice, but instead reflects the ongoing change in land use that has been occurring within the watershed. An estimated 4% of pastureland will be converted to tree farms during the Stage 2 time period.

Practices for Achieving Stage 2 Water Quality Objectives for Cripple Creek

Additional *E. coli* reductions from residential lands beyond the practices needed during Stage 1 are needed to achieve the Stage 2 Objectives. Cumulatively, this would result in the correction of approximately 100% of the failing septic systems in the Cripple Creek watershed. Tables 37 and 38 below display the residential practices that would be needed in addition to the practices already listed for Stage 1. It is also estimated that 50% of the 2133 septic systems (i.e. 1067) will need to be pumped out during Stage 2.

Table 37. Stage 2 septic system practices for Upper-Middle Cripple Creek

Watershed Planning Unit	Estimated #of Failing Septic Systems to be Addressed	Septic System Repair (70%)	Replaced with	
			Conventional Septic System (20%)	Alternative Waste Treatment System (10%)
Upper-Middle Cripple Creek	58	42	10	6

Table 38. Stage 2 septic system practices for Lower Cripple Creek

Watershed Planning Unit	Estimated #of Failing Septic Systems to be Addressed	Septic System Repair (70%)	Replaced with	
			Conventional Septic System (20%)	Alternative Waste Treatment System (10%)
Lower Cripple Creek	81	30	9	5

It is estimated that in order to achieve the Stage 2 Objective, 97 miles of stream exclusion fencing would need to be installed along perennial streams beyond the amount needed to meet the Stage 1 Objectives for Cripple Creek. Tables 39 and 40 below displays the estimated number of livestock exclusion systems that would be needed in the Cripple Creek watershed during Stage 2.

Table 39. Stage 2 livestock exclusion practices for Upper-Middle Cripple Creek

Watershed Planning Unit	Estimated Stream Exclusion Fence Length (miles)		# of VA Agriculture Cost-Share Livestock Exclusion Systems*		
		SL-6, CRSL-6, (10%)	LE-1T (5%)	LE-2 (5%)	WP-2, CRWP-2 (80%)
Upper-Middle Cripple Creek	72.3	28	14	14	227

Table 40. Stage 2 livestock exclusion practices for Lower Cripple Creek

Watershed Planning Unit	Estimated Stream Exclusion Fence Length (miles)	# of VA Agriculture Cost-Share Livestock Exclusion Systems*			
		SL-6, CRSL-6, (10%)	LE-1T (5%)	LE-2 (5%)	WP-2, CRWP-2 (80%)
Lower Cripple Creek	24.7	10	5	5	77

*Assumes one system includes 1,348 feet of livestock exclusion fencing, as based on recent fence length in livestock exclusion systems installed in Wythe County; the percentage in parentheses is the estimated proportion of systems out of 100% that would be installed based on practice popularity; the number of systems was derived by: dividing the length of fence needed per sub-watershed by 1,348, multiplying by the percentage in parentheses, and rounding to the nearest whole number.

Tables 41 and 42 below shows the agricultural practices that would be needed to meet the Stage 2 Objectives for Cripple Creek in addition to the practices that are needed to achieve the Stage 1 Objectives. As with Elk Creek, modeling indicates that increasing the load reductions from other sources (i.e. septic systems, direct deposition, & cropland) beyond those reductions indicated in Tables 41 and 42 will not result in the achievement of the Stage 2 objective because the vast majority of the bacteria load in the watershed is derived from pasture run-off. Meeting the Stage 2 Objective depends upon the ability to eliminate most of the bacteria load (i.e. 80%) coming from pasture. Furthermore, modeling indicates that the required level of bacteria reduction from pastures would not be fully achieved solely through improved pasture management. In order to attain the load reduction from pasture that is needed to achieve the Stage 2 objective, it would likely be necessary to construct a large number of retention ponds within pastures in order to capture pasture run-off and prevent bacteria from reaching streams by allowing the contaminated water to evaporate or be filtered through the soil.

Table 41. Stage 2 upland agricultural practices for Upper-Middle Cripple Creek

Watershed Planning Unit	Pasture (acres)	Reforestation of Erodible Pasture [FR-1] (acres)	Field Borders [WL-1] (acres)	Fescue Conversion [WL-3] (acres)	Grazing Land Mgmt. [EQiP 528, SL-10] (acres)	Animal Waste Control Facility* [WP-4]	Heavy Use Protection Area** (NRCS 561	Retention Ponds [WP-1] (acres treated)
Upper-Middle Cripple Creek	20,416	565	35	595	1,701	2	2	12,862

* assume 60 dairy/system; 40% of daily production transferred to storage

** assume 90 beef/system; 20% of daily production transferred to storage

Table 42. Stage 2 upland agricultural practices for Lower Cripple Creek

Watershed Planning Unit	Pasture (acres)	Reforestation of Erodible Pasture [FR-1] (acres)	Field Borders [WL-1] (acres)	Fescue Conversion [WL-3] (acres)	Grazing Land Mgmt. [EQiP 528, SL-10] (acres)	Animal Waste Control Facility* [WP-4]	Heavy Use Protection Area** (NRCS 561	Retention Ponds [WP-1] (acres treated)
Lower Cripple Creek	10,574	359	22	344	2,844	1	1	6,662

* assume 60 dairy/system; 40% of daily production transferred to storage

** assume 90 beef/system; 20% of daily production transferred to storage

Stage 2 Implementation Costs

Table 43: Stage 2 BMP Costs for Elk Creek

Best Management Practice	Unit	Estimated Cost per Unit	Units Needed	Total Cost
Residential Practices				
Septic System Pump-out (RB-1)	System	$275	370	$101,750
Septic System Repair (RB-3)	System	$3,500	78	$273,000
Septic System Replacement (RB-4, RB-4P)	System	$5,000	22	$110,000
Alternative Waste Treatment System (RB-5)	System	$15,000	9	$135,000
Total Cost of Residential Practices				**$619,750**
Agricultural Control Measures				
Grazing Land Mgmt. System (NRCS-EQiP 528, SL-10)	Acre	$75	4,566	$342,450
Livestock Exclusion System (SL-6T, CRSL-6)	System	$32,800	14	$459,200
Livestock Exclusion System (LE-1T)	System	$32,800	7	$229,699
Livestock Exclusion System (LE-2T)	System	$20,000	7	$140,000
Stream Protection System (WP-2)	System	$1,500	112	$168,000
Animal Waste Control Facility (WP-4)	System	$150,000	1	$150,000
Heavy Use Protection Area (NRCS 561)	System	$12,000	9	$108,000
Reforestation of Erodible Pastureland (FR-1)	Acre	$82	183	$15,006
Sediment Retention, Erosion, Or Water Control Structure (WP-1)	Acre-Treated	$138	14,457	$1,995,066
Total Cost of Agricultural Practices				**$3,607,421**

Table 44: Stage 2 BMP Costs for Upper-Middle Cripple Creek

Best Management Practice	Unit	Estimated Cost per Unit	Units Needed	Total Cost
Residential Practices				
Septic System Pump-out (RB-1)	System	$275	267	$73,425
Septic System Repair (RB-3)	System	$3,500	42	$147,000
Septic System Replacement (RB-4, RB-4P)	System	$5,000	10	$50,000
Alternative Waste Treatment System (RB-5)	System	$15,000	6	$90,000
Total Cost of Residential Practices				**$360,425**
Agricultural Control Measures				
Grazing Land Mgmt. System (NRCS-EQiP 528, SL-10)	Acre	$75	1,701	$127,575
Livestock Exclusion System (SL-6T, CRSL-6)	System	$32,800	28	$918,400
Livestock Exclusion System (LE-1T)	System	$32,800	14	$459,200
Livestock Exclusion System (LE-2T)	System	$20,000	14	$280,000
Stream Protection System (WP-2)	System	$1,500	227	$340,500
Animal Waste Control Facility (WP-4)	System	$150,000	2	$300,000
Heavy Use Protection Area (NRCS 561)	System	$12,000	2	$24,000
Reforestation of Erodible Pastureland (FR-1)	Acre	$82	565	$46,330
Sediment Retention, Erosion, Or Water Control Structure (WP-1)	Acre-Treated	$138	12,862	$1,774,956
Field Borders / Wildlife Option (WL-1)	Acre	$250	35	$8,750
Fescue Conversion / Wildlife Option (WL-3)	Acre	$350	595	$208,250
Total Cost of Agricultural Practices				**$4,487,961**

Table 45: Stage 2 BMP Costs for Lower Cripple Creek

Best Management Practice	Unit	Estimated Cost per Unit	Units Needed	Total Cost
Residential Practices				
Septic System Pump-out (RB-1)	System	$275	267	$73,425
Septic System Repair (RB-3)	System	$3,500	30	$105,000
Septic System Replacement (RB-4, RB-4P)	System	$5,000	9	$45,000
Alternative Waste Treatment System (RB-5)	System	$15,000	5	$75,000
Total Cost of Residential Practices				**$298,425**
Agricultural Control Measures				
Grazing Land Mgmt. System (NRCS-EQiP 528, SL-10)	Acre	$75	2,844	$213,000
Livestock Exclusion System (SL-6T, CRSL-6)	System	$32,800	10	$328,000
Livestock Exclusion System (LE-1T)	System	$32,800	5	$164,000
Livestock Exclusion System (LE-2T)	System	$20,000	5	$100,000
Stream Protection System (WP-2)	System	$1,500	77	$115,500
Animal Waste Control Facility (WP-4)	System	$150,000	1	$150,000
Heavy Use Protection Area (NRCS 561)	System	$12,000	1	$12,000
Reforestation of Erodible Pastureland (FR-1)	Acre	$82	359	$29,438
Sediment Retention, Erosion, Or Water Control Structure (WP-1)	Acre-Treated	$138	6,662	$919,356
Field Borders / Wildlife Option (WL-1)	Acre	$250	22	$5,500
Fescue Conversion / Wildlife Option (WL-3)	Acre	$350	344	$120,400
Total Cost of Agricultural Practices				**$2,157,194**

Tables 46, 47, and 48 below display the total estimated technical assistance costs of for achieving the Stage 2 Objectives for Cripple Creek and Elk Creek.

Table 46. Estimated Stage 2 technical assistance costs for Upper-Middle Cripple Creek

Watershed Planning Unit	Agricultural Component FTEs	Residential Component FTEs	Estimated Cost per FTE	Stage 2 Period (yrs)	Total Stage 1 Staff Cost
Upper-Middle Cripple Creek	2.0	0.25	$60,000/yr.	10	$1,350,000

Table 47. Estimated Stage 2 technical assistance costs for Lower Cripple Creek

Watershed Planning Unit	Agricultural Component FTEs	Residential Component FTEs	Estimated Cost per FTE	Stage 2 Period (yrs)	Total Stage 1 Staff Cost
Lower Cripple Creek	1.0	0.25	$60,000/yr.	10	$750,000

Table 48. Estimated Stage 2 technical assistance costs for Elk Creek

Watershed Planning Unit	Agricultural Component FTEs	Residential Component FTEs	Estimated Cost per FTE	Stage 2 Period (yrs)	Total Stage 1 Staff Cost
Elk Creek	1.0	0.25	$60,000/yr.	10	$750,000

Table 49 below displays the total estimated costs for achieving the Stage 2 Objectives for Cripple Creek and Elk Creek.

Table 49. Total costs to implement Stage 2 for the Cripple and Elk Creek watersheds

Watershed Planning Unit	Agricultural BMPs	Residential BMPs	Technical Assistance	Total Cost
Upper-Middle Cripple Creek	**$4,487,961**	**$360,425**	**1,350,000**	**$6,198,386**
Lower Cripple Creek	**$2,157,194**	**$298,425**	**$750,000**	**$3,205,619**
Elk Creek	**$3,607,421**	**$619,750**	**$750,000**	**$4,977,171**

Timeline and Milestones

Tables 50, 51, and 52 below display the BMP implementation milestones for the Cripple and Elk Creek watersheds. The information in these tables can be used to guide the planning of implementation projects and track progress towards meeting water quality improvement objectives.

Table 50. Elk Creek Implementation Milestones

Best Management Practice	Stage 1, Years 2014 - 2018	Stage 1, Years 2019 - 2023	Stage 2, Years 2024 - 2028	Stage 2, Years 2029-2033
Septic System Pump-out (RB-1)	185	185	185	185
Septic System Repair (RB-3)	14	15	39	39
Septic System Replacement (RB-4, RB-4P)	42	43	11	11
Alternative Waste Treatment System (RB-5)	12	13	5	4
Grazing Land Management System (NRCS-EQiP 528, SL-10)	6,222	6,221	2,283	2,283
Livestock Exclusion System (LE-1T)	3	3	4	3
Livestock Exclusion System (LE-2T)	1	2	4	3
Livestock Exclusion System (SL-6T, CRSL-6)	9	9	7	7
Stream Protection System (WP-2,CRWP-2)	1	2	56	56
Animal Waste Control Facility (WP-4)	1	0	1	0
Heavy Use Protection Area (NRCS 561)	1	0	5	4
Sediment Retention, Erosion, Or Water Control Structure (WP-1)	0	0	7,228	7,229
Conservation Tillage (SL-15)	20	0	0	0
Reforestation of Erodible Pastureland (FR-1)	92	92	92	91

Table 51. Upper-Middle Cripple Creek Implementation Milestones

Best Management Practice	Stage 1, Years 2014 - 2018	Stage 1, Years 2019 - 2023	Stage 2, Years 2024 - 2028	Stage 2, Years 2029-2033
Septic System Pump-out (RB-1)	134	133	134	133
Septic System Repair (RB-3)	33	33	21	21
Septic System Replacement (RB-4, RB-4P)	39	38	5	5
Alternative Waste Treatment System (RB-5)	12	11	3	3
Grazing Land Management System (NRCS-EQiP 528, SL-10)	8290	8290	851	850
Livestock Exclusion System (LE-1T)	6	6	7	7
Livestock Exclusion System (LE-2T)	3	3	7	7
Livestock Exclusion System (SL-6T, CRSL-6)	17	18	14	14
Stream Protection System (Livestock Exclusion) (WP-2, CRWP-2)	3	3	114	113
Animal Waste Control Facility (WP-4)	1	0	1	1
Heavy Use Protection Area (NRCS 561)	1	0	1	1
Sediment Retention, Erosion, Or Water Control Structure (WP-1)	0	0	6,431	6,431
Conservation Tillage (SL-15)	85	84	0	0
Permanent Vegetative Cover on Cropland (SL-1)	14	13	0	0
Reforestation of Erodible Pastureland FR-1)	183	183	283	282
Field Borders / Wildlife Option (WL-1)	13	12	18	17
Fescue Conversion / Wildlife Option (WL-3)	198	198	298	297

Table 52. Lower Cripple Creek Implementation Milestones

Best Management Practice	Stage 1, Years 2014 - 2018	Stage 1, Years 2019 - 2023	Stage 2, Years 2024 - 2028	Stage 2, Years 2029-2033
Septic System Pump-out (RB-1)	134	133	134	133
Septic System Repair (RB-3)	18	18	15	15
Septic System Replacement (RB-4, RB-4P)	23	23	5	4
Alternative Waste Treatment System (RB-5)	7	7	3	2
Grazing Land Management System (NRCS-EQiP 528, SL-10)	3,328	3,327	1,422	1,422
Livestock Exclusion System (LE-1T)	1	1	3	2
Livestock Exclusion System (LE-2T)	1	0	3	2
Livestock Exclusion System (SL-6T, CRSL-6)	7	0	5	5
Stream Protection System (WP-2,CRWP-2)	1	0	39	38
Animal Waste Control Facility (WP-4)	1	0	1	0
Heavy Use Protection Area (NRCS 561)	1	0	1	0
Sediment Retention, Erosion, Or Water Control Structure (WP-1)	0	0	3,331	3,331
Conservation Tillage (SL-15)	53	53	0	0
Permanent Vegetative Cover on Cropland (SL-1)	8	8	0	0
Reforestation of Erodible Pastureland (FR-1)	70	69	180	179
Field Borders / Wildlife Option (WL-1)	5	5	11	11
Fescue Conversion / Wildlife Option (WL-3)	77	77	172	172

Table 53 below displays the water quality milestones for the Cripple and Elk Creek watersheds. The information in these tables indicates the excepted water quality improvements in the impaired stream segments as a result of Stage 1 and 2 BMP implementation efforts. It is important to note that the TMDLs for the impaired segments of Cripple Creek and Elk Creek will not be fully attained at the end of Stage 2. However, based on stakeholder input, the Stage 2 endpoints (i.e. water quality criteria violation rates and associated *E. coli* load reductions) reflect the maximum practicable extent of BMP implementation that is technically, socially, and economically acceptable for stakeholders in these watersheds.

Table 53. Water Quality Milestones for Cripple and Elk Creek Watersheds

Impaired Stream Segment	Watershed Planning Unit	Existing Condition	End of Stage 1 Year 2024		End of Stage 2 Year 2034	
		% Violation of SSM *E. coli* Criteria	% Violation of GM *E. coli* Criteria	% Violation of SSM *E. coli* Criteria	% Violation of GM *E. coli* Criteria	% Violation of SSM *E. coli* Criteria
Cripple Creek, from Dry Run confluence to Francis Mill Creek confluence	Upper-Middle Cripple Creek	46%	0.0	10.4	0	4.8
Cripple Creek, from the Dean Branch confluence to the mouth	Lower Cripple Creek	25%	0.0	10.4	0	5.4
Elk Creek, from the confluence of Comers Rock Branch to the mouth	Elk Creek	27%*	0*	10.1*	0*	3.7*

*these are the existing & modeled violation rates for the monitoring station located at the mouth of Elk Creek, the location where the TMDL has been established. There are actually three segments of Elk Creek impaired by *E.coli*: the upper segment from Comers Rock Branch confluence downstream to Turkey Fork confluence (Segment ID:VAS-N05R_EKC03A02) has an existing SSM violation rate of 54%; the middle segment from Turkey Fork confluence downstream to the Knob Fork confluence (Segment ID:VAS_N05R-EKC02A00) has an existing SSM violation rate of 50-67%; as indicated in the table above, the lower segment from the Knob Fork confluence downstream to mouth (Segment ID: VAS_NO5R_EKC01A00) has an existing SSM violation rate of 27%, and the lower 4.3 milesof the Knob Fork have an existing SSM violation rate of 50%.

Monitoring

Monitoring can be used for four different purposes associated with water quality improvement efforts in the Cripple and Elk Creek watersheds. The first purpose is to verify the effectiveness of BMPs that have been installed. For example, Soil and Water District personnel perform annual spot checks on agricultural practices each year in order to ensure that they are being properly operated and maintained throughout their design lifespan. The second purpose is to refine implementation strategies. For example, *E. coli* levels can be monitored at the mouth of tributary streams in order to identify hotspots and priority areas for BMP implementation. The third purpose is to evaluate trends in E. coli levels relative to BMP implementation efforts. Periodic monitoring should occur in the mainstem of Cripple Creek and Elk Creek throughout BMP implementation efforts in order to evaluate the effectiveness of BMPs and implementation strategies at reducing *E. coli* levels. It is recommended that citizen monitoring groups take on the role of *E. coli* trend monitoring and assessment. The suggested monitoring regime is to sample *E. coli* at established DEQ monitoring stations four times a month, during at least one month per season, once out of every two years. Trend monitoring is not designed to assess violation of water quality standards; instead its purpose is to capture long term temporal variability in order to describe the direction and rate of change in water quality parameters.

The fourth purpose is to evaluate the *E. coli* impairment status in the impaired segments of Cripple and Elk Creek. This type of monitoring is conducted by the DEQ's ambient monitoring program at a network of fixed stations. The ambient monitoring data includes bacteria, physical parameters (dissolved oxygen, temperature, pH, and conductivity), nutrients and suspended solids. The general monitoring schedule includes sampling every month for one year followed by five years without monitoring. *E. coli* monitoring by DEQ in both Cripple and Elk Creek watersheds is provisionally scheduled to occur in 2018, 2024, 2028 and 2034 in order to align with the midpoints and endpoints of Stage 1 and Stage 2 in each watershed. Benthic macroinvertebrate monitoring will also occur in these watersheds but is not used to evaluate impairment by *E. coli*. The DEQ ambient monitoring stations and associated monitoring schedule are depicted in Table 54 below. For reference, the available *E. coli* monitoring data for the two watersheds has been provided in Appendix D.

Although there are no volunteer monitoring programs currently established in the Cripple or Elk Creek watersheds, residents have expressed interest in volunteer monitoring during workgroup discussions. It is recommended that local stakeholders establish a volunteer monitoring program in order to refine implementation strategies and evaluate trends. The National Committee for the New River is able to assist with the development and implementation of volunteer monitoring efforts in these watersheds.

Table 54. Projected *E. coli* monitoring in the impaired segments of Cripple Creek and Elk Creek during TMDL Implementation*

Watershed	Sub-watershed (Impaired Segment)	Station ID	Station Type	*Trend Monitoring (by Local Stakeholders)*	*Impairment Status* Monitoring (by DEQ)
Cripple Creek	Lower Cripple	9-CPL001.03	Ambient	Starting in 2015 and ending in 2033: sampling at least twice per month, during one or more months per season, during two or more seasons per year, every odd-numbered year at minimum	Sampling once per month for 12 consecutive months in years: 2018 2024 2028 2034
Cripple Creek	Upper-Middle Cripple	9-CPL018.47	Ambient		
Elk Creek	Lower Elk	9-EKC000.11	Ambient		
Elk Creek	Lower Elk	9-EKC010.47	Ambient		
Elk Creek	Middle Elk	9-EKC012.13	Ambient		
Elk Creek	Upper Elk	9-EKC017.51	Ambient		

*This is a list of the established stations for monitoring *E. coli* levels in the impaired stream segments with TMDLs that are addressed in this plan. There are additional monitoring stations on Cripple Creek that are not listed in this table.

Targeting Implementation Actions

Efforts to achieve water quality objectives will be more effective if they target resources to a particular sub-watershed until satisfactory improvements in water quality are achieved before resources are targeted to another sub-watershed. A lack of targeting usually results in a lack of ability to demonstrate measurable improvements in water quality since resources are spread too thinly across too broad of an area. On the other hand, targeting increases the ability to demonstrate measurable improvements in water quality. In this regard, having a successful record of planning, coordinating, and implementing an effort that has resulted in documented improvements in water quality facilitates the ability of watershed stakeholders to successfully compete for additional resources.

There are multiple ways that targeting can occur and each form of targeting requires the development of a specific implementation strategy. For example, a “low-hanging fruit” strategy seeks to concentrate resources where the challenges are relatively easy to overcome and the resources needed are minimal. This strategy is often successful where resources are scarce and there is a need to build substantial momentum (e.g. in landowner support) in order to resolve larger, long-term challenges. In contrast, the “big-bite” strategy targets resources towards the greatest pollution sources in an effort to achieve large cumulative reductions. This strategy is often successful pollution contributions are dominated by identifiable “hot-spots” in the watershed, there are a limited number of hotspots, a large amount of resources are initially available, and long-term resource availability is tenuous. A third strategy seeks to achieve the "biggest bang for the buck". For example, this type of strategy may focus efforts on drainages where the ratio of livestock excluded to miles of fence installed would be the greatest. This strategy is often successful where pollution sources are widespread within drainages, sources are relatively equal in their contributions, resources are scarce but steady, detailed land use information is available, and landowners are readily willing to participate. It should be anticipated that meeting water quality objectives will require the use of different strategies at different stages of an implementation effort due to shifts in factors such as funding, agency priorities, personnel, landowner interest, technology, information, etc.

However targeting is performed, the intent is to scale (spatially and temporally) the available resources to a watershed area at which the achievement of water quality objectives can be demonstrated as a result of implementing conservation practices. The following system presented below prioritizes Cripple and Elk Creek sub-watersheds for agricultural BMP implementation based upon a "biggest bang for the buck" approach. In this approach, sub-watersheds are prioritized for implementation based on the ratio of livestock to miles of stream exclusion fence needed on perennial streams within each sub-watershed. Since livestock are the greatest source of *E. coli* loads to streams in the two watersheds, the sub-watersheds in which the greatest number of livestock can be excluded from streams per mile of fencing should have higher priority for implementation efforts since each dollar spent in these sub-watersheds will likely result in a relatively greater bacteria load reductions. It is suggested that water quality improvements would be maximized if residential BMPs were targeted to the high priority agricultural sub-watersheds, although it is not as critical for residential BMPs to be scaled down to targeted sub-watersheds since these BMPs are more site specific and contribute relatively little to total E. coli loading. Although targeted implementation is important, as recommended by stakeholders, it will also be important to reserve some resources for implementing effective BMPs in other sub-watersheds as suitable opportunities arise.

Targeting BMP Implementation within the Elk Creek Watershed

The sub-watersheds below are ranked in descending order based on the animal numbers per fence length required. For reference, Figure 6 below displays the TMDL sub-watersheds mentioned in the ranking system.

1) The middle sub-watershed (i.e. TMDL sub-watersheds ELC06 through ELC09) in the vicinity of the locality of Elk Creek that includes the mainstem of Elk Creek from the Powder Mill Rd (Rt. 663) crossing downstream to the Turkey Fork confluence and all tributary drainages in between. This sub-watershed has the highest livestock to fencing ratio (up to 402 cows would be excluded from streams per mile of fence) and water quality monitoring since 2005 indicates that this section of Elk Creek has shown the highest average levels of *E. coli*.

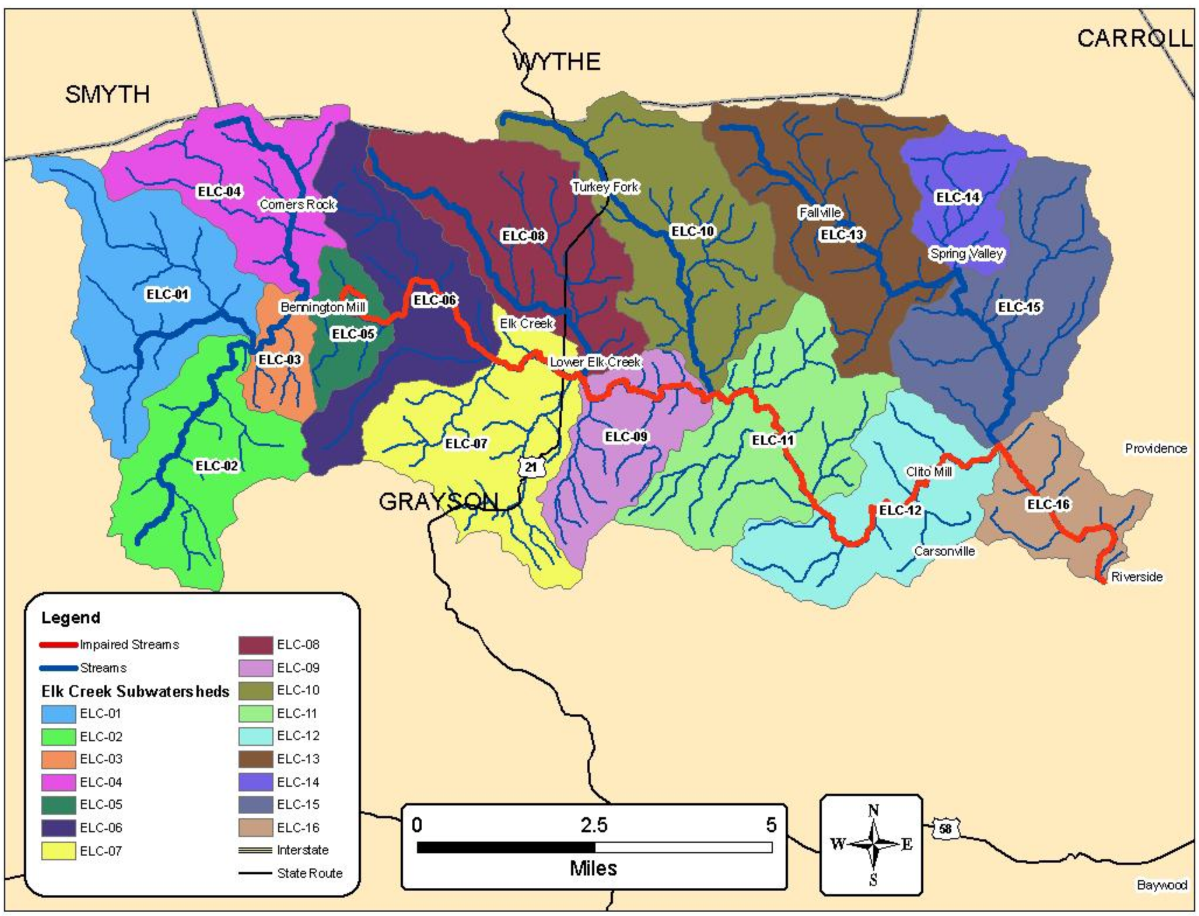
2) The entire upper sub-watershed (i.e. TMDL sub-watersheds ELC01 through ELC05) upstream of the Powder Mill Rd crossing. This sub-watershed has the second highest livestock to

fencing ratio (up to 309 cows would be excluded from streams per mile of fence) and water quality monitoring since 2005 indicates that this section of Elk Creek has shown the second highest average levels of *E. coli*.

3) The entire sub-watershed downstream of (and including) the Turkey Fork drainage (i.e. TMDL sub-watersheds ELC10 through ELC16). This sub-watershed has the third highest livestock to fencing ratio (up to 185 cows would be excluded from streams per mile of fence) and water quality monitoring since 2005 indicates that this section of Elk Creek has shown the third highest average levels of *E. coli*.

Additionally, watershed residents are interested in conducting *E. coli* monitoring and assessment work in Elk Creek tributaries while implementation efforts progress. This type of information can be used to further refine spatial targeting, e.g. to prioritize tributary drainages for BMP implementation within the priority sub-watershed.

Figure 6. Elk Creek sub-watersheds delineated during the 2009 TMDL study



Targeting BMP Implementation within the Cripple Creek Watershed

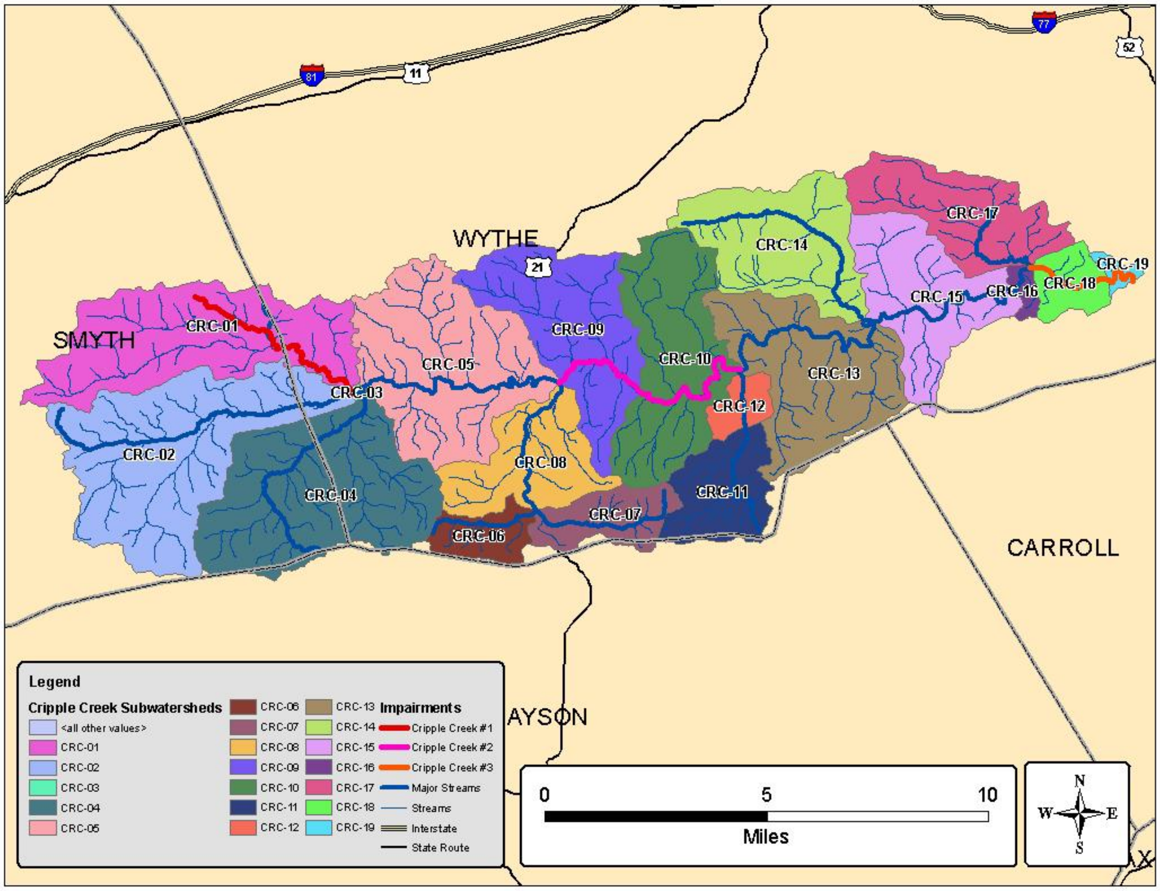
The sub-watersheds below are ranked in descending order based on the animal numbers per fence length required. For reference, Figure 7 below displays the TMDL sub-watersheds mentioned in the ranking system.

1) The middle Cripple Creek sub-watershed between the confluence of Crigger Creek and the confluence of Francis Mill Creek (i.e. TMDL sub-watersheds CRC05 through CRC10. This sub-watershed has the highest livestock to fencing ratio (up to 182 cows would be excluded from streams per mile of fence) and water quality monitoring since 2005 indicates that this section of Cripple Creek has the highest average levels of *E. coli*.

2) The lower Cripple Creek sub-watershed downstream of (and including) the Francis Mill Creek drainage to the mouth of Cripple Creek at the New River (i.e. TMDL sub-watersheds CRC11 through CRC19). This sub-watershed has the third highest livestock to fencing ratio (up to 177 cows would be excluded from streams per mile of fence) and water quality monitoring since 2005 indicates that this section of Elk Creek has the second highest average levels of *E. coli* (except for the Slate Spring Branch drainage which has shown very high levels of *E. coli* and perhaps should be targeted separately for BMP implementation)

3) The upper Cripple Creek sub-watershed upstream of (and including) the Crigger Creek drainage (i.e. TMDL sub-watersheds CRC01 through CRC04). This sub-watershed has the third highest livestock to fencing ratio (up to 107 cows would be excluded from streams per mile of fence) and water quality monitoring since 2005 indicates that this section of Cripple Creek has the lowest average levels of *E. coli*.

Figure 7. Cripple Creek sub-watersheds delineated during the 2009 TMDL study



Education and Outreach

Individual contact with watershed residents is crucial for facilitating water quality improvement efforts in these watersheds. Technical staff should conduct a number of outreach activities in the watershed to raise local awareness, encourage community support and participation in reaching the implementation plan milestones. For example, personnel from the Virginia Cooperative Extension Service and the Soil & Water Conservation Districts are able to participate in the development, coordination, and implementation of watershed education and outreach efforts. Conducting farm tours and field days can be an effective way for partners to communicate to local stakeholders about the benefits of participating in efforts to improve water quality. Outreach efforts activities can include information provided in newsletters, postcards, presentations at local civic group meetings, and perhaps even in church bulletins. Stakeholder groups can partner

During the development of this plan, one encouraging thing that arose out of the workgroup meetings is that residents of the Elk Creek watershed expressed interest in forming a watershed council under the existing structure of the New River Soil & Water Conservation District, in order to conduct education & outreach efforts, facilitate BMP implementation efforts, and perform volunteer monitoring.

The following organizations conduct water quality education and outreach activities in the Cripple and Elk creek watersheds that facilitate the improvement of BMP implementation.

Cripple Creek Watershed

- Big Walker Soil & Water Conservation District
- Evergreen Soil & Water Conservation District
- USDA Farm Service Agency
- USDA Natural Resource Conservation Service
- Virginia Cooperative Extension Service
- Virginia Department of Health
- National Committee for the New River
- New River Watershed Roundtable
- New River Land Trust

Elk Creek Watershed

- New River Soil & Water Conservation District
- USDA Farm Service Agency
- USDA Natural Resource Conservation Service
- Virginia Cooperative Extension Service
- Virginia Dept. of Health
- National Committee for the New River
- Grayson Landcare
- New River Land Trust

Stakeholders' Roles and Responsibilities

Listed below are the primary organizations that have water quality protection responsibilities in Virginia. Contact information for state and local organizations that participate in water quality protection activities can be found in Appendix E.

Environmental Protection Agency

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

Department of Environmental Quality

DEQ has responsibility for monitoring the waters to determine compliance with state standards and for requiring permitted point dischargers to maintain loads within permit limits. DEQ develops pollution budgets (i.e. Total Maximum Daily Loads, to TMDLs) which identify the amount of a given pollutant that can be present in a water body and still meet water quality standards designed to protect the designated uses of the water body. DEQ also has the lead role in the development of water quality improvement plans (i.e. TMDL implementation plans) to address non-point source pollutants such as bacteria from failing septic systems, pet waste, and livestock operations that contribute to water quality impairments. DEQ provides grant funding for the implementation of urban, residential, and agricultural practices that reduce non-point source pollutants addressed within water quality improvement plans. DEQ also regulates confined animal facilities and the land application of treated sewage sludge (commonly referred to as biosolids) through permits.

Department of Conservation and Recreation

DCR is a major participant in facilitating the TMDL implementation process. DCR administers the Virginia Agricultural Cost Share program which provides local Soil & Water Conservation Districts with funding to install agricultural BMPs.

Evergreen, Big Walker Soil and New River Soil & Water Conservation Districts

The New River, Evergreen, and Big Walker SWCDs provide outreach, technical and financial assistance to farmers and property owners in the Cripple and Elk Creek watersheds through the Virginia Agricultural BMP Cost-Share and Tax Credit programs. Their responsibilities will include promoting implementation goals, available funding and the benefits of BMPs and providing assistance in the survey, design, layout, and approval of agricultural BMPs. Education and outreach activities are also a significant portion of their responsibilities. In the Cripple Creek watershed, the Evergreen and Big Walker SWCDs will have lead responsibility for implementing agricultural practices. In the Elk Creek watershed, the New River SWCD will have lead responsibility for implementing agricultural and residential BMPs. The New River SWCD also has an interest in serving as an umbrella organization for a watershed group consisting of Elk Creek watershed residents. It is anticipated that this group will advise the SWCD on water quality protection efforts, help coordinate education & outreach activities, and facilitate the implementation of BMPs in the watershed.

Virginia Department of Agriculture and Consumer Services

Through Virginia's Agricultural Stewardship Act, the VDACS Commissioner of Agriculture investigates claims that an agricultural producer is causing a water quality problem on a case-by-case basis. If verified, the producer can be required to submit an agricultural stewardship plan to the local soil and water conservation district. The enforcement of the Agricultural Stewardship Act is entirely complaint-driven. This Act is a state regulatory tool that can support implementing conservation practices to address pollutant sources in TMDL impaired watersheds even though the Act does not specifically reference pathogens as a pollutant.

Virginia Department of Game and Inland Fisheries

The Landowner Incentives Program administered by DGIF provides technical and financial assistance for completing fish habitat restoration projects on private lands. The program can fund practices such as stream exclusion fencing in livestock pastures, which can result in sediment, nutrient, thermal, and bacteria pollution reductions.

Virginia Department of Health

VDH has responsibility for administering septic system regulations. VDH issues permits for the repair and installation of septic systems and the installation of alternative waste treatment systems. VDH also investigates complaints about violations of septic system regulations and has enforcement responsibilities. As grant funds become available to assist with residential BMP implementation, VDH will facilitate water quality improvement efforts by referring homeowners to partner organizations that can provide financial assistance for BMP installation.

Local Governments

The local governments in the affected watersheds are Smyth County, Wythe County, and Grayson County. These local governments have enormous potential for involvement in water quality improvement efforts. They can incorporate water quality improvement planning into their local comprehensive plans, they can develop incentives for watershed residents and businesses to implement practices that protect water quality, and they can develop ordinances as appropriate for preventing water pollution- such as requiring that future subdivisions be developed using practices that retain naturally vegetated stream buffers and minimize storm water runoff. Local governments can also perform water quality education and outreach activities. For example, they could promote septic system maintenance by handing out literature when individuals apply for a building permit or by implementing a septic maintenance reminder program.

Water Quality Programs and Activities

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, the New River Roundtable, water quality management plans, erosion and sediment control regulations, stormwater management, a source water protection program, and local comprehensive plans. The integration of TMDL implementation efforts into existing programs with water quality relevance and the ongoing coordination of among local stakeholders would likely to result in additional resources, increased participation, and therefore increased effectiveness. For example, applications from watersheds with established TMDLs are given additional priority when the Evergreen, Big Walker, and New River Soil and Water Conservation Districts (SWCDs) rank applications for implementing cost-shared agricultural practices. Along these lines, the effectiveness of efforts to improve water quality may be further enhanced by the designation of the Cripple and Elk Creek watersheds by the appropriate SWCD's as priority areas for implementing coordinated long-term efforts to improve water quality on agricultural lands. Likewise, it is recommended that local governments utilize the information within this plan to inform their comprehensive plans. For example, the information in this plan can be used to utilized by local governments to: identify approaches for facilitating water quality protection in ways that support economic vitality; develop or update local water quality protection policies; establish goals for addressing household wastewater issues within the affected watersheds; identify processes for local stakeholders to work collaboratively to address residential sources of *E. coli*; develop education and outreach efforts that align with the objectives of this plan; and develop incentives for individuals and businesses to implement practices that protect water quality.

Additional Water Quality Issues

During the Elk Creek workgroup meetings a number of watershed residents expressed concern about health risks associated with the use of pesticides on Christmas tree farms within the Elk Creek watershed. Additionally, segments of Elk Creek have recently been identified as having water quality impairment by excessive amounts of sand and silt in the stream bottom that degraded aquatic habitat and elevated summertime water temperatures that can be harmful to aquatic life. It is recommended that watershed stakeholders proceed towards the resolution of these concerns through the formation of a watershed council that is inclusive of all stakeholder interests. The formation of this council would provide a forum for stakeholders to work collaboratively to develop consensus-based approaches for resolving local concerns and challenges associated with not only water quality and human health, but also issues pertaining to things such as wildlife management, forest management, economic vitality, etc.

The following information is provided for informational purposes and is based on discussions about pesticide concerns in the Elk Creek watershed.

- In terms of regulating pesticides, Virginia is a "label state". All pesticides legal for use in VA are registered by EPA and must be used according to the pesticide label. Pesticides that are legal for use in VA and when used according to the application rates, methods, and restrictions stated on the individual pesticide label are considered to be safe. VDACS pesticide program does not have the authority to regulate pesticides beyond what is stated on the pesticide label. A producer has a legal right to use the pesticide on their property as long as it is used according to the label. If you have a concern that there has been a misuse, VDACS will investigate the incident; complaint investigations will become public information. For example, if the label states that care must be taken to prevent pesticide drift, and drift from a pesticide application was suspected, then VDACs would investigate the incident. James Atwell, is the VDACs pesticide investigator stationed in Wytheville and covers Grayson Co. and one can also contact Kevin Spurlin, the local VA agricultural extension service agent to report complaints.
- Resources available to address human exposure to pesticides include the National Pesticide Information Center in Oregon and a VA Tech website that has information about pesticides. A doctor should be consulted if someone is concerned that they have been exposed to an unsafe level of pesticides. VDACS has information about whether a specific pesticide is registered and what the label regulations are. Pesticide applicator certification records are public information and can be used to determine whether an applicator is applying pesticides without pesticide certification; the VDACS website has information regarding this issue. VDACS encourages concerned residents to talk to neighbors using pesticides and request notification when pesticide use is being planned. Pesticide applicators are not required to tell adjacent landowners what pesticides they are using and when, but residents can find out from their local extension service agent about what pesticides are generally used on local Christmas tree farms. The VA Dept. Health has toxicologists in the Richmond office that may be able to help address concerns about human exposure to pesticides. The contacts are: Khizam Washi and Dwight Flammia- phone 804-864-8182.
- If a pesticide issue is not directly related to a particular concern about a misuse (e.g. a general concern about surface or groundwater contamination), one can contact the DEQ groundwater program that addresses drinking water safety and/or the DEQ surface water programs that address the protection of surface drinking water supplies and the protection of aquatic life in streams & lakes. The regional DEQ office also has pollution response program that can be contacted if there is an incident such as a pesticide spill. One can also contact local government to explore if general concerns can be addressed through local ordinances, e.g. establishing a county ordinance requiring notification of pesticide applications. Since VA is a Commonwealth, there are governing boards to which that the public can present their concerns on a specific issue in order to seek changes to state regulations.
- The State of Virginia monitors and assesses whether or not pesticide and toxics meet water quality standards for drinking water and aquatic life in surface waters, but Elk Creek has not been included in the sampling for pesticides. A lab has to know which specific pesticides or toxics to test for. Since there are thousands of toxics and pesticides it is cost prohibitive to do

routine sampling for all chemicals in all streams. If a specific pesticide or toxic chemical is analyzed in a sample, there needs to be a water quality standard or benchmark to compare to determine if the chemical is at a safe level. Virginia does not have water quality standards for all pesticides. Instantaneous water samples are often not the best way to detect the presence of pesticides in streams, unless sampling is performed immediately after a pesticide has been used. Fish tissue samples, aquatic macroinvertebrates tissue samples, or passive sampling devices (e.g. samplers left in the water for 30 or more days) may be feasible ways to monitor for certain pesticides in streams; there are some standards for levels of toxics and pesticides in biological tissue.

- The Virginia Agricultural Stewardship Act (ASA) addresses specific incidents of water pollution from sediment, nutrient, or pesticide pollution coming from agricultural sources. VDACS investigates citizen complaints of agricultural pollution to determine if agricultural practices are resulting in violations of the ASA. The ASA is administered under the VDACS commissioner's office. If a violation is confirmed, then the producer must implement BMPs to mitigate the pollution problem. The Agricultural Stewardship Act contact is Greg Barts, 540-562-3646, gregory.barts@vdacs.virginia.gov
- In general, pesticides are not addressed by DEQ's Air Quality Program. Air program staff indicated that to address pesticide drift through air sampling one would have to know what chemical to look for and then look at material safety data sheets (MSDS) to determine if monitoring can be performed for the specific chemical. One would also need to determine if there is an applicable air quality standard for the specific chemical; many chemicals do not have standards. If air monitoring is feasible one would need to determine when and how to monitor.

Funding for Implementation

There are a variety of potential funding sources available to assist with implementation activities. The most commonly used funding sources for water quality improvement efforts in Virginia are listed below:

Federal

Environmental Protection Agency: Section 319(h) Grant Program (via VA DEQ)

Natural Resource Conservation Service: Conservation Reserve Program (CRP); Conservation Reserve Enhancement Program (CREP); Environmental Quality Incentives Program (EQiP); Wildlife Habitat Incentive Program (WHIP); Wetland Reserve Program (WRP)

U.S. Dept. of Housing and Urban Development: Community Development Block Grant Program

State

VA Dept. of Environmental Quality: Clean Water State Revolving Loan Fund; Section 319(h) Grant Program and Virginia Water Quality Improvement Fund

VA Dept. of Conservation & Recreation: Virginia Agricultural Best Management Practices Cost-Share Program; Virginia Agricultural Best Management Practices Tax Credit Program; Virginia Agricultural Best Management Practices Loan Program; Virginia Natural Resources Conservation Fund; Virginia Water Quality Improvement Fund; Virginia Small Business Environmental Compliance Assistance Fund Loan Program

Virginia Dept. of Game and Inland Fisheries: Landowner Incentives Program

Virginia Department of Forestry: Provides financial assistance to citizens and landowners to create rain gardens and riparian forest buffers on their property.

Private

Southeast Rural Community Assistance Project, Inc: Indoor Plumbing and Rehabilitation Program; Community Services Block Grant

National Fish and Wildlife Foundation: Hosts competitive, initiative-based grant programs that fund projects to maintain, protect, or restore fish and wildlife habitat which often have complementary water quality benefits.

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Appendix A. Fecal Bacteria Assessment History and Impairment Status

Table B1: Fecal Bacteria Assessment History and Impairment Status for the Cripple Creek Watershed†*

Stream	Description of Stream Segments for which Contact Recreation has been Assessed	Stream Segment Impaired by Fecal Bacteria?					
		2002	2004	2006	2008	2010	2012**
Cripple Creek	Headwaters downstream to Blue Spring Creek confluence	N/A	Y	Y	Y	N	N
Cripple Creek	Blue Spring Creek confluence downstream to Dry Run confluence	N/A	N	N	N	Y	Y
Cripple Creek	Dry Run confluence downstream to Francis Mill Creek confluence	N/A	Y	Y	Y	Y	Y
Cripple Creek	Francis Mill Creek confluence downstream to Dean Branch confluence	N/A	N	N	N	N	N
Cripple Creek	Dean Branch confluence downstream to the mouth	N/A	Y	Y	Y	Y	Y
Crigger Creek	Middle Creek confluence to the mouth	N/A	N/A	N	N	N	N/A
Dry Run	Confluence of East and West Forks downstream to Speedwell	N/A	N	N	N	N	N
Slate Spring Branch	Headwaters to mouth	N/A	Y	Y	Y	Y	Y
Dean Branch	Stream mile 1.7 downstream to the mouth (stream mile 0.0)	N/A	N/A	N/A	N/A	Y	Y

Table B2 Fecal Bacteria Assessment History and Impairment Status for the Elk Creek Watershed†*

Stream	Description of Stream Segments for which Contact Recreation has been Assessed	Stream Segment Impaired by Fecal Bacteria?					
		2002	2004	2006	2008	2010	2012**
Elk Creek	Comers Rock Branch confluence downstream to Turkey Fork confluence	N/A	N/A	Y	Y	Y	Y
Elk Creek	Turkey Fork confluence downstream to the Knob Fork confluence	Y	Y	Y	Y	Y	Y
Elk Creek	Knob Fork confluence downstream to mouth	Y	Y	Y	Y	Y	Y
Knob Fork	Near Spring Valley (stream mile 4.3) downstream to the mouth (stream mile 0.0)	N/A	N/A	Y	Y	Y	Y

†Prior to 2006, the impairment listings were based more broadly on fecal coliform bacteria levels, from 2006 onward impairment listings were based on *E. coli* bacteria, a specific type of fecal coliform bacteria
*N/A indicates that the segment was not assessed during a particular period of time
**2012 impairment listings are considered to be *draft* at the time this document was prepared (11/1/2013)

Appendix B. Workgroup Report

Elk Creek Watershed- Agricultural & Residential Workgroup Summary

Residential Source Sector Discussion

- The goal of the water quality improvement plan for Elk Creek is to meet water quality standards for *E. coli;* these standards correspond to the maximum risk of illness or infection that is considered to be acceptable by health professionals. The State of Virginia's has a two-part *E. coli* standard (a geometric mean not to exceed 126 colony forming units per 100mL and single sample maximum (SSM) not to exceed of 235cfu/100mL). Due to monitoring resource limitations, Virginia usually relies upon the SSM standard to assess E. coli levels. The specific level of risk varies according to the amount of bacteria in the water, which is influenced by land use and the environmental conditions on a given day or week.
- DEQ's mandate is to develop water quality improvement plans for pollutants that have official pollution budgets established. Pollution budgets are established for pollutants that have been found to exceed water quality standards. DEQ uses approved pollution budgets to develop water quality improvement plans that outline the types and amounts of actions needed to address a specific pollutant. This planning effort focuses on *E. coli* since it is the only pollutant in Elk Creek having an established pollution budget. DEQ staff can participate in an effort by stakeholders to develop a more holistic watershed-based plan that addresses multiple types of pollution.
- Addressing household wastewater issues should be a top priority for the plan.
- A number of residences are used as vacation homes, they may not know if a septic system is failing.
- Straight pipes are not as prevalent in Elk Creek as they are neighboring watersheds in Southwest Virginia. Straight pipe identification efforts would likely be more successful if led by a local, trusted stakeholder group.
- Efforts to address household wastewater would likely be more effective if it was done in a positive way rather than by encouraging residents to "turn in" their neighbors who have septic problems and punishing them through enforcement actions.
- One major challenge for addressing household wastewater is that Grayson County does not have its own Health Dept. (currently shared with Wythe County).
- In order for efforts to reduce residential sources of bacteria to be effective there needs to be a way to get landowners to have their systems checked or allow someone to check their system. VDH cannot go on anyone's property without permission. Once a failing septic system is identified, the landowner can submit a repair application to VDH, who will design an appropriate system and help coordinate the installation. However, there is currently a movement within VDH to shift the septic system design work from the public sector to private companies. VDH has begun to record the reason(s) that a system has failed (e.g.

soils, lack of maintenance, etc); this will allow quantification of the causes of system failures in the future and may facilitate water quality planning efforts.

- DEQ has cost-share money available for practices to fix straight pipes and failing septic systems. Once the Elk Creek water quality improvement plan is complete, the watershed will be eligible for stakeholders to seek grant funding from DEQ, available on a competitive basis, to do a project that implements residential practices in accordance with the plan.
- E. *coli* levels in the Knob Fork have a strong influence over the bacteria level at the mouth of Elk Creek and bacteria levels in the Knob Fork require a greater percent reduction than in the rest of the watershed. Residents are interested in focusing BMP implementation efforts in the Knob Fork drainage first, while additional monitoring is performed to identify other priority areas in the watershed for implementing practices. Nevertheless, assistance for completing practices in the rest of the watershed should be available for addressing opportunities that merit immediate attention. An emphasis on completing practices in the Knob Fork could be expressed in the water quality improvement plan, through the ranking system for practices during plan implementation, or both.
- Outreach/education efforts are needed to help people determine if their septic system is failing and be aware of the need for routine septic tank pump-outs. Newspapers, radio, farm supply store, community center, gas station, church bulletins, and key individuals in the community are potential ways to get the word out about septic system maintenance and repair.
- It would be beneficial for residents to participate in education and outreach efforts that support the implementation of practices that improve water quality. Residents can show support for the conservation district, which has completed many practices in the watershed and will continue to do so. Stakeholders can also choose to continue the steering committee after plan completion to serve as an advisory body that helps coordinate and guide water quality improvement efforts. Residents were interested in forming an Elk Creek watershed council under the umbrella of the New River Soil & Water Conservation District.

Agricultural Source Sector Discussion

- Many pastures in the watershed are overgrazed. There is a potential for relocation of feeding areas away from streams. Due to climate conditions, pasture runoff is frequent and it is unlikely that pasture run-off could be completely eliminated. However, bacteria in runoff could be substantially reduced through pasture management techniques that promote healthy soils and vegetation.
- Stream buffers: SL-6 and CREP are the popular exclusion practices; volunteer fencing is too expensive for farmers; cost-share for off-stream livestock watering systems increases participation in stream exclusion systems on pastureland.
- Many landowners in the watershed already use no-till cropping and cover crops.

- One farmer stated that it is not reasonable to expect all farmers to implement a given practice such as fencing off livestock from streams on their lands because all lands are not managed equally. Instead, BMPs should be installed where an evaluation has determined that a specific operation is contributing to elevated bacteria levels in a creek. This would avoid the inefficient/ineffective use of taxpayer money. Implementation efforts should focus on locations that have a greater relative contribution to bacteria levels. Water quality monitoring and site specific evaluations can be used to identify “hot-spots” and identify locations where BMPs would be more or less effective at reducing in-stream bacteria levels.
- Practices that have been completed in the watershed since the completion of the TMDL should be counted towards achieving the goals of the water quality improvement plan.
- Potential agricultural education and outreach approaches: SWCD could offer farm tours; ask highly respected community members to speak on water quality improvement practice that have been successful for them; post information in Independence Declaration, Galax Gazette newspaper articles.
- There was concern that it would not be feasible to install 35 foot stream buffers on many farms because it would exclude too much useable pasture.
- In general, the water quality plans do not prescribe bacteria load reductions from wildlife, since they are considered naturally occurring and these plans focus on controllable sources related to human activities; however, the plan could contain language stating that when wildlife numbers are above management objectives, residents should work with the Fish and Game Dept. to appropriately manage wildlife, e.g. through increasing hunting opportunities.
- The implementation of the agricultural practices in the water quality improvement plan is voluntary. The plan estimates what actions and practices are needed to meet water quality goals, but it’s up to the watershed residents to organize efforts to implement the plan. Since the completed plan will meet state and federal requirements, it allows stakeholders to pursue state and federal grant funding for projects that implement agricultural actions in accordance with the plan.
- Challenges to implementing the plan include developing collaborative efforts among partners and acquiring ongoing funding for staff and land use practices to do enough of the cumulative work required to meet water quality objectives. The plan estimates the actions and resources needed, but does not come with a guarantee that funding will be provided to complete all actions in the plan. State and federal funding for implementing water quality improvement plans is limited; therefore, stakeholder partnerships must propose a project based on the plan and compete against similar proposals in the state for the limited grant funding. Requests for project proposals are issued annually and selected projects typically have a two-year timeframe. This means that stakeholders who get an initial grant and complete a two year project need to apply for subsequent grants to continue the work.
- The key to successful implementation is the support of the communities in the affected watershed. Education and outreach events are crucial for explaining the need and purpose for accelerating the implementation of management practices and persuading folks to

participate in water quality protection practices. Achieving success often requires creative approaches.

Monitoring Discussion

- The general schedule for DEQ's ambient monitoring program is to collects samples monthly for one year, then no samples are collected for 5 years, then sampling occurs again in the 6th year. Elk Creek was last monitored in 2010, would be scheduled to reoccur in 2016 at the earliest.
- There is concern about the uncertainty associated with variability in *E. coli* levels in different times/places within the watershed; the available monitoring data is from only a handful of sites located on the mainstem of Elk Creek and two sites on the Knob Fork, rather than covering the tributaries as well. Residents are interested in citizen monitoring that would sample Elk Creek tributaries to better characterize sources of *E. coli*. Additional monitoring data could be used to better target BMPs to areas where *E*. *coli* contributions are relatively high.
- The National Committee for the New River expressed their support for citizen monitoring efforts and offered resources to assist with the implementation of a monitoring effort.
- DEQ has grant funding available to support citizen monitoring efforts.

Elk Creek- Government Workgroup Discussion Summary

Voluntary programs for BMP implementation

- **Conservation Reserve Enhancement Program (CREP)** – CREP is a state/federal partnership program (between NRCS, FSA, and SWCDs) that offers funding for a water source, pipeline to distribute water, water troughs, stream fencing for cattle operations, and stream buffer establishment. The program typically pays landowners 90-110% of the cost of installing BMPs. The CREP program is popular in Grayson County.
- **Environmental Quality Incentives Program (EQIP)** – Administered by NRCS, this is a flat-rate cost-per-practice component program rather than providing a cost-share percentage of practice. EQIP addresses forestry, animal waste, cropland, and stream fencing. Water quality protection is the main issue concern of for the EQIP program.
- **Virginia Agricultural Cost-Share (VACS) Program** – This is a state program administered by the SWCDs and DCR to assist farmers with implementing BMPs on an ongoing basis. A variety of agricultural practices in the Elk Creek watershed are eligible for cost-share. Districts utilize a ranking process for landowner applications to determine which projects to fund.
- **Agricultural & Residential TMDL Implementation Funding (319 grants)** –Clean Water Act Section 319 funds (federal funds from EPA, administered by DEQ) are made available to stakeholder groups in Virginia on a competitive basis for projects that will implement practices that address water quality impairments in accordance with an approved TMDL implementation plan.

- There is potentially funding for stream mitigation/flood mitigation projects through FEMA.

Regulatory Programs that help protect water quality:

- **Agricultural Stewardship Act** (ASA) – ASA is a complaint-driven law administered by VDACS which relies on either their own staff or SWCDs to investigate. The law addresses water quality issues caused by agricultural operations that are not addressed under DEQ's permitting programs. In cases where problems are verified, the producer is required to develop or have the SWCD develop an agricultural stewardship plan. Producers can apply for state and/or federal funds to assist in financing corrective actions. Civil penalties may be assessed if the producer refuses to develop/implement a plan.
- **Sewage Handling and Disposal Regulations** – VDH administers regulations to eliminate discharges from straight pipes and repair or replace failing septic systems. These regulations define gray water as sewage that needs to be treated. VDH has enforcement authority for these regulations. The State of Virginia Maintenance Code requires that a residence must be kept in a safe and habitable condition, and all plumbing fixtures be properly connected to either a public sewer system or an approved private sewage disposal system; all plumbing must be maintained in properly functioning condition, i.e. kept free from obstructions, leaks, and defects.
- **Grayson County Residential Regulations-** Any parcel that is developed within a subdivision must be checked for septic system suitability. Unless there is a health or safety issue with household wastewater, the regulation is tied to the age of the house, i.e. the regulations existing at the time the residence was built. There are no county regulations that require septic maintenance.

Agricultural Discussion Summary

- The CREP cost-share and incentive payment in conjunction with TMDL cost-share funding for stream exclusion fencing practices offered through DCR is an attractive option for producers.
- Livestock exclusion fencing is problematic where streams flow through narrow valley bottoms because the percentage of valley bottom that is excluded from grazing is much greater than in a wider valley.
- Providing an alternative water source to livestock and hardened stream crossings without fencing off streams can be effective at reducing fecal bacteria. It is possible that providing cost-share for alternative livestock water sources and hardened stream crossing could result in greater total E. coli load reductions in Elk Creek than livestock exclusion systems; although the bacteria load reduction efficiency per farm tract would be lower than if stream exclusion occurred, greater farmer participation rates could equate to a higher cumulative bacteria load reduction. The SWCDs currently cannot provide cost-share for stand-alone alternate water sources and hardened stream crossings without associated fencing. Alternate water sources can be funded as a stand-alone practice under EQiP, but the

practice would never rank high enough to be funded due to scoring criteria that gives precedence to more intensive practices.

- It was suggested that the VACS program should provide 100% cost-share on waste storage systems.
- Currently, the ability of the NRSWCD to work with landowners to implement BMP is limited by the level of staff time rather than BMP funding.

Residential Sector Discussion:

- If a residence is identified as having a sewage problem, VDH will investigate and follow-up with an appropriate course of action. Straight pipes are often found through citizen complaint, but often those complaints are addressing something else and a straight pipe is discovered during a residence inspection. Straight pipe estimates for Elk Creek are probably high if the estimates exclude grey water discharges. VDH provides guidance on correcting identified straight pipes.
- The TMDL IP should emphasize the need for resources to address residential sources of E. coli because some resources are already available to address agricultural sources.

Education & Outreach

- The NRSWCD indicated that not enough E&O is being conducted to address water quality related issues. The NRSWCD mainly focuses on education of kids, i.e. through their kids outdoors and Ag. in the classroom programs.
- The VCE conducts events such as the cattleman's meetings. These meetings are not generally a way to involve new people in conservation efforts as most attendees already participate in conservation activities. Often time rather than money is the limiting factor for conducting E&O.
- Media such as new articles, websites, e-copies and paper copies of newsletters, etc. are valuable E&O tools for communicating a general message to a wide audience, but one on one visits with landowners allow for relationship building and valuable personal conversations about conservation issues, approaches, methods.

Agency Roles

- The NRSWCD would be the lead on agricultural BMP implementation efforts. The NRSWCD would also be willing to lead residential BMP efforts in partnership with VDH.
- The NRSWCD could work with VCE to administer conservation education and outreach for an Elk Creek TMDL implementation effort.
- Grayson LandCare and the National Committee for the New River (NCNR) are two nonprofit organizations covering the Elk Creek watershed that could play a supportive role in TMDL

implementation efforts. The NCNR has worked with The Nature Conservancy and the NRSWCD to complete CREP practices in Grayson County.

Cripple Creek Watershed

Agricultural and Residential Workgroup Summary

Residential Source Sector

- Straight pipes, failing septic systems and direct deposition by livestock account for less than 2% of the total fecal bacteria load, but these sources have a strong influence over bacteria levels during low-flow periods because they directly enter the water on a continual basis. Pasture runoff accounts for most of the total load and has a stronger influence over bacteria levels during higher flows resulting from rain and snowmelt.
- The plan will provide estimates for the types, numbers, and costs of practices, such as replacement of straight pipes with septic systems, and that the plan can serve as a tool for a local stakeholder partnership to acquire grant funding to complete activities described in the plan. The partnership would then undertake education & outreach activities to generate interest and sign people up for installing practices.
- The Speedwell Elementary school is on a septic system that is fairly old, but is maintained on a regular basis. Wes Poole is a school district employee that would be the contact to inquire about the school wastewater system.

Agricultural Source Sector

- The Jefferson National Forest leases out some land to for grazing in the Cripple Creek watershed and all streams within leased areas already have stream exclusion fencing.
- These water quality improvement plans generally do not prescribe activities to reduce bacteria from wildlife because their contributions are considered to be part of natural background conditions while the plan needs to focus upon controllable human sources of bacteria.
- The exclusion of livestock from streams may not be economically feasible for some farmers. There was concern about farmers losing agricultural production land when they establish livestock exclusions systems. It was stated that the state and federal cost-share programs seek to install practices that benefit both the water resource and the farmer; oftentimes, improved agricultural practices result in greater rather than less profits for farmers. The Conservation Reserve Enhancement Program provides a rental payment for streamside areas that are fenced out.
- Conservation easements are a tool for helping to protect water quality. Under such an easement, landowners continue their current land use activities, but current and future landowners are restricted from certain things like subdividing the property under easement

in order to build additional buildings; landowners establish easements primarily because they want to prevent their land from being developed in the future. Any land use restrictions that are placed on the land are done so with the consent of the landowner.

- A barrier to farmer participation in implementing conservation practices to reduce bacteria is the perception among landowners that implementing cost-share practices or conservation easements results in the loss of property rights or eventual repayment for government funds to install practices.
- Establishing shrub & tree buffers without excluding livestock from streams is not as effective as fencing livestock out; establishing more dense vegetation along streams without installing fencing would reduce bacteria inputs from pasture run-off but direct deposition of manure into streams by livestock would still occur; the models indicate that reductions in direct deposition are need in order to meet water quality goals for fecal bacteria.
- It was mentioned that large amounts of chicken and/or turkey manure are spread on fields in the valley near the creek, outside of Speedwell (off St. Peters road?)
- There are opportunities in the watershed to install BMPs that reduce bacteria in runoff water from feedlots.
- Decreased hunting pressure and wildlife management efforts have resulted in increased wildlife populations. It was mentioned that increased hunting pressure and better wildlife management such as better feeding plot management could reduce E. *coli* loads from wildlife.

Education & Outreach

- There is a need to get watershed residents to talk more about agricultural and residential best management practices. Meeting notices in church bulletins might be effective at increasing meeting attendance. An article about the Cripple Creek plan development in the quarterly FSA newsletter would be worthwhile.

Monitoring

- It was noted that 100% of the recent samples from Slate Spring Creek exceeded water quality standards, with several values being very high. It was mentioned that much of the Slate Spring Creek drainage consists of forested public lands, but also that there are some farms in the lower portion of the drainage, and one attendee said that they knew of two locations with straight pipes.
- An attendee requested that DEQ expand their monitoring in Cripple Creek to sample for carcinogenic and toxic chemicals such as pesticides and dioxin in addition to E. coli because of the ongoing concern by residents about chemicals leaching from the old landfill.

Cripple Creek Government Workgroup Discussion Summary

Agricultural Sector

- NRCS staff noted that the PL566 Initiative recently ended (about 4 yrs ago) in the Cripple Creek watershed after beginning prior to 1990. This initiative provided 75% cost-share for the installation of livestock water systems, cropland BMPs, some tree planting and some livestock fencing (mostly cross-fencing). Patrick noted that because the BMPs were installed prior to the TMDL study, they were accounted for in the TMDL study. However, he noted that the PL566 initiative has probably contributed to the lower levels of fecal bacteria load reductions that are needed to meet water quality goals.
- The U.S. Forest Service's Raven Cliff recreation site is managed for wildlife and recreation and has a campground, public access to Cripple Creek for a couple miles, hiking trails, and a historic site. Some of the land is leased for livestock grazing and the NRCS collaborated with the USFS to install livestock fencing on the site in order to meet land management goals.
- The ESWCD, BWSWCD and NRCS indicated that there are a few dairy farms with some potential for installing new practices to reduce manure run-off. One dairy farmer has indicated that it's not feasible to implement no-till cropping practices on their farm. There is a need for at least 2 dairy waste storage systems and 2 beef waste storage systems in the watershed. There are at least a couple farmers who would likely install beef waste storage systems if financial assistance was readily available.
- The ESWCD, BWSWCD and NRCS indicated that cover crop practices have been successful in the Wythe County, while in Smyth County, after funds are allocated to SL-6 practices, there are usually no funds left for cover crop practices.
- The SWCDs and NRCS suggested that Agricultural BMP efforts should focus on winter feeding areas; oftentimes this occurs on flat areas near creeks.
- There is a need and good potential for improved pasture management involving cross-fencing in the Cripple Creek watershed.
- Without funding for additional staff, the SWCDs and NRCS cannot take on an additional workload in associated with implementing additional agricultural BMPs in the Cripple Creek watershed. In terms of funding for cost-share the NRCS and districts have enough money to keep busy working with farmers to install BMPs.
- VCE can get a budget for education and outreach if it is earmarked through the county.
- Suggested methods for communicating with the agricultural community include the FSA newsletter, the extension newsletter, and fliers posted at places like the Cripple Creek store or at the horse showground.
- NRCS and SWCDs would prefer a BMP implementation strategy that provides assistance to anyone in the watershed who is interested rather than a strategy that is targeted to sub-watersheds.

Residential Sector Discussion

- VCE recently completed a study of domestic well water quality in Wythe County. 25% of wells tested positive for E. coli.
- The Wythe County extension agent suggested that estimates for the number of failing septic systems (roughly 250) in the watershed may be too low. It seems like there is a large potential for addressing failing septic systems due to the proportion of houses in the watershed that were built prior to 1950, e.g. perhaps 1/3 of the houses may have never been issued a septic permit. The water quality improvement plan should place high priority on the need for resources to address straight pipes and failing septic systems.
- There is no sewer available in the watershed. A question arose as to whether the county would be interested in some sort of sewer extension project. Rural Retreat has the nearest wastewater treatment facility and it is in the process of expanding its capacity to meet TMDL requirements in the Reed Creek watershed.
- Assuming that funding was made available, the SWCD may be willing to lead the effort to implement a residential septic BMP program. The county might also be appropriate for taking on the lead role if they have the sufficient interest and resources.

Voluntary programs for BMP implementation

- **Conservation Reserve Enhancement Program (CREP)** –See description under Elk Creek Government Workgroup Summary.
- **Environmental Quality Incentives Program (EQIP)** – See description under Elk Creek Government Workgroup Summary.
- **Virginia Agricultural Cost-Share Program** – See description under Elk Creek Government Workgroup Summary.
- **Agricultural & Residential TMDL Implementation Funding** – See description under Elk Creek Government Workgroup Summary.

Regulatory programs that help protect water quality

- **Agricultural Stewardship Act** (ASA) – See description under Elk Creek Government Workgroup Summary.
- **Sewage Handling and Disposal Regulations** – See description under Elk Creek Government Workgroup Summary.

Appendix C: Bacterial Source Tracking Data

Bacteria source tracing results shown in the tables below indicate that wildlife, human, livestock and pets contribute to the *E. coli* levels in Cripple Creek and Elk Creek.

Table 2.3. Presence/absence analysis of bacteria sources at station 9-CPL001.03 in Cripple Creek watershed.

Bacteria Source	Frequency of Presence in All Samples[1] (%)	Frequency of Presence in Samples Exceeding Water Quality Standards[2] (%)
Wildlife	50	100
Human	50	100
Livestock	67	50
Pet	50	50

1 – This is a measure of the number of times the source is present in all 11 samples.

2 – This is a measure of the number of times (i.e., two) the source was present in samples that exceeded the *E. coli* instantaneous standard.

Table 2.2. Presence/absence analysis of bacteria sources at station 9-EKC000.11 in Elk Creek watershed.

Bacteria Source	Frequency of Presence in All Samples[1] (%)	Frequency of Presence in Samples Exceeding Water Quality Standards[2] (%)
Wildlife	58	100
Human	42	50
Livestock	25	0
Pet	17	0

1 – This is a measure of the number of times the source is present in all 12 samples.

2 – This is a measure of the number of times (i.e., two) the source was present in samples that exceeded the *E. coli* instantaneous standard.

Appendix D. Fecal Bacteria Monitoring Data 2000-2013

Note: These results do not include all available DEQ data for the Cripple and Elk Creek watersheds. Monitoring has occurred for additional parameters at the stations listed below and there is likely data for additional stations not listed below.

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Crigger Creek	@ Chestnut Ridge, bridge #6045 Rt 671	9-CGG000.35	28-May-03	13.1	7.49	9.72	114	Fecal Coliform, MF	100
Crigger Creek	@ Chestnut Ridge, bridge #6045 Rt 671	9-CGG000.35	26-Mar-03	9.79	7.41	10.75	75	Fecal Coliform, MF	100
Crigger Creek	@ Chestnut Ridge, bridge #6045 Rt 671	9-CGG000.35	13-Jan-03					Fecal Coliform, MF	100
Crigger Creek	@ Chestnut Ridge, bridge #6045 Rt 671	9-CGG000.35	25-Nov-02	8.09	7.07	11.04	75	Fecal Coliform, MF	100
Crigger Creek	@ Chestnut Ridge, bridge #6045 Rt 671	9-CGG000.35	18-Sep-02	18	7.45	8.03	238	Fecal Coliform, MF	300
Crigger Creek	@ Chestnut Ridge, bridge #6045 Rt 671	9-CGG000.35	30-Jul-02	19.74	7.82	8.47	234	Fecal Coliform, MF	300
Crigger Creek	@ Chestnut Ridge, bridge #6045 Rt 671	9-CGG000.35	22-May-02	11.25	7.86	10.89	123	Fecal Coliform, MF	100
Crigger Creek	@ Chestnut Ridge, bridge #6045 Rt 671	9-CGG000.35	28-Mar-02	6.35	7.5	11.08	92	Fecal Coliform, MF	100
Crigger Creek	@ Chestnut Ridge, bridge #6045 Rt 671	9-CGG000.35	7-Jan-02	2.9	7.55	12.67	177	Fecal Coliform, MF	100
Crigger Creek	@ Chestnut Ridge, bridge #6045 Rt 671	9-CGG000.35	29-Nov-01	12.54	7.65	9.33	205	Fecal Coliform, MF	100
Crigger Creek	@ Chestnut Ridge, bridge #6045 Rt 671	9-CGG000.35	24-Sep-01	15.5	7.44	7.78	226	Fecal Coliform, MF	200
Crigger Creek	@ Chestnut Ridge, bridge #6045 Rt 671	9-CGG000.35	12-Jul-01	15.2	7.09	8.94	114	Fecal Coliform, MF	400
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	24-Sep-07	18.6	8.2		272	E. COLI - MTEC-MF N0/100ML	108
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	20-Aug-07	22	8.3		269	E. COLI - MTEC-MF N0/100ML	1000
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	24-Jul-07	17.2	8.1		263	E. COLI - MTEC-MF N0/100ML	310
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	18-Jun-07	19.7	8.1		273	E. COLI - MTEC-MF N0/100ML	110
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	23-May-07	18.2	8.1		179	E. COLI - MTEC-MF N0/100ML	150
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	24-Apr-07	14.8	8.1	11	195	E. COLI - MTEC-MF N0/100ML	104
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	28-Mar-07	16.1	8.3	10.3	235	E. COLI - MTEC-MF N0/100ML	76
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	6-Feb-07	0	8	13.2	252	E. COLI - MTEC-MF N0/100ML	200

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	28-May-03	15.6	8.22	9.8	239	Fecal Coliform, MF	200
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	26-Mar-03	12	8.42	10.84	223	Fecal Coliform, MF	100
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	13-Jan-03					Fecal Coliform, MF	100
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	25-Nov-02	7.69	7.94	11.78	218	Fecal Coliform, MF	100
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	18-Sep-02	20.9	7.9	8.6	281	Fecal Coliform, MF	4000
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	30-Jul-02	25.01	8.14	7.81	268	Fecal Coliform, MF	400
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	22-May-02	14.01	8.34	10.61	243	Fecal Coliform, MF	400
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	28-Mar-02	8.22	8.15	11.05	193	Fecal Coliform, MF	100
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	7-Jan-02	1.46	7.73	13.04	211	Fecal Coliform, MF	100
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	29-Nov-01	12.07	8.16	11.33	240	Fecal Coliform, MF	100
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	24-Sep-01	17.6	8.11	9.82	256	Fecal Coliform, MF	800
Cripple Creek	near Ivanhoe ford off Rt 639 off Rt 94	9-CPL001.03	12-Jul-01	19.9	8.13	9.08	236	Fecal Coliform, MF	100
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	28-Jan-08	4.6	8	14.5	231	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	18-Dec-07	2.7	8.5		271	E. COLI - MTEC-MF N0/100ML	50
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	27-Nov-07	9.9	8.6	11.5	252	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	23-Oct-07	15.2	8.2	9.5	263	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	24-Sep-07	20	8.5		266	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	20-Aug-07	24.1	8.5		258	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	24-Jul-07	17.2	8.3		250	E. COLI - MTEC-MF N0/100ML	300
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	18-Jun-07	22.2	8.5		263	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	23-May-07	19	8.4		253	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	24-Apr-07	15.1	8.3	10.9	188	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	13-Mar-07	9.6	8.3	11.4	225	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	6-Feb-07	0.3	8	14.3	237	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	28-May-03	16.3	8.42	9.55	230	Fecal Coliform, MF	100
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	26-Mar-03	12.04	8.48	10.88	214	Fecal Coliform, MF	100
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	13-Jan-03					Fecal Coliform, MF	100

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	25-Nov-02	7.97	8.02	11.67	211	Fecal Coliform, MF	100
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	18-Sep-02	21.1	8.18	9.69	271	Fecal Coliform, MF	200
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	30-Jul-02	25.47	8.42	8.59	258	Fecal Coliform, MF	100
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	22-May-02	15.29	8.42	10.41	236	Fecal Coliform, MF	100
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	28-Mar-02	8.53	8.33	11.19	186	Fecal Coliform, MF	100
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	7-Jan-02	1.43	8.05	13.8	194	Fecal Coliform, MF	100
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	29-Nov-01	12.27	8.27	11.79	235	Fecal Coliform, MF	200
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	24-Sep-01	17.9	8.33	9.95	248	Fecal Coliform, MF	400
Cripple Creek	@ Pierce Mill, Rt 641 off Rt 94	9-CPL002.82	12-Jul-01	21.2	8.76	9.66	229	Fecal Coliform, MF	300
Cripple Creek	@ Rt. 94 bridge, 2mi. NW of Ivanhoe	9-CPL003.10	7-Feb-01	2.88	8.09	13.72	240	Fecal Coliform, MF	100
Cripple Creek	@ Rt. 94 bridge, 2mi. NW of Ivanhoe	9-CPL003.10	13-Dec-00	0.9	8.04	13.7	270	Fecal Coliform, MF	200
Cripple Creek	@ Rt. 94 bridge, 2mi. NW of Ivanhoe	9-CPL003.10	19-Oct-00	11.2	7.93	10.25	230	Fecal Coliform, MF	100
Cripple Creek	@ Rt. 94 bridge, 2mi. NW of Ivanhoe	9-CPL003.10	14-Aug-00	18.7	8.2	9.47	257	Fecal Coliform, MF	100
Cripple Creek	@ Rt. 94 bridge, 2mi. NW of Ivanhoe	9-CPL003.10	13-Jun-00	22.5	7.95	8.73	252	Fecal Coliform, MF	100
Cripple Creek	@ Rt. 94 bridge, 2mi. NW of Ivanhoe	9-CPL003.10	6-Apr-00	9.5	7.75	10.84	98	Fecal Coliform, MF	400
Cripple Creek	@ Rt. 94 bridge, 2mi. NW of Ivanhoe	9-CPL003.10	16-Feb-00	6.9	7.77	11.4	91	Fecal Coliform, MF	100
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	28-Jan-08	3.6	8.1	14.4	219	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	18-Dec-07	1	8.3		261	E. COLI - MTEC-MF N0/100ML	120
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	27-Nov-07	9.8	7.8	11.2	248	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	23-Oct-07	14.2	7.8	9	258	E. COLI - MTEC-MF N0/100ML	50
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	24-Sep-07	19.5	8.3		264	E. COLI - MTEC-MF N0/100ML	75
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	20-Aug-07	23.5	8.3		259	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	24-Jul-07	17.5	8.2		257	E. COLI - MTEC-MF N0/100ML	180
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	18-Jun-07	20	8.2		261	E. COLI - MTEC-MF N0/100ML	50
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	23-May-07	18.5	8.2		253	E. COLI - MTEC-MF N0/100ML	75
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	24-Apr-07	14.3	7.9	10.6	184	E. COLI - MTEC-MF N0/100ML	380

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	13-Mar-07	8.2	7.8	11.6	218	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	28-May-03	15.1	7.93	7.28	226	Fecal Coliform, MF	200
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	26-Mar-03	11.79	8.43	11.11	210	Fecal Coliform, MF	100
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	13-Jan-03					Fecal Coliform, MF	100
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	25-Nov-02	7.05	7.83	11.81	203	Fecal Coliform, MF	100
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	18-Sep-02	21.1	8	8.81	261	Fecal Coliform, MF	100
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	30-Jul-02	25.81	8.24	7.86	260	Fecal Coliform, MF	200
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	22-May-02	12.5	8.3	10.7	232	Fecal Coliform, MF	100
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	28-Mar-02	7.3	8.21	11.41	181	Fecal Coliform, MF	100
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	7-Jan-02	0.1	7.93	13.44	198	Fecal Coliform, MF	100
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	29-Nov-01	11.73	8.17	10.98	233	Fecal Coliform, MF	100
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	24-Sep-01	17.9	8.18	9.17	250	Fecal Coliform, MF	300
Cripple Creek	@ Eagle Furnace Rt 642 off Rt 619	9-CPL008.68	12-Jul-01	19	8.07	9.08	221	Fecal Coliform, MF	100
Cripple Creek	South of Eagle Furnace	9-CPL009.78	25-Apr-05	7.76	8.55	12.06	213	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C	120
Cripple Creek	South of Eagle Furnace	9-CPL009.78	25-Apr-05	7.76	8.55	12.06	213	E. COLI - MTEC-MF N0/100ML	210
Cripple Creek	Rt 619 dnstrm Penn Branch confluence	9-CPL012.73	11-Apr-06	11.8	8.6	11	154.4	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C	75
Cripple Creek	Rt 619 dnstrm Penn Branch confluence	9-CPL012.73	11-Apr-06	11.8	8.6	11	154.4	E. COLI - MTEC-MF N0/100ML	70
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	28-Jan-08	6.5	8.5	14.3	211	E. COLI - MTEC-MF N0/100ML	200
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	18-Dec-07	2.2	8.3		238	E. COLI - MTEC-MF N0/100ML	100
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	27-Nov-07	9.3	7.8	11.5	236	E. COLI - MTEC-MF N0/100ML	220
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	23-Oct-07	14.8	7.7	8.9	245	E. COLI - MTEC-MF N0/100ML	420
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	24-Sep-07	18.1	8.2		250	E. COLI - MTEC-MF N0/100ML	380
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	20-Aug-07	21	8.2		246	E. COLI - MTEC-MF N0/100ML	75
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	24-Jul-07	16.3	8.1		251	E. COLI - MTEC-MF N0/100ML	800

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	18-Jun-07	18.6	8.2		249	E. COLI - MTEC-MF N0/100ML	320
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	23-May-07	17	8.1		242	E. COLI - MTEC-MF N0/100ML	380
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	24-Apr-07	12.8	8	11.2	178	E. COLI - MTEC-MF N0/100ML	200
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	13-Mar-07	8.4	7.8	11.1	211	E. COLI - MTEC-MF N0/100ML	120
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	28-May-03	14.5	8.19	10.34	222	Fecal Coliform, MF	100
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	26-Mar-03	10.72	8.41	11.81	204	Fecal Coliform, MF	100
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	13-Jan-03					Fecal Coliform, MF	100
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	25-Nov-02	8.28	7.89	11.91	196	Fecal Coliform, MF	100
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	18-Sep-02	19.5	7.89	8.89	253	Fecal Coliform, MF	500
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	30-Jul-02	23.7	8.23	8.44	248	Fecal Coliform, MF	200
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	22-May-02	13.16	8.27	10.61	225	Fecal Coliform, MF	100
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	28-Mar-02	7.38	8.07	11.24	191	Fecal Coliform, MF	100
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	7-Jan-02	1.77	8.01	13.28	192	Fecal Coliform, MF	100
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	29-Nov-01	12.2	8.27	11.61	222	Fecal Coliform, MF	600
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	24-Sep-01	16.8	8.08	9.25	242	Fecal Coliform, MF	1000
Cripple Creek	@Simmerman, bridge #6193 on Rt 619	9-CPL018.47	12-Jul-01	16.7	7.88	9.36	220	Fecal Coliform, MF	200
Cripple Creek	At Andrews Hollow upstream of Speedwell	9-CPL022.99	28-Jan-08	5	7.9	13.3	194	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	At Andrews Hollow upstream of Speedwell	9-CPL022.99	18-Dec-07	2.1	8.3		219	E. COLI - MTEC-MF N0/100ML	50
Cripple Creek	At Andrews Hollow upstream of Speedwell	9-CPL022.99	27-Nov-07	9.7	7.8	10.1	217	E. COLI - MTEC-MF N0/100ML	50
Cripple Creek	At Andrews Hollow upstream of Speedwell	9-CPL022.99	23-Oct-07	14	7.6	8.4	225	E. COLI - MTEC-MF N0/100ML	620
Cripple Creek	At Andrews Hollow upstream of Speedwell	9-CPL022.99	24-Sep-07	16.9	8		233	E. COLI - MTEC-MF N0/100ML	250
Cripple Creek	At Andrews Hollow upstream of Speedwell	9-CPL022.99	20-Aug-07	19.4	8.1		231	E. COLI - MTEC-MF N0/100ML	100
Cripple Creek	At Andrews Hollow upstream of Speedwell	9-CPL022.99	24-Jul-07	15.4	8.1		232	E. COLI - MTEC-MF N0/100ML	400
Cripple Creek	At Andrews Hollow upstream of Speedwell	9-CPL022.99	18-Jun-07	17	8		234	E. COLI - MTEC-MF N0/100ML	320
Cripple Creek	At Andrews Hollow upstream of Speedwell	9-CPL022.99	23-May-07	15.3	7.9		229	E. COLI - MTEC-MF N0/100ML	550
Cripple Creek	At Andrews Hollow upstream of Speedwell	9-CPL022.99	24-Apr-07	11.8	7.6	11.5	170	E. COLI - MTEC-MF N0/100ML	100
Cripple Creek	At Andrews Hollow upstream of Speedwell	9-CPL022.99	13-Mar-07	7.3	7.8	11.5	200	E. COLI - MTEC-MF N0/100ML	200

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Cripple Creek	@ Chestnut Ridge, bridge #6046 Rt 671	9-CPL026.75	28-May-03	13.1	8.06	10.37	180	Fecal Coliform, MF	100
Cripple Creek	@ Chestnut Ridge, bridge #6046 Rt 671	9-CPL026.75	26-Mar-03	10.65	8.33	11.78	175	Fecal Coliform, MF	100
Cripple Creek	@ Chestnut Ridge, bridge #6046 Rt 671	9-CPL026.75	13-Jan-03					Fecal Coliform, MF	100
Cripple Creek	@ Chestnut Ridge, bridge #6046 Rt 671	9-CPL026.75	25-Nov-02	8.88	7.71	11.09	166	Fecal Coliform, MF	100
Cripple Creek	@ Chestnut Ridge, bridge #6046 Rt 671	9-CPL026.75	18-Sep-02	15.9	7.73	9.3	201	Fecal Coliform, MF	200
Cripple Creek	@ Chestnut Ridge, bridge #6046 Rt 671	9-CPL026.75	30-Jul-02	18.75	8.09	9.02	204	Fecal Coliform, MF	100
Cripple Creek	@ Chestnut Ridge, bridge #6046 Rt 671	9-CPL026.75	22-May-02	11.8	8.32	11.17	185	Fecal Coliform, MF	400
Cripple Creek	@ Chestnut Ridge, bridge #6046 Rt 671	9-CPL026.75	28-Mar-02	7.1	7.87	10.88	163	Fecal Coliform, MF	100
Cripple Creek	@ Chestnut Ridge, bridge #6046 Rt 671	9-CPL026.75	7-Jan-02	3.86	7.65	12.33	155	Fecal Coliform, MF	300
Cripple Creek	@ Chestnut Ridge, bridge #6046 Rt 671	9-CPL026.75	29-Nov-01	11.82	7.87	10.43	177	Fecal Coliform, MF	100
Cripple Creek	@ Chestnut Ridge, bridge #6046 Rt 671	9-CPL026.75	24-Sep-01	14.4	7.78	9.35	193	Fecal Coliform, MF	200
Cripple Creek	@ Chestnut Ridge, bridge #6046 Rt 671	9-CPL026.75	12-Jul-01	13.4	7.69	9.83	178	Fecal Coliform, MF	400
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	28-Jan-08	8.1	8.1	11.7	181	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	18-Dec-07	4.1	8.6		199	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	27-Nov-07	9.6	7.9	11	182	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	23-Oct-07	13.6	7.6	8.7	182	E. COLI - MTEC-MF N0/100ML	75
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	24-Sep-07	13.6	8.2		188	E. COLI - MTEC-MF N0/100ML	100
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	20-Aug-07	15.4	8.3		194	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	24-Jul-07	13.2	8.4		198	E. COLI - MTEC-MF N0/100ML	220
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	18-Jun-07	14.1	8.1		197	E. COLI - MTEC-MF N0/100ML	100
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	23-May-07	13.6	8.2		186	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	24-Apr-07	12.1	7.4	10.3	142	E. COLI - MTEC-MF N0/100ML	75
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	13-Mar-07	9	7.7	11.7	168	E. COLI - MTEC-MF N0/100ML	25
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	28-May-03	12.9	7.93	9.8	177	Fecal Coliform, MF	300
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	26-Mar-03	10.56	8.26	11.74	170	Fecal Coliform, MF	100
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	13-Jan-03					Fecal Coliform, MF	100

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	25-Nov-02	9.09	7.6	10.61	172	Fecal Coliform, MF	100
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	18-Sep-02	15	7.56	9.23	184	Fecal Coliform, MF	100
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	30-Jul-02	17.47	7.96	8.79	191	Fecal Coliform, MF	200
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	22-May-02	11.44	8.08	10.36	179	Fecal Coliform, MF	100
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	28-Mar-02	6.99	7.75	10.84	155	Fecal Coliform, MF	100
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	7-Jan-02	4.77	7.62	11.42	146	Fecal Coliform, MF	300
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	29-Nov-01	11.63	7.8	10.13	160	Fecal Coliform, MF	400
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	24-Sep-01	14	7.78	9.53	179	Fecal Coliform, MF	700
Cripple Creek	near Cedar Springs, bridge #6057 Rt 692	9-CPL028.10	12-Jul-01	14.7	7.69	9.47	160	Fecal Coliform, MF	500
Dean Branch	South of Porters Crossroads	9-DEN000.03	30-Dec-13	7.55	8.04		276	E. COLI - MTEC-MF N0/100ML	250
Dean Branch	South of Porters Crossroads	9-DEN000.03	7-Nov-13	11.19	8.4		395	E. COLI - MTEC-MF N0/100ML	25
Dean Branch	South of Porters Crossroads	9-DEN000.03	24-Oct-13	9.56	8.34		395	E. COLI - MTEC-MF N0/100ML	25
Dean Branch	South of Porters Crossroads	9-DEN000.03	23-Sep-13	15.05	8.26		384	E. COLI - MTEC-MF N0/100ML	175
Dean Branch	South of Porters Crossroads	9-DEN000.03	22-Aug-13	18.61	8.2		200	E. COLI - MTEC-MF N0/100ML	1150
Dean Branch	South of Porters Crossroads	9-DEN000.03	16-Jul-13	17.48	8.23		345	E. COLI - MTEC-MF N0/100ML	75
Dean Branch	South of Porters Crossroads	9-DEN000.03	26-Jun-13	18.24	8.3		392	E. COLI - MTEC-MF N0/100ML	375
Dean Branch	South of Porters Crossroads	9-DEN000.03	2-May-13	13.9	8.3		397	E. COLI - MTEC-MF N0/100ML	75
Dean Branch	South of Porters Crossroads	9-DEN000.03	10-Apr-13	13.93	8.47		343	E. COLI - MTEC-MF N0/100ML	25
Dean Branch	South of Porters Crossroads	9-DEN000.03	19-Mar-13	8.52	8.68	11.41	352	E. COLI - MTEC-MF N0/100ML	25
Dean Branch	South of Porters Crossroads	9-DEN000.03	5-Feb-13	7.26	8.1	10.66	340	E. COLI - MTEC-MF N0/100ML	25
Dean Branch	South of Porters Crossroads	9-DEN000.03	7-Jan-13	4.86	8.45	10.93	440	E. COLI - MTEC-MF N0/100ML	50
Dean Branch	South of Porters Crossroads	9-DEN000.03	28-Jan-08	4.6	8.1	13.5	451	E. COLI - MTEC-MF N0/100ML	25
Dean Branch	South of Porters Crossroads	9-DEN000.03	18-Dec-07	4	8.4		470	E. COLI - MTEC-MF N0/100ML	25
Dean Branch	South of Porters Crossroads	9-DEN000.03	27-Nov-07	8.9	8	11.5	432	E. COLI - MTEC-MF N0/100ML	75
Dean Branch	South of Porters Crossroads	9-DEN000.03	23-Oct-07	15.4	7.9	8.5	438	E. COLI - MTEC-MF N0/100ML	220
Dean Branch	South of Porters Crossroads	9-DEN000.03	24-Sep-07	17.9	8.3		456	E. COLI - MTEC-MF N0/100ML	25
Dean Branch	South of Porters Crossroads	9-DEN000.03	20-Aug-07	21.6	8.2		457	E. COLI - MTEC-MF N0/100ML	50

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Dean Branch	South of Porters Crossroads	9-DEN000.03	24-Jul-07	15.6	8.1		401	E. COLI - MTEC-MF N0/100ML	1300
Dean Branch	South of Porters Crossroads	9-DEN000.03	18-Jun-07	18.9	8.2		442	E. COLI - MTEC-MF N0/100ML	400
Dean Branch	South of Porters Crossroads	9-DEN000.03	23-May-07	16.1	8.2		424	E. COLI - MTEC-MF N0/100ML	300
Dean Branch	South of Porters Crossroads	9-DEN000.03	24-Apr-07	13.9	8.1	10.9	327	E. COLI - MTEC-MF N0/100ML	25
Dean Branch	South of Porters Crossroads	9-DEN000.03	13-Mar-07	9.2	7.9	10.7	389	E. COLI - MTEC-MF N0/100ML	200
Dean Branch	South of Porters Crossroads	9-DEN000.03	6-Feb-07	2.2	8	13.3	432	E. COLI - MTEC-MF N0/100ML	25
Dean Branch	South of Porters Crossroads	9-DEN000.39	18-Apr-13	12.96	8.5	10.89	304	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C	75
Dean Branch	South of Porters Crossroads	9-DEN000.39	18-Apr-13	12.96	8.5	10.89	304	E. COLI - MTEC-MF N0/100ML	70
Dry Run	near Speedwell off Rt21 private property	9-DYR002.34	28-May-03	12.2	7.12	9.51	45	Fecal Coliform, MF	100
Dry Run	near Speedwell off Rt21 private property	9-DYR002.34	26-Mar-03	9.15	6.94	10.5	47	Fecal Coliform, MF	100
Dry Run	near Speedwell off Rt21 private property	9-DYR002.34	13-Jan-03					Fecal Coliform, MF	100
Dry Run	near Speedwell off Rt21 private property	9-DYR002.34	25-Nov-02	5.83	6.81	11.32	33	Fecal Coliform, MF	100
Dry Run	near Speedwell off Rt21 private property	9-DYR002.34	18-Sep-02	18.4	7.24	7.98	148	Fecal Coliform, MF	100
Dry Run	near Speedwell off Rt21 private property	9-DYR002.34	30-Jul-02	21.73	7.58	7.46	137	Fecal Coliform, MF	100
Dry Run	near Speedwell off Rt21 private property	9-DYR002.34	22-May-02	8.32	7.17	10.78	50	Fecal Coliform, MF	100
Dry Run	near Speedwell off Rt21 private property	9-DYR002.34	28-Mar-02	3.91	7.07	11.87	45	Fecal Coliform, MF	100
Dry Run	near Speedwell off Rt21 private property	9-DYR002.34	7-Jan-02	-0.16	7.08	14.23	59	Fecal Coliform, MF	100
Dry Run	near Speedwell off Rt21 private property	9-DYR002.34	29-Nov-01	11.52	7.35	9.78	78	Fecal Coliform, MF	100
Dry Run	near Speedwell off Rt21 private property	9-DYR002.34	24-Sep-01	16	7.39	8.79	95	Fecal Coliform, MF	300
Dry Run	near Speedwell off Rt21 private property	9-DYR002.34	12-Jul-01	16.9	7.26	8.86	81	Fecal Coliform, MF	200
Kinser Creek	S of Groseclose Chapel	9-KNS002.44	27-May-09	12.8	6.5	8.9	13	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C	25
Kinser Creek	S of Groseclose Chapel	9-KNS002.44	27-May-09	12.8	6.5	8.9	13	E. COLI - MTEC-MF N0/100ML	10
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 619	9-SPB000.10	28-Jan-08	7.2	8.5	13.5	290	E. COLI - MTEC-MF N0/100ML	600

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 620	9-SPB000.10	18-Dec-07	0.6	8.4		327	E. COLI - MTEC-MF N0/100ML	2000
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 621	9-SPB000.10	27-Nov-07	10	8.3	11.9	310	E. COLI - MTEC-MF N0/100ML	2000
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 622	9-SPB000.10	23-Oct-07	15.1	7.6	7.2	316	E. COLI - MTEC-MF N0/100ML	2000
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 623	9-SPB000.10	24-Sep-07	18.3	8.2		315	E. COLI - MTEC-MF N0/100ML	2000
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 624	9-SPB000.10	20-Aug-07	22.5	8.2		302	E. COLI - MTEC-MF N0/100ML	1400
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 625	9-SPB000.10	24-Jul-07	15.3	8.2		291	E. COLI - MTEC-MF N0/100ML	1200
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 626	9-SPB000.10	18-Jun-07	17.5	8.3		297	E. COLI - MTEC-MF N0/100ML	2000
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 627	9-SPB000.10	23-May-07	16.6	8.4		260	E. COLI - MTEC-MF N0/100ML	2000
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 628	9-SPB000.10	24-Apr-07	13.2	7.8	10.7	134	E. COLI - MTEC-MF N0/100ML	650
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 629	9-SPB000.10	13-Mar-07	8.6	7.8	11.4	190	E. COLI - MTEC-MF N0/100ML	350
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 630	9-SPB000.10	28-May-03	15	8.13	9.3	177	Fecal Coliform, MF	700
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 631	9-SPB000.10	26-Mar-03	11.69	8.6	10.88	167	Fecal Coliform, MF	800
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 632	9-SPB000.10	13-Jan-03					Fecal Coliform, MF	100
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 633	9-SPB000.10	25-Nov-02	8.87	7.82	11.1	222	Fecal Coliform, MF	700
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 634	9-SPB000.10	18-Sep-02	21.2	8.12	9.1	348	Fecal Coliform, MF	700
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 635	9-SPB000.10	30-Jul-02	26.1	7.88	5.76	347	Fecal Coliform, MF	8000
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 636	9-SPB000.10	22-May-02	13.52	8.26	9.94	254	Fecal Coliform, MF	200
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 637	9-SPB000.10	28-Mar-02	7.46	8.15	11.15	157	Fecal Coliform, MF	300

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 638	9-SPB000.10	7-Jan-02	-0.15	7.8	12.97	242	Fecal Coliform, MF	500
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 639	9-SPB000.10	29-Nov-01	12.41	8.24	10.7	272	Fecal Coliform, MF	500
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 640	9-SPB000.10	24-Sep-01	16.5	8.13	8.9	283	Fecal Coliform, MF	6300
Slate Spring Branch	@ Eagle Furnace, Rt 642 off Rt 641	9-SPB000.10	12-Jul-01	17.1	8.16	9.44	292	Fecal Coliform, MF	2000
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	8-Nov-10	4.3	7.8	12.1	85	E. COLI - MTEC-MF N0/100ML	50
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	9-Sep-10	16.2	7.8	8.8	90	E. COLI - MTEC-MF N0/100ML	50
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	8-Jul-10	22.7	7.9	8.3	89	E. COLI - MTEC-MF N0/100ML	25
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	10-May-10	11.5	7.6	10	70	E. COLI - MTEC-MF N0/100ML	100
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	22-Mar-10	9	6.7	10.9	68	E. COLI - MTEC-MF N0/100ML	2000
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	4-Jan-10	-0.1	6.8	13.7	23	E. COLI - MTEC-MF N0/100ML	25
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	4-Nov-09	7.3	7.2	11.6	76	E. COLI - MTEC-MF N0/100ML	200
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	10-Sep-09	17.2	7.1	8.4	84	E. COLI - MTEC-MF N0/100ML	1900
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	22-Jul-09	19	7.4	8.6	84	E. COLI - MTEC-MF N0/100ML	100
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	6-May-09	13.9	7.1	9	70	E. COLI - MTEC-MF N0/100ML	2000
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	12-Mar-09	7.1	7.3	11.3	68	E. COLI - MTEC-MF N0/100ML	50
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	26-Jan-09	1.7	7.1	12.8	66	E. COLI - MTEC-MF N0/100ML	50
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	19-Mar-08	9.2	7.6	10.7	70	E. COLI - MTEC-MF N0/100ML	290
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	20-Feb-08	2.8	7.6	12.6	68	E. COLI - MTEC-MF N0/100ML	78
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	28-Jan-08	0.9	7.1	14.4	72	E. COLI - MTEC-MF N0/100ML	33.4
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	18-May-05	16.76	7.99	9.42	65	E. COLI - MTEC-MF N0/100ML	320
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	21-Mar-05	7.46	7.74	10.84	65.8	E. COLI - MTEC-MF N0/100ML	1100
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	6-Jan-05	9.15	7.63	10.53	62.5	E. COLI - MTEC-MF N0/100ML	840
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	3-Nov-04	16.57	8.42	9.29	70	E. COLI - MTEC-MF N0/100ML	300
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	16-Sep-04	18.97	7.79	8.52	78	E. COLI - MTEC-MF N0/100ML	420
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	15-Jul-04	21.47	8.68	9.35	79	E. COLI - MTEC-MF N0/100ML	120

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	20-May-04	18.57	7.86	9.2	69	E. COLI - MTEC-MF N0/100ML	600
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	9-Mar-04	3.59	7.37	12.23	62	E. COLI - MTEC-MF N0/100ML	200
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	8-Jan-04	0.17	6.95	15.29	16	E. COLI - MTEC-MF N0/100ML	25
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	24-Nov-03	9.7	7.41	10.5	59	E. COLI - MTEC-MF N0/100ML	2000
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	25-Sep-03	15.9	7.77	9.59	79	E. Coli in water, 4 ml dilution	180
Elk Creek	Bridge # 1009 on Rt 274 off Rt 94	9-EKC000.11	16-Jul-03	20.2	7.7	8.78	73	E. Coli in water, 4 ml dilution	350
Elk Creek	At Carmel Church on Rt. 650	9-EKC003.78	26-Feb-01	7.55	7.23	11.62	78	Fecal Coliform, MF	600
Elk Creek	At Carmel Church on Rt. 650	9-EKC003.78	12-Dec-00	2.3	7.64	12.96	80	Fecal Coliform, MF	100
Elk Creek	At Carmel Church on Rt. 650	9-EKC003.78	10-Oct-00	6.31	6.98	12.26	89	Fecal Coliform, MF	100
Elk Creek	At Carmel Church on Rt. 650	9-EKC003.78	28-Aug-00	19.5	7.33	9.41	89	Fecal Coliform, MF	1100
Elk Creek	At Carmel Church on Rt. 650	9-EKC003.78	19-Jun-00	22.4	7.4	8.51	92.3	Fecal Coliform, MF	100
Elk Creek	At Carmel Church on Rt. 650	9-EKC003.78	26-Apr-00	9.8	7.1	10.84	47	Fecal Coliform, MF	5700
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	8-Nov-10	5.1	7.6	11.8	100	E. COLI - MTEC-MF N0/100ML	100
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	9-Sep-10	17.2	7.8	8.4	108	E. COLI - MTEC-MF N0/100ML	120
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	8-Jul-10	23.6	7.8	7.5	103	E. COLI - MTEC-MF N0/100ML	600
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	10-May-10	12.1	7.5	10.2	77	E. COLI - MTEC-MF N0/100ML	250
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	22-Mar-10	8.4	6.6	9.6	75	E. COLI - MTEC-MF N0/100ML	2000
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	4-Jan-10	-0.1	6.6	12.8	51	E. COLI - MTEC-MF N0/100ML	25
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	4-Nov-09	8	7.1	11.1	80	E. COLI - MTEC-MF N0/100ML	100
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	10-Sep-09	16.8	7.1	8.2	89	E. COLI - MTEC-MF N0/100ML	2000
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	22-Jul-09	18.8	7.3	8.3	95	E. COLI - MTEC-MF N0/100ML	650
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	6-May-09	13.4	6.9	9.5	76	E. COLI - MTEC-MF N0/100ML	1600
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	12-Mar-09	6.3	7.1	11.4	74	E. COLI - MTEC-MF N0/100ML	150
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	26-Jan-09	2.4	7.1	12.5	75	E. COLI - MTEC-MF N0/100ML	100
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	18-May-05	15.55	7.65	9.22	71	E. COLI - MTEC-MF N0/100ML	1350
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	21-Mar-05	6.57	7.56	11.17	73.1	E. COLI - MTEC-MF N0/100ML	950

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	6-Jan-05	9.6	7.5	10.14	70.7	E. COLI - MTEC-MF N0/100ML	200
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	3-Nov-04	16.56	8.32	9.46	78	E. COLI - MTEC-MF N0/100ML	850
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	16-Sep-04	18.65	7.68	8.56	89	E. COLI - MTEC-MF N0/100ML	1800
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	15-Jul-04	19.75	8.14	8.65	85	E. COLI - MTEC-MF N0/100ML	920
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	20-May-04	18.8	7.65	9.11	75	E. COLI - MTEC-MF N0/100ML	1900
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	9-Mar-04	2.97	7.07	12.16	66	E. COLI - MTEC-MF N0/100ML	220
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	8-Jan-04	0.18	6.72	13.87	65	E. COLI - MTEC-MF N0/100ML	100
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	24-Nov-03	9.9	7.15	9.9	65	E. COLI - MTEC-MF N0/100ML	620
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	25-Sep-03	15	7.46	9.41	86	E. COLI - MTEC-MF N0/100ML	700
Elk Creek	Bridge # 6031 on Rt 654 off Rt 660	9-EKC010.47	16-Jul-03	19.5	7.46	8.5	83	E. COLI - MTEC-MF N0/100ML	1400
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	8-Nov-10	5.6	7.6	12.6	96	E. COLI - MTEC-MF N0/100ML	150
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	9-Sep-10	17.6	7.8	8.9	108	E. COLI - MTEC-MF N0/100ML	220
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	8-Jul-10	23.5	8.2	9.5	101	E. COLI - MTEC-MF N0/100ML	700
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	10-May-10	11.4	7.4	10.5	75	E. COLI - MTEC-MF N0/100ML	100
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	22-Mar-10	8.3	6.6	9.5	68	E. COLI - MTEC-MF N0/100ML	2000
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	4-Jan-10	-0.2	6.7	12.2	73	E. COLI - MTEC-MF N0/100ML	50
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	4-Nov-09	7.9	7	10.9	77	E. COLI - MTEC-MF N0/100ML	280
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	10-Sep-09	16.4	7.1	7.9	87	E. COLI - MTEC-MF N0/100ML	2000
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	22-Jul-09	17.9	7	8.4	95	E. COLI - MTEC-MF N0/100ML	1900
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	6-May-09	13.2	6.8	9.8	73	E. COLI - MTEC-MF N0/100ML	1600
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	12-Mar-09	5.9	7	11.3	72	E. COLI - MTEC-MF N0/100ML	400
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	26-Jan-09	2.3	7	12.3	74	E. COLI - MTEC-MF N0/100ML	300
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	18-May-05	15.26	7.55	9.22	70	E. COLI - MTEC-MF N0/100ML	1300
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	21-Mar-05	6.27	7.6	11.66	69.3	E. COLI - MTEC-MF N0/100ML	25
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	6-Jan-05	9.29	7.32	10.23	71.4	E. COLI - MTEC-MF N0/100ML	480
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	3-Nov-04	16.5	8.13	9.55	77	E. COLI - MTEC-MF N0/100ML	2000
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	16-Sep-04	18.42	7.56	8.51	89	E. COLI - MTEC-MF N0/100ML	620

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	15-Jul-04	19.36	7.87	8.38	85	E. COLI - MTEC-MF N0/100ML	2000
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	20-May-04	17.84	7.31	8.9	72	E. COLI - MTEC-MF N0/100ML	2000
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	9-Mar-04	2.99	7.05	12.11	64	E. COLI - MTEC-MF N0/100ML	220
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	8-Jan-04	0.15	6.83	13.03	64	E. COLI - MTEC-MF N0/100ML	120
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	24-Nov-03	9.9	7.1	9.78	65	E. COLI - MTEC-MF N0/100ML	2000
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	25-Sep-03	14.8	7.27	9.22	86	E. Coli in water, 4 ml dilution	2000
Elk Creek	Wooden bridge on Rt 696 off Rt 21	9-EKC012.13	16-Jul-03	19.4	7.28	8.22	83	E. Coli in water, 4 ml dilution	1200
Elk Creek	SW of Lower Elk Creek	9-EKC013.81	19-Apr-05	11.96	7.77	10.54	71	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C	500
Elk Creek	SW of Lower Elk Creek	9-EKC013.81	19-Apr-05	11.96	7.77	10.54	71	E. COLI - MTEC-MF N0/100ML	370
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	8-Nov-10	5.4	7.5	11.4	84	E. COLI - MTEC-MF N0/100ML	75
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	9-Sep-10	16.8	7.7	8.4	100	E. COLI - MTEC-MF N0/100ML	500
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	8-Jul-10	23.5	8.1	7.8	90	E. COLI - MTEC-MF N0/100ML	220
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	10-May-10	11.1	7.5	10.2	65	E. COLI - MTEC-MF N0/100ML	50
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	22-Mar-10	7.9	6.8	10.1	64	E. COLI - MTEC-MF N0/100ML	1200
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	4-Jan-10	-0.1	6.7	13	65	E. COLI - MTEC-MF N0/100ML	25
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	4-Nov-09	7.9	7.2	11.2	63	E. COLI - MTEC-MF N0/100ML	350
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	10-Sep-09	16	7.1	8.6	80	E. COLI - MTEC-MF N0/100ML	2000
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	22-Jul-09	17.1	7.2	8.6	86	E. COLI - MTEC-MF N0/100ML	1200
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	6-May-09	12.7	7.3	10.2	59	E. COLI - MTEC-MF N0/100ML	1400
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	12-Mar-09	5.3	7.3	11.8	62	E. COLI - MTEC-MF N0/100ML	420
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	26-Jan-09	1.8	7.1	12.7	63	E. COLI - MTEC-MF N0/100ML	150
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	15-Dec-08	9.1	7.6	10.6	59	E. COLI - MTEC-MF N0/100ML	150
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	12-Nov-08	6.8	8.5	12.7	78	E. COLI - MTEC-MF N0/100ML	120
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	29-Oct-08	2.4	7.1	13.8	81	E. COLI - MTEC-MF N0/100ML	250
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	22-Sep-08	15.9	8	9.4	93	E. COLI - MTEC-MF N0/100ML	1100

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	18-Aug-08	21.8	8.5	8.6	102	E. COLI - MTEC-MF N0/100ML	100
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	14-Jul-08	18.5	7.6	8	89	E. COLI - MTEC-MF N0/100ML	2000
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	30-Jun-08	18.7	7.5	8.1	81	E. COLI - MTEC-MF N0/100ML	1600
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	21-May-08	12.1	7.8	9.5	64	E. COLI - MTEC-MF N0/100ML	520
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	23-Apr-08	12.3	8	10.4	64	E. COLI - MTEC-MF N0/100ML	720
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	19-Mar-08	9	8.3	10.9	62	E. COLI - MTEC-MF N0/100ML	100
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	20-Feb-08	2.1	7.7	12.8	53	E. COLI - MTEC-MF N0/100ML	25
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	28-Jan-08	0.3	7.1	14.7	69	E. COLI - MTEC-MF N0/100ML	50
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	18-May-05	14.53	7.88	9.43	60	E. COLI - MTEC-MF N0/100ML	580
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	21-Mar-05	5.8	8.58	10.79	59.6	E. COLI - MTEC-MF N0/100ML	25
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	6-Jan-05	8.58	7.5	10.52	60.9	E. COLI - MTEC-MF N0/100ML	580
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	3-Nov-04	16.38	8.53	9.47	65	E. COLI - MTEC-MF N0/100ML	280
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	16-Sep-04	18.11	7.78	8.45	76	E. COLI - MTEC-MF N0/100ML	1500
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	15-Jul-04	18.82	7.77	8.14	75	E. COLI - MTEC-MF N0/100ML	1000
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	20-May-04	16.76	7.54	9.25	56	E. COLI - MTEC-MF N0/100ML	1100
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	9-Mar-04	2.6	6.97	12.38	53	E. COLI - MTEC-MF N0/100ML	320
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	8-Jan-04	0.16	7.05	14	51	E. COLI - MTEC-MF N0/100ML	280
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	24-Nov-03	9.9	7.2	10.17	55	E. COLI - MTEC-MF N0/100ML	580
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	25-Sep-03	13.6	7.49	9.69	73	E. Coli in water, 4 ml dilution	2000
Elk Creek	Bridge # 6041 on Rt 663 off Rt 658	9-EKC017.51	16-Jul-03	19	7.61	8.78	72	E. Coli in water, 4 ml dilution	2000
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	8-Nov-10	5.4	7.5	11.8	69	E. COLI - MTEC-MF N0/100ML	100
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	9-Sep-10	16.1	7.6	8.8	75	E. COLI - MTEC-MF N0/100ML	220
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	8-Jul-10	21.2	7.7	8.5	71	E. COLI - MTEC-MF N0/100ML	200
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	10-May-10	10.3	7.4	10.4	57	E. COLI - MTEC-MF N0/100ML	120
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	22-Mar-10	8.5	6.8	10.4	57	E. COLI - MTEC-MF N0/100ML	2000
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	4-Jan-10	-0.1	6.8	13.6	19	E. COLI - MTEC-MF N0/100ML	420
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	4-Nov-09	7.1	7.1	11.2	64	E. COLI - MTEC-MF N0/100ML	100

Stream Name	Station Location	Station ID	Collection Date	Temp (^oC)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	10-Sep-09	16	7	8.9	67	E. COLI - MTEC-MF N0/100ML	2000
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	22-Jul-09	18.1	7.2	8.7	69	E. COLI - MTEC-MF N0/100ML	280
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	6-May-09	13.1	7	9.6	58	E. COLI - MTEC-MF N0/100ML	280
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	12-Mar-09	5.7	7.3	11.7	53	E. COLI - MTEC-MF N0/100ML	2000
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	26-Jan-09	2.4	7	12.4	53	E. COLI - MTEC-MF N0/100ML	450
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	15-Dec-08	8.7	7.4	10.7	59	E. COLI - MTEC-MF N0/100ML	25
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	12-Nov-08	7.2	7.8	11.5	66	E. COLI - MTEC-MF N0/100ML	75
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	29-Oct-08	4.4	7.6	12.3	68	E. COLI - MTEC-MF N0/100ML	180
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	22-Sep-08	16.8	7.6	9	73	E. COLI - MTEC-MF N0/100ML	50
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	18-Aug-08	20.4	7.7	8	74	E. COLI - MTEC-MF N0/100ML	25
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	14-Jul-08	19	7.6	8.6	75	E. COLI - MTEC-MF N0/100ML	880
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	30-Jun-08	19.5	7.6	8.2	76	E. COLI - MTEC-MF N0/100ML	800
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	21-May-08	13.2	7.5	9.3	60	E. COLI - MTEC-MF N0/100ML	380
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	23-Apr-08	12.9	7.7	9.6	58	E. COLI - MTEC-MF N0/100ML	680
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	19-Mar-08	9.3	7.8	11.1	57	E. COLI - MTEC-MF N0/100ML	120
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	20-Feb-08	2.8	7.5	12.6	54	E. COLI - MTEC-MF N0/100ML	100
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	28-Jan-08	1.1	7.1	14.3	56	E. COLI - MTEC-MF N0/100ML	250
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	18-May-05	16.11	7.79	9.25	55	E. COLI - MTEC-MF N0/100ML	180
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	21-Mar-05	7.72	7.7	10.1	47.1	E. COLI - MTEC-MF N0/100ML	25
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	6-Jan-05	8.64	7.47	10.49	52.5	E. COLI - MTEC-MF N0/100ML	620
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	3-Nov-04	15.93	7.75	8.6	62	E. COLI - MTEC-MF N0/100ML	1200
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	16-Sep-04	18.03	7.7	8.81	67	E. COLI - MTEC-MF N0/100ML	700
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	15-Jul-04	18.97	7.78	8.57	64	E. COLI - MTEC-MF N0/100ML	500
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	20-May-04	17.54	7.5	8.94	59	E. COLI - MTEC-MF N0/100ML	1000
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	9-Mar-04	3.96	7.2	11.98	50	E. COLI - MTEC-MF N0/100ML	300
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	8-Jan-04	0.08	6.85	11.49	48	E. COLI - MTEC-MF N0/100ML	120
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	24-Nov-03	9.8	7.34	10.31	51	E. COLI - MTEC-MF N0/100ML	2000
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	25-Sep-03	14.6	7.53	9.55	64	E. Coli in water, 4 ml dilution	150

Stream Name	Station Location	Station ID	Collection Date	Temp (°C)	Field Ph	Dissoved Oxygen (mg/L)	Specific Conductance (µS/cm)	Parameter Name	Value
Knob Fork	Bridge # 6028 on 650 off Rt 660	9-KNB000.03	16-Jul-03	18.6	7.5	8.87	60	E. Coli in water, 4 ml dilution	750
Knob Fork	East of The Pilot	9-KNB003.98	1-Apr-08	12.7	7.6	10.4	52	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C	25
Knob Fork	East of The Pilot	9-KNB003.98	1-Apr-08	12.7	7.6	10.4	52	E. COLI - MTEC-MF N0/100ML	10
Middle Fork Elk Creek	At Comers Rock Rd Crossing	9-ECM001.01	31-May-11	20.2	7.2	8.6	61	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C	1600
Middle Fork Elk Creek	At Comers Rock Rd Crossing	9-ECM001.01	31-May-11	20.2	7.2	8.6	61	E. COLI - MTEC-MF N0/100ML	800

Appendix E. List of Contacts

NRCS, Marion Service Center
340 N. Main St Suite 102, Marion, VA 24354
(276) 783-7289
NRCS, Wytheville Service Center
100 USDA Drive, Wytheville, VA 24382
(276) 228-3513
NRCS, Galax Service Center
968 East Stuart Drive, Galax, VA 24333
(276) 236-7191
Evergreen SWCD
340 N. Main St Suite 102, Marion, Virginia 24354
(276) 783-7280
Big Walker SWCD
100 USDA Drive, Wytheville, VA 24382
(276) 228-3513
New River SWCD
968 East Stuart Drive, Galax, VA 24333
(276) 236-7191
New River Highland RC&D
325 E. Main St Suite E-2, Wytheville, VA 24382
(276) 227-0536
Mt. Rogers Planning District Commission
1021 Terrace Dr., Marion, VA 24354
(276) 783-5103

Smyth County Government
121 Bagley Cir, Suite 100 Marion, VA 24354
(276) 783-3298
Smyth County Health Department
201 Francis Marion Lane, Marion, VA 24354
(276) 781-7460
Wythe-Grayson Health Dept.
750 W Ridge Rd, Wytheville, VA 24382
(276) 228-5507
Wythe County Government
340 S 6th St., Wytheville, VA 24382
276) 223-4500
Grayson County Government
129 Davis Street, Independence, VA 24348
(276) 773-2471
Virginia Cooperative Ext. Service- Wythe Co.
225 S. 4th St, Suite 301, Wytheville, VA 24382
(276) 223-6040
Virginia Coop. Extension Service-Grayson Co.
129 Davis St, Courthouse Basement, Room 103, Independence, VA 24348
(276) 773-2491

Virginia Coop. Ext. Service- Smyth Co.
121 Bagley Circle; Suite 434 Marion, VA 24354
(276) 783-5175
Virginia Dept. of Ag. & Cons. Services- Ag. Stewardship Program
P.O. Box 1163, Richmond, VA 23218
804) 837-9311
Virginia Dept. of Conservation and Recreation
355-A Deadmore Street, Abingdon, VA. 24210
(276) 676-5562
Virginia Dept. of Environmental Quality
355-A Deadmore Street, Abingdon, VA. 24210
(276) 676-4800
Virginia Dept. of Game and Inland Fisheries
1796 Hwy 16, Marion, VA 24354
(276) 783-4860
Grayson Landcare
PO Box 373, Independence, VA 24348
(276) 238-7073
National Committee for the New River
PO Box 1480, West Jefferson, NC 28694
(336) 846-6267