

Roseberry Creek Watershed Restoration Plan

Name of Project: Roseberry Creek Watershed Restoration Initiative

Lead Organization: Knox County Stormwater Management Department

Watershed ID: Roseberry Creek Watershed, Knox County, HUC TN 0610104001 – 0500

1. Introduction

The Roseberry Creek watershed drains an area of 8,412 acres or 13 square miles and is located in the 999 square mile Holston River watershed. Located entirely in the eastern portion of Knox County, TN (Figure 1), land use in the watershed is mostly rural with livestock grazing operations the dominate land use (Figure 2). Pockets of rural housing and single family residential subdivisions are scattered throughout the watershed. Northeast Knox Utility District is located in the watershed and supplies potable water. Limited sewer is provided by the Knoxville Utility Board. There are very few commercial enterprises. The watershed contains the eastern portion of the 500 acre House Mountain State Natural Area.

The Knox County Soil Conservation District (Knox Co. SCD) and the Natural Resource Conservation Service (NRCS) have completed several projects on agricultural properties in the watershed and 2,385 feet of three tributaries to Roseberry Creek were restored by the Tennessee Stream Mitigation Program.

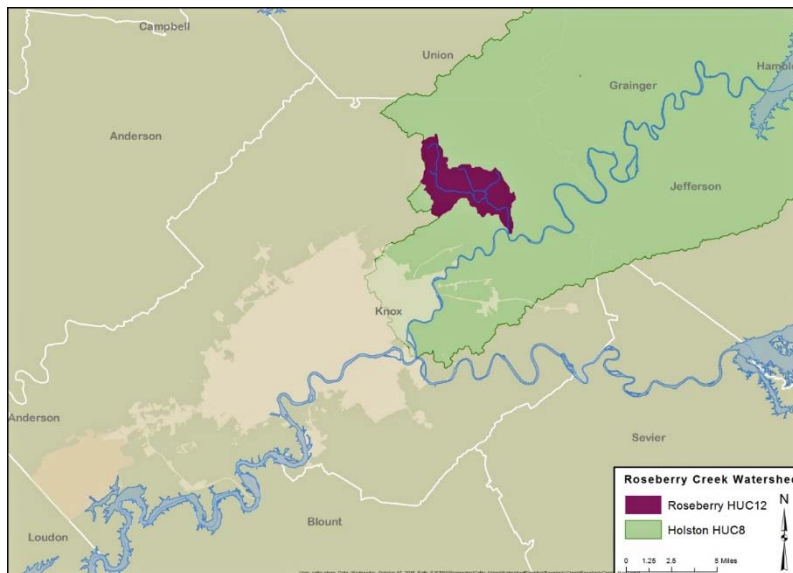


Figure 1. Roseberry Creek Watershed Location Map

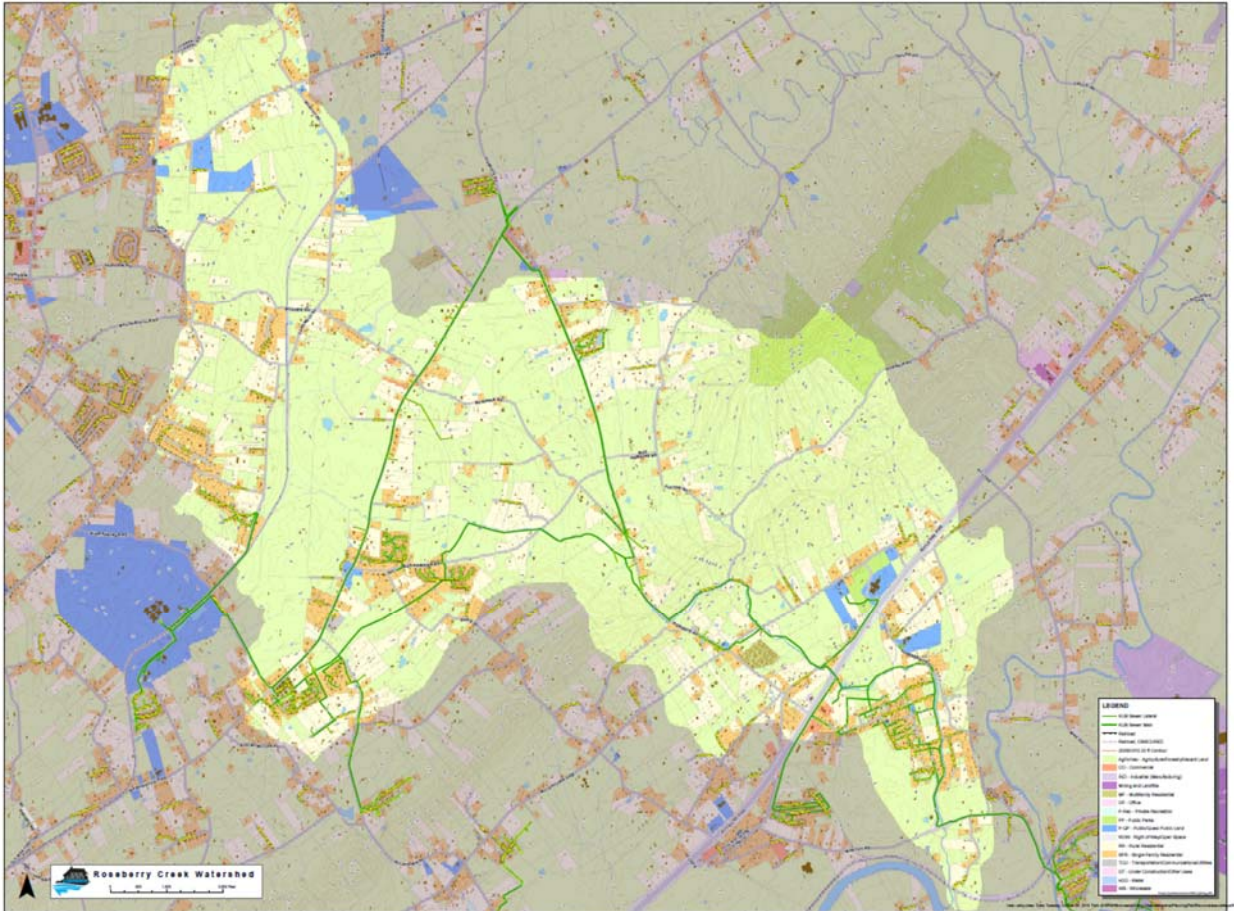


Figure 2. Roseberry Creek Watershed Land Use

2.0. Sources and Causes of Pollutants and Impairments

All 19.92 miles of Roseberry Creek are listed in the draft 2014 303(d) list (Table 1). The primary pollutant of concern is *Escherichia coli* (*E. coli*). Sources of *E. coli* impairments identified by Tennessee Department of Environment and Conservation (TDEC) are poor agricultural practices (i.e., pasture grazing) and failing septic systems. There are limited areas of sanitary sewer in the Roseberry Creek Watershed. Figure 2 shows agricultural lands and the areas that have sanitary sewer access. All impairments described by TDEC are from non-point sources. There are no permitted point source discharges in this watershed.

This plan will address the reduction of *E. coli* from the non-point sources identified by TDEC. Reductions in pollutant loading will be achieved by implementing best management practices (BMPs) on agricultural lands and addressing failing septic systems by connecting those failed systems to existing sewer lines or by repairing them according to Knox County’s Health Department specifications.

Table 1. TDEC 2014 303d Waterbody Status

Waterbody ID	Impacted Waterbody	County	Miles/Acres Impaired	Cause/TMDL Priority	Pollutant Source	Comments
TN06010104001-0500	ROSEBERRY CREEK	Knox	20.0	Escherichia coli NA	Pasture Grazing Septic Tanks	Category 5. EPA approved a pathogen TMDL that addresses the known pollutant

Data from TDEC’s most recent collection efforts show that levels of *E.coli* are still above the state standard of 126 colony forming units per 100 ml as a geometric mean based on a minimum of 5 samples collected within a 30 day period. TDEC only has one sample site in the Roseberry Creek Watershed. It is located 0.6 miles from the Holston River at the bridge on Mascot Road. 5-in-30 samples were last collected in the summer of 2014. The sample point and impaired stream segments are shown in Figure 3. The sample data are shown in Table 2.

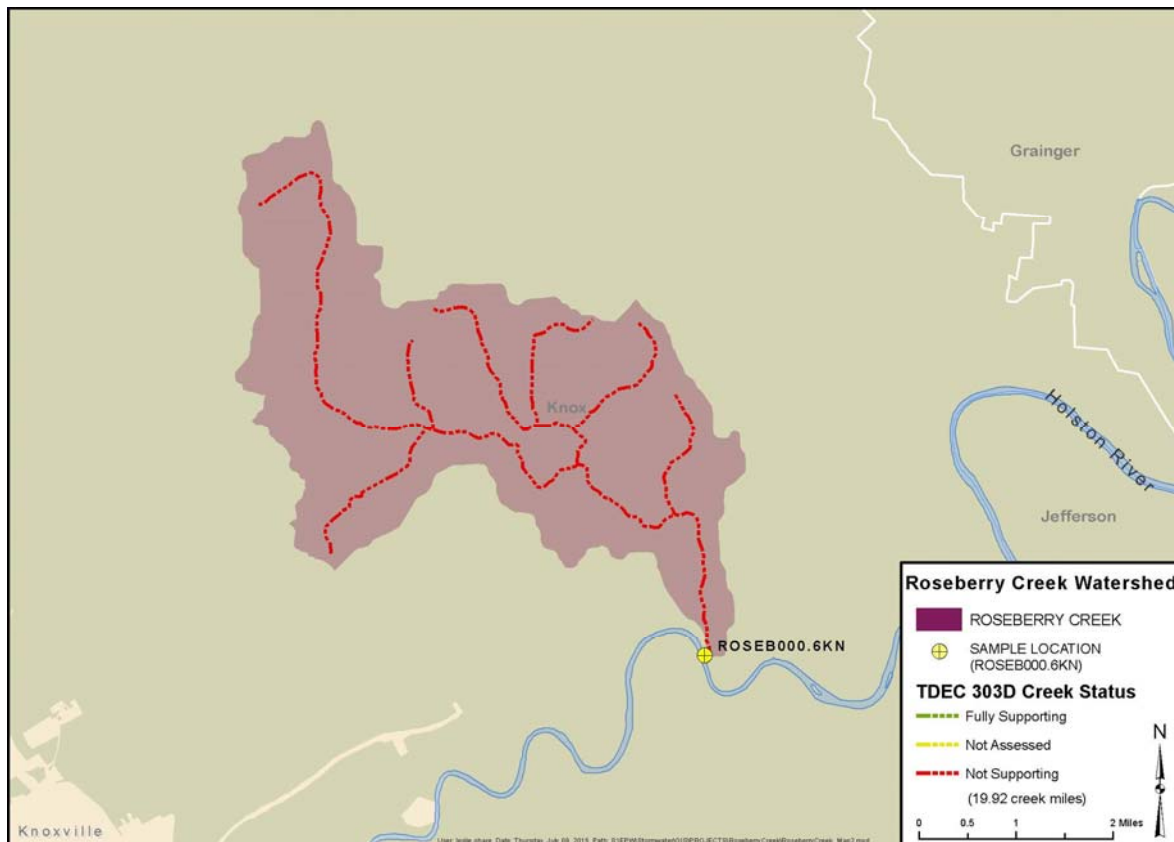


Figure 3. Impaired stream segments and sample site location

Table 2. TDEC 2014 *E.coli* Data

2014 TDEC Roseberry Creek <i>E.coli</i> Data for the Roseberry Creek Watershed						
Location	<i>E.coli</i> CFU/ 100mL	<i>E.coli</i> CFU/ 100mL	<i>E.coli</i> CFU/ 100mL	<i>E.coli</i> CFU/ 100mL	<i>E.coli</i> CFU/ 100mL	Geometric Mean
	8/4/2014	8/13/2014	8/18/2014	8/25/2014	8/27/2014	
ROSEB000.6KN	248	225	548	276	276	297.5

Recent data from TDEC indicates that *E.coli* levels are above state water quality standards in Roseberry Creek. In order to meet water quality standards the current geomean of five individual samples in 30 days must be below 126 CFU/100mL and the ROSEB000.6KN sampling location shows a 2014 geomean of 297.5. Biological surveys conducted by the Knox Co. SCD in 2014 for the Flat Creek Watershed indicate that one of the major sources of the pollutant to be pasture grazing. Flat Creek is adjacent to Roseberry Creek with similar land use. Most livestock operations allow access to the creek and over grazing is common. The combination of this sparse pasture vegetation along with minimal riparian buffers greatly increases its *E.coli* loading.

About 55% percent of the land area, or approximately 4,400 acres, in the Roseberry Creek Watershed is in parcels designated as agricultural. Pasture on these agricultural parcels is between 2,000 and 2,500 acres based on aerial imagery and ground-truthing surveys. The majority of these pastures are in need of improvements such as updated grazing practices, creating riparian buffers, excluding livestock from creek access and providing alternative watering sources.

In addition to livestock, a preliminary assumption can be made that that failing septic systems are a source of *E.coli* in the watershed. According to estimates provided in the Holston River Watershed Total Maximum Daily Load (TMDL) study, 45% of Knox County residences are on septic systems. Within the Roseberry Creek Watershed most properties lack sewer access as shown in Figure 4. A desktop analysis has identified 1,147 properties in Roseberry Creek as not having access to sewer. From experience in other watersheds of a similar socioeconomic demographic, it is likely that many of these systems are in need of repair or replacement.

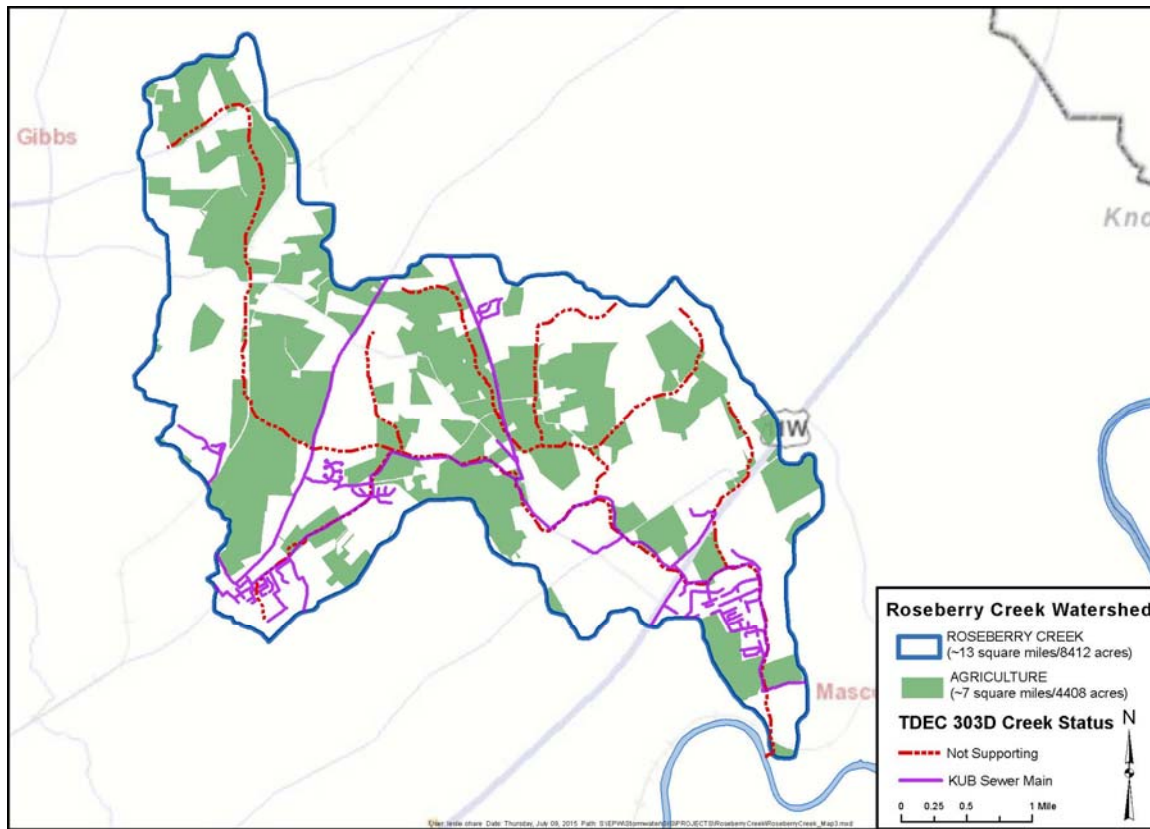


Figure 4. Agricultural lands and sewer

2.0 Holston River Watershed TMDL

A TMDL study was approved for the Holston River Watershed in 2008 and provides estimates of the load reduction in Roseberry Creek needed to meet water quality standards. Load duration curves were used to calculate target *E.coli* load reductions. The TMDL recommends the *E.coli* load to be reduced to 10% below the state standard or a geometric mean of 113 CFU/100 ml or an Instantaneous Maximum of 847 CFU/100 ml. The TMDL breaks the daily load reduction needs into four categories: High Flows, Moist Conditions, Mid-Range Flows, and Low Flows. Based on 2004 data Roseberry Creek needs reductions of 7.0% to meet the Margin of Safety (MOS) standards during Mid-Range Flows for daily loading. No other reductions are needed during other flow regimes based on daily loading, however, a reduction of 75% in *E.coli* loading is needed to meet the TMDL target MOS 30 day geometric mean. This data is shown here in Tables 3 and 4 (Source: Holston River Watershed TMDL 2008).

Table 3. Calculated Load Reduction Based on Daily Loading - Roseberry Creek

Sample Date	Flow Regime	Flow (cfs)	PDFE (%)	Concentration (CFU/100ml)	Load (CFU/Day)	% Reduction to meet TMDL (%)	Average of Load Reductions	% Reduction to TMDL - MOS
5/26/04	High Flows	71.08	4.4%	727	1.26E+12	NR	NR	NR
7/29/04	Moist Conditions	20.23	16.7%	548	2.71E+11	NR	NR	NR
6/29/04		16.70	20.8%	365	1.49E+11	NR		
8/3/04		12.51	27.8%	291	8.91E+10	NR		
9/22/04		9.36	35.5%	548	1.26E+11	NR		
7/20/04	Mid Range Flows	4.98	54.6%	276	3.36E+10	NR	5.5	7.0
8/11/04		4.71	55.8%	330	3.87E+10	NR		
10/1/04		4.41	58.4%	517	5.58E+10	NR		
8/17/04		3.89	62.2%	1300	1.24E+11	27.6		
10/7/04		3.67	63.9%	285	2.56E+10	NR		

PDFE – Percent of Days Flow Exceeded
 NR - No Reduction Required

Table 4. Calculated Load Reduction Based on Geomean Data - Roseberry Creek

Sample Date	Flow (cfs)	PDFE (%)	Concentration (CFU/100ml)	Geometric Mean (CFU/100ml)	Calculated Reduction	
					To Target GM (126 CFU/100ml)	To Target - MOS (113CFU/100ml)
7/20/04	4.98	54.6%	276			
7/29/04	20.23	16.7%	548			
8/3/04	12.51	27.8%	291			
8/11/04	4.79	55.8%	330			
8/17/04	3.89	62.2%	1300	452.07	72.1	75

Note: Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

3.0 Estimate of Load Reductions Expected From Management Measures

The goal of this plan is to reduce the levels of *E.coli* in Roseberry Creek to a degree that it can be removed in its entirety from TDEC’s 303d list. Implementing the BMP’s recommended in its first phase will significantly reduce the inputs of *E.coli* from pasture and septic sources. Prior to BMP implementation, a 5 in 30 geometric mean analysis will be conducted to determine which sub-basins of Roseberry Creek contain the highest concentrations of *E. coli*. Management practices for agriculture and septic systems will then be implemented simultaneously focusing on the sub-basins with the highest concentrations of *E. coli*. The Knox Co. SCD and NRCS will work to place agricultural BMPs on identified properties focusing on livestock exclusion fencing, watering systems, and pasture management. Knox Co. Stormwater will partner with the Knox Co. Health Department to identify and fix failing septic systems. After three years of BMP implementation, Stormwater staff will conduct a 5-in-30 geometric mean analysis at the TDEC

sample site on Mascot Road for comparison with 2014 results. The plan will then be adapted to reflect the results.

Although the Roseberry Creek Watershed is on the 303(d) list only for *E. coli*, the BMPs necessary to reduce *E. coli* will also reduce other pollutants of concern; primarily phosphorus, nitrogen, and sediment. The BMPs necessary to reach *E. coli* targets were modeled using EPA's STEP-L model show that annual load reductions can be reduced by 23,764 lbs. for nitrogen, 2,216 lbs. for phosphorus, and 440 tons for sediment. The modeled results are shown in table 5.

Table 5: Nitrogen, Phosphorus, and Sediment load reductions

Practice	Amount		N Reduction Factor	= lbs N/year
Riparian Buffer	26,136 ft.	X	0.28	7,318.08
Exclusion Fencing	28,000 ft.	X	0.11	3,080.00
Cross Fencing	12,000 ft.	X	0.25	3,000.00
Watering Facility	12	X	70.23	842.76
Pipeline	12,500 ft	X	0.13	1,625.00
Heavy Use Area	36,000 sq. ft.	X	0.09	3,240.00
Stream Crossing	3	X	160.98	482.94
Septic System Repair	35	X	119.28	4,174.80
<i>Expected Reduction in N load =</i>				23,763.58

Practice	Amount		P Reduction Factor	= lbs P/year
Riparian Buffer	26,136 ft.	X	0.02	522.72
Exclusion Fencing	28,000 ft.	X	0.01	280.00
Cross Fencing	12,000 ft.	X	0.02	240.00
Watering Facility	12	X	5.88	70.56
Pipeline	12,500 ft	X	0.02	250.00
Heavy Use Area	36,000 sq. ft.	X	0.01	360.00
Stream Crossing	3	X	17.425	52.28
Septic System Repair	35	X	12.58	440.30
<i>Expected Reduction in P load =</i>				2,215.86

Practice	Amount		Sediment Reduction Factor	= Tons Sediment / Year
Riparian Buffer	26,136 ft.	X	0.002	52.27
Exclusion Fencing	28,000 ft.	X	0.001	28.00

Cross Fencing	12,000 ft.	X	0.006	72.00
Watering Facility	12	X	0.004	.05
Pipeline	12,500 ft	X	0.006	75.00
Heavy Use Area	36,000 sq. ft.	X	0.002	72.00
Stream Crossing	3	X	5.375	16.13
Septic System Repair	35	X	3.564	124.74
<i>Expected Reduction in sediment load =</i>				440.19

4.0 BMP List, Educational Activities, and Budget

The focus of this project plan is to install agricultural BMPs and repair failing septic systems in the Roseberry Creek Watershed. Applied agricultural practices will include changing land management to promote infiltration of storm water; excluding livestock from creeks or controlling access; and creating riparian and other zones to filter runoff. Each farm that participates in the project will be assessed individually, to determine the BMPs that will best help to protect the natural resources both on and downstream of the farm while protecting the sustainability of the farming operation and the land. The Knox County SCD and NRCS will interface with landowners and install BMPs on properties following NRCS and Knox County SCD standards and specifications to insure maximum impact. Where appropriate the agricultural operation will install some or all of the following practices: riparian forest buffers, exclusion/access control fencing, prescribed rotational grazing plan, cross fencing (to allow rotational grazing and improve pasture quality and infiltration), alternate watering systems, stream crossings, heavy use areas (for watering and/or feeding), and pipeline for alternate watering systems.

Failed septic systems will be identified through a ground-truthing process and by complaints submitted to the Health Department. Knox County Environmental Specialists will inspect systems, develop plans for repair, provide installation oversight, and conduct final inspections. Homeowners with failed systems may have to replace septic tanks, and/or drain field lines. All work will be performed by Health Department approved contractors.

The Roseberry Creek Restoration Initiative will prioritize projects that are expected to have the highest benefit in terms of reducing *E.coli* loading to impacted creeks and waterways.

4.1 BMP List and Budget

Table 6 below shows the specific quantity of BMPs necessary to make a significant impact in water quality. The cost of each BMP is based on NRCS's 2014 state average cost list.

Table 6. Budget

Best Management Practices and Community Outreach	Quantity	Cost	Unit	Budget Estimate
Agricultural and Residential BMPs				
Riparian Forest Buffer	21	\$816.65	Ac	\$17,150
Access Control/Livestock Exclusion Fencing	28,000	\$2.41	Ft	\$67,480
Cross Fencing for Rotational Grazing	12,000	\$1.77	Ft	\$21,240
Tanks for Watering Facilities	12	\$1,280.00	Ea	\$15,360
Heavy Use Area for Watering Facilities	12	\$1,470.00	Ea	\$17,670
Pipeline for Watering Facilities	12,500	\$2.30	Ft	\$28,750
Heavy Use Area Feeding Pads	3	\$2,608.00	Ea	\$7,824
Stream Crossings	3	\$6,298.00	Ea	18,894
Septic System Repairs	35	\$5,000.00	Ea	175,000
Community Engagement				
Farmer's Breakfasts	4	\$750.00	Ea	\$3,000
Farm Field Days	2	\$2,500.00	Ea	\$5,000
Marketing	Mailings, Signs, Septic Awareness Events, misc.			\$25,000
Total Project Budget				\$402,368

4.2 Community Engagement

Community engagement is vital to the successful implementation of the Roseberry Creek Watershed Initiative. To effectively plan community engagement activities it is essential to have an understanding of the watershed’s social infrastructure including key institutions (e.g., schools, libraries, senior centers), social organizations and networks, community leaders and community events. This information will be obtained for the Roseberry Creek Watershed and integrated into its community engagement activities. These activities are divided into two categories: one is “general watershed awareness/education” aimed at the population-at-large within the watershed and the other is “targeted outreach” with activities that have a narrower purpose/message and are directed at a specific subpopulation.

“General Awareness/Education” activities include:

- Newspaper articles in the local Shopper News discussing problems and solutions to water quality problems in the Roseberry Creek Watershed.
- Creation of a Roseberry Creek Watershed-specific informational display.
- Presentations about Roseberry Creek to community groups and professional organizations.

- Installation of Roseberry Creek Watershed signs along major thoroughfares and at bridge crossings.
- Installation of BMP interpretive signs on public lands.
- Creation of a Roseberry Creek page on the Knox County Stormwater Management website.

“Targeted Outreach” activities include:

- Participation in select community events.
- “Farmer's Breakfasts” to introduce agricultural operators to the Knox County SCD and NRCS. Breakfasts will include a presentation on a relevant water quality issue and provide information on septic maintenance and repair and NRCS/SCD cost share assistance programs.
- Farm Field Days to discuss and demonstrate BMPs.
- Targeted mailings to farmers offering cost share programs.
- Targeted mailings to homeowners with septic systems. Mailings will include maintenance tips and offer cost share assistance to homes with identified failing septic systems.

The Community Action Committee’s seven-member AmeriCorps Water Quality Team under the leadership of Initiative partners will help to conduct community engagement activities.

5.0 Project Tasks, Timeline, and Assessment of Progress

The Roseberry Creek Watershed Initiative will be implemented in three phases over a 10 year period. Phase I will be four years long with the first year focusing on gathering information about the watershed’s social infrastructure and monitoring *E. coli* levels. Year 1 will also kick off the community engagement activities with the installation of watershed signs. The following three years of Phase I will include both community engagement activities as well as the application of BMPs. Phases II and III will each be conducted over three years and with their primary focus on restoration. At the end of each of the three phases quantitative geometric mean assessments for *E. coli* will be conducted using TDEC protocol to assess the effectiveness of BMP installations. TDEC has determined impacts stemming from pasture grazing and failing septic systems to be the cause of impairment to Roseberry Creek. Projected tasks under Phase I are as follows, with a timeline of these tasks further delineated in Table 6.

5.1 Phase I Tasks

Task 1. Implement the following Community Engagement activities by the 4th quarter of 2019.

Building awareness of the water quality issues in the Roseberry Creek Watershed and how residents can help to solve them is critical to the success of this plan. Initial awareness activities will begin in 2016 and will include installing watershed signs along major thoroughfares and bridge crossings along with the initiation of watershed-focused articles in the Shopper News and other community publications. A community wide “kickoff” meeting will be held in early 2017. Based on an inventory of the social organizations and networks, a succession of presentations over the course of Phase I will be conducted for targeted groups. In 2017, the first Farmer's Breakfasts will be held and in 2018 the first Farm Tour will be conducted. Towards the end of Phase I interpretive signs will be installed at public BMP sites. A Phase I ending community wide celebration will be held in 2019.

Task 2. Implement failed septic system repair program by the 4th quarter of 2019.

According to the TDEC 2014 draft 303(d) list one of the leading causes of *E. coli* impairment in Roseberry Creek is septic system failure. Historical septic system complaint information from the Knox Co. Health Dept. substantiates this. Knox County Stormwater will provide cost share funds to fix septic systems for 20 homeowners identified as having septic failures by the end of the 4th quarter of 2019. This will be accomplished by partnering with the Health Department to offer assistance to qualified homeowners. Experience in other watersheds has shown that after the initial round of cost shared septic repairs in Roseberry Creek, word of mouth will be sufficient to bring the total up to 20.

Task 3. Implement Ag BMP program by the 4th quarter of 2019

Pasture grazing has been identified by TDEC as the second cause of *E. coli* impairment to Roseberry Creek. Monitoring conducted by Knox County Stormwater will help identify those parcels contributing *E. coli* through livestock operations. Outreach efforts including mailings, newspaper articles, targeted presentations, and Farmers Breakfasts will inform farm owners of voluntary cost share opportunities. In order to meet water quality goals in Roseberry Creek the following practices will be installed:

- 28,000 feet exclusion fencing
- 12,000 feet cross fencing for rotational grazing
- 12 alternative watering systems
- 3 stream crossings
- 3 heavy use area feeding pads
- 21 acres of riparian buffer

Task 6.0 Monitoring and Evaluation

Overall progress towards achieving Roseberry Creek Watershed Restoration Initiative goals will be assessed in quarterly Steering Committee meetings starting in 2016 and lasting the duration

of the project. Annual qualitative and quantitative monitoring efforts over Phase I will be undertaken by the AmeriCorp Water Quality Team and the data will be used to assure the project is on track.

At the completion of Phase I in 2019, TDEC’s *E. coli* measurements will be compared to baseline data from 2014 and 2016. This analysis will determine if changes need to be made to the *E. coli* reduction strategies for Phase II and III implementation. Phase I milestones including the above BMPs, septic system repairs and education/targeted outreach efforts will be evaluated based on the effectiveness of their execution. The overall project will be considered successful when the *E. coli* loads and concentrations are low enough for Roseberry Creek and its tributaries to be removed from the 303(d) list.

5.2 Phase I Timeline

Plan Year	2016				2017				2018				2019			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Activity																
Community Engagement																
Assess social infrastructure of watershed (e.g., community organizations, networks)	X															
Implement outreach: newspaper articles, website, presentations	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Community wide “kickoff” meeting					X											
Install Roseberry Creek Watershed signs			X	X												
Install Roseberry Creek signs at road crossings			X	X												
Farmer’s Breakfasts							X				X					
Farm Tours										X						
Targeted mailings - septic							X									
Targeted mailings - agriculture						X										
Install BMP signs																X
Community wide celebration																X
Septic Repair Program																
Repair failed septic systems							X	X	X	X	X	X	X			
Agriculture BMP Program																
Implement BMPs on farms							X	X		X	X	X		X	X	
Monitoring and Evaluation																
Locate sample sites		X														
5 in 30 Geomean Analysis			X													
Annual single sample and analysis for <i>E. coli</i> by CAC AmeriCorps Water Quality Team							X				X				X	

6.0 Criteria to Assess Achievement of Load Reduction Goal

Phase I of this ten year watershed initiative will be assessed based on the completion of its interim milestones and on *E.coli* load reductions from 2016 to 2019. Interim milestones include the installation of agricultural BMPs, septic system repairs and the implementation of community engagement activities. Quarterly meetings with the Roseberry Creek Watershed partners will be used to assess whether interim milestones are on track with the above timeline. Community engagement will be considered successful if scheduled activities are effectively conducted and outreach materials are created and disseminated. Quarterly assessments of project milestones will determine if adaptive management measures are needed.

Overall, *E.coli* load changes will be measured by comparing TDEC's *E. coli* measurements in 2019 against baseline data from 2014 and 2016. The 2019 data will be analyzed to determine if changes to Phase II and III restoration strategies need to be made. The Watershed Initiative will be deemed successful when *E. coli* loads and concentrations are low enough Roseberry Creek and its tributaries in their entirety are removed from the 303(d) list.

7.0 Monitoring and Documenting Success

TDEC will monitor its site on Mascot Road in the Roseberry Creek Watershed for *E. coli* levels on a five-year cycle. Knox County will monitor the additional sites selected prior to implementation. Monitoring sites will be located at the confluence of major tributaries on the main stem. The monitoring data will be compared with pre-project baseline data to determine the effectiveness of the restoration efforts. TDEC will collect samples in 2019, the last year in the first phase of the project. Qualitative data on land use adjacent to creeks and measurements of *E.coli* levels will be collected annually by the AmeriCorp Water Quality Team and used to help adapt the plan as needed.