Flat Creek Watershed Restoration Plan

NAME OF PROJECT:

Flat Creek Watershed Restoration

LEAD ORGANIZATION:

Knox County Soil Conservation District

WATERSHED IDENTIFICATION

Flat Creek Watershed; Grainger, Union and Knox Counties, HUC TN 060101040306

INTRODUCTION:

The Flat Creek watershed drains an area of 43,721 acres or 68 square miles in the 999 square mile Holston River watershed. The watershed originates in Grainger County and flows through portions of Union and Knox Counties before its confluence with the Holston River in eastern Knox County. The watershed is mostly rural pastoral landscape with a mix of livestock grazing operations of varying sizes and wooded properties. Poverty is apparent in the watershed, especially in Union and Grainger Counties where the Natural Resource Conservation Service (NRCS) has listed the area as part of their StrikeForce for rural growth and opportunity. The StrikeForce program identifies counties across the country with persistent rural poverty and aims to address resource concerns in these historically underserved areas.

The watershed also contains the 500 acre House Mountain State Natural Area which provides recreation trails and views from its 2,100 foot crest. Flowing from the preserve is a tributary that is listed as a Tennessee Exceptional Water which joins Flat Creek at mile 7.9.

The following maps show the Flat Creek watershed in relation to the Holston River watershed (Figure 1) and the 303d list status of the creeks in the watershed (Figure 2).

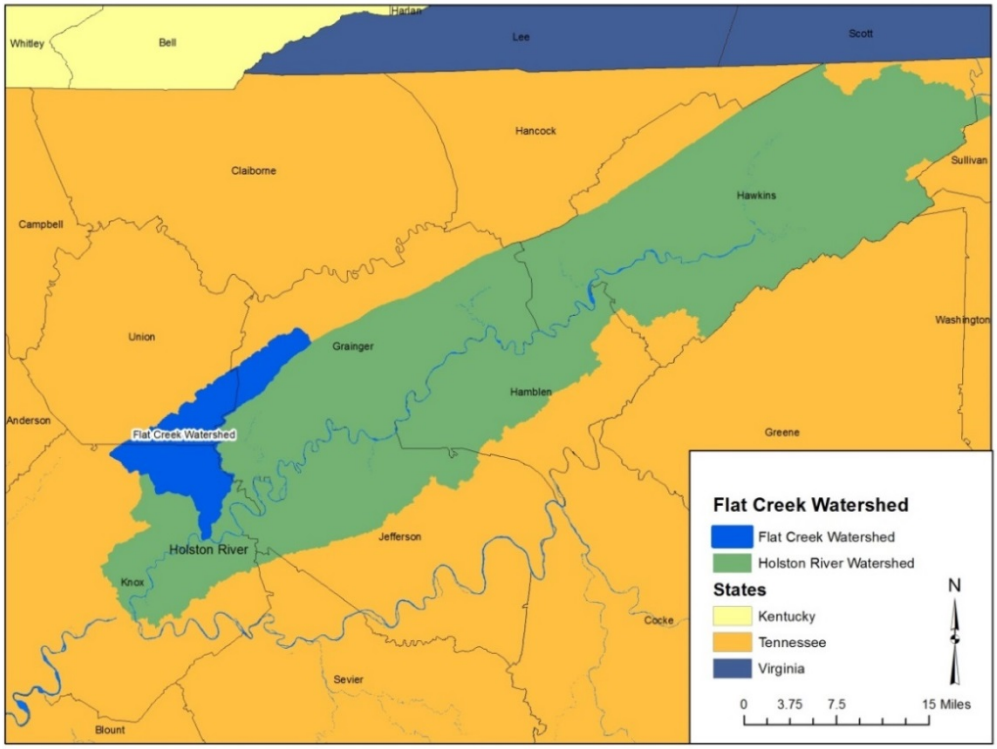

*Figure 1*Flat Creek *Watershed Vicinity Map*

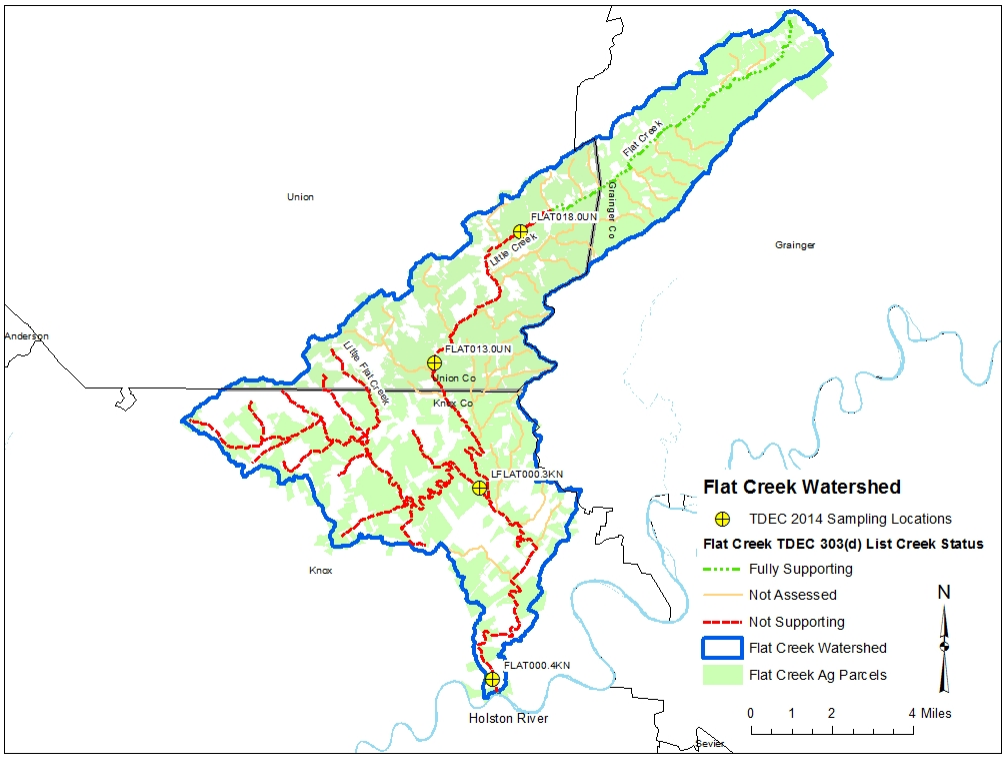

Figure 2 Detail Map of the Flat Creek *Watershed*

1 SOURCES AND CAUSES OF POLLUTANTS IN THE WATERSHED:

Three Creek Segments in the Flat Creek Watershed have been listed as impaired by TDEC in their 2014 303d list. Sixteen miles of Flat Creek is listed as impaired due to total phosphorus from a Municipal Point Source and *E. coli* from non-point sources while 2.8 miles of Flat Creek are listed as impaired due to *E. coli* levels. Thirty miles of Little Flat Creek is listed as impaired due to elevated *E. coli* levels. In total TDEC has placed 49 miles of creek in the Flat Creek watershed on the 303d list as not supporting their designated uses out of a total of 142 miles of streams. As shown in Figure 2, only 39 miles of the remaining stream are listed as supporting their designated uses and 53 miles are listed as not assessed (mainly small tributaries).

The sources of the *E. coli* have been identified by TDEC as Pasture Grazing and Animal Feeding Operations (NPS), while the source of the Phosphorus is listed as a Municipal Point Source. This plan will address the reduction of non-point source pollutants, namely *E. coli*. Phosphorus derived from the Municipal Point Source should be reduced to acceptable levels and its reduction is beyond the scope of this watershed plan. The impacted waterbodies, the cause of the impaction and the pollutant source are listed in table 1.

Table 1 TDEC 2014 303d Waterbody Status

Waterbody ID	Impacted Waterbody	County	Miles Impaired	Cause	Pollutant Source	Comments
TN06010104019 - 0100	Little Flat Creek	Knox	30.3	*E. coli*	Animal Feeding Operations (NPS)	Category 4a. EPA approved a pathogen TMDL that addresses the known pollutant
TN06010104019 - 1000	Flat Creek	Union Knox	16.3	Total Phosphorus *E. coli*	Municipal Point Source Pasture Grazing	Category 5. EPA approved a pathogen TMDL that addresses a known pollutant.
TN06010104019 - 2000	Flat Creek	Union Knox	2.8	*E. coli*	Pasture Grazing Collection System Failure	Category 4a. 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 of a minimum of 5 samples collected within a 30 day period. TDEC sampled four locations in the Flat Creek Watershed, three on Flat Creek and one on Little Flat Creek in 2014. The data are shown in Table 2. Only three samples were available from the sampling point furthest up in the watershed due to low flows. The locations of the sampling points are shown in Figure 2.

Table 2 TDEC 2014 E. coli Data

2014 TDEC Flat Creek *E. coli* Data for the Flat Creek Watershed						
Location	***E. coli* CFU/ 100mL**	***E. coli* CFU/ 100mL**	***E. coli* CFU/ 100mL**	***E. coli* CFU/ 100mL**	***E. coli* CFU/ 100mL**	**Geometric Mean**
	8/4/2014	8/13/2014	8/18/2014	8/25/2014	8/27/2014	
FLAT000.4KN	147	**>2420**	161	96	84	**215.2**
LFLAT000.3KN	816	**>2420**	548	260	219	**572.7**
FLAT13.0UN	186	**1414**	345	108	161	**275.2**
FLAT018.0UN	135	**1553**	291	NA	NA	NA

Although 39 miles of the upper portion of Flat Creek are currently listed as supporting their designated uses recent data from TDEC indicates that *E. coli* levels are above state water quality standards. The 2007 water quality standards state that no individual water sample may contain over 941 CFU/100mL and the FLAT018.OUN sampling location contains a sample of 1553 CFU/ 100mL. This, in combination with qualitative data collected by Knox Soil Conservation district, indicates that although the upper segment of Flat Creek is currently listed as supporting its designated uses the entire watershed would benefit from management changes that would lead to reductions in *E. coli* levels. Biological surveys conducted by Knox, Union, and Grainger Soil Conservation Districts in 2014 indicate that the major sources of the pollutant is pasture grazing. Livestock with direct access to the creeks is common and the majority of the pastures could be classified as overgrazed. The combination of sparse pasture vegetation and no riparian buffers greatly increases the *E. coli* loading to the creeks especially during rainfall events.

Sixty-eight percent of the land area in the Flat Creek Watershed is in parcels designated as agricultural, of which pasture is between 40-60%, or between 11,942 and 17,913 acres —based on aerial imagery, ground-truthing surveys and expert opinion. 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, failing septic systems can safely be assumed to be a source of *E. coli* in the watershed. According to estimates provided in the Holston River TMDL 80% of the population of Grainger County, 75% of Union County residences and 45% of Knox County residences are on septic systems. It is safe to assume that failing septic systems are a contributor to *E. coli* bacteria in the Flat Creek Watershed. Failing sceptic systems are commonly associated with low income residence, and as previously mentioned, the watershed has a high percentage of low income residents who are reliant on septic systems.

1.1 FLAT CREEK WATERSHED TMDL

A Total Maximum Daily Load (TMDL) document was approved for the Holston River in 2008 and provides estimates of the load reduction in Flat 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, Flat Creek needs reductions of 3.2% to meet the Margin of Safety (MOS) standards during Mid-Range Flows for daily loading. No other reductions are needed during other flow regime based on daily loading, however, a reduction of 81% in *E. coli* loading is needed to meet the TMDL target MOS 30 day geometric mean. For Little Flat Creek daily load reduction to meet TMDL-MOS are as follows: High Flows: 22%, Moist Condition: 17%, Mid-Range Flows: 22%, Low Flows: No Reduction Required. Reductions based on geometric mean are not available for Little Flat Creek. This data is shown in the following table (Source: Holston River Watershed TMDL 2008). Note: PDFE is defined as the percent of days the flow was exceeded.

Calculated Load Reduction Based on Daily Loading – Flat Creek

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL	Average of Load Reductions	% Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]
6/22/04	High Flows	200.64	2.1%	228	1.12E+12	NR		
6/28/04		58.39	9.7%	461	6.59E+11	NR	**NR**	**NR**
7/7/04	Moist Conditions	32.51	18.1%	770	6.12E+11	NR		
8/3/04		24.95	24.1%	727	4.44E+11	NR		
7/1/04		21.79	27.8%	435	2.32E+11	NR	**NR**	**NR**
9/23/04	Mid-Range Flows	13.50	40.1%	387	1.28E+11	NR		
7/14/04		10.74	47.0%	1046	2.75E+11	**10.0**		
9/29/04		8.39	53.7%	135	2.77E+10	NR		
7/20/04		8.31	54.0%	435	8.84E+10	NR		
7/22/04		7.56	56.6%	313	5.79E+10	NR		
8/16/04		6.85	59.4%	727	1.22E+11	NR	**1.7**	**3.2**
9/2/04	Low Flows	4.36	70.6%	365	3.89E+10	NR	**NR**	**NR**

Note: NR = No reduction required
NA = Not applicable

Calculated Load Reduction Based on Geomean Data – Flat Creek

Sample Date	Flow	PDFE	Concentration	Geometric Mean	Calculated Reduction	
					to Target GM (126 CFU/100 ml)	to Target – MOS (113 CFU/100 ml)
	[cfs]	[%]	[CFU/100 ml]	[CFU/100 ml]	[%]	[%]
6/22/04	200.64	2.1%	228			
6/28/04	58.39	9.7%	461			
7/1/04	21.79	27.8%	435			
7/7/04	32.51	18.1%	770			
7/14/04	10.74	47.0%	1046	516.69	75.6	78.1
7/20/04	8.31	54.0%	435	502.08	74.9	77.5
7/22/04	7.56	56.6%	313	529.31	76.2	78.7
8/3/04	24.95	24.1%	727	603.00	**79.1**	**81.3**

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

Calculated Load Reduction Based on Daily Loading – Little Flat Creek

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL	Average of Load Reductions	% Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]
1/11/05	High Flows	57.29	1.3%	172	2.41E+11	NR		
5/24/00		34.50	3.1%	2419	2.04E+12	**61.1**		
12/13/04		22.53	5.6%	461	2.54E+11	NR	**20.4**	**21.7**
2/3/05	Moist Conditions	10.79	14.3%	310	8.19E+10	NR		
4/12/05		9.99	16.0%	520	1.27E+11	NR		
5/4/05		8.32	19.4%	148	3.01E+10	NR		
6/2/05		6.39	25.9%	5290	8.27E+11	**82.2**		
11/9/04		4.51	35.2%	310	3.42E+10	NR	**16.4**	**16.8**
3/3/05	Mid-Range Flows	3.36	43.1%	100	8.23E+09	NR		
2/24/00		2.22	54.3%	50	2.72E+09	NR		
8/24/00		2.19	54.7%	2419	1.30E+11	**61.1**	**20.4**	**21.7**
7/21/04	Low Flows	1.07	72.1%	108	2.81E+09	NR		
10/5/04		0.92	75.1%	291	6.58E+09	NR		
8/11/04		0.87	76.2%	214	4.54E+09	NR		
9/1/04		0.49	88.2%	299	3.57E+09	NR		
11/2/00		0.21	99.3%	44	2.28E+08	NR	**NR**	**NR**

Note: NR = No reduction required
NA = Not applicable

2 ESTIMATE OF LOAD REDUCTIONS EXPECTED FROM MANAGEMENT MEASURES

The goal of this project is to reduce the levels of *E. coli* in the Flat Creek Watershed to a degree to which the watershed would be removed from TDEC's 303d list. Implementing the best management practices (BMPs) recommended in this plan will significantly reduce the inputs of *E. coli* from pasture and septic sources. Estimating the *E. coli* load reductions gained from installing agricultural best management practices and fixing failing septic systems is not possible with the data available. The authors therefore recommend that a tiered approach be taken on the project using adaptive management and best professional judgment. This would take the form of installing agricultural BMPs on a subset of the farms in the watershed and assessing the change in *E. coli* loading following TDEC's 2019 data collection cycle. Adaptive management measures would then be taken to meet the project goal of removing the watershed from the 303d list.

In addition to reducing *E. coli* this project will reduce nitrogen, phosphorus, and sediment loads in the watershed. Load reductions resulting from the implementation of each BMP and for the project as a whole can be projected using modeling. The STEPL (Spreadsheet Tool for Estimating Pollutant Load) model was used to estimate load reductions for the project and the results are shown in table 4. For the project as a whole an annual load reduction of 52,966 pounds of nitrogen, 4,551 pounds of phosphorus and 698 tons of sediment is predicted for the flat creek watershed. More information on the STEPL model, which was developed by Tetra Tech, Inc., can be found on the EPA's website (http://it.tetratech-ffx.com/steplweb/).

Table 3 Nitrogen, Phosphorus and Sediment Load Reduction

Practice	Amount	Nitrogen Reduction Factor	Lbs. Nitrogen Reduced / Yr.	Phosphorus Reduction Factor	Lbs. Phosphorus Reduced/ Yr.	Sediment Reduction Factor	Tons Sediment Reduced/ Yr.
Riparian Forest Buffer 60 Ac = 2,613,600 sq. ft. @ 35' wide = 74674 linear ft.	74674 ft.	0.28	20909	0.02	1493.48	0.002	149.35
Exclusion Fence	80000 ft.	0.11	8800	0.01	800	0.001	80
Cross Fencing	35000 ft.	0.25	8750	0.02	700	0.006	210
Watering Facility	35	70.23	2458	5.88	205.8	0.004	0.14
Pipeline for Watering Facilities	35 ft.	0.13	5	0.02	0.7	0.006	0.21
Heavy use area feeding pad (3 @ 20x60 ft.)	36000 square ft.	0.09	3240	0.01	360	0.002	72
Stream Crossing: low water crossing-hard armor at 8@ 12x80=960x8=1920 sq. ft.	8	160.98	1288	17.425	139.4	5.375	43
Critical Area Planting	25 Ac.	100.04	2501	13.56	339	0.055	1.375
Forage and Biomass Planting	300 Ac.	6.78	2034	0.66	198	0.175	52.5
Septic System Repair	25	119.28	2982	12.58	314.5	3.564	89.1
Total for Flat Creek Watershed Project			**52,966** Lbs. N Reduced		**4,551** Lbs. P Reduced		**698** Tons Sediment Reduced

3 BMP LIST, EDUCATIONAL ACTIVITIES AND BUDGET

3.1 BMP LIST

The focus of this project will be to install agricultural BMPs in the Flat Creek Watershed. These practices will focus on changing management of land to promote infiltration of storm water, exclude livestock from creeks or control there access and create riparian and other zones to filter runoff. Each farm that participates in the program will be assessed individually and practice recommendations will be developed to protect the natural resources both on and downstream of the

farm while protecting the sustainability of the farming operation and the land. BMPs will follow NRCS and 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), Streambank Restoration, and Wells and/or pipeline for Alternate Watering Stations.

The project will prioritize projects that are projected to have the highest benefit in terms of reducing *E. coli* loading to impacted creeks and waterways. More specifically projects where farms are adjacent to impacted creeks will be prioritized. The two overarching priorities will be controlling livestock's access to waterways through access control fencing and riparian buffers and improving infiltration rates through pasture management improvements. Pasture management improvements will focus on promoting a rotational grazing system which has many benefits for the farmer as well as the environment. A properly managed rotational grazing system results in higher forage heights and greater average above ground biomass, both of which promote infiltration and filtration of storm water.

3.1 EDUCATIONAL ACTIVITIES

Education and outreach will be critical to insure initial and ongoing participation by the stakeholders in the watershed restoration plan. A series of farmers' breakfasts will kick off the program to generate interest and BMP implementation. Local farmers and community members will be invited to the farmers' breakfasts and a discussion of the program goals and resources will be led by the watershed coordinator and the local soil conservation district. A farm tour to demonstrate the methods and benefits of agricultural BMPs will be conducted in the first year of the restoration plan.

Education and outreach material will be developed and disseminated to increase public participation in the project. This will include posters showing the location of the watershed and advertising the availability of financial assistance for Ag BMPs and septic system repairs. Newspaper articles will be written to share information on available programs. Targeted mailers will be sent to potential participants in the watershed.

3.2 BUDGET

The following budget 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.

BMP Name	Quantity	Cost	Unit	Budget Estimate
Riparian Forest Buffer	60	816.65	Ac	$ 48,999.00
Exclusion Fence/Access Control Fence	80,000	2.41	Ft	$ 192,800.00
Cross Fencing	35,000	1.77	Ft	$ 61,950.00
Watering Facility (Tanks)	35	1280	Ea	$ 44,800.00
Heavy Use Area For Watering Facility	35	1470	Ea	$ 51,450.00
Pipeline for Watering Facilities	36,000	2.3	Ft	$ 82,800.00
Wells	3500	14.14	Ft	$ 49,490.00
Heavy Use Area Feeding Pad	8	2608	Ea	$ 20,864.00
Stream Crossing	8	6298	Ea	$ 50,384.00
Critical Area Planting	25	274	Ac	$ 6,850.00
Forage and Biomass Planting	300	266	Ac	$ 79,800.00
Septic System Repair	25	5,000	Ea	$ 125,000.00
Educational Events				$ -
Farmers Breakfasts	12	700	Ea	$ 8,400.00
Farm Field Days	6	3500	Ea	$ 21,000.00
Communications and Marketing	Newspaper-Mailouts-Brochure			$ 8,000.00
Total Budget for Project				**$ 852,587.00**

4 PROJECT TASKS TIMELINE AND ASSESSMENTS OF PROGRESS:

This watershed plan will be implemented in three phases lasting a total of 9-15 years. Assessments of success will be conducted at the end of each 3-5 year phase. Data from TDEC's 5 year collection cycle will be used to measure success at the end of the first phase. Quarterly meetings with the partners implementing the plan will be conducted to insure adherence to the schedule. Specific tasks pertaining to the first phase of the project are outlined in the following table.

The grant partners will accomplish the following during the first phase of the project:

TASK 1: IMPLEMENT THE FOLLOWING AGRICULTURAL BMPS BY THE 3RD QUARTER OF 2019

According to TDEC's assessments and biological assessments made by Knox, Union, and Grainger Soil Conservation Districts agricultural sources account for the majority of pathogens in Flat Creek. The majority of the project funding will be directed towards the following: install 60 acres of riparian buffer, 80,000 feet of livestock exclusion/access control fence, 35,000 feet of cross fencing, 35 alternative watering facilities including wells and pipeline if necessary, 8 heavy use area feeding pads, 8 stream crossings, 25 acres of critical area planting, and 300 acres of pasture renovation (Forage and Biomass Planting).

The Knox, Union, and Grainger Co Soil Conservation Districts and the NRCS will provide a variety of outreach measures to insure that the above is realized through the voluntary participation of producers. This will include target mailers, onsite meetings, farmers' breakfasts, and farm tours.

TASK 2: IMPLEMENT THE SEPTIC SYSTEM REPAIR COST-SHARE PROGRAM. REPAIR 25 FAILING RESIDENTIAL SEPTIC SYSTEMS BY THE 3RD QUARTER OF 2019

The majority of the residences of the Flat Creek watershed are using septic systems to dispose of household wastewater and it can be safely assumed that some of these systems are failing. Although the relative pathogen load from failing septic system verses agricultural runoff is not available it is the opinion of the project partners that it is a significant source. Septic systems will be selected for repair where a long term viable solution to the specific problem is available. Failing septic systems will be located by working with the Knox, Union and Grainger County Health Departments and advertising the availability of funding in local newspapers and at public outreach events.

TASK 3: CONDUCT 4 FARMERS BREAKFASTS FOR PROJECT INPUT AND OUTREACH, 2 FARM FIELD DAYS BY THE 3RD QUARTER OF 2019

Public participation and buy in are essential for project success. The project will be kicked off with a series of farmers' breakfasts where the public will be invited to learn about project goals and objectives and the availability of support for participants. Public input will be solicited at these meetings and new ideas will be incorporated into the adaptive management portion of the project.

Two farm field days will be held to demonstrate agricultural BMPs and discuss the benefits of these practices, both in terms of benefit to the environment and to the producers.

TASK 4: MONITORING AND EVALUATION

Progress towards project goals will be assessed quarterly starting in 2015 and lasting the duration of the project through meetings with the partnering organizations. Ultimately success will be measured against TDECs *E. coli* measurements in 2019 and compared to baseline data from 2004, 2009, and 2014. The data will be analyzed in 2019 and the watershed plan will be re-assessed and necessary changes to the strategy to reduce NPS pollutants will be made. The project will be considered successful when the above BMPs, septic system repairs and education events are completed and *E. coli* loads and concentrations are low enough for the creeks in the watershed to be removed from the 303(d) list. Annual qualitative and quantitative monitoring efforts will be undertaken by the AmeriCorps Water Quality Team and the data will be used to assure the project is on track.

Table 4 Flat Creek Watershed Implementation Plan

Year of Plan	**2016**				**2017**				**2018**				**2019**				**2020**			
Quarter	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Activity																				
Outreach and Education																				
Farmers Breakfasts	X			X	X			X												
Farm Tour			X				X													
Develop and Disseminate informational materials	X	X	X	X	X															
Agricultural BMPs and Septic System Repairs																				
Implement Agricultural BMPs		X	X	X	X	X	X	X	X	X	X	X	X	X	X					
Repair Failing Septic Systems		X	X	X	X	X	X	X	X	X	X	X								
Monitoring																				
Collect Annual Biological and *E. coli* data (By AmeriCorps)			X				X				X				X				X	
Collect *E. coli* samples -- 5 in 30 day period (TDEC 5 year cycle)															X					
Evaluation																				
Conduct Quarterly Meeting with the project partners			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Evaluate success in meeting *E. coli* reduction goals																X	X			
Adaptive Management-- Make necessary changes to Watershed Plan																		X	X	X

5 CRITERIA TO ASSESS ACHIEVEMENT OF LOAD REDUCTION GOALS

Ultimately success will be measured against TDECs *E. coli* measurements in 2019 and compared to baseline data from 2004, 2009, and 2014. The data will be analyzed in 2019 and the watershed plan will be re-assessed and necessary changes to the strategy to reduce NPS pollutants will be made. The project will be considered successful when the above BMPs, septic system repairs and education events are completed *and E. coli* loads and concentrations are low enough for the creeks in the watershed to be removed from the 303(d) list.

The project will be implemented based on the above schedule and success will be measured on the timely completion of the listed BMPs, septic system repairs and educational/outreach tasks. Quarterly meetings with the grant partners will be used to assess whether the project is on schedule. Education and outreach will be considered successful if scheduled events are completed and outreach materials are completed and disseminated. Quarterly assessments of BMPs implementation will be used to determine if interim milestones are being met, and adaptive management measures will be taken if necessary.

6 MONITORING AND DOCUMENTING SUCCESS

The Tennessee Department of Environment and Conservation (TDEC) will monitor four sites in the Flat Creek Watershed for *E. coli* levels on a 5 year cycle. 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 year after 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 AmeriCorps Water Quality Team and used to help adapt the plan as needed during the implementation phase.

Annual reports will be generated by the Watershed Coordinator documenting progress towards implementing the project tasks. A final report will be generated at the end of the first phase of the project and will incorporate and discuss the data collected by TDEC.