Tuttle Creek Lake

Watershed Restoration and Protection Strategy

Lower Big Blue River and Lower Little Blue River Watersheds

Final Draft Plan May 27, 2010

Approved by KDHE June 2, 2010

Funding for the development of this plan was provided through EPA 319 grant 2004-0032 from the Kansas Department of Health and Environment.

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1.0 Preface

The purpose of this Watershed Restoration and Protection Strategy (WRAPS) report for the Lower Big Blue/Lower Little Blue Rivers Watershed is to outline a plan of restoration and protection goals and actions for the surface waters of the watershed. Watershed goals are characterized as “restoration” or “protection”. Watershed restoration is for surface waters that do not meet water quality standards, and for areas of the watershed that need improvement in habitat, land management, or other attributes. Watershed protection is needed for surface waters that currently meet water quality standards, but are in need of protection from future degradation.

The WRAPS development process involves local communities and governmental agencies working together toward the common goal of a healthy environment. Local participants or stakeholders provide valuable grass roots leadership, responsibility and management of resources in the process. They have the most “at stake” in ensuring the water quality existing on their land is protected. Agencies bring science-based information, communication, and technical and financial assistance to the table. Together, several steps can be taken towards watershed restoration and protection. These steps involve building awareness and education, engaging local leadership, monitoring and evaluation of watershed conditions, in addition to assessment, planning, and implementation of the WRAPS process at the local level. Final goals for the watershed at the end of the WRAPS process are to provide a sustainable water source for drinking and domestic use while preserving food, fiber, and timber production. Other crucial objectives are to maintain recreational opportunities and biodiversity while protecting the environment from flooding, and negative effects of urbanization and industrial production. The ultimate goal is watershed restoration and protection that will be “locally led and driven” in conjunction with government agencies in order to better the environment for everyone.

This report is intended to serve as an overall strategy to guide watershed restoration and protection efforts by individuals, local, state, and federal agencies and organizations. At the end of the WRAPS process, the Stakeholder Leadership Team (SLT) will have the capability, capacity and confidence to make decisions that will restore and protect the water quality and watershed conditions of the Lower Big Blue/Lower Little Blue Rivers Watershed.

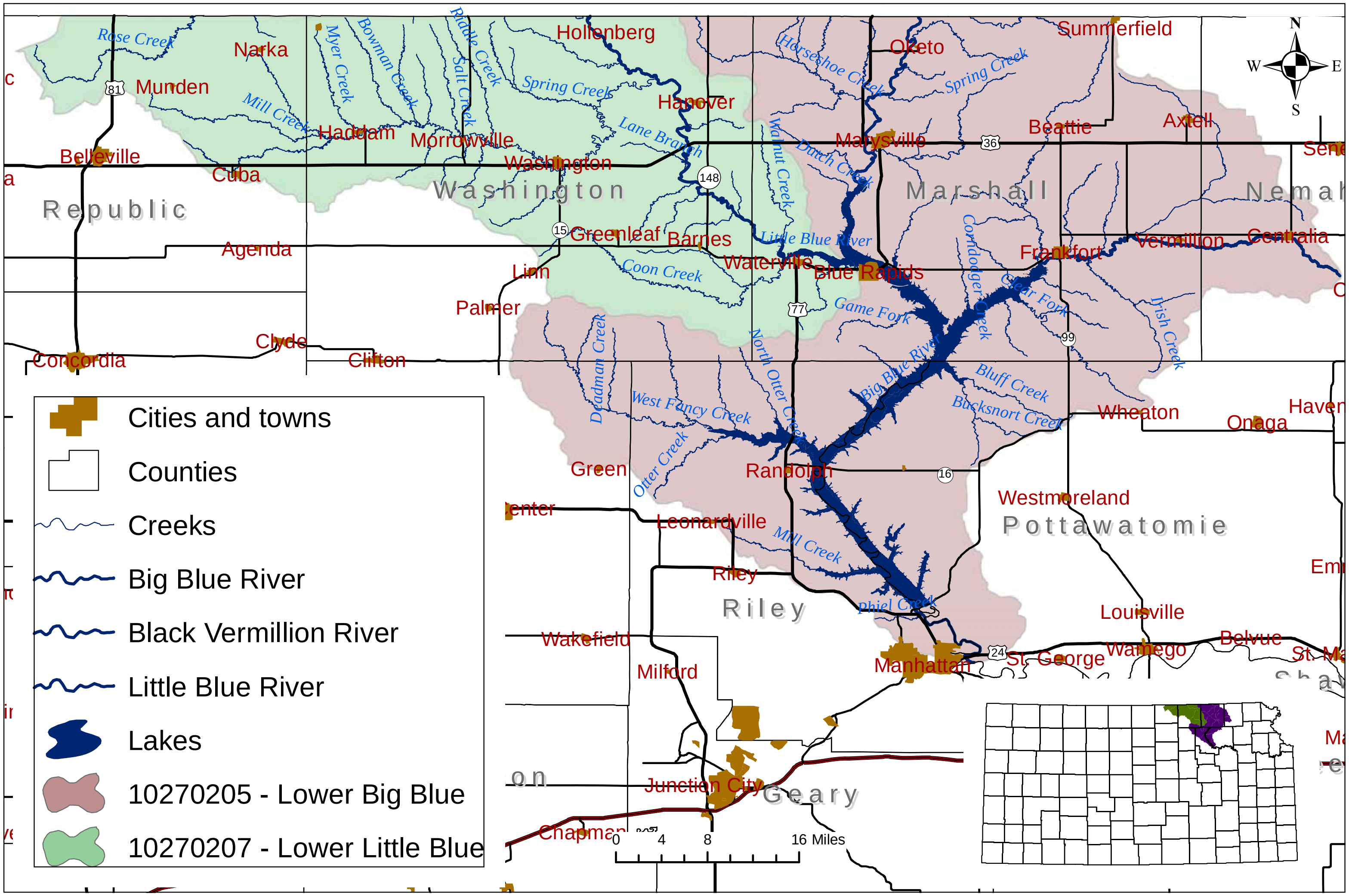
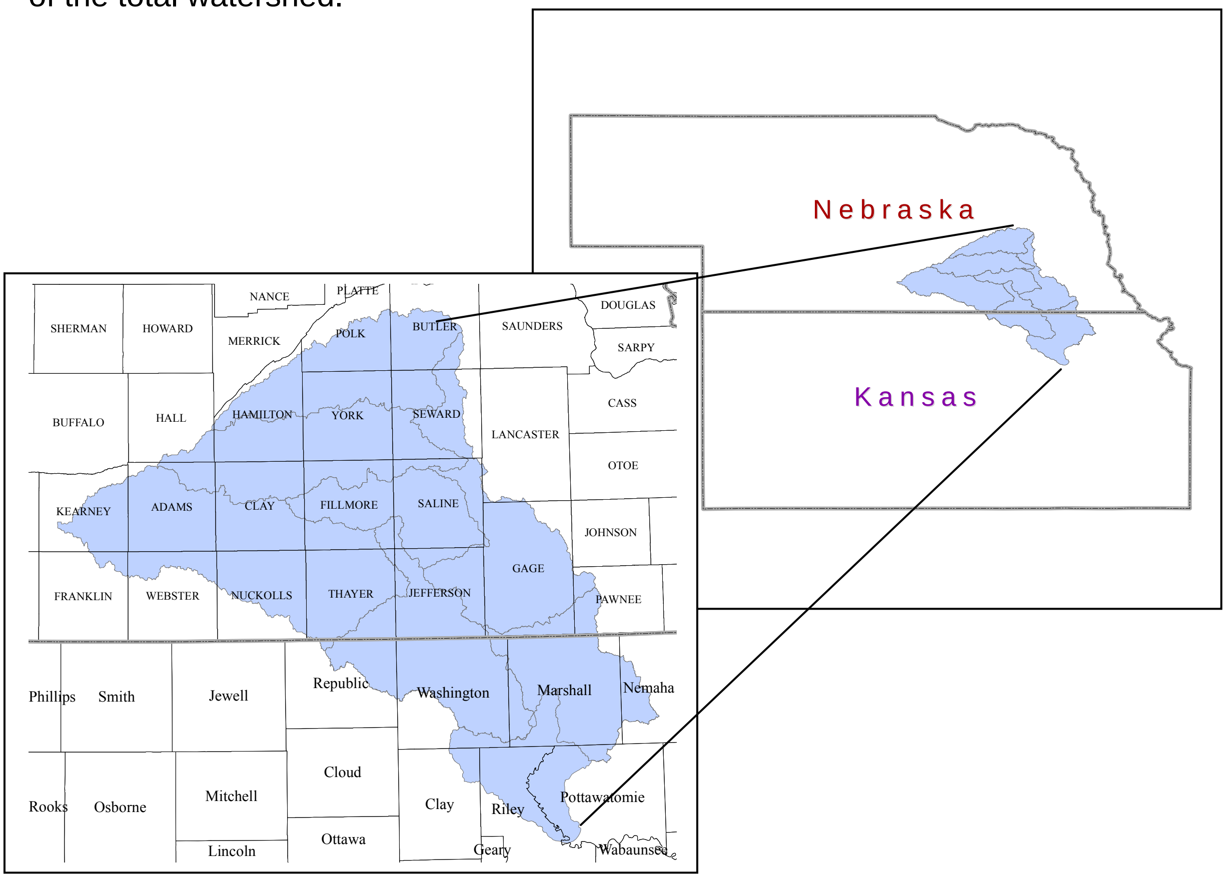


Figure 1. Map of Lower Big Blue/Lower Little Blue Rivers Watershed.

2.0 Description of the Watershed

Much of the watershed draining the Big Blue and Little Blue Rivers lies in Nebraska. Only approximately 25 percent is actually in Kansas. Therefore, it is necessary that Kansas and Nebraska work in unison to achieve water quality improvements. However, this WRAPS project only includes the Kansas portion of the total watershed.



EPA Targeted Watershed Grant [1]

In an effort to work across state lines, the entire watershed in Kansas and Nebraska has been granted an EPA Targeted Watershed Grant. EPA Targeted Watershed Grant funds will be used to advance the goals of the Tuttle Creek Lake partners and to implement watershed management plans. This grant program is a competitive program designed to encourage collaborative, community-driven approaches to meet clean water goals. The goals for this grant are:

- Target and implement Best Management Practices (BMPs) for agriculture in critical sub-watersheds.
- Install continuous no-till cultivation practices.
- Establish riparian buffer strips and filter strips.

- Enhance educational efforts, including development of nutrient and herbicide plans and field demonstrations about conservation practices
- Utilize market-based incentives to encourage and support landowner adoption of BMPs, including cost-share assistance for planting specialty forest products in riparian buffer strips.
- Conduct water quality monitoring to inventory reductions in sediment, nutrient, herbicide and bacteria runoff due to installation of BMPs.

Blue River Compact [2]

Kansas and Nebraska have an interstate compact to achieve pollution abatement programs in each of the two states and to reduce further reduction of pollution. Agreements of this compact in terms of water quality are as follows:

Article VI--Water Quality Control

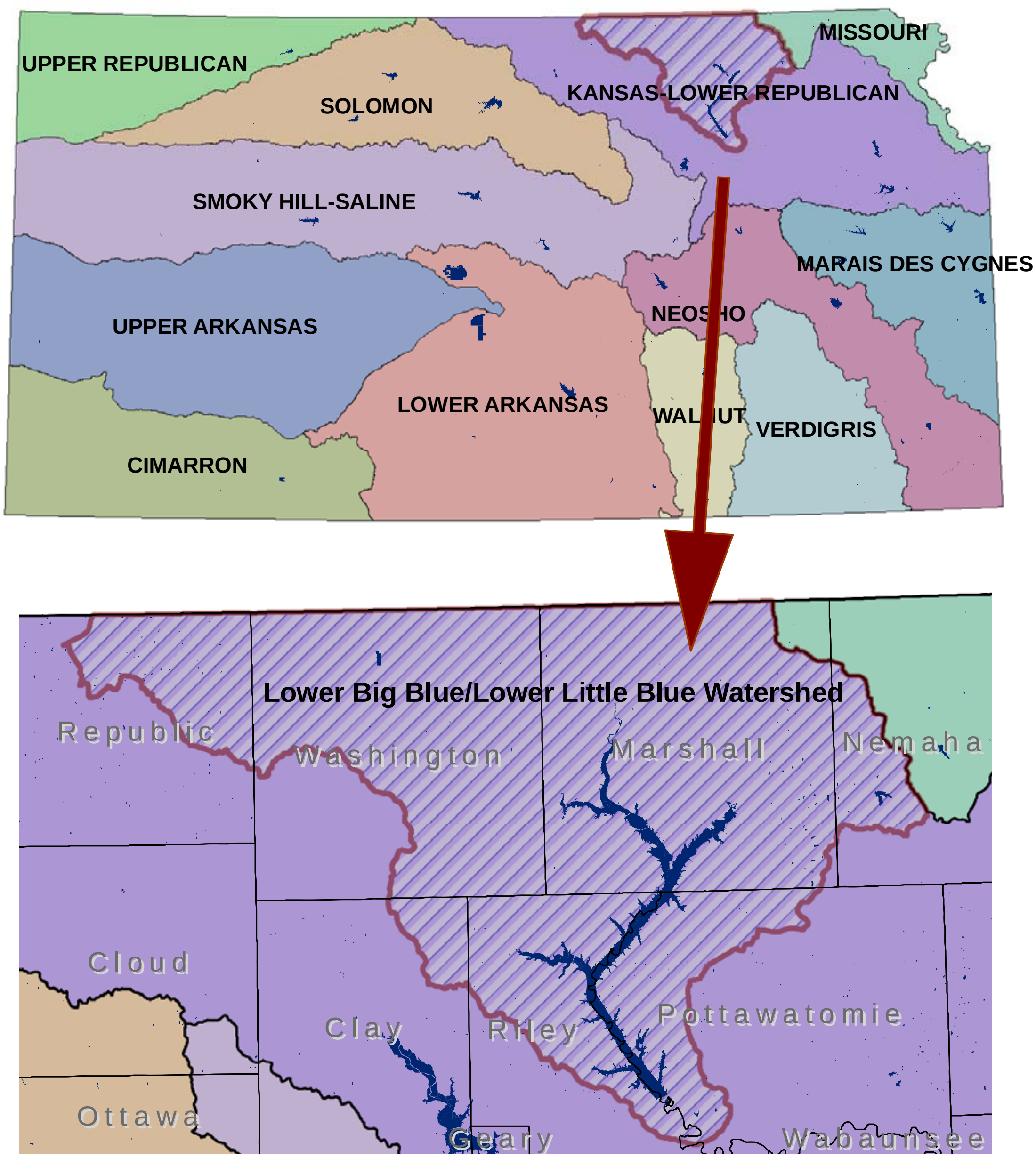
- *6.1 The states of Kansas and Nebraska mutually agree to the principle of individual state efforts to control natural and man-made water pollution within each state and to the continuing support of both states in active water pollution control programs.*
- *6.2 The two states agree to cooperate, through their appropriate state agencies, in the investigation, abatement, and control of sources of alleged interstate pollution within the Big Blue river basin whenever such sources are called to their attention by the administration.*
- *6.3 The two states agree to cooperate in maintaining the quality of the waters of the Big Blue river basin at or above such water quality standards as may be adopted, now or hereafter, by the water pollution control agencies of the respective states in compliance with the provisions of the federal water quality act of 1965, and amendments thereto.*
- *6.4 The two states agree to the principle that neither state may require the other to provide water for the purpose of water quality control as a substitute for adequate waste treatment*.

The Stakeholder Leadership Team (SLT) has been meeting since 2007 and they have set their **watershed restoration and protection goals** as:

1. protect and restore water quality throughout the watersheds,
2. protect the water supply storage capacity in Tuttle Creek Lake,
3. protect recreational uses at Tuttle Creek Lake
4. preserve and enhance wildlife habitat in the watershed,
5. control flooding, and
6. protect the productivity of agricultural lands throughout the watershed.

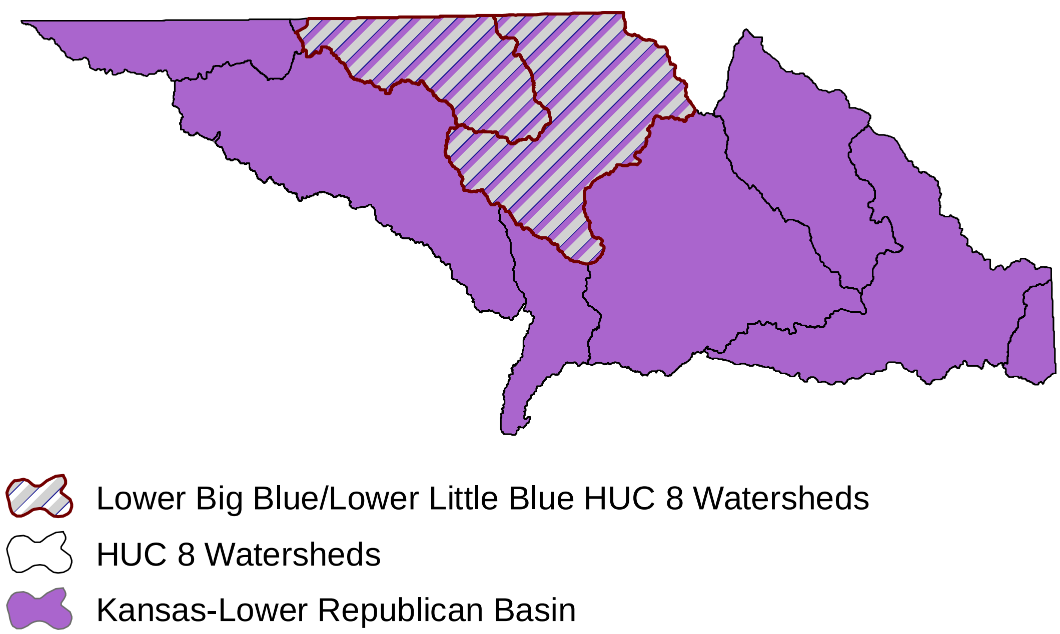
3.0 Watershed Review

There are twelve river basins located in Kansas. The scope of this WRAPS project is a portion of the Kansas-Lower Republican Basin in north-central Kansas. The entire basin drains the Kansas River and its tributaries into the Missouri River and eventually empties into the Gulf of Mexico. The extent of the WRAPS area is the Big Blue and Little Blue Rivers and their supporting tributaries. The geographical endpoint of the watershed is the confluence of the Big Blue River and the Kansas River below Tuttle Creek Lake and dam.



A watershed is an area of land that catches precipitation and funnels it to a particular creek, stream, and river and so on, until the water drains into an ocean. A watershed has distinct elevation boundaries that do not follow political “lines” such as county, state and international borders. Watersheds come in all shapes and sizes, with some only covering an area of a few acres while others are thousands of square miles across.

HUC is an acronym for **H**ydrologic **U**nit **C**odes. HUCs are an identification system for watersheds. Each watershed has a unique HUC number in addition to a common name. As watersheds become smaller, the HUC number will become larger. For example, the Kansas-Lower Republican Basin is one of twelve basins in the state of Kansas. Within the Kansas-Lower Republican Basin are ten HUC 8 classifications. The Lower Big Blue/Lower Little Blue Watershed, which contains Tuttle Creek Lake, is comprised of two 8 digit HUC watersheds – 10270205 (Lower Big Blue) and 10270207 (Lower Little Blue). HUC 8s can further be split into smaller watersheds that are given HUC 10 numbers and HUC 10 watersheds can be further divided into smaller HUC 12s.



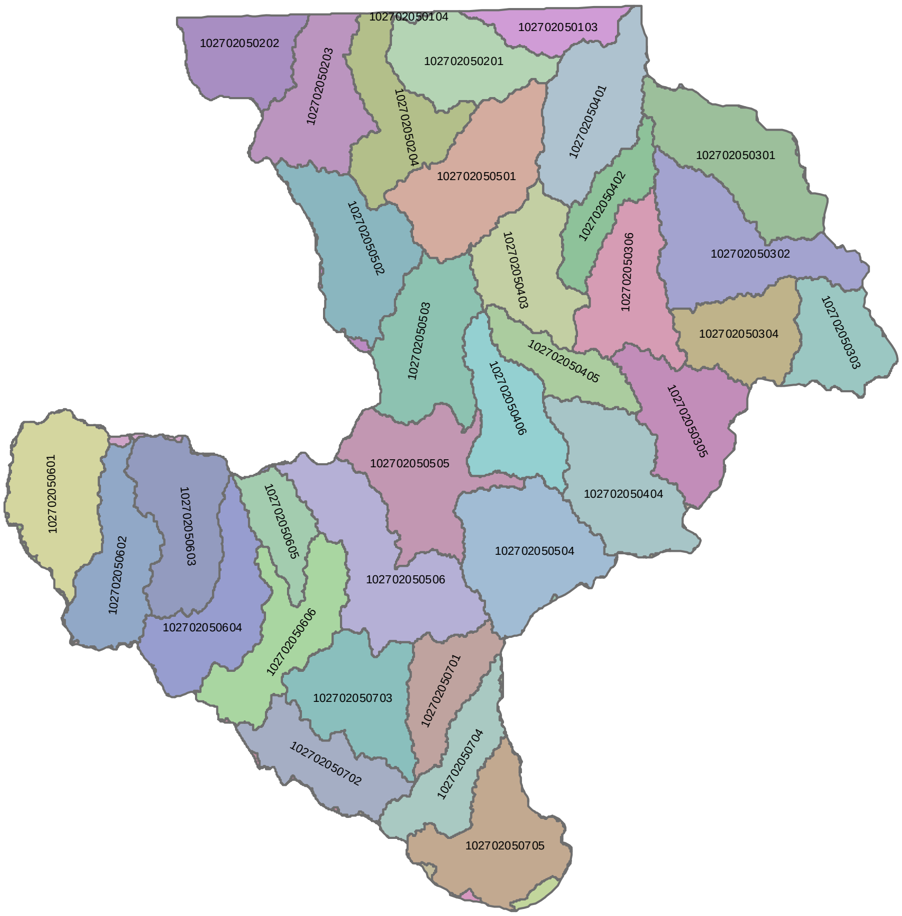


Figure 2. HUC 12 Delineations of the Lower Big Blue Watershed.

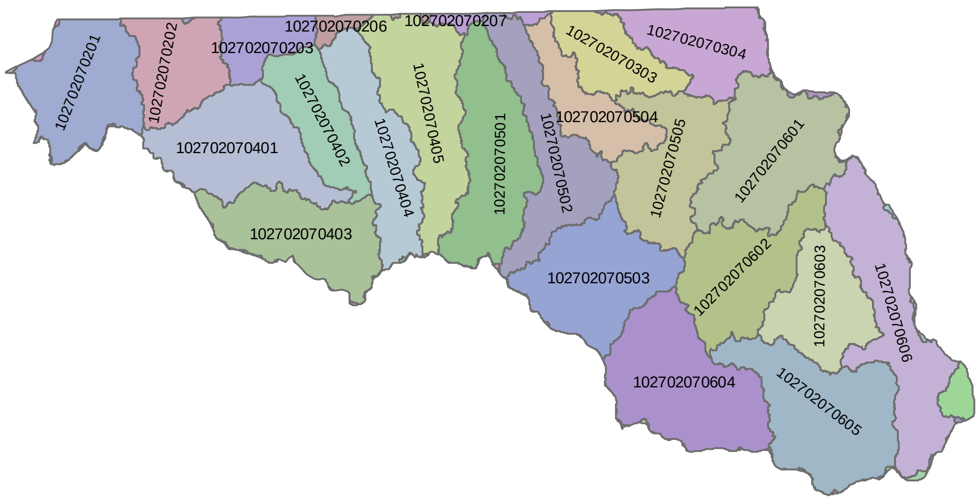


Figure 3. HUC 12 Delineations of the Lower Little Blue Watershed.

The Lower Big Blue and Lower Little Blue Watersheds are designated as Category I watersheds indicating they are in need of restoration as defined by the 1999 Kansas Unified Watershed Assessment submitted by the Kansas Department of Health and Environment (KDHE) and the United States Department of Agriculture (USDA).[3] A Category I watershed does not meet state water quality standards or fails to achieve aquatic system goals related to habitat and ecosystem health. Category I watersheds are also assigned a priority for restoration. The Lower Big Blue watershed is ranked 2nd and the Lower Little Blue watershed is ranked 10th in priority out of 92 watersheds in the state.

The Lower Little Blue Watershed covers 564,375 acres and the Lower Big Blue Watershed covers 991,887 for a total of this WRAPS project of 1,556,262 acres. There are numerous towns and cities in this watershed in addition to developed areas surrounding Tuttle Creek Lake.

3.1 Land Cover/Land Uses

Land use activities have a significant impact on the types and quantity of pollutants in the watershed. The two major land uses in the watershed are cropland (47%) and grassland (39%). Approximately eighty percent of the cropland in the watershed does not have buffers and only five percent is in continuous no-till. This much conventional farming coupled with the relatively high rainfall for Kansas leads to an increased potential for erosion and increased nutrient runoff originating from cropland. On the Big and Little Blue Rivers, approximately 36 miles of buffer are characterized as barren land, or not adequate vegetation to stabilize the riverbanks, hence a very high potential for streambank erosion and increased nutrient loadings from the banks. Cropland is the source of sediment from overland flow, nutrients from overuse or application prior to a rainfall event of fertilizers, E. coli bacteria from manure applied before a rainfall event, and atrazine applied on crops in the spring. Grassland can contribute E. coli bacteria from grazing livestock that have access to streams and ponds, in addition to sediment from cattle trails and gullies in pastures. The rest of the land uses in the watershed is woodlands (7.01%), water (1.29%) and other (4.94%).

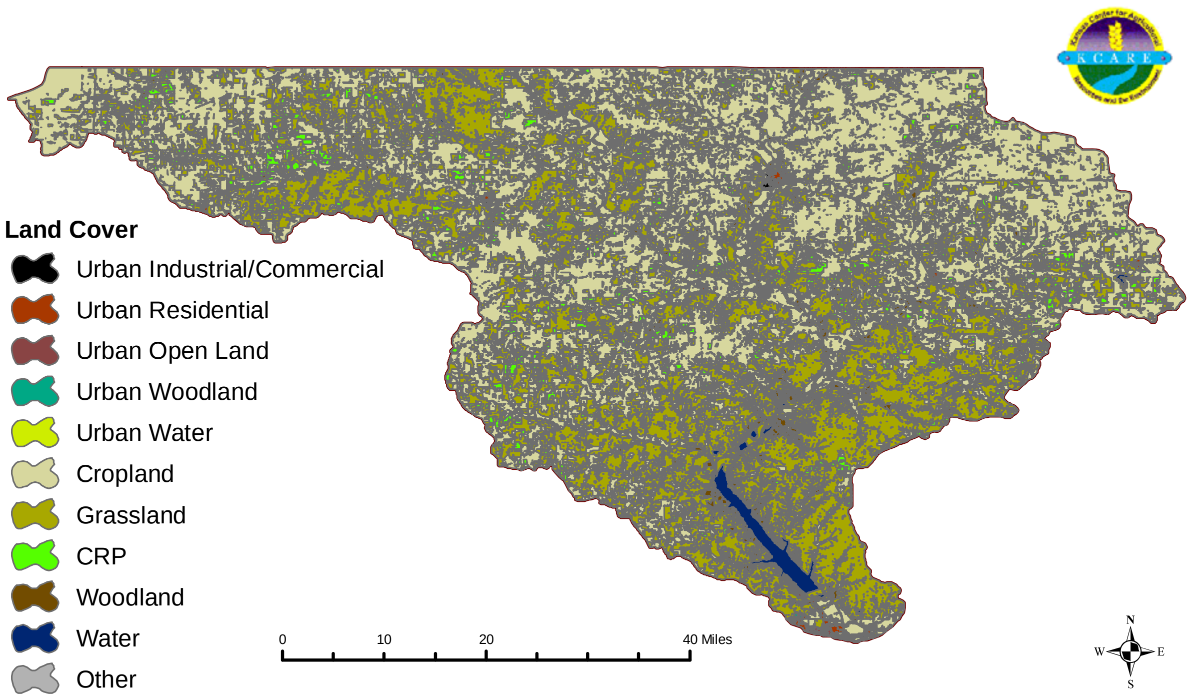


Figure 4. Land Cover and Land Use of the Lower Little Blue/Lower Big Blue Watershed. [37]

Table 1. Land Use in the Watershed, 2005. *Calculated from Kansas Applied Remote Sensing Program, 2005 :Kansas Land Cover Patterns, Kansas Geospatial Community Commons.*

Land Use	*Acres*	*Percentage*
Lower Big Blue/Lower Little Blue Watershed		
Urban Industrial/Commercial	2,394	0.15
Urban Residential	5,187	0.33
Urban Open Land	4,593	0.30
Urban Woodland	996	0.06
Urban Water	27	0.00
Cropland	737,540	47.40
Grassland	612,488	39.36
CRP	63,207	4.06
Woodland	109,020	7.01
Water	20,119	1.29
Other	509	0.03
Total	**1,556,081**	**100.00**

3.2 Designated Uses

Surface waters in this watershed are generally used for aquatic life support (fish), human health purposes, domestic water supply, recreation (fishing, boating, swimming), groundwater recharge, industrial water supply, irrigation and livestock watering. These are commonly referred to as "designated uses" as stated in the Kansas Surface Water Register, 2004, issued by KDHE.

Table 2. Designated Water Uses for the Lower Big Blue Watershed. [4] Kansas Surface Water Register, 2004, KDHE.

Designated Uses Table								
Stream Name	**AL**	**CR**	**DS**	**FP**	**GR**	**IW**	**IR**	**LW**
Ackerman Creek	E	B						
Big Blue River, Segment 2	E	B						
Big Blue River, Segment 1, 17, 18	E	B	X	X	X	X	X	X
Big Blue River, Segment 7, 20, 21	E	C	X	X	X	X	X	X
Black Vermillion R, Segment 11, 13, 14	E	b	X	X	X	X	X	X
Black Vermillion R, Segment 8, 10	E	C	X	X	X	X	X	X
Black Vermillion R Clear Fork	E	C	X	X	X	X	X	X
Black Vermillion R N Fk, S Fk	E	B	X	X	X	X	X	X
Bluff Cr	S	B						

Designated Uses Table, Cont.								
Stream Name	**AL**	**CR**	**DS**	**FP**	**GR**	**IW**	**IR**	**LW**
Bommer Cr, Carter Cr, Cedar Cr, Corndodger Cr, De Shazer Cr, Deadman Cr, Deer Cr, Dog Walk Cr, Elm Cr N, Hop Cr, Indian Cr, Jim Cr, Johnson Fk, Kearney Br, Lily Cr, Little Indian Cr, Meadow Cr, Murdock Cr, Perkins Cr, Pheil Cr, Raemer Cr, Schell Cr, School Br, Scotch Cr, Weyer Cr	E	b						
Bucksnort Cr	S	B						
Dutch Cr	E	b	X					
Elm Cr N, Fancy Cr N	E	b		X				
Fancy Cr W, Horseshoe Cr	E	C		X				
Game Fk	E	B	X					
Timber Cr, Mission Cr	E	C						
Mill Cr	E	C	X	X				
Otter Cr	E	B	X	X				
Otter Cr N	E	B	X	X				
Roubidoux Cr, Spring Cr	E	B		X				
Spring Cr, Segment 65	S	B	X	X				
Timber Cr	E	B	X					

AL = Aquatic Life Support
CR = Contact Recreation Use
DS = Domestic Water Supply
FP = Food Procurement
GR = Groundwater Recharge
IW = Industrial Water Supply
IR = Irrigation Water Supply
LW = Livestock Water Supply

A=Primary contact stream segment or lake that has a posted public swimming area
B=Primary contact stream segment or lake is by law or written permission of the landowner open to and accessible by the public
b=Secondary contact stream segment or lake is not open to and accessible by the public under Kansas law
C=Primary contact stream segment or lake that is not open to and accessible by the public under Kansas law
S=Special aquatic life use water
E = Expected aquatic life use water
X = Referenced stream segment or lake is assigned the indicated designated use
O = Referenced stream segment or lake does not support the indicated

Table 3. Designated Water Uses for the Lower Little Blue Watershed. [4]
Kansas Surface Water Register, 2004, KDHE.

Designated Uses Table								
Stream Name	**AL**	**CR**	**DS**	**FP**	**GR**	**IW**	**IR**	**LW**
Ash Creek, Bowman Cr, Cherry Cr, Mill Cr, Myer Cr, Salt Cr, Spring Cr	E	b		X				
Beaver Cr, Bolling Cr, Buffalo Cr, Camp Cr, Cedar Cr, Fawn Cr, Gray Br, Humphrey Br, Iowa Cr, Jones Cr, Joy Cr, Lane Br, Malone Cr, Melvin Cr, Mercer Cr, Mill Cr S Fk, Riddle Cr, Rose Cr,	E	b						
Coon Cr. Mill Cr	E	C	X	X				
Mill Cr	E	a		X				
Little Blue River, Segments 1,2,3	E	C	X	X	X	X	X	X
Little Blue River, Segment 4	E	b	X	X	X	X	X	X
School Cr, Silver Cr	E							
Walnut Cr	E	C						

AL = Aquatic Life Support
CR = Contact Recreation Use
DS = Domestic Water Supply
FP = Food Procurement
GR = Groundwater Recharge
IW = Industrial Water Supply
IR = Irrigation Water Supply
LW = Livestock Water Supply

A=Primary contact stream segment or lake that has a posted public swimming area
a=Secondary contact recreation stream segment or lake is by law or written permission of the landowner open to and accessible by the public
B=Primary contact recreation stream segment or lake is by law or written permission of the landowner open to and accessible by the public
b=Secondary contact recreation stream segment or lake is not open to and accessible by the public under Kansas law
C=Primary contact recreation stream segment or lake that are not open to and accessible by the public under Kansas law
S=Special aquatic life use water
E = Expected aquatic life use water
X = Referenced stream segment or lake is assigned the indicated designated use
O = Referenced stream segment or lake does not support the indicated beneficial use
Blank=Capacity of the referenced stream segment or lake to support the indicated designated use has not been determined by use attainability analysis

3.3 Special Aquatic Life Waters

Special aquatic life use waters are defined as "surface waters that contain combinations of habitat types and indigenous biota not found commonly in the state, or surface waters that contain representative populations of threatened or endangered species". The Lower Big Blue/Lower Little Blue Watershed has 4 creeks that are listed as special aquatic life use waters: Bluff Creek, Bucksnort Creek, Clear Creek and Spring Creek.

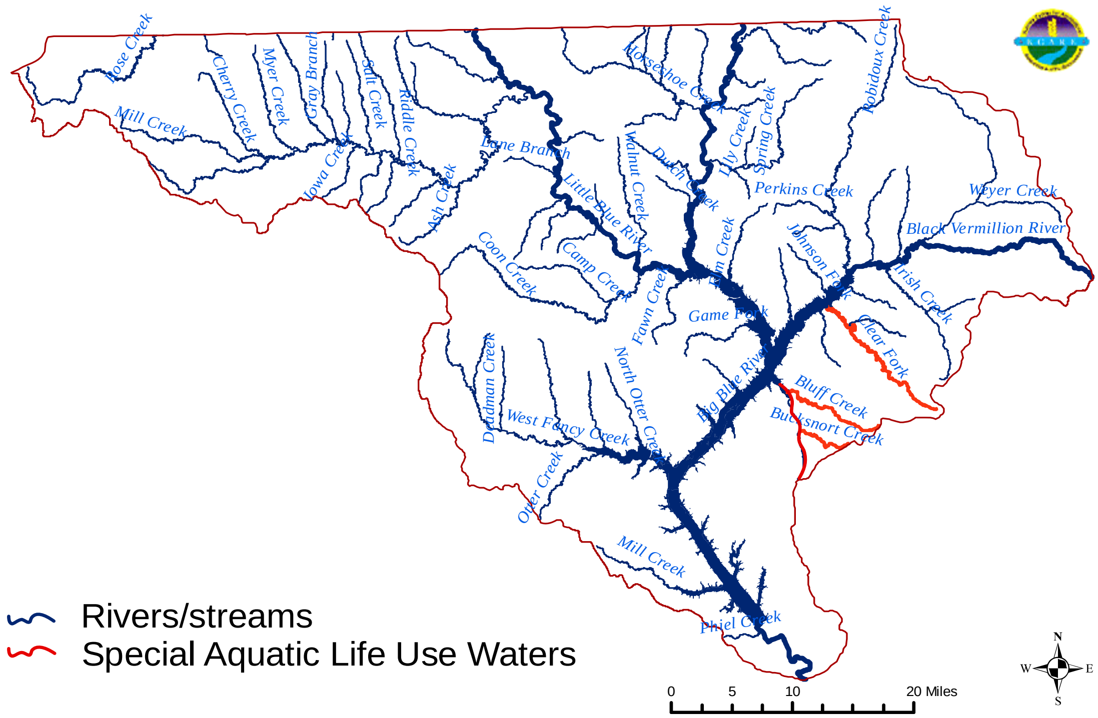


Figure 5. Special Aquatic Life Use Waters in the Watershed.[5] Kansas Department of Health and Environment.

The special aquatic life use waters are located in an area that is primarily grassland, as can be seen by the figure below. Pollutants that might threaten the health of these waters would be livestock related. Manure in the streams would deposit fecal coliform bacteria and nutrients. Livestock traffic paths or access to the streams and subsequent bank erosion would lead to sediment deposition in the streams.

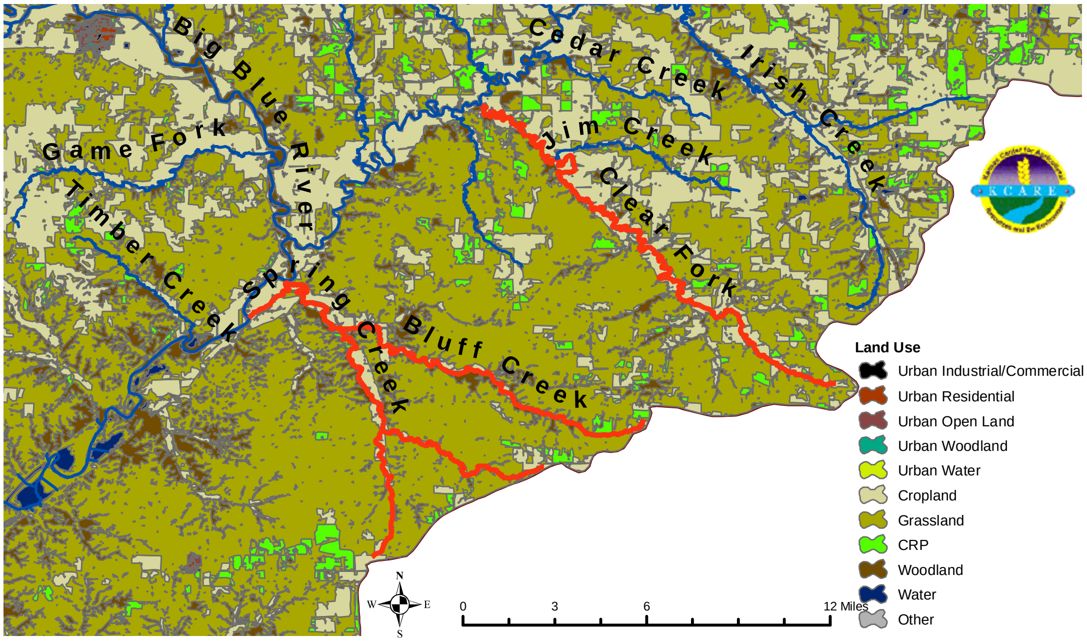


Figure 6. Special Aquatic Life Use Waters in the Watershed with Land Use Showing the Predominance of Grassland near the Streams. [37] Kansas Department of Health and Environment.

3.4 Public Water Supply and NPDES

The watershed has numerous public water supply diversion points and rural water districts in addition to countless private wells. Most of the public water supplies in this watershed are groundwater. Public water supplies can be affected by atrazine concentrations in the spring and summer months. High atrazine concentrations cause an increase in cost to public water suppliers in treatment costs. A public water supply that derives its water from a surface water supply can be affected by sediment – either in difficulty at the intake in accessing the water or in treatment of the water prior to consumption. Nutrients and fecal coliform bacteria will also affect surface water supplies.

Table 4. Public Water Supplies in the Tuttle Creek Watershed [6]

Public Water Suppliers	County	Source of Water	Population	Comments	KWO 2010 Projections
Clay Co. RWD #1 *	CY	1 well	103		
Axtell	MS	1 well, MS Co. RWD #3, NM Co. RWD #3	417		
Beattie	MS	MS Co. RWD #3	264		
Blue Rapids	MS	3 wells	1,022		

Public Water Supplies, Cont.					
Public Water Suppliers	**County**	**Source of Water**	**Population**	**Comments**	**KWO 2010 Projections**
Frankfort	MS	3 wells	795		
Marshall Co. RWD #1	MS	MS Co. RWD #3	172		
Marshall Co. RWD #2	MS	Marysville	NA	Included in Marysville's population; annexed in 2003	
Marshall Co. RWD #3	MS	5 wells	1,135		
Marysville	MS	3 wells, water rights on Big Blue not used	3,179		
Oketo	MS	2 wells	81		
Summerfield	MS	3 wells (in Nebraska)	208		
Vermillion	MS	2 wells	115		
Waterville	MS	2 wells	627		
Winifred	MS	MS Co. RWD #3	NA	Included in MS Co. RWD #3 population	
Centralia	NM	NM Co. RWD #3	NA	Included in Seneca's population	486
Nemaha Co. RWD #2 *	NM	Seneca (7 wells (5), 3 springs)	NA	Included in Seneca's population	309
Nemaha Co. RWD #3 *	NM	4 wells, NM Co. RWD #2	1,850		
Olsburg	PT	1 well, PT Co. RWD #2	212		
Pottawatomie Co. RWD #1 *	PT	7 wells	3,927		
Pottawatomie Co. RWD #2 *	PT	3 wells, PT Co. RWD #1	610		
Pottawatomie Co. RWD #3 *	PT	3 wells, Onaga	1,426		
Cuba	RP	2 wells, RP Co. RWD #2	191		
Munden	RP	RP Co. RWD #2	NA	Included in RP Co. RWD #2 population	116
Narka	RP	RP Co. RWD #2	NA	Included in RP Co. RWD #2 population	92
Republic Co. RWD #2 *	RP	2 wells	1,250		
Randolph	RL	RL Co. RWD #1	184		

Public Water Supplies, Cont.					
Public Water Suppliers	**County**	**Source of Water**	**Population**	**Comments**	**KWO 2010 Projections**
Riley Co. RWD #1 *	RL	Ogden (3 wells)	NA	Included in Ogden's population	1374
Barnes	WS	2 wells	140		
Greenleaf	WS	4 wells (2)	335		
Haddam	WS	4 wells	151		
Hanover	WS	WS Co. RWD #1	592		
Mahaska	WS	2 wells	96		
Morrowville	WS	WS Co. RWD #1	152		
Washington	WS	3 wells (1)	1,134		
Washington Co. RWD #1	WS	10 wells	1,368		
Washington Co. RWD #2 *	WS	4 wells	655		
			22,391		
Seneca and Ogden are not located in Tuttle Creek Watershed.					
* Only portions of these rural water districts are located in Tuttle Creek Watershed					

Wastewater treatment facilities are permitted and regulated through KDHE. They are considered point sources for pollutants. National Pollutant Discharge Elimination System (NPDES) permits specify the maximum amount of pollutants allowed to be discharged to surface waters. Having these point sources located on streams or rivers may impact water quality in the waterways. For example, municipal waste water can contain suspended solids, biological pollutants that reduce oxygen in the water column, inorganic compounds or bacteria. Waste water will be treated to remove solids and organic materials, disinfected to kill bacteria and viruses, and discharged to surface water. Treatment of municipal waste water is similar across the country. Industrial point sources can contribute toxic chemicals or heavy metals. Treatment of industrial waste water is specific to the industry and pollutant discharged. [7] Any pollutant discharge from point sources that is allowed by the state is considered to be Wasteload Allocation.

Table 5. List of Permitted Point Source Facilities. [8]

Facility Name	Ownership	Description	Industrial Classification	City	County
Ga-Pacific Corp Blue Rapids	Private	Gypsum Products	Not On El	Blue Rapids	Marshall

Permitted Point Source Facilities, Cont.					
Facility Name	**Ownership**	**Description**	**Industrial Classification**	**City**	**County**
Blue Rapids City Of Stp	Public	Sewerage Systems	Municipal	Blue Rapids	Marshall
City Frankfort W Stab Lagoon	Public	Sewerage Systems	Municipal	Frankfort	Marshall
Summerfield City Of Stp	Public	Sewerage Systems	Municipal	Summerfield	Marshall
Randolph City Of Wwtf	Public	Sewerage Systems	Municipal	Randolph	Riley
Axtell City Of Stp	Public	Sewerage Systems	Municipal	Axtell	Marshall
Beattie, City Of Wwt Fac	Public	Sewerage Systems	Municipal	Beattie	Marshall
Rocky Ford Trailer Court	Private	Oper Of Res Mobile Home Sites	Not On El	Manhattan	Riley
University Park Wwtp	Public	Sewerage Systems	Municipal	Manhattan	Riley
Centralia City Of Wwtp	Public	Sewerage Systems	Municipal	Centralia	Nemaha
Baileyville Impr. Dist. #1 Wwt	Public	Sewerage Systems	Municipal	Baileyville	Nemaha
Vermillion Wwt Facility	Public	Sewerage Systems	Municipal	Vermillion	Marshall
Super 8 Motel	Pub Pri			Marysville	Marshall
Mccall Pattern Company	Pub Pri			Manhattan	Riley
Marysville - Proposed	Pub Pri			Marysville	Marshall
Olsburg	Pub Pri			Olsburg	Pottawatomie
Timber Creek Development	Pub Pri	Contractors-Single Family Hous	Not On El	Manhattan	Riley
Brownawell Terry	Private	Beef Cattle Feedlots	On Elg	Wymore	Gage

Permitted Point Source Facilities, Cont.					
Facility Name	**Ownership**	**Description**	**Industrial Classification**	**City**	**County**
Burchard Wwtf	Public	Sewerage Systems	Municipal	Burchard	Pawnee
Barneston Wwtf	Public	Sewerage Systems	Municipal	Barneston	Gage
Leonardville City Of		Gypsum Products	Not On El	Blue Rapids	Marshall
Winifred Feedlots	Private	Sewerage Systems	Municipal	Blue Rapids	Marshall
Diller Wwtf		Sewerage Systems	Municipal	Frankfort	Marshall

Thousands of onsite wastewater systems exist in the basin. The functional condition of these systems is generally unknown. Best guess is that ten percent of onsite wastewater systems are either failing or inadequately constructed. [9] All counties in the watershed have sanitary codes.

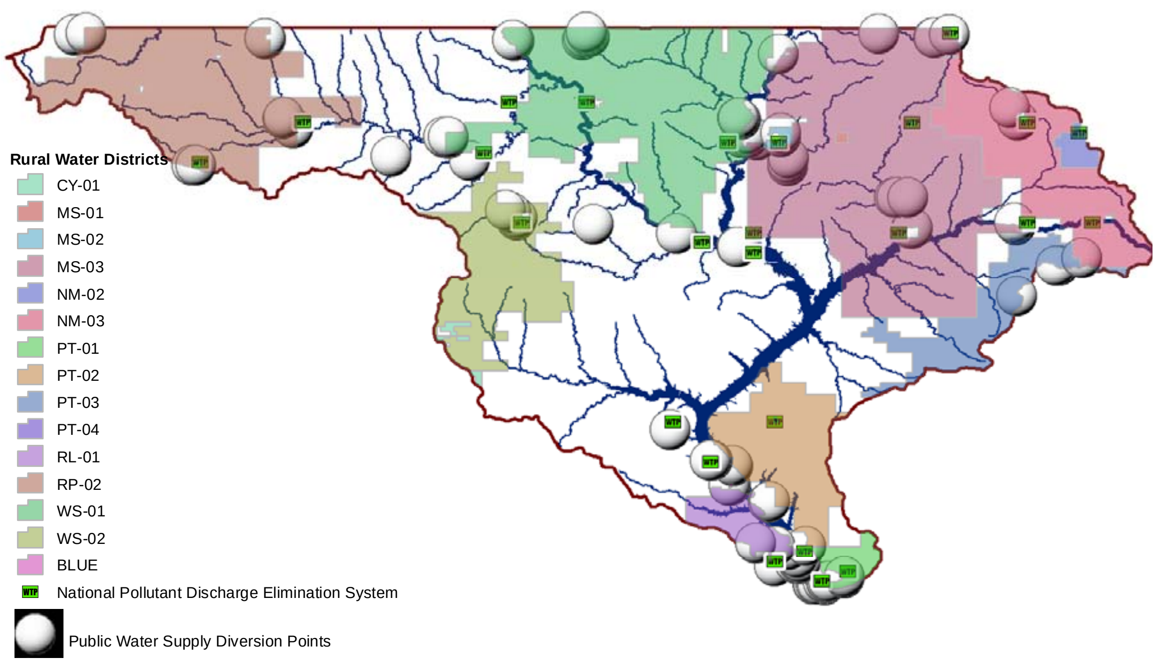


Figure 7. Rural Water Districts, Public Water Supply Diversion Points and NPDES Treatment Facilities.[10] Kansas Department of Health and Environment. Rural water districts, 2006 and public water supply source water wells and surface water intakes, 1994. These sites include those that are currently in use and those that have been functional in the past.

3.5 Aquifers

Three aquifers underlie the watershed:

- Alluvial Aquifer - The alluvial aquifer is a part of and connected to a river system and consists of sediments deposited by rivers in the stream valleys. The Big and Little Blue and Black Vermillion Rivers have an alluvial aquifer that lies along and below the rivers.
- Glacial Drift - The Glacial Drift aquifer was formed by deposits of rock left by the glacier that covered northeast Kansas 700,000 years ago. These rock deposits of sand and gravel create a porous area that traps and holds water deposits.
- Dakota Aquifer - The Dakota aquifer extends from southwestern Kansas to the Arctic Circle. In recent years, the Dakota aquifer has been used for irrigation purposes in southwest and in north-central Kansas (Cloud, Republic and Washington counties) and continues to present time. The Dakota aquifer also provides water for municipal, industrial, and stock water supplies. A one-mile distance between these wells is the current stipulation for drilling in the Dakota.

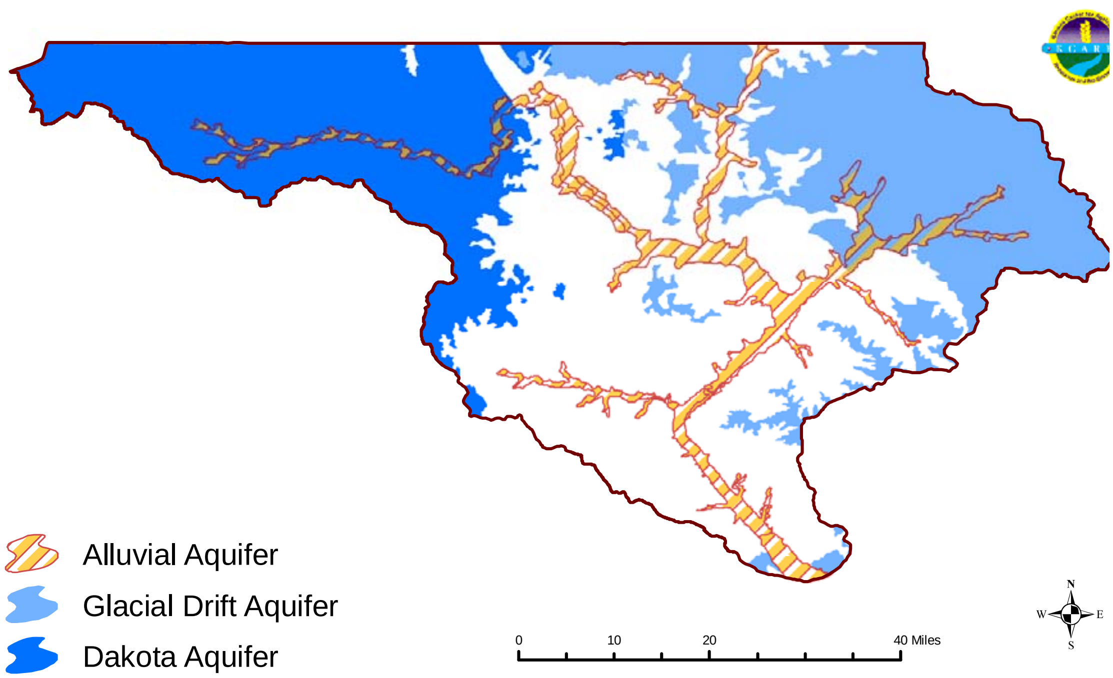


Figure 8. Aquifers in the Watershed.[11] Kansas Geospatial Community Commons.

3.6 TMDLs in the Watershed

A TMDL designation sets the maximum amount of pollutant that a specific body of water can receive without violating the surface water-quality standards, resulting in failure to support their designated uses. TMDLs established by Kansas may be done on a watershed basis and may use a pollutant-by-pollutant approach or a biomonitoring approach or both as appropriate. TMDL establishment means a draft TMDL has been completed, there has been public notice and comment on the TMDL, there has been consideration of the public comment, any necessary revisions to the TMDL have been made, and the TMDL has been submitted to EPA for approval. The desired outcome of the TMDL process is indicated, using the current situation as the baseline. Deviations from the water quality standards will be documented. The TMDL will state its objective in meeting the appropriate water quality standard by quantifying the degree of pollution reduction expected over time. Interim objectives will also be defined for midpoints in the implementation process. [12] In summary, TMDLs provide a tool to target and reduce point and nonpoint pollution sources. The goal of the WRAPS process is to address high priority TMDLs.

KDHE reviews TMDLs assigned in each of the twelve basins of Kansas every five years on a rotational schedule. Table 6 includes the review schedule for the Kansas-Lower Republican Basin.

Table 6. ***TMDLs Review Schedule for the Kansas Lower Republican Basin.*** [13]

Year Ending in September	Implementation Period	Possible TMDLs to Revise	TMDLs to Evaluate
2010	2011-2020	1999	1999
2015	2016-2025	1999, 2007	1999, 2007
2020	2021-2030	1999, 2007, 2010	1999, 2007, 2010

TMDLs in the watershed are listed in Table 4 below.

Table 7 TMDLs in the Watershed [14] TMDLs in the green shaded lines are the TMDLs that will be addressed in the targeted areas of the watershed.

Water Segment	TMDL Pollutant	Endgoal of TMDL	Priority	Sampling Station
Big Blue River above Tuttle Creek	FCB	No more than 10% of samples over applicable criteria	High	SC233, SC 240, SC717
Black Vermillion River	FCB	No more than 10% of samples over applicable criteria	High	SC128, SC129, SC130, SC131, SC132, SC133, SC134, SC141, SC505

TMDLs in the Watershed, Cont.				
Water Segment	**TMDL Pollutant**	**Endgoal of TMDL**	**Priority**	**Sampling Station**
Fancy Creek	FCB	No more than 10% of samples over applicable criteria	Medium	SC502
Tuttle Creek Lake Watershed	Atrazine	Monthly average exceedance over 3 ppb occur no more than once in three years. Annual concentrations < 3ppm in Tuttle Creek Lake, its outlet and streams. No individual sample >170ppb.	High	LM021001, SC502, SC505, SC240, SC232, SC233, SC507, SC712, SC717, SC741
Little Blue River	FCB	No more than 10% of samples over applicable criteria	High	SC232, SC240, SC507
Centralia Lake	Aquatic Plants	Summer chlorophyll a concentrations = or < 12ug/l. pH between 6.5 and 8.5	Medium	LM073701
Centralia Lake	Eutrophication	Summer chlorophyll a concentrations = or < 12ug/l. pH between 6.5 and 8.5	Medium	LM073701
Centralia Lake	pH	Summer chlorophyll a concentrations = or < 12ug/l. pH between 6.5 and 8.5	Medium	LM073701
Tuttle Creek Lake	Eutrophication	Average concentrations of total phosphorus in conservation pool <50 ppb.	High	LM021001

TMDLs in the Watershed, Cont.				
Water Segment	**TMDL Pollutant**	**Endgoal of TMDL**	**Priority**	**Sampling Station**
Tuttle Creek Lake	Atrazine	Managed pool (<1078') <3ppb at all times. Seasonal flood pool (1078' to 1083') >3ppb once in 3 years. Critical flood pool (>1082') >3ppb will be <10% during spring flood conditions.	High	LM021001
Tuttle Creek Lake	Siltation	Storage in conservation pool will remain within 90% of 1996 storage: 270,000-275,000 acre ft.	High	LM021001
Tuttle Creek Lake	Alachlor	Managed pool <1078' below 0.70 tons/day. Flood pool above 1078' = or <0.92 tons/day.	High	LM021001
Tuttle Creek Lake and Watershed	Atrazine	Managed pool (<1078') <3ppb at all times. Seasonal flood pool (1078' to 1083') >3ppb once in 3 years. Critical flood pool (>1082') >3ppb will be <10% during spring flood conditions.	High	LM021001, SC502, SC505, SC240, SC232, SC233, SC507, SC712, SC717, SC741
Lake Idlewild	Eutrophication	Summer chlorophyll a concentration = or <20ug/l.	Low	LM061201
Washington County State Fishing Lake	Dissolved Oxygen	DO = or >5mg/l over 80% of water column.	Low	LM010901
Washington County State Fishing Lake	Aquatic Plants	Maintain 50% open water in lake.	Low	LM010901
Washington Wildlife Area	Eutrophication	Summer chlorophyll a concentration = or <20ug/l.	Low	LM010941

TMDLs in the Watershed, Cont.				
Water Segment	**TMDL Pollutant**	**Endgoal of TMDL**	**Priority**	**Sampling Station**
Washington Wildlife Area	Siltation	TSS in conservation pool <7.65 tons or 60mg/l.	Low	LM010941

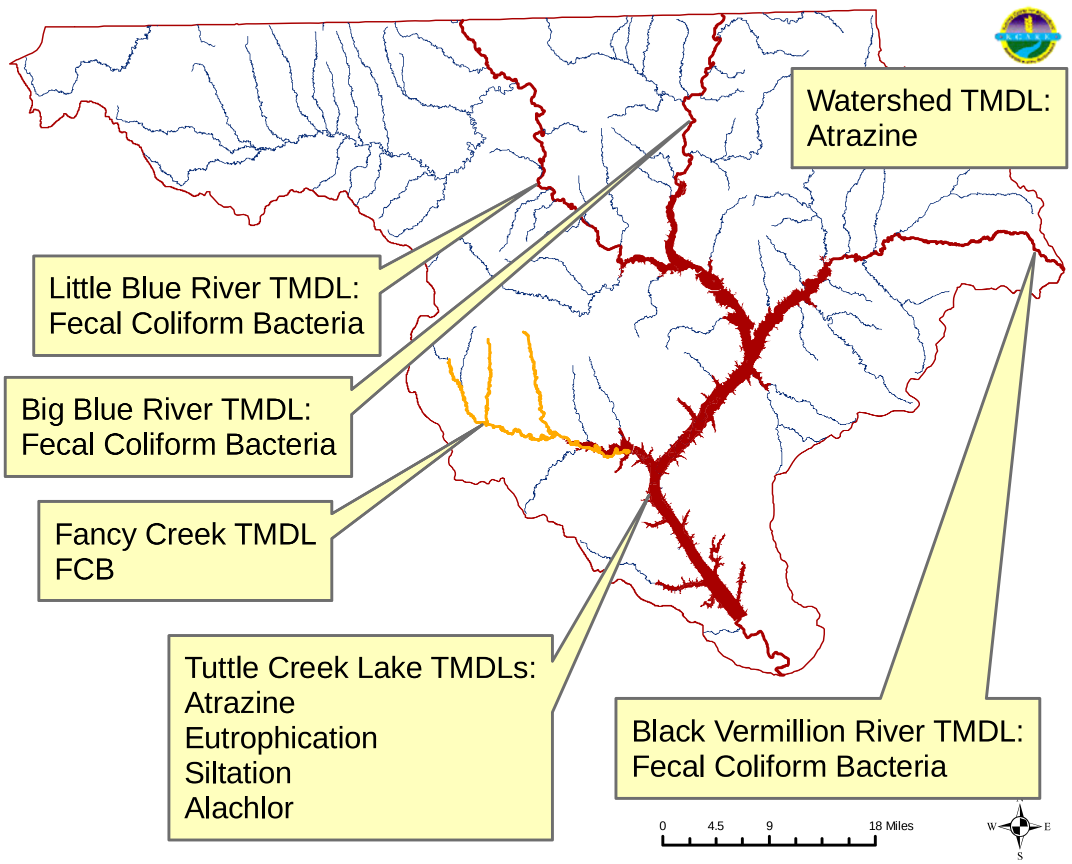


Figure 9. High Priority TMDLs in the Watershed with Medium Priority Fancy Creek. [15]

Table 8. Current Pollutant Conditions in the Watershed. [17]

Watershed and Impairment	Sampling Sites	Sampling Times	Excursions Seen	Baseline Condition
Big Blue FCB	Barnes	Spring	42%	Nonsupport of designated uses
		Summer/Fall	40%	
		Winter	None	
	Marysville	Spring	5 of 18 samples	Nonsupport of designated uses
		Summer/Fall	6 of 23 samples	
		Winter	None	

Current Pollutant Conditions, Cont.				
Watershed and Impairment	Sampling Sites	Sampling Times	Excursions Seen	Baseline Condition
Little Blue FCB	Blue Rapids	Spring	42%	Nonsupport of designated uses
		Summer/Fall	40%	
		Winter	None	
	Hollenburg	Spring	5 of 12 samples	
		Summer/Fall	5 of 13 samples	
		Winter	None	
	Mill Creek	Spring	3 of 11 samples	
		Sumer/Fall	4 of 13 samples	
		Winter	None	
Black Vermillion FCB	Frankfort	Spring	40%	Partial support of designated uses
		Summer/Fall	15%	
		Winter	13%	
Fancy Creek FCB	Winkler	Spring	50%	Partial support of designated uses
		Summer	13%	
		Winter	11%	
Tuttle Creek Watershed Atrazine	There are three things to note from the monthly distribution of atrazine in Tuttle Creek Lake. First, there is a definite seasonality to atrazine in the lake with the maximum concentrations occurring in May and June, mirroring in-stream concentrations occurring with runoff events in the drainage. Second, atrazine travels down the lake over time, degrading and becoming dilute as the initial slug flows toward the dam, much like a plug flow loading event. High concentrations at the upper lake decline with time at lower lake stations. Furthermore, initial low concentrations at the lower lake increase through the summer, albeit, remaining below the criterion. Later in summer, concentrations at the lower lake exceed those found in the upper lake. Finally, the earliest data were collected in the mid-1980's by USGS. Subsequent sampling by KDHE and KC-COE have shown reduced levels of atrazine later in the summer than those recorded by USGS. The months of digression are restricted to May and June, an improvement over USGS samples over 3 µg/l collected in July through October. This third observation is indicative of improved pesticide management in the drainage, with further application restrictions on atrazine labels since 1993.			
Centralia Lake Eutrophication, Aquatic Plants, pH	• Summer Chlorophyll-a 48.31 ppb (very eutrophic) • Total phosphorus average 157.1 ppm (elevated) • pH high 21% of the time, average 7.88 • Inorganic turbidity is low and light availability in the water column is high			

Current Pollutant Conditions, Cont.				
Watershed and Impairment	Sampling Sites	Sampling Times	Excursions Seen	Baseline Condition
Tuttle Creek Lake Eutrophication	• Total phosphorus 185 ppb (high levels) • Chlorophyll-a averages 2.81 ppb • Trophic State Index 40.7			
Tuttle Creek Lake and Watershed Atrazine	Lake consistently has elevated pesticides, notably atrazine during spring time conditions. Atrazine levels drop below the 3 ppb criterion in summer and winter. Most excursions have been associated with water in flood pool above 1078'. Sixty-seven percent of samples taken in 1993 or before were over 3 ppb. The percentage of excursions dropped to 27% from 1994-1998. The percentages demonstrated non-support of the designated uses. Sampling also occurred in the watershed at the lake headwaters (240); major intra-Kansas tributaries (502, 505, 507); and the stateline (232 ,233). Additionally, biweekly samples for atrazine were taken over 1996-1998 in the Black Vermillion watershed (stations 128-134, 141).			
Tuttle Creek Lake Siltation	Lake has consistently high levels of turbidity and siltation. The lake has seen a 30% loss of its original storage since the dam closed in 1962. Based on trend analysis of sediment survey data from the Corps of Engineers, projections to 2008 indicate a loss of 48,000 acre-feet of storage from 1996 surveyed levels. Siltation within the headwaters and arms of the lakes coincidentally reduces the surface area of the lake, as well. KWO estimates there is a current loss of multi-purpose pool of 40.45%. [16]			
Tuttle Creek Lake Alachlor	Lake consistently has elevated pesticides, occasional detects of alachlor above the 2 ppb criterion were noted in June of 1991 (2.7 ppb) and 1994 (2.7 and 3.0 ppb). Summer samples taken in 1996-1998 detected alachlor below the water quality standard(.88, 1.3 and 1.2 ppb). The excursion in water quality occurred while the pool was above 1075'. Numerous samples taken by the Corps of Engineers in 1996 and 1997 showed alachlor levels above 2 ppb from June to early September.			
Lake Idlewild Eutrophication	• Total phosphorus 165 ppb (high levels) • Chlorophyll-a averages 109 ppb • Inorganic turbidity is low and light availability in the water column is high			
Washington County SFL Dissolved Oxygen, Aquatic Plants	• DO levels 5.8 mg/L at surface, 2.2 mg/L at bottom of lake • The high macrophyte cover does not come with a corresponding high density • The dissolved oxygen regime is “marginal” rather than a hard impairment			

Current Pollutant Conditions, Cont.				
Watershed and Impairment	Sampling Sites	Sampling Times	Excursions Seen	Baseline Condition
Washington WA Eutrophication, Siltation	• Chlorophyll a concentration 80 ppb (hypereutrophic) • Total phosphorus concentration 218 ppb (elevated) • Inorganic turbidity is low and light availability in the water column is high • Total Suspended Solids 57,5 mg/L			

3.7 303d List of Impaired Waters in the Watershed

The Lower Big Blue/Lower Little Blue Watershed has numerous new listings on the 2008 "303d list". A 303d list of impaired waters is developed biennially and submitted by KDHE to EPA. To be included on the 303d list, samples taken during the KDHE monitoring program must show that water quality standards are not being met. This in turn means that designated uses are not met. The 2008 303d list emphasis is on the Smoky Hill-Saline, Solomon, Upper Republican and Kansas-Lower Republican basins. The Lower Big Blue/Lower Little Blue Watershed is a part of the Kansas-Lower Republican basin. TMDL development and revision for waters of the Kansas-Lower Republican basin is scheduled for 2009-2010. TMDLs will be developed over the next two years for "high" priority impairments. Priorities are set by work schedule and TMDL development timeframe rather than severity of pollutant. If it will be greater than two years until pollutant can be assessed, the priority will be listed as "low". All of the new impairments listed below are related to high sediment and nutrient loading in the watershed. (http://www.kdheks.gov/tmdl/download/2008_303d_List.pdf)

Note: Implemented strategies for addressing current TMDLs as determined by the SLT and outlined in this report will have an additional benefit by proactively addressing the impairments on the 303d list. The ultimate goal will be to eliminate the need for TMDL development of these impairments.

Table 9. 2008 303d List of Impaired Waters in the Lower Big Blue/Lower Little Blue Watershed [17] Impairments in the green shaded lines are those that will benefit from addressing TMDLs in the watershed as outlined in this report.

Water Segment	Impairment	Priority	Sampling Station
Big Blue River near Blue Rapids	Phosphorus	High	SC240
Big Blue River near Oketo	Phosphorus	High	SC233
Black Vermillion River near Frankfort	Phosphorus	High	SC505
Horseshoe Creek near Marysville	Phosphorus	High	SC717
North Elm Creek near Oketo	Phosphorus	High	SC731
Big Blue River near Blue Rapids	Total Suspended Solids	High	SC240

303d List of Impaired Waters, Cont.			
Water Segment	**Impairment**	**Priority**	**Sampling Station**
Big Blue River near Oketo	Total Suspended Solids	High	SC233
Black Vermillion River near Frankfort	Total Suspended Solids	High	SC505
Horseshoe Creek near Marysville	Total Suspended Solids	High	SC717
Big Blue River near Oketo	Biology	Low	SC233
Big Blue River near Blue Rapids	Copper	Low	SC240
Big Blue River near Oketo	Copper	Low	SC233
Black Vermillion River near Frankfort	Copper	Low	SC505
Big Blue River near Blue Rapids	Lead	Low	SC240
Big Blue River near Oketo	Lead	Low	SC233
Black Vermillion River near Frankfort	Lead	Low	SC505
Horseshoe Creek near Marysville	Lead	Low	SC717
Big Blue River near Blue Rapids	pH	Low	SC240
Big Blue River near Oketo	pH	Low	SC233
Horseshoe Creek near Marysville	Sulfate	Low	SC717
Black Vermillion River near Frankfort	Biology	Unable to make a definitive determination due to a small number of samples analyzed	SC505
Rocky Ford Wildlife Area	Mercury	Unable to make a definitive determination due to a small number of samples analyzed	LM020601
Little Blue River near Hollenberg	Phosphorus	High	SC232
Little Blue River near Waterville	Phosphorus	High	SC741
Rose Creek near Narka	Phosphorus	High	SC712
Little Blue River near Hollenberg	Total Suspended Solids	High	SC232
Little Blue River near Waterville	Total Suspended Solids	High	SC741
Mill Creek near Hanover	Total Suspended Solids	High	SC507
Rose Creek near Narka	Total Suspended Solids	High	SC712
Little Blue River near Hollenberg	Biology	Low	SC232
Little Blue River near Hollenberg	Copper	Low	SC232
Little Blue River near Waterville	Copper	Low	SC741
Mill Creek near Hanover	Copper	Low	SC507
Rose Creek near Narka	Copper	Low	SC712

303d List of Impaired Waters, Cont.			
Water Segment	**Impairment**	**Priority**	**Sampling Station**
Washington County State Fishing Lake	Eutrophication	Low	LM010901
Little Blue River near Hollenberg	Lead	Low	SC232
Little Blue River near Waterville	Lead	Low	SC741
Mill Creek near Hanover	Lead	Low	SC507
Rose Creek near Narka	Lead	Low	SC712
Washington Wildlife Area	Lead	Low	LM010901
Little Blue River near Hollenberg	pH	Low	SC232
Washington Wildlife Area	Dissolved Oxygen	Unable to make a definitive determination due to a small number of samples analyzed	LM010941

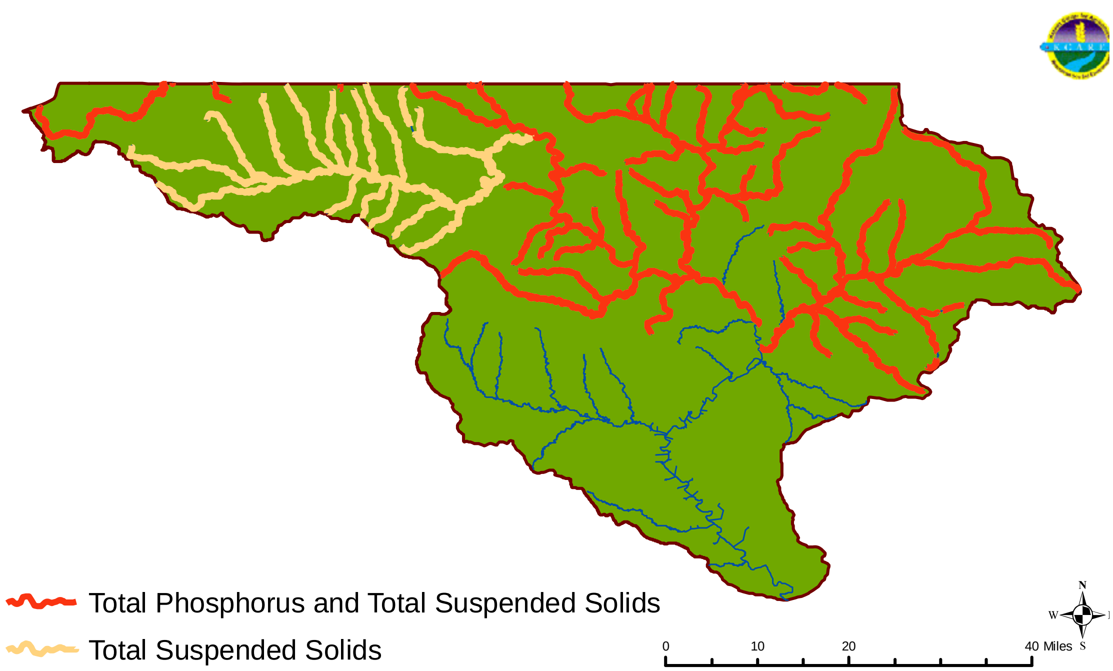


Figure 10. High Priority Streams on the 303d List. [18]

3.8 TMDL Load Allocations [19]

Nutrient and sediment TMDL loading into Tuttle Creek was primarily based on empirical information from the 1990’s. Atrazine loading was refined with data collected between 2000 and 2004. A total load is derived from the TMDL. Typically, a portion of that load is assigned as a wasteload allocation to point sources; e.g., NPDES facilities, CAFOs and other regulated sites. A portion of the load is set aside as a margin of safety, effectively hedging future loadings from causing exceedances of the applicable water quality standards. The balance of the load is the load allocation, which comprises natural load contributions, atmospheric deposition and the loads from traditional non-point sources in the watershed. These non-point specific load allocations are the charge of the WRAPS project to address. All BMPs derived by the SLT will be directed at achieving the Load Allocation of the specific pollutant through reductions in non-point source loadings.

3.8.1 Eutrophication and Siltation

The Tuttle Creek Lake TMDLs for Eutrophication and Siltation were developed in 1999 during the fledgling days of the Kansas TMDL program. As a result, their analysis was chiefly empirical in nature, relying on available data collected by KDHE and the Corps of Engineers in the lake and the streams of the watershed. Simple mass loading calculations were used to estimate desired load allocations of phosphorus and sediment (as total suspended solids [TSS]). Because the nature of loading in the Big Blue Basin was so overwhelmingly driven by runoff conditions and non-point sources, no wasteload allocations were assigned to the relatively small NPDES facilities discharging into the surface waters above Tuttle Creek Lake.

For eutrophication, the desired endpoint was to reduce phosphorus levels in Tuttle Creek Lake to 50 ppb. Based on calculated estimates, that goal would require a 90% reduction in the current loads entering the lake. The margin of safety was set as 100 tons per year of phosphorus and was deducted from the load allocations to be assigned to the non-point sources in the watershed.

For siltation, the desired endpoint was to maintain the future conservation pool of Tuttle Creek Lake to within 10% of existing amount of conservation storage. By examining the historic rates of storage loss in Tuttle Creek Lake, it was determined that a 48% reduction of sediment loading was necessary to achieve the goal of the TMDL. Further calculation revealed this equated to approximately 3 million tons per year of TSS. That value was assigned to the non-point sources of the watershed as the Load Allocation. The margin of safety implicitly assumed that practices would be more effective at reducing sediment loadings and accumulations in the lake would be less than calculated within the TMDL, but no specific load value was assigned.

These load allocations represent the best estimate available at the time of the TMDL development. Subsequent data collection, including new bathymetric surveys, will provide additional information to refine these estimated allocations in the future, in concert with periodic review and revision of this WRAPS watershed plan. Additionally, a breakout of the relative load reduction responsibilities between Nebraska and Kansas will need to be calculated for the next iteration of this watershed plan.

Table 10. Tuttle Creek Lake TMDL Summary for Total Phosphorus and Total Suspended Solids

Description	Allocations (Tons/year)	Allocations (Tons/day)*
TP NPS Load Allocation	860	2.36
TP Wasteload Allocation	0	0
TP Margin of Safety	100	0.27
Total TP Load	960	2.63
TSS NPS Load Allocation	3,000,000	8219
TSS Wasteload Allocation	0	0
TSS Margin of Safety	Implied ~ 0	0
Total TSS Load	3,000,000	8219
		* nominally annual load / 365 days

3.8.2 Atrazine

The original atrazine TMDL developed for Tuttle Creek Lake in 1999 was revised in 2007 using more data from the lake and the watershed stations. This TMDL also did not establish a wasteload allocation to point sources because atrazine is primarily an agricultural herbicide. The TMDL did assign Load Allocations to the three major streams entering Tuttle Creek Lake and broke out the allocations between Nebraska and Kansas. The margin of safety was explicitly set by requiring more reduction in non-point source loading than necessary to attain the 3 ppb water quality criterion.

Table 11. Tuttle Creek Lake TMDL Summary for Atrazine

Description	Allocation (lbs/day)	Assigned Allocation (lbs/day)
Big Blue River Load Allocation	32.3	
Nebraska Assigned LA		27.8
Kansas Assigned LA		4.5
Little Blue River Load Allocation	18.7	
Nebraska Assigned LA		14.0
Kansas Assigned LA		4.7
Black Vermillion Load Allocation	4.5	
Total Load Allocation	55.5	
Nebraska Allocation		41.8
Kansas Allocation		13.7

3.8.3 Bacteria

Bacteria TMDLs were first developed using fecal coliform bacteria data in 1999; since then, the bacteria indicator has changed to E. coli and the manner in which to assess bacteria has changed to looking at geometric means of at least five samples taken within a given 30-day period. Bacteria loads are nonsensical, resulting in huge numbers, given that high bacteria levels coincide with the high flows of runoff. The ability of any given practice to abate bacteria pollution comes down to its ability to detain bacteria-laden water long enough to kill off the bacteria. Because of the unique situation that defines bacteria impairment, an alternative manner to assess “load” reductions was needed.

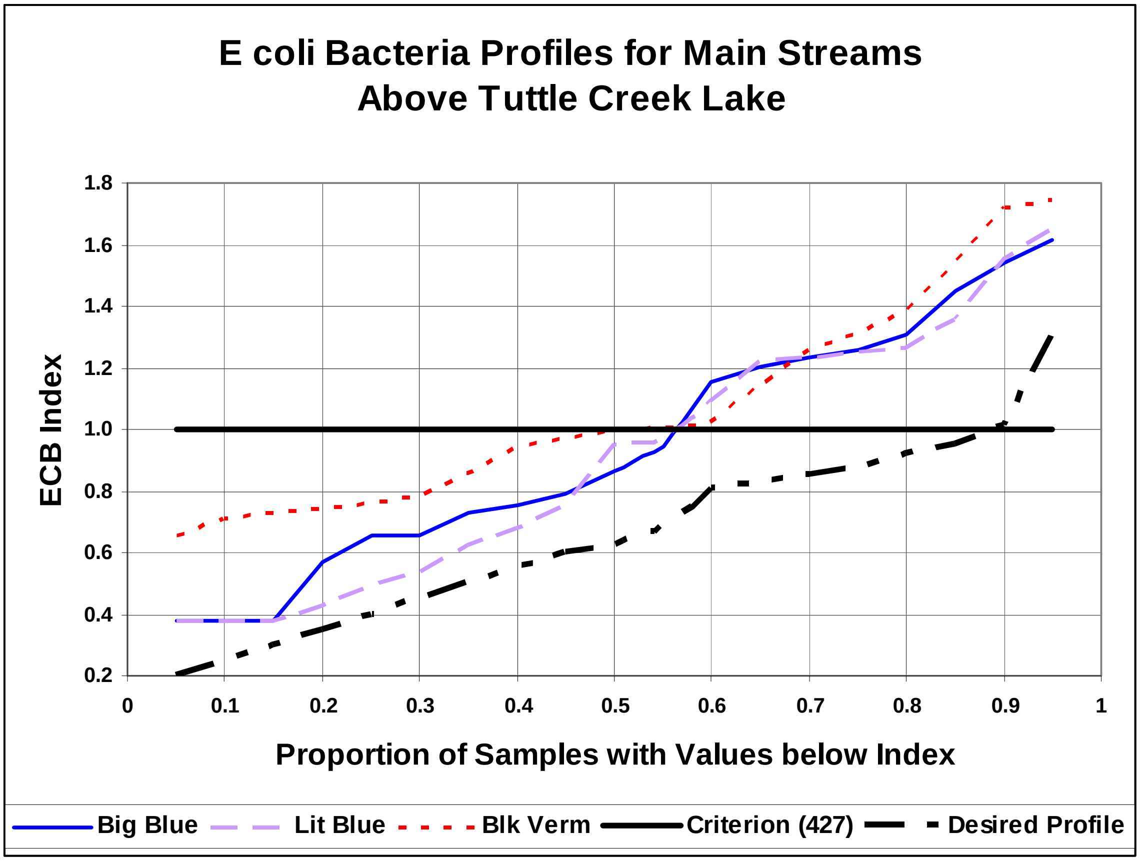
The critical measure of improving the sanitary conditions of a stream is to not only reduce the magnitude of bacteria samples collected in any of the streams comprising the Tuttle Creek watershed, but to also reduce the frequency of high bacteria levels as well as the duration of time those levels exist. In order to measure these reductions, the bacteria count values of individual samples are transformed using logarithms and normalized by dividing by the logarithm of the applicable bacteria criterion. For most streams, the primary contact recreation criterion is either 262 or 427 counts, depending upon the accessibility of the stream. The resulting ratio creates an index of relative conformance to the water quality standards. The frequency distribution of the ratios for a given stream is then derived, creating a bacteria profile for the stream, displaying the proportion of samples that are less than the criterion (the unity line).

That profile line serves as the baseline of current conditions and the expectation for load reduction is that practices to abate bacteria entering the stream will result in a future profile of sample index values that lies under the current line, and hopefully with a majority of the profile below 1. The three characteristics of magnitude, duration and frequency are represented by the profile lines and demarcate the reduction in “loading” of bacteria.

Reductions in magnitude are represented by smaller index values comprising the profile. Reduced duration is marked by a lowering of the profile line, thereby reducing the area lying between the unity line (criterion) and the upper portions of the profile. Reduced frequency is deduced by movement of the crossover point where the profile intersects unity further to the right, indicating that an increased percentage of samples now show compliant conditions relative to the criterion value. Note there is still allowance for occasional spikes of high bacteria, provided they do not occur frequently.

Load reduction in the future is seen as downward movement of subsequent sample profiles, to a point where there is reason to intensively sample the stream. Intensive sampling would then occur four different times during the April-October primary recreation season, in the manner prescribed by the water quality standards (five samples taken within 30-days). From those intensive data, the decision can be made as to whether the stream now meets water quality standards.

As with the other impairments, bacteria are fully treated by the point sources and thus there are no wasteload allocations to be assigned to the NPDES facilities.



Load Allocations for Tuttle Creek Lake Summary

1) **Total Phosphorus Non-point Source Load Allocation = 860 tons per year**
2) **Total Suspended Solids Non-point Source Load Allocation = 3 million tons per year**
3) **Atrazine Non-point Source Load Allocation = 55.5 pounds per day; 41.8 pounds per day allocated to Nebraska at the stateline; 13.7 pounds per day allocated to the drainage within Kansas**
4) **Bacteria Non-point Source Load Allocation = subsequent bacteria profiles plotting below current profiles, with a majority of profile lying below 1.**

3.9 *Source Water Protection*

In 1996, every state was required to conduct a Source Water Assessment (SWA) on all public water supplies. In order to protect their source of drinking water, public water supplies were then encouraged by KDHE to develop a Source Water Protection Plan (SWPP). The Big Blue/Little Blue Watershed has 96 active PWS sites. None were ranked as highly susceptible by the SWA. Ten public water supplies that ranked as having a moderate susceptibility and need to

develop a SWPP are listed below in alphabetical order (not in order of importance):
Axtell
Barnes
Blue Rapids
Frankfort
Green
Greenleaf
Haddem
Leonardville
Mahaska
Manhattan
Oketo
Vermillion
The SLT would like to provide funding through the Kansas Rural Water Association to assist these communities in developing their SWPP.

3.10 *Wildlife Habitat*

The SLT believes that all water quality improvements will improve wildlife ecosystems – both terrestrial and aquatic. Native grasses, forbs, tree and brush management are all beneficial to upland game bird species, specifically prairie chickens. Rangeland burning regimes of not burning on a yearly basis will help provide nesting and brood habitat.

4.0 Critical Targeted Areas and Load Reduction Methodology

4.1 Critical Targeted Areas

The Big Blue/Little Blue Rivers Watershed was assessed using the Soil and Water Assessment Tool (SWAT) by Kansas State University Department of Biological and Agricultural Engineering. SWAT was used as an assessment tool to estimate annual average pollutant loadings such as nutrients and sediment that are coming from the land into the stream. At the end of simulation runs the average annual loads are calculated for each subwatershed. Some areas have higher loads than the others. Based on experience and technical knowledge, the areas or subwatersheds with the top 20-30% of the highest loads among all areas within the watershed are selected as critical (targeted) areas for cropland and livestock BMPs implementation.

The SWAT model was developed by USDA-ARS from numerous equations and relationships that have evolved from years of runoff and erosion research in combination with other models used to estimate pollutant loads from animal feedlots, fertilizer and agrochemical applications, etc. The SWAT model has been tested for a wide range of regions, conditions, practices, and time scales. Evaluation of monthly and annual streamflow and pollutant outputs indicate SWAT functioned well in a wide range of watersheds. The model directly accounts for many types of common agricultural conservation practices, including terraces and small ponds; management practices, including fertilizer applications; and common landscape features, including grass waterways. The model incorporates various grazing management practices by specifying amount of manure applied to the pasture or grassland, grazing periods, and amount of biomass consumed or trampled daily by the livestock. Septic systems, NPDES discharges, and other point-sources are considered as combined point-sources and applied to inlets of subwatersheds. These features made SWAT a good tool for assessing rural watersheds in Kansas.

The SWAT model is a physically based, deterministic, continuous, watershed-scale simulation model developed by the USDA Agricultural Research Service. ArcGIS interface of ArcSWAT version 9.2 was used. It uses spatially distributed data on topography, soils, land cover, land management, and weather to predict water, sediment, nutrient, and pesticide yields. A modeled watershed is divided spatially into subwatersheds using digital elevation data according to the drainage area specified by the user. Subwatersheds are modeled as having non-uniform slope, uniform climatic conditions determined from the nearest weather station, and they are further subdivided into lumped, non-spatial hydrologic response units (HRUs) consisting of all areas within the subwatershed having similar soil, land use, and slope characteristics. The use of HRUs allows slope, soil, and land-use heterogeneity to be simulated within each subwatershed, but ignores pollutant attenuation between the source area and stream and limits spatial representation of wetlands, buffers, and other BMPs within a subwatershed.

The model includes subbasin, reservoir, and channel routing components.

1. The subbasin component simulates runoff and erosion processes, soil water movement, evapotranspiration, crop growth and yield, soil nutrient and carbon cycling, and pesticide and bacteria degradation and transport. It allows simulation of a wide array of agricultural structures and practices, including tillage, fertilizer and manure application, subsurface drainage, irrigation, ponds and wetlands, and edge-of-field buffers. Sediment yield is estimated for each subbasin with the Modified Universal Soil Loss Equation (MUSLE). The hydrology model supplies estimates of runoff volume and peak runoff rates. The crop management factor is evaluated as a function of above ground biomass, residue on the surface, and the minimum C factor for the crop.
2. The reservoir component detains water, sediments, and pollutants, and degrades nutrients, pesticides and bacteria during detention. This component was not used during the simulations.
3. The channel component routes flows, settles and entrains sediment, and degrades nutrients, pesticides and bacteria during transport. SWAT produces daily results for every subwatershed outlet, each of which can be summed to provide daily, monthly, and annual load estimates. The sediment deposition component is based on fall velocity, and the sediment degradation component is based on Bagnold's stream power concepts. Bed degradation is adjusted by the USLE soil erodibility and cover factors of the channel and the floodplain. This component was utilized in the simulations but not used in determining the critical areas.

Data for the Tuttle Creek SWAT model were collected from a variety of reliable online and printed data sources and knowledgeable agency personnel within the watershed. Input data and their online sources are:

1. 30 meters DEM (USGS National Elevation Dataset)
2. 30m NLCD 2001 Land Cover data layer (USDA-NRCS)
3. STATSGO soil dataset (USDA-NRCS)
4. NCDC NOAA daily weather data (NOAA National Climatic Data Center)
5. Point sources (KDHE on county basis)
6. Septic tanks (US Census)
7. Crop rotations (local knowledge)
8. Grazing management practices (local knowledge)

In every watershed, there are specific locations that contribute a greater pollutant load due to soil type, proximity to a stream and land use practices. By focusing BMPs in these areas; pollutants can be reduced at a more efficient rate.

Through research at the University of Wisconsin, it has been shown that there is a “bigger bang for the buck” with streamlining BMP placement in contrast to a “shotgun” approach of applying BMPs in a random nature throughout the watershed. Therefore, the SLT has targeted areas in the watershed to focus BMP placement for sediment runoff, nutrients and E. coli bacteria from livestock production and atrazine runoff. Targeting for this watershed will be accomplished in two different areas:

1. Cropland and livestock areas will be targeted for sediment, phosphorus, fecal coliform bacteria and atrazine
2. Streambanks will be targeted for sediment.

The maps produced by the modeling are displayed below. It is noted that the darker the color on the map, the higher the pollutant load potential.

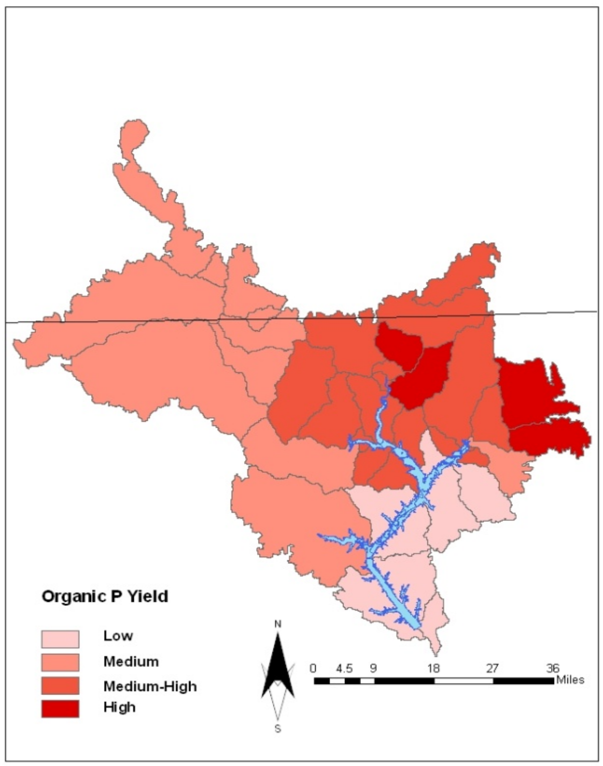


Figure 11. Phosphorus (kg P/acre) Yield as Determined by SWAT.

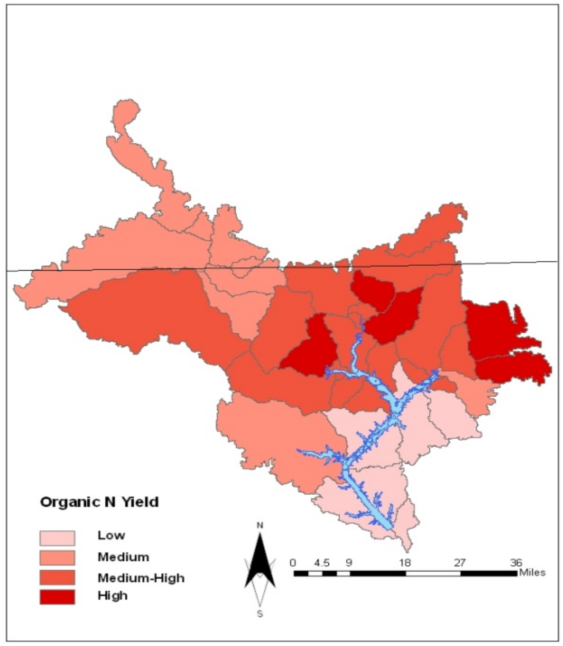


Figure 12. Nitrogen (kg N/acre) Yield as Determined by SWAT

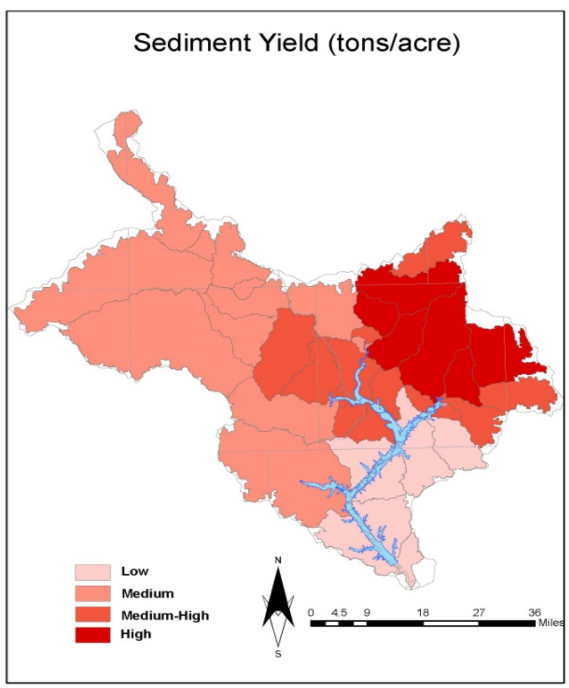


Figure 13. Sediment Yield (tons/acre) as Determined by SWAT

After locating initial critical targeted areas, the area was groundtruthed. Groundtruthing is a method used to determine what BMPs are currently being utilized in the targeted areas. It involves conducting windshield surveys throughout the targeted areas identified by the watershed models to determine which BMPs are currently installed. These surveys are conducted by local agency personnel and members of the SLT that are familiar with the area and its land use history. Groundtruthing provides the current adoption rate of BMPs, pictures of the targeted areas, and may bring forth additional water quality concerns not captured by watershed modeling. In 2008, the groundtruthing provided the current adoption rates for four common BMPs (buffers, no-till, waterways and subsurface fertilizer application) in the cropland area of the watershed. Local agency personnel were utilized to provide current adoption rates for the number of nutrient management plans in the watershed. The results are as follows:

- Vegetative buffer strip – current adoption rate of 19%
- No-till cultivation – current adoption rate of 5%
- Nutrient management plans – current adoption rate of 21%
- Grassed Waterways – current adoption rate of 57%
- Subsurface fertilizer application – current adoption rate of 5%

The SWAT model was revised using the groundtruthing information. This allows the SWAT model to develop a more accurate determination of appropriate targeted areas. The SWAT model then determined number of acres needed to be implemented for each BMP. This information is included in Tables 15 and 22.

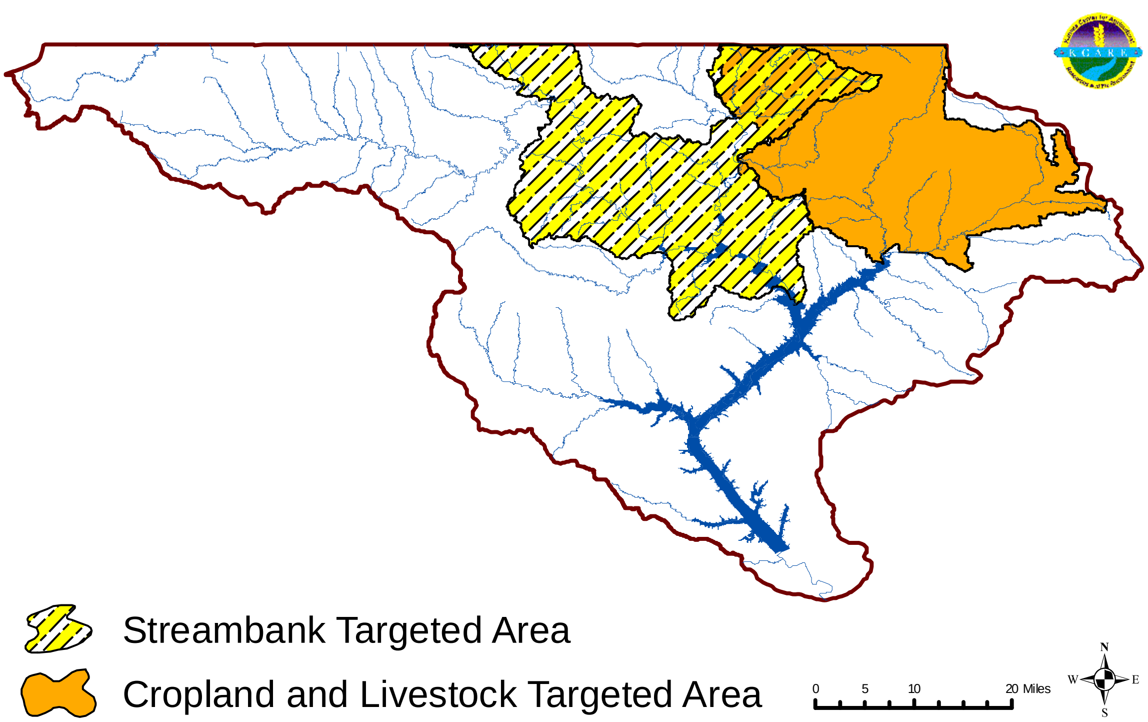


Figure 14. SWAT Targeted Areas in the Watershed for Streambank, Cropland and Livestock BMP Placement.

4.1.1 Cropland and Livestock Targeted Areas

The SWAT delineated (primary ranked) Targeted Area of this project is to be used for the determination of BMP placement for sediment (overland origin), nutrient, and atrazine BMP placement. The SLT has also chosen this same area for targeted livestock BMPs.

The SWAT model has delineated the targeted area into six sub basins. The HUC 12s that are included in these sub basins are:

- Sub basin #6: 102702050201, 102702050204
- Sub basin #8: 102702050501
- Sub basin #9: 102702050301, 102702050302
- Sub basin #15: 102702050401, 102702050402, 102702050403
- Sub basin #26: 102702050306
- Sub basin #29: 102702050201, 102702050103

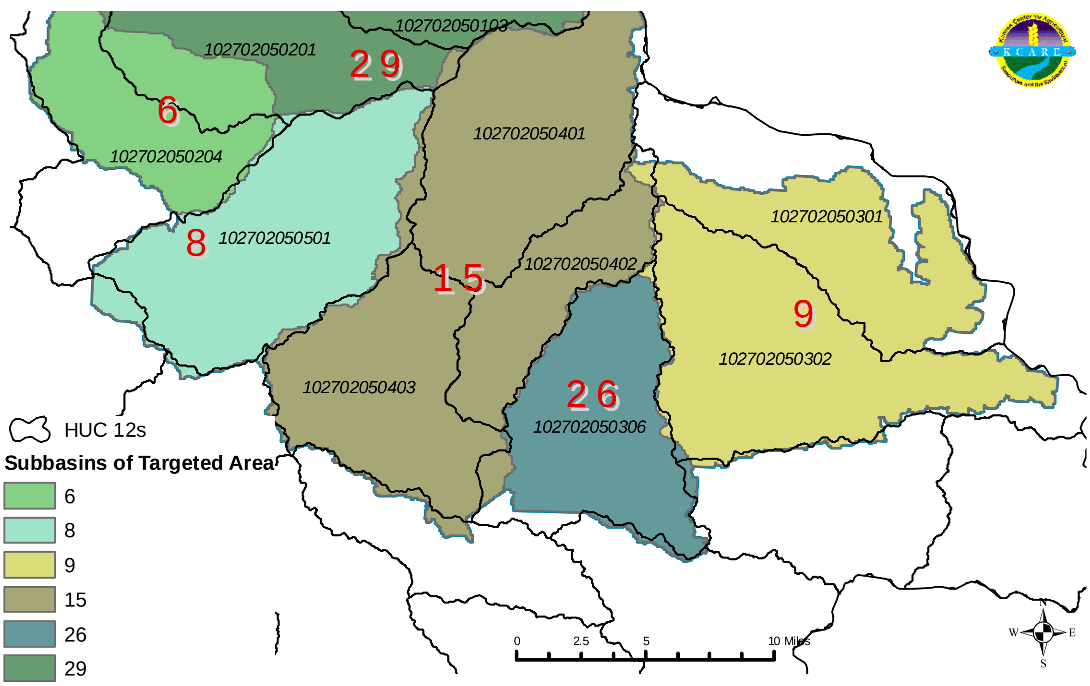


Figure 15. Enlarged View of Cropland and Livestock SWAT Targeted Area in the Watershed.

Table 12. Land Use in Each Sub Basin

Landuse Breakdown (acres)						
Sub basin	**Pasture or Hay**	**Percent Pasture or Hay**	**Cultivated**	**Percent Cultivated**	**Percent Other Land Uses**	**Total**
6	4,540	19	16,102	67	14	23,740
9	11,929	20	41,940	70	10	59,797
8	7,662	20	25,119	66	14	37,863
26	8,871	34	12,919	50	16	26,025
28	17,576	27	38,430	60	13	64,014
15	22,669	28	48,061	60	12	80,732
	73,247		182,570			292,172

4.1.2 Streambank Targeted Areas

The streambank targeted area is preliminary. Final targeted areas for placement of streambank BMPs will be determined by the SLT upon completion and analysis of the streambank assessment being conducted by Kansas Alliance of Wetlands and Streams (KAWS). This assessment will be concluded in 2010. The targeted area in this report was derived from analyzing the main stem of the Big Blue and Little Blue Rivers targeting riparian areas that were considered “barren” on the land use map. The HUC 12s included in this area are: 102702070304, 102702070601, 1027020700602, 102702070603, 102702070606, 102702050503, 102702050502, 102702050204, and 102702050201. The acreages involved in the targeted areas are: 338 in the Little Blue River and 276 in the Big Blue River. This data was obtained by using the Riparian Map Layer from Kansas Geospatial Commons and isolating the barren areas along the main stems of the Little Blue and the Big Blue Rivers. These barren areas will contribute sediment through erosion, and possibly nutrients and fecal coliform bacteria if livestock are allowed access to the river.

Figure 16. Enlarged View of Streambank Targeted Area in the Watershed.

4.2 Load Reduction Estimate Methodology

4.2.1 Cropland

Baseline loadings are calculated using the SWAT model delineated to the HUC 14 watershed scale. Best management practice (BMP) load reduction efficiencies are derived from K-State Research and Extension Publication MF-2572. [20] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

4.2.2 Livestock

Baseline nutrient loadings per animal unit are calculated using the Livestock Waste Facilities Handbook.[21] Livestock management practice load reduction efficiencies are derived from numerous sources including K-State Research and Extension Publication MF-2737 and MF-2454.[22] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

4.2.3 Estimating Annual Loads

In 2001 the State Conservation Commission [23] identified 13 eroded streambank sites along eight miles of the Little Blue River in Washington County, Kansas. It was estimated that approximately 4.66 million tons of soil loss had occurred over the past 24 years.

Average annual soil loss: $\frac{4.66 \text{ million tons}}{24 \text{ years}} = 194{,}166 \text{ tons/year}$

The average length of each site is 400M, this implies an average annual bank erosion:

$$\frac{194{,}166}{13 \text{ sites} * 400\text{m}} = 37.34 \text{ tons/meter/year or } 11.38 \text{ tons/foot/year}$$

Estimating Costs

A 2009 study conducted by the KSU Agricultural Economists [24] calculated the cost of stabilizing these 13 sites at $710,011.38 or an average of $41.66 per linear foot, including all engineering and design costs.

Targeting Methodology

A 1991 riparian inventory conducted by USDA/NRCS [28] on the Little Blue and Big Blue Rivers categorized 27.94 and 22.77 miles, respectively, of buffers along the river as barren land, or no visible riparian protection. This assessment also categorized the Little and Big Blue Rivers with 11.67 and 12.96 miles of buffers as containing cropland, respectively. It is recommended that streambank stabilization projects be targeted first within barren land areas and second within cropland areas.

NOTE: The SLT of the Lower Big Blue/Lower Little Blue Rivers Watershed has determined that the focus of this WRAPS process will be on four key impairments of the watershed listed in order of importance:

1. **sedimentation,**
2. **nutrients,**
3. **bacteria** and
4. **atrazine**.

All goals and best management practices will be aimed at protecting the watershed from further degradation. The following sections in this report will address these concerns. The following maps will focus on the targeted area of the watershed as determined by SWAT modeling.

5.0 Impairments Addressed by the SLT

5.1 Sediment

Tuttle Creek Lake and Washington Wildlife Area have TMDLs for **siltation (sedimentation)**. The Black Vermillion River, the Big Blue River, the Little Blue River, Mill Creek, Rose Creek and Horseshoe Creek are listed on the 303d listing (refer to page 29) for Total Suspended Solids, which is another indication of sediment in the water column. (http://www.kdheks.gov/tmdl/download/2008_303d_List.pdf)

Silt or sediment accumulation in lakes and wetlands reduces reservoir volume and therefore, limits public access to the lakes because of inaccessibility to boat ramps, beaches and the water side. In addition to the problem of sediment loading in lakes, pollutants can be attached to the suspended soil particles in the water column causing higher than normal concentrations. Reducing erosion is necessary for a reduction in sediment. Agricultural best management practices (BMPs) such as continuous no-till, conservation tillage, grass buffer strips around cropland, terraces, grassed waterways and reducing activities within the riparian areas will reduce erosion and improve water quality. BMPs have been selected by the SLT (and will be discussed later in this section) based on acceptability by the landowners, cost effectiveness and pollutant load reduction effectiveness.

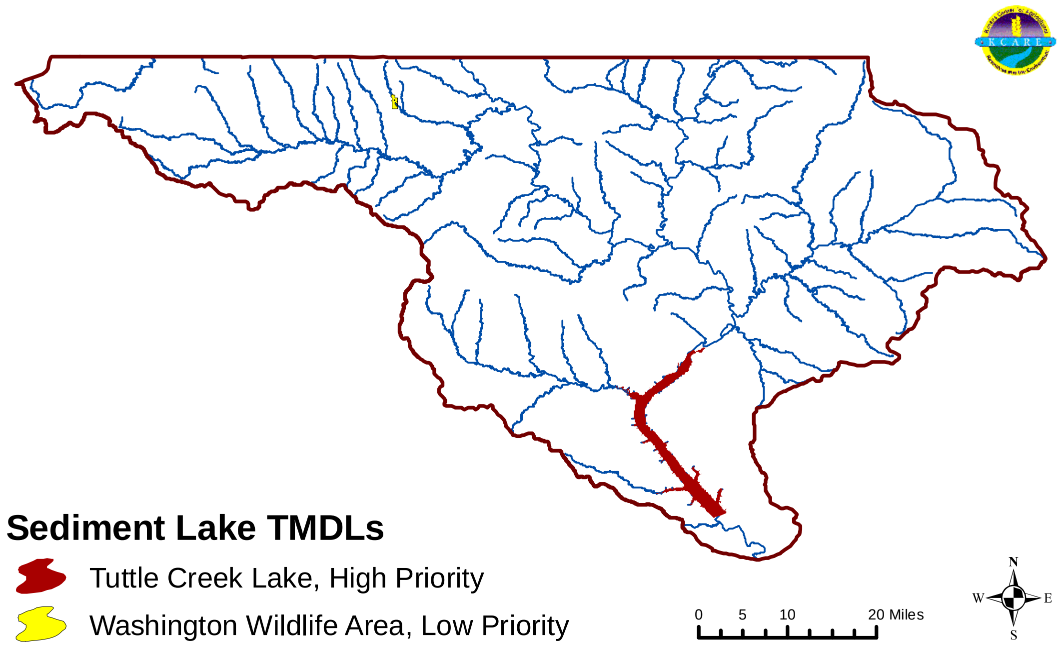


Figure 17. Sediment TMDLs in the Watershed, 2005 [25]***.*** *Kansas Department of Health and Environment, 2006.*

For more information concerning each lake, refer to:
http://www.kdheks.gov/tmdl/klr/TuttleSILT.pdf
http://www.kdheks.gov/tmdl/klr/WashWASILT.pdf

5.1.1 Possible Sources of the Impairment

Activities performed on the land affects sediment that is transported downstream to the lakes. Physical components of the terrain are important in sediment movement. The slope of the land, propensity to generate runoff and soil type are important. Sediment can also come from streambank erosion and sloughing of the sides of the river and stream bank. A lack of riparian cover can cause washing on the banks of streams or rivers and enhance erosion. Animal movement, such as livestock that regularly cross the stream, can cause pathways that will erode. Another source of sediment is silt that is present in the stream from past activities and is gradually moving downstream with each high intensity rainfall event.

5.1.1.A Land Use

Land use activities have a significant impact on the types and quantity of sediment transfer in the watershed. Construction projects in the watershed and in communities can leave disturbed areas of soil and unvegetated roadside ditches that can wash in a rainfall event. In addition, agricultural cropland that is under conventional tillage practices and a lack of maintenance of agricultural BMP structures can have cumulative effects on land transformation through sheet and rill erosion. The primary land uses in the basins are grasslands (39.36%), cropland (47.40%), woodlands (7.01%), water (1.29%) and other (4.94%). The primary land uses in the targeted area of the watershed is cropland (76.5%) and grassland (16.5%).

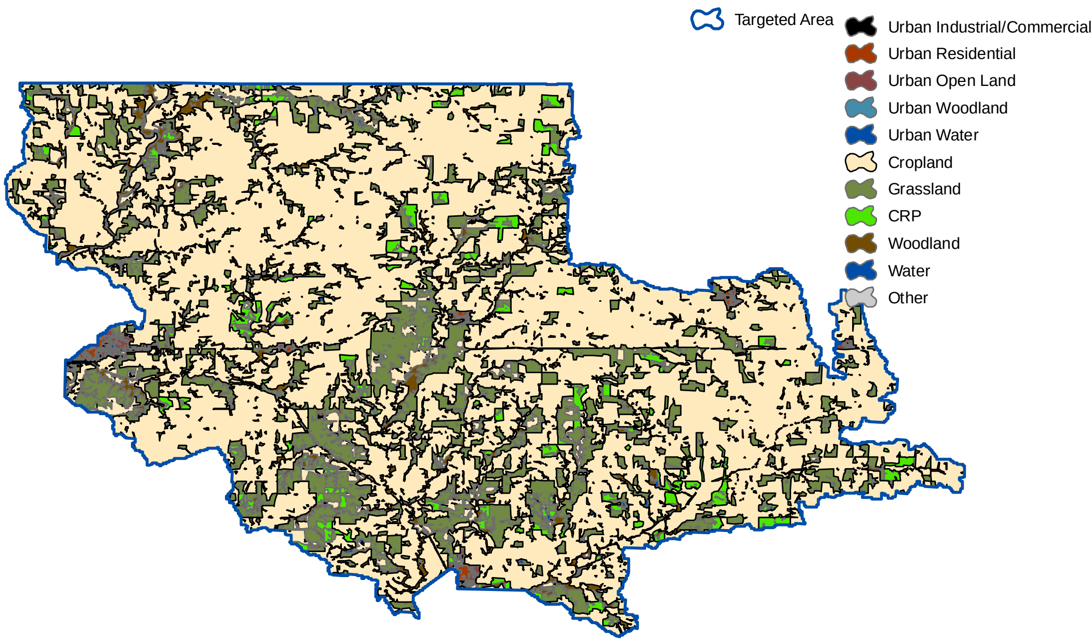


Figure 18. Land Cover of the Targeted Area of the Watershed, 2005. [37]
Kansas Applied Remote Sensing Program, Kansas Geospatial Community Commons.

Table 13. Land Use in the Watershed and the Targeted Area 2005.
Calculated from Kansas Applied Remote Sensing Program, 2005 :Kansas Land Cover Patterns, Kansas Geospatial Community Commons.

Land Use	***Acres***	***Percentage***
Lower Big Blue/Lower Little Blue Watershed		
Urban Industrial/Commercial	2,394	0.15
Urban Residential	5,187	0.33
Urban Open Land	4,593	0.30
Urban Woodland	996	0.06
Urban Water	27	0.00
Cropland	737,540	47.40
Grassland	612,488	39.36
CRP	63,207	4.06
Woodland	109,020	7.01
Water	20,119	1.29
Other	509	0.03
Total	**1,556,081**	**100.00**
Urban Industrial/Commercial	981	0.23
Urban Residential	1,218	0.29

Land Use	*Acres*	*Percentage*
Targeted Area		
Urban Open Land	1,166	0.28
Urban Woodland	169	0.04
Urban Water	15	0.00
Cropland	322,715	76.48
Grassland	69,654	16.51
CRP	9,910	2.35
Woodland	14,530	3.44
Water	1,553	0.37
Other	35	0.01
Total	**421,946**	**100.00**

5.1.1.B Soil Erosion by Wind and/or Water

NRCS has established a "T factor" in evaluating soil erosion. T is the soil loss tolerance factor. It is defined as the maximum amount of erosion at which the quality of a soil as a medium for plant growth can be maintained. It is assigned to soils without respect to land use or cover and ranges from 1 ton per acre for shallow soils to 5 tons per acre for deep soils that are not as affected by loss of productivity by erosion. T factors represent the goal for maximum annual soil loss in sustaining productivity of the land use. [26]

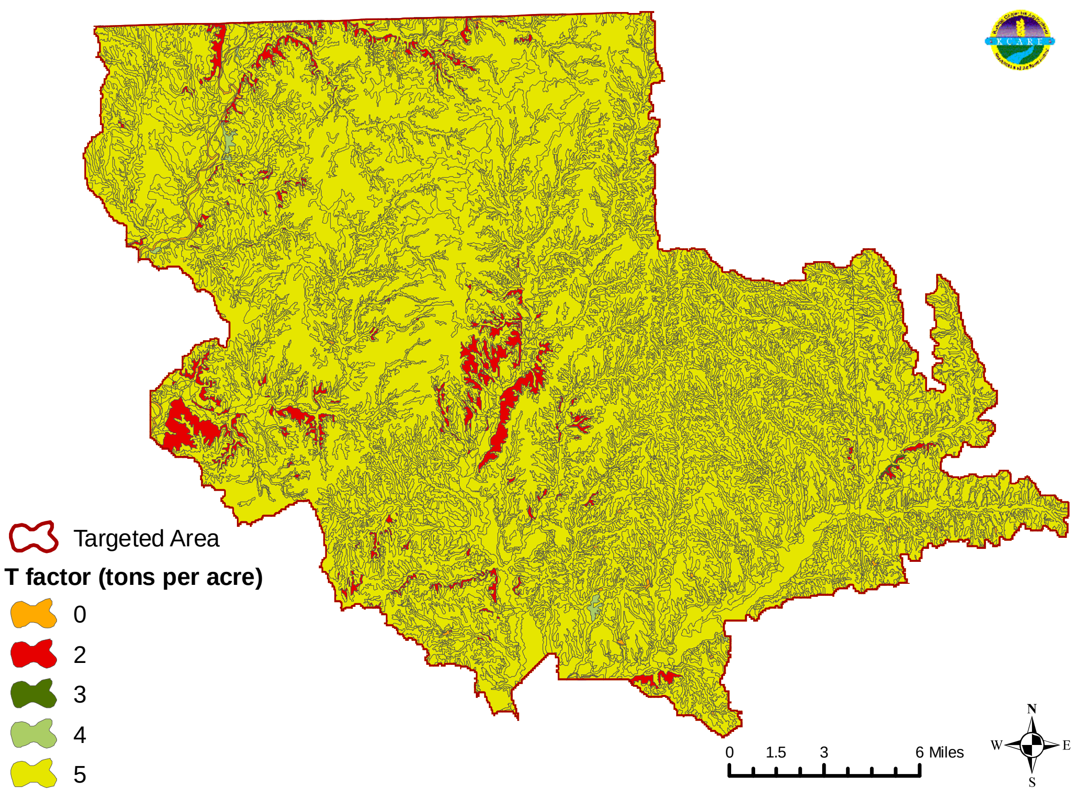


Figure 19. T Factor of the Targeted Area **[27]*.*** *Data derived from SSURGO NRCS Soil Data Mart utilizing Soil Data Viewer.*

5.1.1.C Riparian Quality

An adequately functioning and healthy riparian area will stop the sediment flow from cropland and rangeland. Cropland lying adjacent to the stream without buffer protection will cause erosion along the streambanks. On the Big and Little Blue Rivers, approximately 36 miles of buffer are characterized as barren land, or not adequate vegetation to stabilize the riverbanks, hence a very high potential for streambank erosion and increased nutrient loadings from the banks.

Table 14. Riparian Land Use in the Cropland Targeted Area for a 100 foot buffer. Calculated from USDA/NRCS data, 1991.

Land Use	Acres	Percent
Barren Land	90	0.3
Crop Land	9,130	30.8
Crop/Tree Mix	4,694	15.8
Forest Land	4,929	16.6
Pasture	4,549	15.4
Pasture/Tree Mix	4,118	13.9
Shrub/Shrub Land	716	2.4
Urban Land	195	0.7
Urban/Tree Mix	144	0.5
Water	1,055	3.6
	29,620	100

In the targeted area, the predominant land use in the riparian areas is cropland at 30 percent. This is the land that can be most vulnerable to runoff and erosion. Buffers and filter strips along with forested riparian areas can be used to impede erosion and streambank sloughing. The SLT has decided because of this, that they will incorporate BMPs aimed at cropland filter and buffer strips into the WRAPS plan.

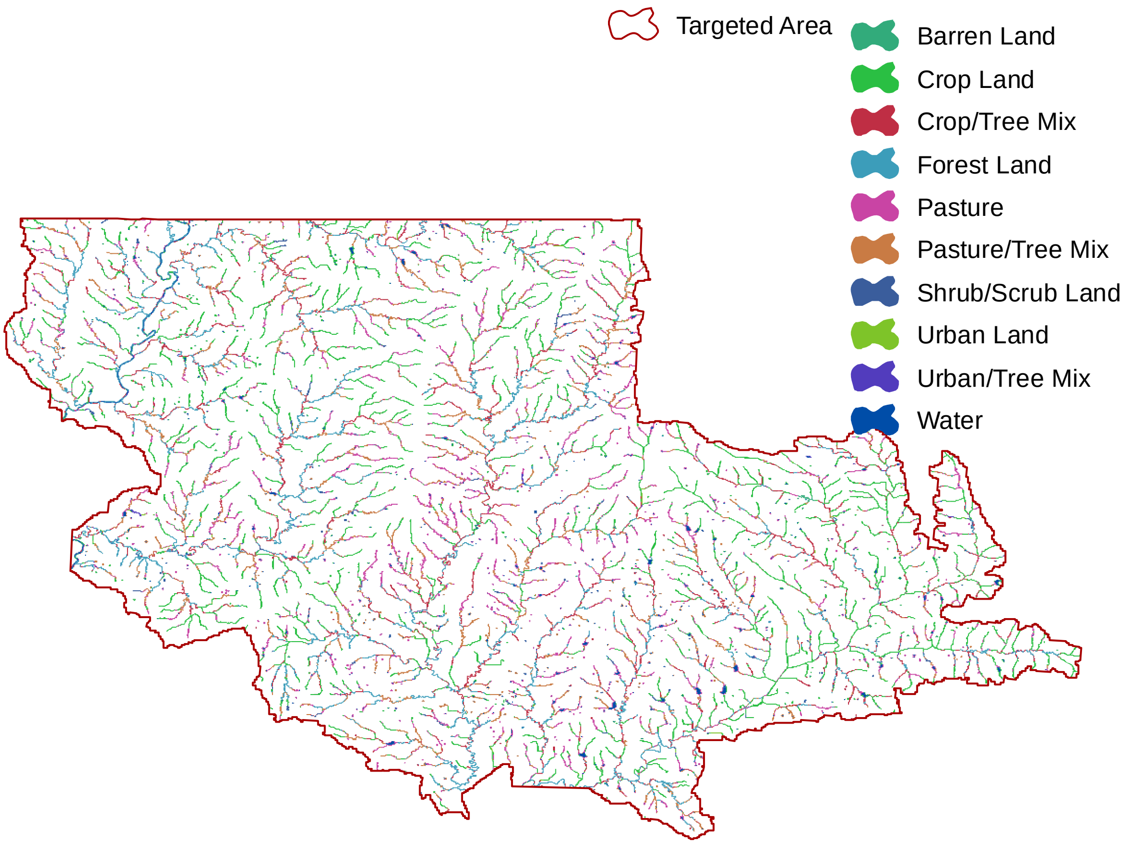


Figure 20. Riparian Inventory of the Targeted Area. [28] *Data from USDA/NRCS, 1991.*

KEY:

Forest Land - Areas adjacent to a stream that contains trees with a canopy cover greater than 51% of the 100 foot buffer zone.

Crop Land - Areas adjacent to a stream where no trees area are present and in which 51% of the 100 foot buffer is planted or was planted during the previous growing season for the production of adapted crops for harvest, including row crops, small-grain crops, legume, hay crops, nursery crops, and other specialty crops.

Crop/Tree Mix - Cropland landuse areas that contain a tree canopy cover of less than 50% of the 100 foot buffer zone.

Pasture- Areas adjacent to a stream in which 51% or more of the 100 foot buffer contains pastureland, native pasture, or range land.

Pasture/Tree Mix - Grassland land use areas that contain a tree canopy cover of less than 50% of the 100 foot buffer zone.

Urban Land - Areas adjacent to a stream where 51% or more of the 100 foot buffer contains dwellings or is located in an urban area without trees adjacent to the stream. Highways, railroads, and other transportation facilities are considered to be part of the urban & built-up land base if they are surrounded by other urban and built-up areas.

Urban/Tree Mix - Urban land use areas that contain a tree canopy cover of less than 50% of the 100 foot buffer zone.

Shrub/Scrub Land - Areas adjacent to a stream that contain shrubs or brush/scrub vegetation with a canopy cover greater than 51% of the 100 foot buffer zone. Areas are composed of multi-stemmed woody plants, shrubs, and vines including areas that contain a wide diversity of vegetative cover that are not distinguishable.

Barren Land - Areas adjacent to a stream where 51% of the 100 foot buffer contains land without any discernible vegetative cover, including quarries, borrows pits, and dry ponds.

Water - Areas adjacent to a stream where 51% of the 100 foot buffer contains water.

5.1.1.D Rainfall and Runoff

Rainfall amounts and subsequent runoff can affect sediment runoff from agricultural areas and urban areas into streams and Tuttle Creek Lake. High rainfall events can cause cropland erosion and sloughing of streambanks, which add sediment to streams and rivers ultimately ending in Tuttle Creek Lake.

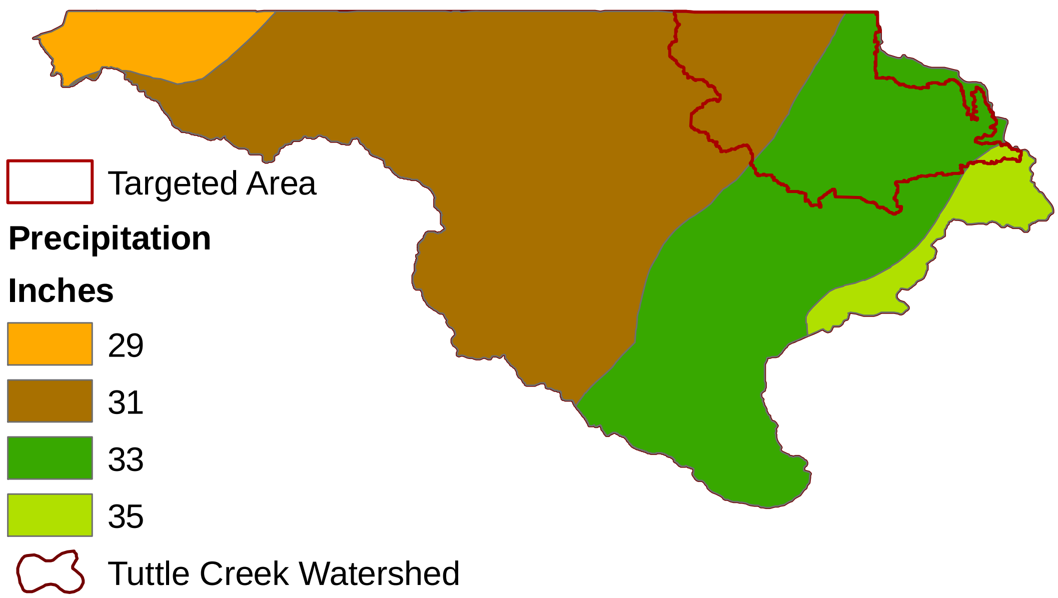
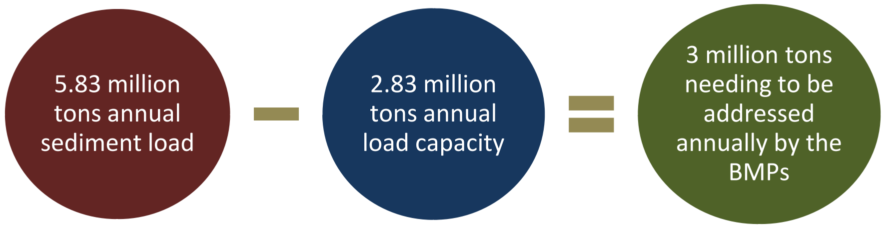


Figure 21. Average Yearly Precipitation in the Watershed with the Targeted Area Highlighted. [29] *USDA/NRCS National Water and Climactic Center.*

5.1.2 Best Management Practices for Sediment Reduction

The current estimated sediment load in the Lower Big Blue/Lower Little Blue watershed is 5.83 million tons per year according to the TMDL section of KDHE. **The total load reduction needed to meet the sediment TMDL is 3,000,000 tons of sediment**.



The SLT has laid out specific BMPs that they have determined will be acceptable to watershed residents as listed below. At the beginning of this process, BMPs were discussed at the SLT meeting. The SLT came to an agreement on a list of BMPs that they felt would be acceptable and result in significant pollutant reduction progress. Each individual at the meeting then ranked the list of BMPs. These individual rankings were compiled and the top five were determined for cropland. Specific acreages or projects that need to be implemented per year have been determined through modeling and economic analysis and approved by the SLT as listed below.

Table 15. BMPs to be Implemented as Determined by the SLT to Address the Tuttle Creek Siltation TMDL.

Protection Measures	Best Management Practices and Other Actions	Acres or Projects Needed to be Implemented Annually		
		Cropland Groundtruthing Determined Adoption Rates		
1.0 Prevention of sediment contribution from **cropland**	1.1 Establish buffers strips along crop fields	Current adoption rate = 19%	Adoption rate goal = 34%	2,739 acres
	1.2 Encourage continuous no-till cultivation practices	Current adoption rate = 5%	Adoption rate goal = 30%	4,564 acres
	1.3 Prepare nutrient management plans with producers	Current adoption rate = 21%	Adoption rate goal = 46%	4,564 acres
	1.4 Establish grassed waterways in crop fields	Current adoption rate = 57%	Adoption rate goal = 67%	1,826 acres
	1.5 Implement subsurface fertilizer application	Current adoption rate = 5%	Adoption rate goal = 10%	913 acres
2. Prevention of sediment contribution from **streambank** erosion	2.1 Streambank stabilization	3,275 feet per year of streambank stabilization		

The table below lists the cropland BMPs and acres implemented with the associated load reductions attained by implementing all of these BMPs.

Table 16. Estimated Sediment Load Reductions for Implemented BMPs on Cropland to Address the Tuttle Creek Lake Siltation TMDL.

Annual Soil Erosion Reduction (tons), Cropland BMPs						
Year	**Buffer**	**No-Till**	**Nutrient Management**	**Grassed Waterways**	**Subsurface Fertilizer**	**Total Load Reduction**
1	8,247	20,617	6,872	4,398	0	40,134
2	16,493	41,234	13,745	8,797	0	80,268
3	24,740	61,850	20,617	13,195	0	120,402
4	32,987	82,467	27,489	17,593	0	160,536
5	41,234	103,084	34,361	21,991	0	200,670
6	49,480	123,701	41,234	26,390	0	240,804
7	57,727	144,318	48,106	30,788	0	280,938
8	65,974	164,934	54,978	35,186	0	321,072
9	74,220	185,551	61,850	39,584	0	361,206
10	82,467	206,168	68,723	43,983	0	401,340
11	90,714	226,785	75,595	48,381	0	441,474
12	98,961	247,402	82,467	52,779	0	481,608
13	107,207	268,018	89,339	57,177	0	521,742
14	115,454	288,635	96,212	61,576	0	561,877
15	123,701	309,252	103,084	65,974	0	602,011
16	131,948	329,869	109,956	70,372	0	642,145
17	140,194	350,486	116,829	74,770	0	682,279
18	148,441	371,102	123,701	79,169	0	722,413
19	156,688	391,719	130,573	83,567	0	762,547
20	164,934	412,336	137,445	87,965	0	802,681
21	173,181	432,953	144,318	92,363	0	842,815
22	181,428	453,570	151,190	96,762	0	882,949
23	189,675	474,186	158,062	101,160	0	923,083
24	197,921	494,803	164,934	105,558	0	963,217
25	206,168	515,420	171,807	109,956	0	1,003,351
26	214,415	536,037	178,679	114,355	0	1,043,485
27	222,661	556,654	185,551	118,753	0	1,083,619
28	230,908	577,270	192,423	123,151	0	1,123,753
29	239,155	597,887	199,296	127,549	0	1,163,887
30	247,402	618,504	206,168	131,948	0	1,204,021
31	255,648	639,121	213,040	136,346	0	1,244,155
32	263,895	659,738	219,913	140,744	0	1,284,289
33	272,142	680,354	219,913	145,142	0	1,317,551

Annual Soil Erosion Reduction (tons), Cropland BMPs, Cont.						
Year	Buffer	No-Till	Nutrient Management	Grassed Waterways	Subsurface Fertilizer	Total Load Reduction
34	280,388	700,971	219,913	149,541	0	1,350,813
35	288,635	721,588	219,913	153,939	0	1,384,074
36	296,882	742,205	219,913	158,337	0	1,417,336
37	305,129	762,822	219,913	162,735	0	1,450,598
38	313,375	783,438	219,913	167,134	0	1,483,860
39	321,622	783,438	219,913	171,532	0	1,496,505
40	329,869	783,438	219,913	175,930	0	1,509,150

The table below demonstrates the streambank load reductions attained by implementing 3,275 feet of stabilization projects annually.

Table 17. Estimated Sediment Load Reductions for Implemented BMPs on Streambanks to Address the Tuttle Creek Lake Siltation TMDL.

Year	Cumulative Streambank Reduction (tons)
Feet of Stabilization Annually	3,275
1	37,271
2	74,543
3	111,814
4	149,085
5	186,356
6	223,628
7	260,899
8	298,170
9	335,441
10	372,713
11	409,984
12	447,255
13	484,526
14	521,798
15	559,069
16	596,340
17	633,611
18	670,883
19	708,154
20	745,425
21	782,696

Sediment Load Reductions from Streambank BMPs, Cont.	
Year	Cumulative Streambank Reduction (tons)
Feet of Stabilization Annually	3,275
22	819,968
23	857,239
24	894,510
25	931,781
26	969,053
27	1,006,324
28	1,043,595
29	1,080,866
30	1,118,138
31	1,155,409
32	1,192,680
33	1,229,951
34	1,267,223
35	1,304,494
36	1,341,765
37	1,379,036
38	1,416,308
39	1,453,579
40	1,490,850

The table below shows the combined load reduction for sediment that is attained by implementing all cropland and streambank BMPs annually. The percent of TMDL achievement is illustrated in the right column. At the end of forty years, the sediment TMDL will be reached.

Table 18. Combined Cropland and Streambank Sediment Reductions to meet the Tuttle Creek Lake Siltation TMDL in Forty Years.

Combination of Cropland and Streambank BMPs to Meet the Tuttle Creek Sediment TMDL				
Year	Streambank Reduction (tons)	Cropland Reduction (tons)	Total Reduction (tons)	% of TMDL
1	37,271	40,134	77,405	3%
2	74,543	80,268	154,811	5%
3	111,814	120,402	232,216	8%
4	149,085	160,536	309,621	10%

Combination of Cropland and Streambank BMPs to Meet the Tuttle Creek Sediment TMDL, Cont.				
Year	Streambank Reduction (tons)	Cropland Reduction (tons)	Total Reduction (tons)	% of TMDL
5	186,356	200,670	387,026	13%
6	223,628	240,804	464,432	15%
7	260,899	280,938	541,837	18%
8	298,170	321,072	619,242	21%
9	335,441	361,206	696,648	23%
10	372,713	401,340	774,053	26%
11	409,984	441,474	851,458	28%
12	447,255	481,608	928,864	31%
13	484,526	521,742	1,006,269	34%
14	521,798	561,877	1,083,674	36%
15	559,069	602,011	1,161,079	39%
16	596,340	642,145	1,238,485	41%
17	633,611	682,279	1,315,890	44%
18	670,883	722,413	1,393,295	46%
19	708,154	762,547	1,470,701	49%
20	745,425	802,681	1,548,106	52%
21	782,696	842,815	1,625,511	54%
22	819,968	882,949	1,702,916	57%
23	857,239	923,083	1,780,322	59%
24	894,510	963,217	1,857,727	62%
25	931,781	1,003,351	1,935,132	65%
26	969,053	1,043,485	2,012,538	67%
27	1,006,324	1,083,619	2,089,943	70%
28	1,043,595	1,123,753	2,167,348	72%
29	1,080,866	1,163,887	2,244,754	75%
30	1,118,138	1,204,021	2,322,159	77%
31	1,155,409	1,244,155	2,399,564	80%
32	1,192,680	1,284,289	2,476,969	83%
33	1,229,951	1,317,551	2,547,502	85%
34	1,267,223	1,350,813	2,618,035	87%
35	1,304,494	1,384,074	2,688,568	90%
36	1,341,765	1,417,336	2,759,101	92%
37	1,379,036	1,450,598	2,829,635	94%
38	1,416,308	1,483,860	2,900,168	97%
39	1,453,579	1,496,505	2,950,084	98%
40	**1,490,850**	**1,509,150**	**3,000,000**	**100%**

Table 19. Annual Sediment Load Reduction by Category.

Best Management Practice					Total Load Reduction (tons)	% of Sediment TMDL
Total Cropland Best Management Practices						
Buffer	**No-Till**	**Nutrient Management**	**Waterways**	**Subsurface Fert**		
329,869	783,438	219,913	175,930	0	1,509,150	50.3%
Total Streambank Best Management Practices					1,490,850	49.7%
Total					**3,000,000**	**100.0%**

Refer to Section 7, "Costs of BMP Implementation" for specific BMP costs in order to meet the TMDL.

5.2 Nutrients

Tuttle Creek Lake, Centralia Lake, Lake Idlewild and Washington County State Fishing Lake and Wildlife Area have TMDLs for excess **nutrient** related pollutant issues: eutrophication, low levels of dissolved oxygen, aquatic plants and pH. The Black Vermillion River, the Big Blue River, the Little Blue River, North Elm Creek, and Horseshoe Creek are listed on the 303d listing (refer to page 29) for nutrient problems. (http://www.kdheks.gov/tmdl/download/2008_303d_List.pdf)

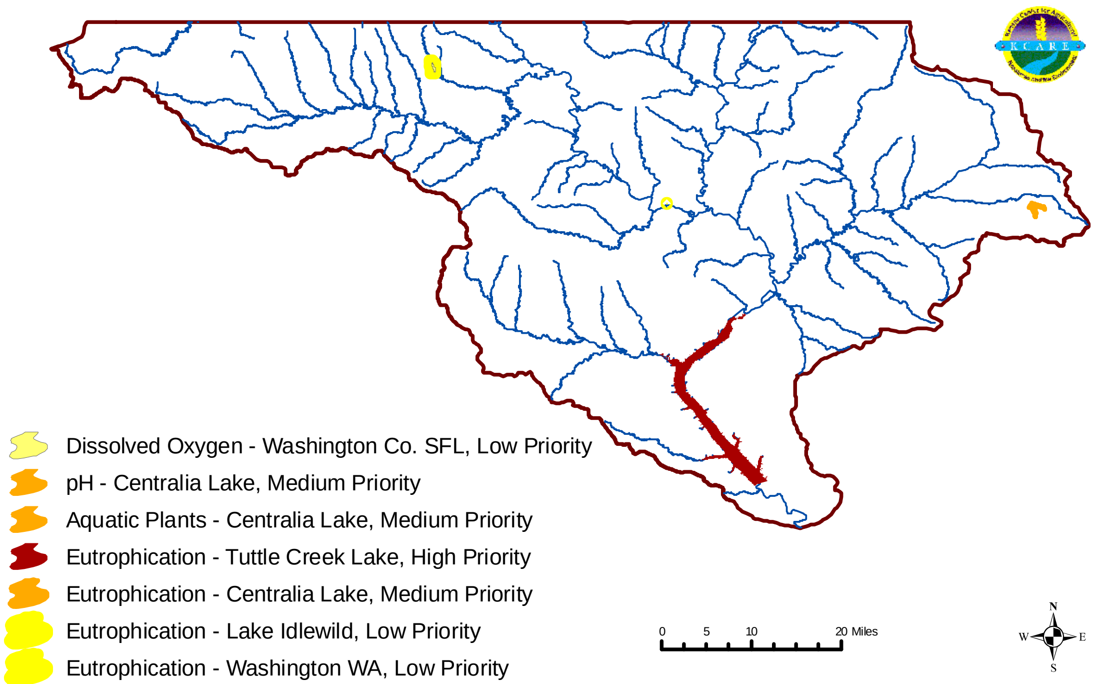


Figure 22. Nutrient Related TMDLs in the Watershed, 2005. [25] *Kansas Department of Health and Environment, 2006.*

Eutrophication is a natural process that occurs when a water body receives excess nutrients. These excess nutrients, primarily nitrogen and phosphorus, create optimum conditions that are favorable for algal blooms and plant growth. Centralia Lake, Tuttle Creek Lake, Lake Idlewild, and Washington County State Fishing Lake and Wildlife Area have TMDLs for eutrophication. Proliferation of algae and subsequent decomposition depletes available **dissolved oxygen** in the water profile. This lack of oxygen is devastating for aquatic species and can lead to fish kills. Washington County State Fishing Lake has a TMDL for dissolved oxygen. Desirable criteria for a healthy water profile includes dissolved oxygen rates greater than 5 milligrams per liter and biological oxygen demand (BOD) less than 3.5 milligrams per liter. BOD is a measure of the amount of oxygen removed in water from biodegradable organic matter. It can be used to indicate organic pollution levels. Excess nutrients can originate from failing septic systems and manure and fertilizer runoff in rural and urban areas. In addition to low dissolved oxygen, **aquatic plants** (macrophytes or microscopic plants in an aquatic environment) proliferate in nutrient (nitrogen and phosphorus) rich waters. Centralia Lake and Washington County State Fishing Lake have TMDLs for aquatic plants. The goal for these two lakes is to have at least 50 percent open water or uninhabited by aquatic plants. Similarly, **pH** averages close to 8.0, which exceeds the criteria for healthy ecosystem. The pH spikes in the summertime are correlated to periods of increased phytoplankton (minute floating aquatic plants) population due to excessive nutrients in the water profile.

For more information concerning each lake, refer to:
http://www.kdheks.gov/tmdl/klr/centraliaE.pdf
http://www.kdheks.gov/tmdl/klr/TuttleE.pdf
http://www.kdheks.gov/tmdl/klr/idlewild.pdf
http://www.kdheks.gov/tmdl/klr/washsflDO.pdf
http://www.kdheks.gov/tmdl/klr/washsflAP.pdf
http://www.kdheks.gov/tmdl/klr/WashWAE.pdf

5.2.1 Possible Sources of the Impairment

An excess in nutrients can be caused by any land practice that will contribute to nitrogen or phosphorus in surface waters. Examples are (but not limited to):

- Fertilizer runoff from agricultural and urban lands,
- Manure runoff from domestic livestock and wildlife in close proximity to streams and rivers,
- Failing septic systems, and
- Phosphorus recycling from lake sediment.

Activities performed on the land affects nutrient loading in the lakes of the watershed. Land use in this watershed is primarily agricultural (or agriculture related), therefore, agricultural BMPs are necessary for reducing nitrogen and phosphorus. Some examples of nitrogen and phosphorus BMPs include:

- Soil sampling and appropriate fertilizer recommendations,
- Minimum and continuous no-till farming practices,
- Filter and buffer strips installed along waterways,
- Reduce contact to streams from domestic livestock,
- Develop nutrient management plans for manure management, and
- Replace failing septic systems.

BMPs have been selected by the SLT (and will be discussed later in this section) based on acceptability by the landowners, cost effectiveness and pollutant load reduction effectiveness.

5.2.1.A Soil Type and Runoff Potential

Soil type has an influence on runoff potential and erosion throughout the watershed. Soils are classified into four hydrologic soil groups (HSG). The soils within each of these groups have the same runoff potential after a rainfall event if the same conditions exist, such as plant cover or storm intensity. Soils are categorized into four groups: A, B, C and D. The targeted area of the watershed is predominantly (79 percent) soil group D. This soil group has the highest potential for runoff.

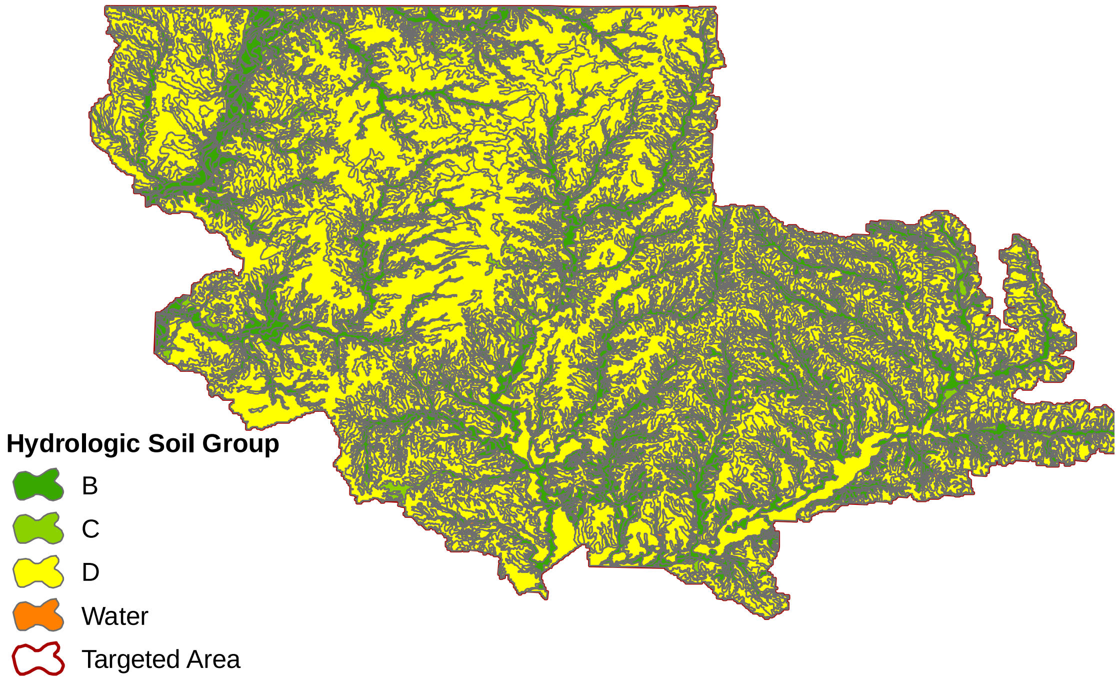


Figure 23. Hydrologic Soil Groups of the Targeted Area. [30] *Data derived from SSURGO NRCS Soil Data Mart.*

Table 20. Hydrologic Soil Groups of the Targeted Area. *Calculated from SSURGO Soil Data Mart.*

Hydrologic Soil Group	Definition	Acres of Targeted Area in HSG	Percentage of Targeted Area in HSG
A	Soils with low runoff potential. Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep well drained to excessively well-drained sands or gravels.	0	0
B	Soils having moderate infiltration rates even when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well drained to well drained soils with moderately fine to moderately coarse textures.	50,308	19.1

Hydrologic Soil Groups, Cont.			
Hydrologic Soil Group	**Definition**	**Acres of Targeted Area in HSG**	**Percentage of Targeted Area in HSG**
C	Soils having slow infiltration rates even when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures.	4,544	1.7
D	Soils with high runoff potential. Soils having very slow infiltration rates even when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious material.	207,837	78.9
Other	Water, dams, pits, sewage lagoons	675	.3
Total		263,364	100

5.2.1.B Land Use

Land use activities have a significant impact on nutrients that are dissolved in water flow. Phosphorus and nitrogen can runoff during rainfall events from fertilized fields and urban yards and contribute to eutrophication. Livestock that are housed in close proximity to a stream or that are allowed to loaf in the water can contribute to phosphorus loading in the streams and lakes. To view the land use map and summary table, see Figure 4 and Table 1 on page 13.

5.2.1.C Population and Nutrient Runoff

Failing, improperly installed or lack of an onsite wastewater system can leak nutrients to the watershed. There is no way of knowing how many failing or improperly constructed systems exist in the watershed. Thousands of onsite wastewater systems may exist in this watershed and the functional condition of these systems is generally unknown. However, best guess would be that ten percent of households have failing or insufficient wastewater systems. Therefore, the exact number of systems is directly tied to population.

Table 21. Population in the Watershed. [31] *US Census Bureau, 2006.*

County	Population	Persons per square mile
Clay	8,625	13.7
Marshall	10,349	12.1
Nemaha	10,374	14.9
Pottawatomie	19,220	21.6
Republic	5,033	8.1
Riley	62,527	103
Washington	5,944	7.2
	Total: 122,072	**Average: 25.8**

Most of the watershed would be considered low population. The Kansas average for persons per square mile is 32.9, whereas, the average for the watershed is 25.8. However, Riley County has a much higher population due to the city of Manhattan. Excluding Riley County, the average persons per square mile is 12.9 which is much lower than the statewide average.

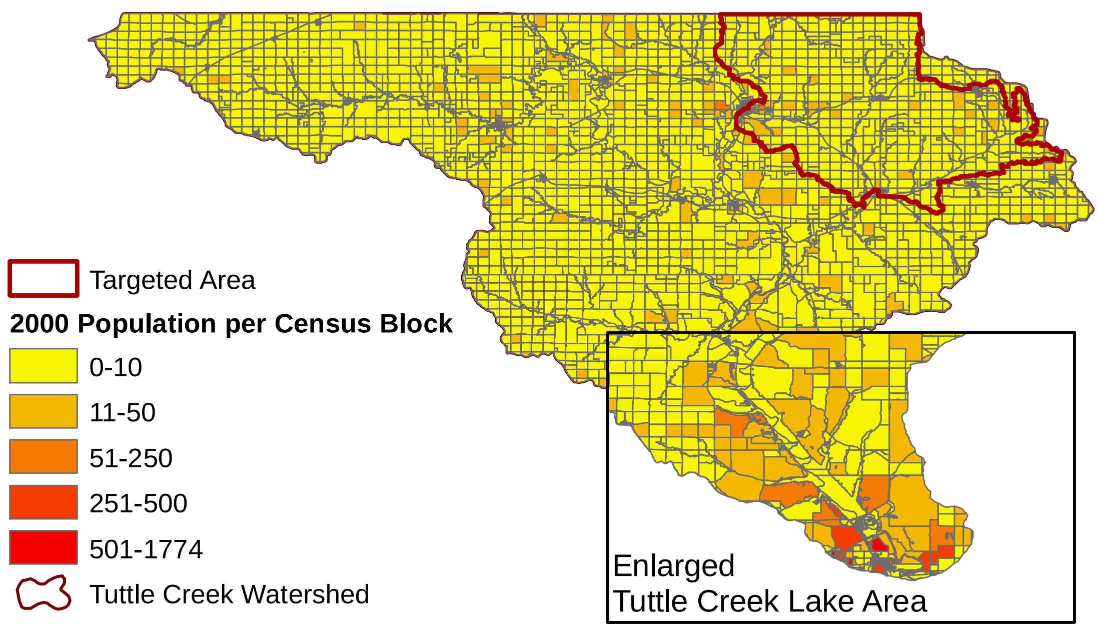


Figure 24. Census Count 2000 with the Targeted Area Highlighted. [32] *Data from US Census Bureau, 2000.*

5.2.1.D Grazing Density and Confined Animal Feeding Operations

Grasslands consist of approximately 39 percent of the watershed. This area is a highly productive forage source for beef cattle. Grazing density will affect grass cover and potential manure runoff since a thicker and healthier grass cover will trap manure. In Kansas, animal feeding operations (AFOs) with greater than 300 animal units must register with KDHE. Confined animal feeding operations

(CAFOs), those with more than 999 animal units, must be permitted with EPA. An animal unit or AU is an equal standard for all animals based on size and manure production. For example: 1 AU=one animal weighing 1,000 pounds. The watershed contains numerous CAFOs. (This data is derived from KDHE, 2003. It may be dated and subject to change). Number of and location of CAFOs is important in nutrient reduction because of the manure that is generated and must be disposed of by the CAFOs. Most farmers haul manure to cropland and incorporate it to be used as fertilizer for the crops. However, due to hauling costs, fields close to the feedlot tend to receive more manure over the course of time than fields that are at a more distant location. These close fields will have a higher concentration of soil phosphorus and therefore, a higher incidence of runoff potential as phosphorus can be attached to the soil particles. Prevention of erosion is a part of reduction of phosphorus in surface water.

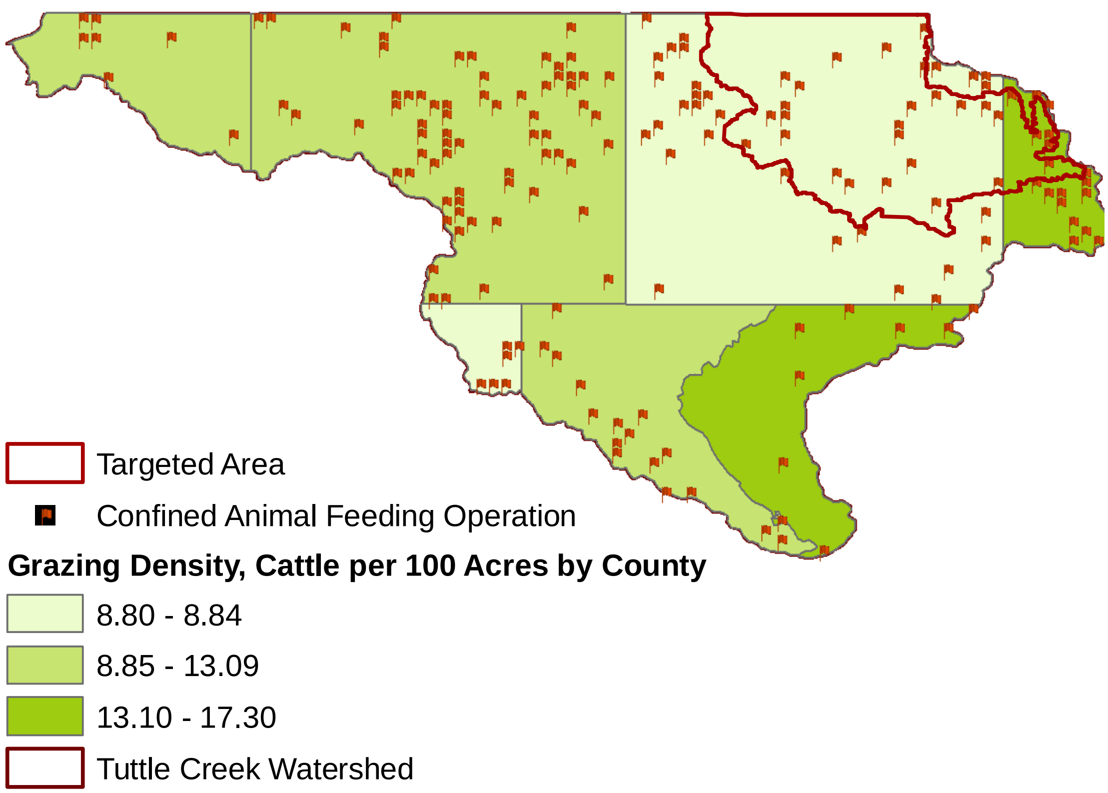


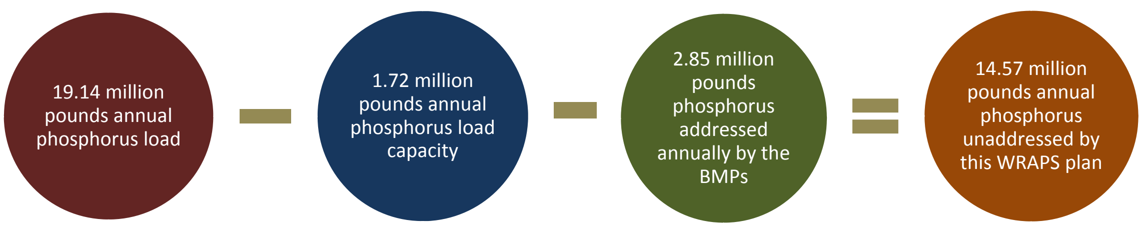
Figure 25. Grazing Density and CAFOs in the Watershed with the Targeted Area Highlighted. [33] *National Agricultural Statistics Service, 2002. CAFO data provided by Kansas Department of Health and Environment, 2003. Data may be dated and subject to change.*

5.2.1.E Rainfall and Nutrient Runoff

Rainfall amounts and subsequent runoff can affect nutrient runoff from agricultural areas and urban areas into streams and Tuttle Creek Lake. High intensity events mobilize soluble phosphorus from fertilizer and manure and carry it with the rain water into streams and lakes. For more information concerning rainfall in the Big Blue/Little Blue Watershed, refer to Figure 21 on page 48.

5.2.2 Best Management Practices Needed to Meet TMDL

The current estimated phosphorus load in the Lower Big Blue/Lower Little Blue Watershed is 19.14 million pounds per year according to the TMDL section of KDHE. The amount of phosphorus in the system contributes to all TMDLs in this watershed (dissolved oxygen, pH, aquatic plants and eutrophication) as discussed previously in this section. Due to the large amount of phosphorus entering the system from Nebraska, phosphorus reductions will not be able to meet the TMDL. In the future, cooperation with Nebraska is needed to achieve phosphorus reduction adequate to meet the TMDL. A Targeted Watershed Grant exists between Kansas and Nebraska at this time, and needs to be supported by the WRAPS process. A 95% reduction would be needed to meet the TMDL. **At the end of this forty year plan, if all BMPs have been implemented, 2,850,393 pounds will have been reduced from the watershed.**



It is to be noted that the cropland BMPs are in support of the sediment TMDL, however, phosphorus will also be reduced by implementing these specific sediment BMPs. The SLT has laid out specific BMPs that they have determined will be acceptable to watershed residents. At the beginning of this process, BMPs were discussed at the SLT meeting. The SLT came to an agreement of a list of BMPs that they felt would be acceptable and result in significant pollutant reduction progress. Each individual at the meeting then ranked the list of BMPs. These individual rankings were compiled and the top five were determined to be used on cropland, the top four for livestock related issues and one BMP for streambanks. These BMPs are listed in the table below. The acres and number of projects needed annually have been approved by the SLT.

Table 22. BMPs and Number of Acres or Installed Projects to be Implemented as Determined by the SLT to Address the Tuttle Creek Lake Eutrophication TMDL.

Protection Measures	Best Management Practices and Other Actions	Number of Acres or Projects Needed to be Installed Annually		
		Cropland Groundtruthing Determined Adoption Rates		
1.0 Prevention of phosphorus contribution from **cropland**	1.1 Establish buffers strips along crop fields	Current adoption rate = 19%	Adoption rate goal = 34%	2,739 acres
	1.2 Encourage continuous no-till cultivation practices	Current adoption rate = 5%	Adoption rate goal = 30%	4,564 acres
	1.3 Prepare nutrient management plans with producers	Current adoption rate = 21%	Adoption rate goal = 46%	4,564 acres
	1.4 Establish grassed waterways in crop fields	Current adoption rate = 57%	Adoption rate goal = 67%	1,826 acres
2.0 Prevention of phosphorus contribution from **livestock**	2.1 Install vegetative filter strips along creeks	1 site per year		
	2.2 Relocate small feedlots away from streams	1 site every other year		
	2.3 Relocate pasture feeding sites away from streams	2 sites per year in native grass pastures		
		1 site every other year in cool season grass pastures		
	2.4. Promote alternative watering sites away from stream	2 sites per year in native grass pastures		
		1 site every other year in cool season pastures		
		1 site per year in cropland that is being used for winter grazing of crop stubble		
3.0 Prevention of phosphorus contribution from soil originating from **streambank** sloughing	3.1 Streambank stabilization	3,275 feet per year of streambank stabilization		

The table below lists the cropland and livestock BMPs and acres implemented with the associated load reductions attained by implementing all of these BMPs.

Table 23. Estimated Phosphorus Load Reductions for Implemented Cropland BMPs to Address the Tuttle Creek Lake Eutrophication TMDL.

Annual Phosphorous Runoff Reduction (pounds), Cropland BMPs						
Year	**Buffer**	**No-Till**	**Nutrient Management**	**Grassed Waterways**	**Subsurface Fertilizer**	**Total Load Reduction**
1	3,606	4,808	3,005	1,923	1,202	14,543

Annual Phosphorous Runoff Reduction (pounds), Cropland BMPs, Cont.						
Year	Buffer	No-Till	Nutrient Management	Grassed Waterways	Subsurface Fertilizer	Total Load Reduction
2	7,212	9,615	6,010	3,846	2,404	29,087
3	10,817	14,423	9,014	5,769	3,606	43,630
4	14,423	19,231	12,019	7,692	4,808	58,173
5	18,029	24,038	15,024	9,615	6,010	72,716
6	21,635	28,846	18,029	11,538	7,212	87,260
7	25,240	33,654	21,034	13,462	8,413	101,803
8	28,846	38,462	24,038	15,385	9,615	116,346
9	32,452	43,269	27,043	17,308	10,817	130,889
10	36,058	48,077	30,048	19,231	12,019	145,433
11	39,663	52,885	33,053	21,154	13,221	159,976
12	43,269	57,692	36,058	23,077	14,423	174,519
13	46,875	62,500	39,062	25,000	15,625	189,062
14	50,481	67,308	42,067	26,923	16,827	203,606
15	54,086	72,115	45,072	28,846	18,029	218,149
16	57,692	76,923	48,077	30,769	19,231	232,692
17	61,298	81,731	51,082	32,692	20,433	247,235
18	64,904	86,538	54,086	34,615	21,635	261,779
19	68,510	91,346	57,091	36,538	22,837	276,322
20	72,115	96,154	60,096	38,462	24,038	290,865
21	75,721	100,961	63,101	40,385	25,240	305,408
22	79,327	105,769	66,106	42,308	26,442	319,952
23	82,933	110,577	69,111	44,231	27,644	334,495
24	86,538	115,385	72,115	46,154	28,846	349,038
25	90,144	120,192	75,120	48,077	30,048	363,581
26	93,750	125,000	78,125	50,000	31,250	378,125
27	97,356	129,808	81,130	51,923	32,452	392,668
28	100,961	134,615	84,135	53,846	33,654	407,211
29	104,567	139,423	87,139	55,769	34,856	421,754
30	108,173	144,231	90,144	57,692	36,058	436,298
31	111,779	149,038	93,149	59,615	37,260	450,841
32	115,385	153,846	96,154	61,538	38,462	465,384
33	118,990	158,654	96,154	63,461	39,663	476,923
34	122,596	163,461	96,154	65,385	40,865	488,461
35	126,202	168,269	96,154	67,308	42,067	500,000
36	129,808	173,077	96,154	69,231	43,269	511,538
37	133,413	177,884	96,154	71,154	44,471	523,076
38	137,019	182,692	96,154	73,077	45,673	534,615
39	140,625	182,692	96,154	75,000	46,875	541,346
40	144,231	182,692	96,154	76,923	48,077	548,076

The table below demonstrates the phosphorus load reductions for implemented livestock BMPs in the watershed.

Table 24. Estimated Load Reductions for Implemented Livestock BMPs in the Watershed to Address the Tuttle Creek Lake Eutrophication TMDL..

Annual Phosphourous Load Reduction (pounds)								
			Relocate Pasture Feeding		Off-Stream Watering System			
Year	Vegetative Filter Strip	Relocate Feedlot	Native	Cool Season	Native	Cool Season	Cropland	Annual Reduction
1	638		153		153		25	**969**
2	638	957	153	204	153	204	25	**3,302**
3	638		153		153		25	**4,271**
4	638	957	153	204	153	204	25	**6,604**
5	638		153		153		25	**7,573**
6	638	957	153	204	153	204	25	**9,906**
7	638		153		153		25	**10,875**
8	638	957	153	204	153	204	25	**13,208**
9	638		153		153		25	**14,177**
10	638	957	153	204	153	204	25	**16,510**
11	638		153		153		25	**17,479**
12	638	957	153	204	153	204	25	**19,812**
13	638		153		153		25	**20,781**
14	638	957	153	204	153	204	25	**23,114**
15	638		153		153		25	**24,083**
16	638	957	153	204	153	204	25	**26,416**
17	638		153		153		25	**27,385**
18	638	957	153	204	153	204	25	**29,718**
19	638		153		153		25	**30,687**
20	638	957	153	204	153	204	25	**33,020**
21	638		153		153		25	**33,989**
22	638	957	153	204	153	204	25	**36,322**
23	638		153		153		25	**37,291**
24	638	957	153	204	153	204	25	**39,624**
25	638		153		153		25	**40,593**
26	638	957	153	204	153	204	25	**42,926**
27	638		153		153		25	**43,895**
28	638	957	153	204	153	204	25	**46,229**
29	638		153		153		25	**47,197**
30	638	957	153	204	153	204	25	**49,531**
31	638		153		153		25	**50,499**

Annual Phosphourous Load Reduction (pounds), Cont.								
	Vegetative Filter Strip	Relocate Feedlot	Relocate Pasture Feeding		Off-Stream Watering System			Annual Reduction
32	638	957	153	204	153	204	25	**52,833**
33	638		153		153		25	**53,801**
34	638	957	153	204	153	204	25	**56,135**
35	638		153		153		25	**57,103**
36	638	957	153	204	153	204	25	**59,437**
37	638		153		153		25	**60,405**
38	638	957	153	204	153	204	25	**62,739**
39	638		153		153		25	**63,707**
40	638	957	153	204	153	204	25	**66,041**

The table below demonstrates the phosphorus load reductions attained by implementing 3,275 feet of stabilization projects annually. Phosphorus is attached to soil particles, therefore, reducing erosion along streams will also have the benefit of reducing phosphorus content of the water.

Table 25. Estimated Phosphorus Load Reductions for Implemented BMPs on Streambanks to Address the Tuttle Creek Lake Eutrophication TMDL..

Year	Cumulative Streambank Phosphorus Reduction (pounds)
Feet of Stabilization Annually	3,275
1	55,907
2	111,814
3	167,721
4	223,628
5	279,534
6	335,441
7	391,348
8	447,255
9	503,162
10	559,069
11	614,976
12	670,883
13	726,790
14	782,696
15	838,603
16	894,510
17	950,417
18	1,006,324

Phosphorus Load Reduction for Streambanks, Cont.	
Year	Cumulative Streambank Phosphorus Reduction (pounds)
Feet of Stabilization Annually	3,275
19	1,062,231
20	1,118,138
21	1,174,045
22	1,229,951
23	1,285,858
24	1,341,765
25	1,397,672
26	1,453,579
27	1,509,486
28	1,565,393
29	1,621,300
30	1,677,207
31	1,733,113
32	1,789,020
33	1,844,927
34	1,900,834
35	1,956,741
36	2,012,648
37	2,068,555
38	2,124,462
39	2,180,369
40	2,236,275

The table below shows the combined load reduction for phosphorus that is attained if all cropland, livestock and streambank BMPs annually. The percent of TMDL achievement is illustrated in the right column. At the end of forty years, the phosphorus TMDL will be reduced by 16 percent.

Table 26. Combined Cropland, Livestock, and Streambank Phosphorus Reductions to Address the Tuttle Creek Lake Eutrophication TMDL in Forty Years. Forty years is the life of the plan, but will not meet the phosphorus TMDL.

Annual Phosphorous Load Reduction from Cropland, Livestock, and Streambank Stabilization BMPs					
Year	Cropland	Livestock	Streambank	Total	% of TMDL
1	14,543	969	55,907	**71,419**	0.41%
2	29,087	3,302	111,814	**144,202**	0.83%

Annual Phosphorous Load Reduction from Cropland, Livestock, and Streambank Stabilization BMPs, Cont.					
Year	Cropland	Livestock	Streambank	Total	% of TMDL
3	43,630	4,271	167,721	**215,621**	1.24%
4	58,173	6,604	223,628	**288,405**	1.66%
5	72,716	7,573	279,534	**359,823**	2.07%
6	87,260	9,906	335,441	**432,607**	2.48%
7	101,803	10,875	391,348	**504,026**	2.89%
8	116,346	13,208	447,255	**576,809**	3.31%
9	130,889	14,177	503,162	**648,228**	3.72%
10	145,433	16,510	559,069	**721,012**	4.14%
11	159,976	17,479	614,976	**792,430**	4.55%
12	174,519	19,812	670,883	**865,214**	4.97%
13	189,062	20,781	726,790	**936,633**	5.38%
14	203,606	23,114	782,696	**1,009,416**	5.79%
15	218,149	24,083	838,603	**1,080,835**	6.20%
16	232,692	26,416	894,510	**1,153,619**	6.62%
17	247,235	27,385	950,417	**1,225,037**	7.03%
18	261,779	29,718	1,006,324	**1,297,821**	7.45%
19	276,322	30,687	1,062,231	**1,369,240**	7.86%
20	290,865	33,020	1,118,138	**1,442,023**	8.28%
21	305,408	33,989	1,174,045	**1,513,442**	8.69%
22	319,952	36,322	1,229,951	**1,586,225**	9.11%
23	334,495	37,291	1,285,858	**1,657,644**	9.52%
24	349,038	39,624	1,341,765	**1,730,428**	9.93%
25	363,581	40,593	1,397,672	**1,801,847**	10.34%
26	378,125	42,926	1,453,579	**1,874,630**	10.76%
27	392,668	43,895	1,509,486	**1,946,049**	11.17%
28	407,211	46,229	1,565,393	**2,018,832**	11.59%
29	421,754	47,197	1,621,300	**2,090,251**	12.00%
30	436,298	49,531	1,677,207	**2,163,035**	12.42%
31	450,841	50,499	1,733,113	**2,234,454**	12.83%
32	465,384	52,833	1,789,020	**2,307,237**	13.24%
33	476,923	53,801	1,844,927	**2,375,651**	13.64%
34	488,461	56,135	1,900,834	**2,445,430**	14.04%
35	500,000	57,103	1,956,741	**2,513,844**	14.43%
36	511,538	59,437	2,012,648	**2,583,622**	14.83%
37	523,076	60,405	2,068,555	**2,652,036**	15.22%
38	534,615	62,739	2,124,462	**2,721,815**	15.62%
39	541,346	63,707	2,180,369	**2,785,422**	15.99%
40	548,076	66,041	2,236,275	**2,850,393**	16.36%

Load reduction to meet Phosphorus TMDL: 17,420,000 lbs/year

Table 27. Annual Phosphorus Load Reduction by Category.

					Total Load Reduction (pounds)	% of Phosphorous TMDL
Cropland Best Management Practices						
Buffer	**No-Till**	**Nutrient Management**	**Waterways**	**Subsurface Fertilizer**		
144,231	182,692	96,154	76,923	48,077	548,076	3.2%
Livestock Best Management Practices						
Filter Strip	**Relocate Feedlot**	**Relocate Pasture Feeding Site**	**Alternative Water Supply**			
6,376	4,785	3,312	2,416		16,889	0.1%
Total Streambank Best Management Practices					2,236,275	13.0%
Total					**2,801,241**	**16.2%**

Refer to Section 7, “Costs of BMP Implementation” for specific BMP costs.

5.3 Fecal Coliform Bacteria

The Big and Little Blue Rivers, Black Vermillion River and Fancy Creek have TMDLs for **fecal coliform bacteria (FCB)**. FCB is present in the digestive tract of all warm blooded animals including humans and animals (domestic and wild). FCB presence in water indicates that the water has been in contact with human or animal waste. While FCB is not itself harmful to humans, its presence indicates that disease causing organisms, or pathogens, may also be present. A few of these are Giardia, Hepatitis, and Cryptosporidium. Presence of FCB in waterways can originate from failing septic systems, runoff from livestock production areas, close proximity of any mammals to water sources, and manure application to agricultural fields. Water quality standards for fecal coliform bacteria have a limit of 200cfu (colony forming units) /100ml of water for primary contact recreation, such as swimming, and a limit of 2,000 cfu/ml of water for secondary, non-contact recreation, such as wading and fishing. BMPs have been selected by the SLT (and will be discussed later in this section) based on acceptability by the landowners, cost effectiveness and pollutant load reduction effectiveness.

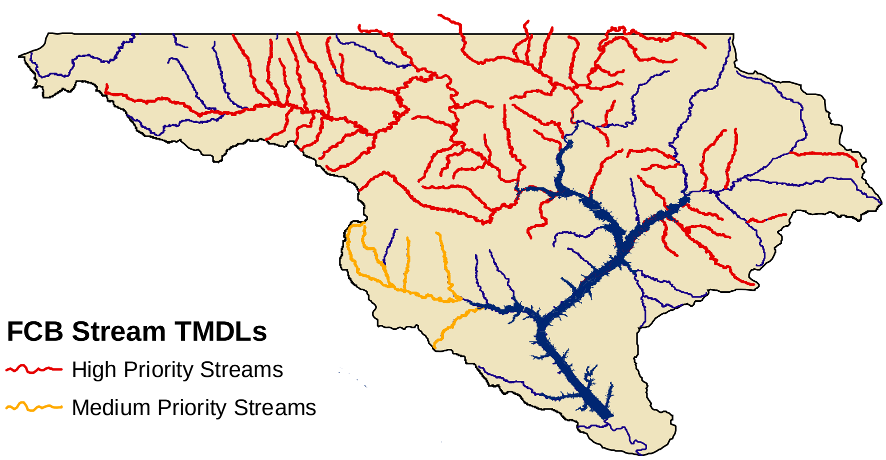


Figure 26. Fecal Coliform Bacteria TMDLs in the Watershed. [25] *Kansas Department of Health and Environment, 2006.*

KDHE is transitioning from measuring FCB to measuring levels of **E. coli bacteria**. E. coli is more specific for indicating potential for human disease. In order to qualify for listing on the 303d list, water samples will have to meet a new requirement: the average of five samples taken over a months time will have to exceed the criteria level. In the past, one sample exceedance could require the issuance of a TMDL for FCB. Therefore, in the future, it will be more difficult for a TMDL for E. coli to be issued.

For more information concerning FCB in the watershed, refer to:

http://www.kdheks.gov/tmdl/klr/BigBlueFCB.pdf
http://www.kdheks.gov/tmdl/klr/BlackVermillionFCB.pdf
http://www.kdheks.gov/tmdl/klr/FancyCkFCB.pdf
http://www.kdheks.gov/tmdl/klr/LittleBlueFCB.pdf

5.3.1 Possible Sources of the Impairment

FCB can originate in both rural and urban areas. It can be caused by both point and nonpoint sources. Failing onsite wastewater systems, manure runoff from livestock operations, improper manure disposal and livestock or wildlife access to streams can contribute to FCB in streams.

5.3.1.A Land Use and Fecal Coliform Transport

Livestock production areas are a source of FCB. Manure generated by any mammal can contain FCB. Livestock that are housed in close proximity to a stream or allowed to loaf in the water source can shed FCB. Wild animals are also contributors in streams and lakes. However, the wild animal population is not as easily controlled as limiting livestock from water sources. Alternative water supplies allow the livestock to have access to fresh water while limiting the time they spend in surrounding areas. This not only reduces FCB, but provides a clean drinking water source. For more information on land use in the watershed, refer to Figure 4 and Table 1 on page 13.

5.3.1.B Population and Wastewater Systems

Failing, improperly installed or lack of an onsite wastewater system can contribute FCB to the watershed. There is no way of knowing how many failing or improperly constructed systems exist in the watershed. Thousands of onsite wastewater systems may exist in this watershed and the functional condition of these systems is generally unknown. However, best guess would be a percentage of the population of the watershed would have insufficient wastewater systems. Therefore, the exact number of systems is directly tied to population. For more information on population in the watershed, refer to Table 24 and Figure 17 on page 58.

5.3.1.C Manure Runoff from Fields and Livestock Operations

In Kansas, animal feeding operations (AFOs) with greater than 300 animal units must register with KDHE. Confined animal feeding operations (CAFOs), those with more than 999 animal units, must be permitted with EPA. An animal unit or AU is an equal standard for all animals based on size and manure production. For example: 1 AU=one animal weighing 1,000 pounds. The watershed contains numerous CAFOs. (This data is derived from KDHE, 2003. It may be dated and subject to change). CAFOs are not allowed to release manure from the operation. However, they are allowed to spread manure on cropland fields for distribution. If this application is followed by a rainfall event or the manure is applied on frozen ground, it can run off into the stream. Smaller operations are not regulated by the state. Many of these operations are located along streams because of historic preferences by early settlers. Movement of feeding sites away from the streams and providing alternate watering sites is logistically important to prevention of FCB entering the stream.

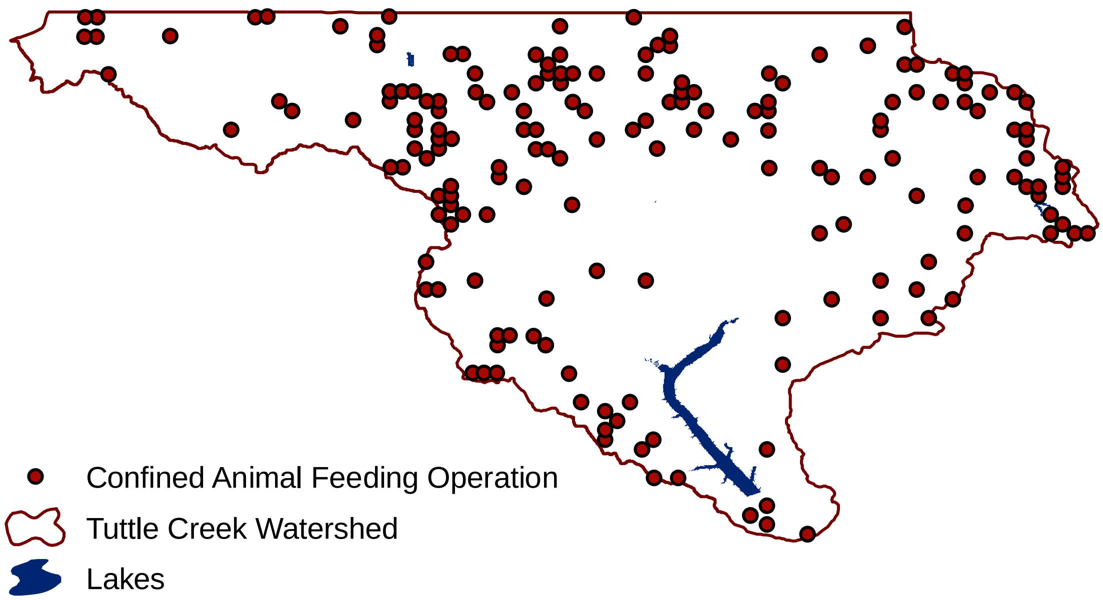


Figure 27. Confined Animal Feeding Operations in the Watershed. [34] *Data provided by Kansas Department of Health and Environment, 2003. Data may be dated and subject to change.*

5.3.1.D Rainfall and Manure Runoff

Rainfall amounts and subsequent runoff can affect FCB runoff from agricultural areas. High intensity events mobilize FCB from livestock and wildlife. Manure that is recently applied on cropland can also have FCB runoff. For more information concerning rainfall in the Big Blue/Little Blue Watershed, refer to Figure 18 on page 47.

5.3.2 Pollutant Loads and Load Reductions

The current estimated pollutant load for fecal coliform bacteria cannot be estimated. Fecal coliform bacteria concentrations are difficult to model and the scope of this WRAPS project does not include modeling for fecal coliform bacteria. Environmental factors affect the viability of the FCB since it is a living organism. The fate of FCB is affected by variations in initial bacteria loading, ambient temperature, amount of sunlight or UV rays, and a decrease in survivability over time are all factors that affect the viability of FCB. The SLT has laid out specific BMPs that are related to livestock management practices. At the beginning of this process, BMPs were discussed at the SLT meeting. The SLT came to an agreement of a list of BMPs that they felt would be acceptable and result in significant pollutant reduction progress. Each individual at the meeting then ranked the list of BMPs. These individual rankings were compiled and the top five were determined to be used to reduce fecal coliform bacteria. The SLT believes that these BMPs will be acceptable to watershed residents. These BMPs are listed in the table below.

Table 28. BMPs to be Implemented as Determined by the SLT to Reduce Fecal Coliform Bacteria Contribution to Address the Black Vermillion River FCB TMDL and the Big Blue River FCB TMDL.

<table>
<tr><th>Protection Measures</th><th>Best Management Practices and Other Actions</th><th>Projects Needed to be Implemented Annually</th></tr>
<tr><td rowspan="7">1.0 Prevention of fecal coliform bacteria contribution from livestock</td><td>1.1 Install vegetative filter strips along creeks</td><td>1 site per year</td></tr>
<tr><td>1.2 Relocate small feedlots away from streams</td><td>1 site every other year</td></tr>
<tr><td rowspan="2">1.3 Relocate pasture feeding sites away from streams</td><td>2 sites per year in native grass pastures</td></tr>
<tr><td>1 site every other year in cool season grass pastures</td></tr>
<tr><td rowspan="3">1.4. Promote alternative watering sites away from stream</td><td>2 sites per year in native grass pastures</td></tr>
<tr><td>1 site every other year in cool season grass pastures</td></tr>
<tr><td>1 site per year in cropland that is being used for winter grazing of crop stubble</td></tr>
</table>

Refer to Section 7, "Costs of BMP Implementation" for specific BMP costs.

5.4 Atrazine

Tuttle Creek Lake and its entire watershed have a TMDL for **Atrazine**. Atrazine is a highly soluble inexpensive herbicide that is used to treat corn and sorghum. It is primarily applied in the springtime to prevent broadleaf and grassy weeds. However, a rainfall event after application can cause overland runoff carrying the herbicide with the flow. The TMDL for atrazine in Tuttle Creek watershed is 3 ppb (parts per billion). Due to seasonal application, spikes occur in the spring – primarily May and June. Atrazine flows with water into Tuttle Creek Lake. It also infiltrates the groundwater that is used as a public water supply for the City of Manhattan. This leads to extra expense for the city for atrazine removal prior to distribution.

Almost all atrazine concentrations in waters will originate from atrazine applied during the current year. Atrazine flows with overland runoff. Very little is attached to sediment. Therefore, control of atrazine involves control of overland runoff, not erosion. Increasing continuous no-till acreage has had a positive effect on reducing sediment runoff from crop fields. However, the opposite appears to be the case with atrazine runoff. Due to high levels of residue and no incorporation of the chemical at application time, the odds of having a runoff event are increased. Proper timing is therefore an especially important factor in atrazine application on continuous no-till fields.

Tuttle Creek Lake has three "pools" or zones: a managed pool at or below 1075.0 feet msl (mean sea level) in elevation, a seasonal flood pool between 1075.0' and 1136.0' msl, and a critical flood pool over 1136.0' to 1156.8 msl which retains flood event waters. Top of dam elevation is 1159.0 msl. The multi-purpose elevation and below is kept full of water and above multi-purpose elevation, the COE tries to keep free of water. [35] The TMDL endpoint for atrazine involves the following:

1) Atrazine levels in the managed pool of Tuttle Creek Lake will remain below 3 ppb at all times.
2) Atrazine levels in the seasonal flood pool of Tuttle Creek Lake will be above 3 ppb once in three years.
3) The atrazine levels in the critical flood pool of Tuttle Creek Lake will be over 3 ppb in less than 10% of the samples taken during spring flood conditions.

In order to achieve these reductions, atrazine loading from the watershed must be reduced. Best management practices (BMPs) for atrazine can be incorporated into farm management. BMPs can include:

1) Use of alternative herbicides
2) Application in split times (one in fall and one in spring)
3) Incorporate atrazine in the top 2" of soil at application
4) Create buffer zones surrounding cropping fields

5) Install terraces and grassed waterways.
(http://www.kdheks.gov/tmdl/klr/Tuttle_ATR.pdf)

BMPs have been selected by the SLT (and will be discussed later in this section) based on acceptability by the landowners, cost effectiveness and pollutant load reduction effectiveness.

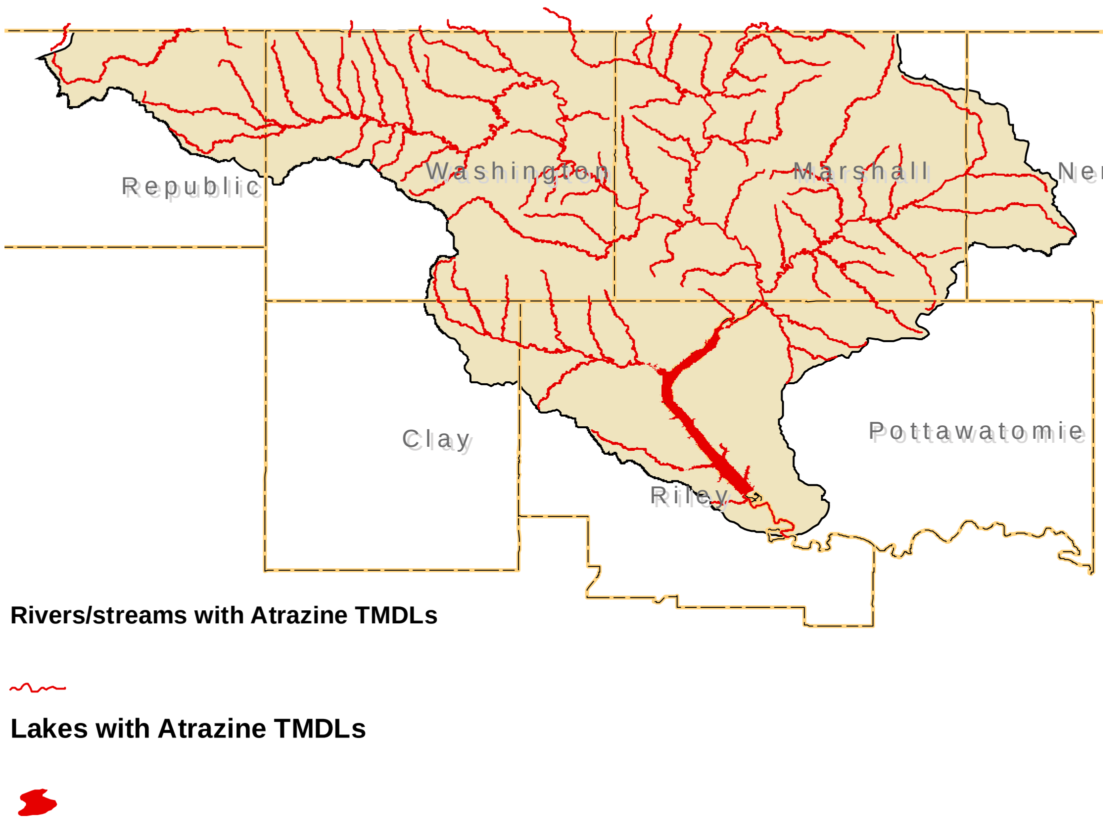


Figure 28. Atrazine TMDLs in the Tuttle Creek Watershed. [25] *Kansas Department of Health and Environment.*
(http://www.kdheks.gov/tmdl/klr/Tuttle_ATR.pdf)

5.4.1 Sources of the Impairment

5.4.1.A Cropland Application

Cropland sprayed with atrazine is the only source of atrazine concentrations in the surface waters of the watershed. Atrazine is applied primarily to corn and sorghum. Approximately one third of the acreage in the watershed is cropland that is planted to these two crops.

Farm Use, by Percentage of Total Agricultural Land

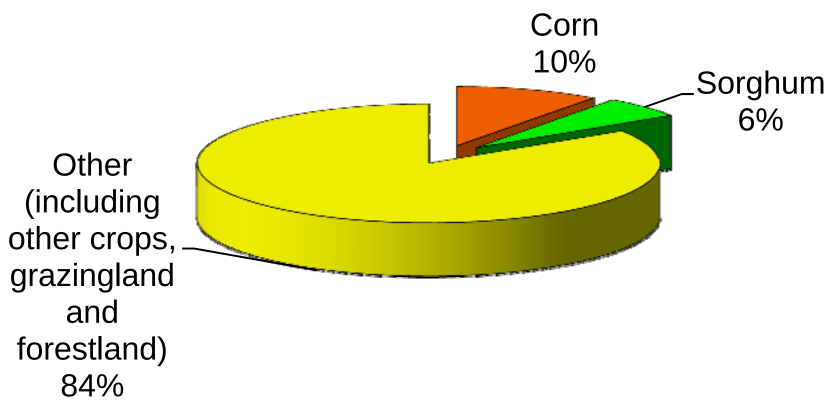


Figure 29. Farm Use.[36] Total farm use in the counties of the watershed by percentage. 2007 Census of Agriculture, USDA NASS. (www.agcensus.usda.gov)

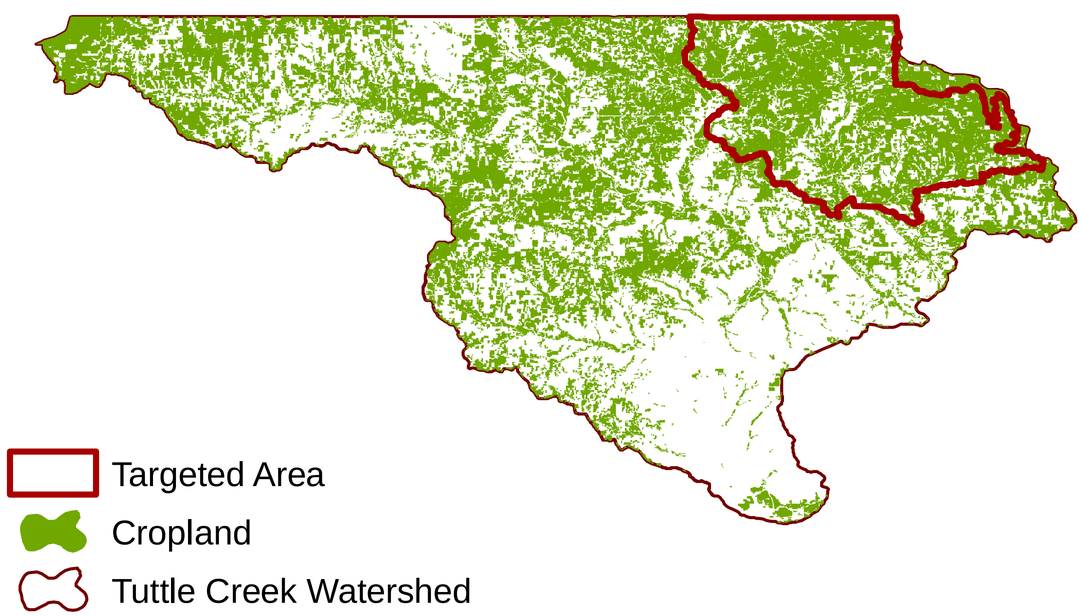


Figure 30. Cropland Distribution in the Watershed with the Targeted Area Highlighted, 2005.[37] *Kansas Applied Remote Sensing Program, Kansas Geospatial Community Commons*

Table 29. Acres of Soybeans, Corn and Sorghum in the Watershed. [36] 2007 Census of Agriculture, USDA NASS. (www.agcensus.usda.gov)

Counties in the Watershed	Corn, Acres	Sorghum, Acres	Land in Farms, Acres
Clay	15,421	33,209	350,949
Marshall	63,002	29,975	514,818
Nemaha	84,560	6,451	450,508
Pottawatomie	29,665	6,094	428,601
Republic	57,257	33,016	406,745
Riley	8,694	11,750	231,960
Washington	35,372	50,340	548,034
Total	**293,971**	**170,835**	**2,931,615**

5.4.1.B Rainfall and Runoff

Rainfall duration (extended duration of rainfall events causing soil saturation and subsequent runoff) and intensity (high rainfall rates overwhelming soil adsorptive capacity causing runoff) are key components that affect atrazine runoff from agricultural cropland. When atrazine application is applied in the late spring, the chances are greater that a high intensity rainfall event will wash away the atrazine on the field. High intensity rainfall events primarily occur in the late spring in this watershed. (Figure 31) Also important is the time to rainfall after application. The longer the time span, the less runoff of atrazine.

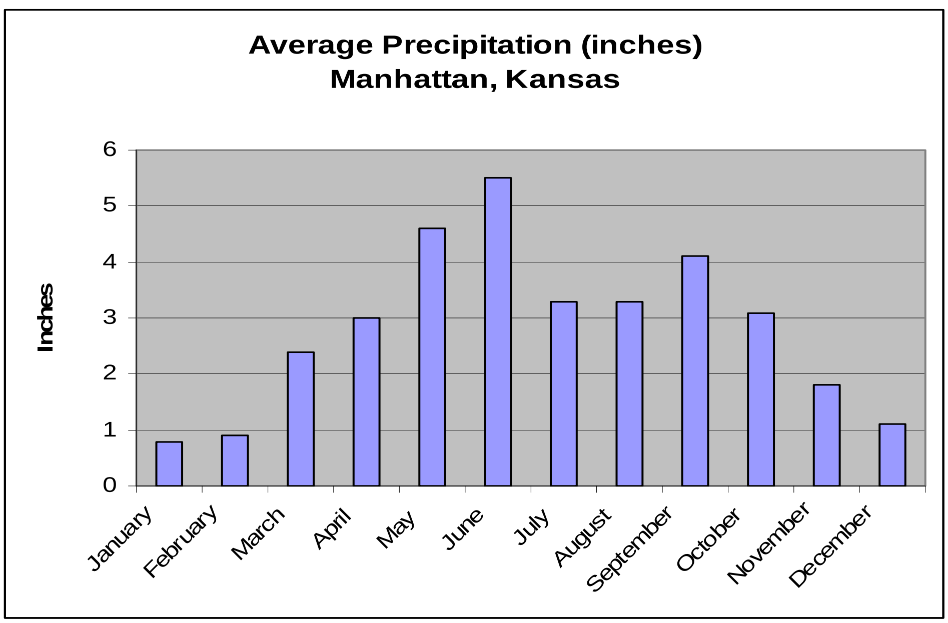
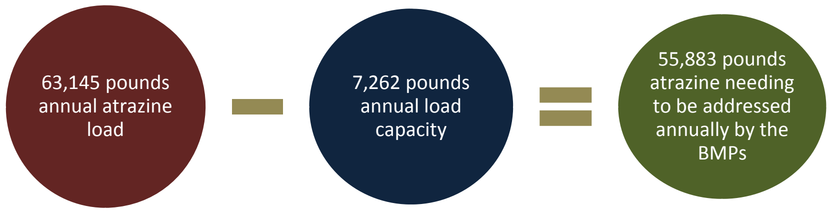


Figure 31. Average Precipitation by Month. [38] Manhattan, Kansas. (http://countrystudies.us/united-states/weather/kansas/manhattan.htm)

5.4.2 Pollutant Loads and Load Reductions

The current estimated pollutant load for atrazine is 63,145 pounds in the months of May and June in Tuttle Creek Lake. **The load needs to be reduced by 55,883 pounds to meet the TMDL.**



Listed below are actions that can be taken in order to reduce atrazine. At the beginning of this process, BMPs for atrazine were discussed at the SLT meeting. The SLT came to an agreement on a list of BMPs that they felt would be acceptable and result in significant pollutant reduction progress. Each individual at the meeting then ranked the list of BMPs. These individual rankings were compiled and the top five were determined for atrazine reduction. The timeframe needed to meet the TMDL for atrazine is forty years. At this time, the focus will be on “protection” instead of “restoration”.

Table 30. BMPs as Determined by the SLT to Reduce to Address the Tuttle Creek Watershed Atrazine TMDL.

BMP	Adoption Rate	Acres Adopted	Reduction Effectiveness	Reduction (lbs)	% of TMDL
Use Alternative Herbicide	30%	61,625	100%	18,944	34%
Vegetative Buffers	40%	82,167	40%	10,103	18%
Split Application	50%	102,709	35%	11,050	20%
Apply Before April 15	50%	102,709	50%	15,786	28%
Total				**55,883**	**100%**

The table below lists the cropland BMPs and acres implemented with the associated load reductions attained by implementing all of these BMPs. It will take forty years to reach the TMDL if all BMPs are implemented.

Table 31. Estimated Atrazine Load Reductions for Implemented BMPs on Cropland to Address the Tuttle Creek Watershed Atrazine TMDL..

Annual Atrazine Load Reductions						
Year	**Use Alternative Herbicide**	**Vegetative Buffers**	**Split Application**	**Apply Before April 15**	**Total Annual Reduction**	**% of TMDL**
1	474	253	276	395	**1,397**	2.5%
2	947	505	553	789	**2,794**	5.0%
3	1,421	758	829	1,184	**4,191**	7.5%

Annual Atrazine Load Reductions, Cont.						
Year	Use Alternative Herbicide	Vegetative Buffers	Split Application	Apply Before April 15	Total Annual Reduction	% of TMDL
4	1,894	1,010	1,105	1,579	**5,588**	10.0%
5	2,368	1,263	1,381	1,973	**6,985**	12.5%
6	2,842	1,515	1,658	2,368	**8,382**	15.0%
7	3,315	1,768	1,934	2,763	**9,780**	17.5%
8	3,789	2,021	2,210	3,157	**11,177**	20.0%
9	4,262	2,273	2,486	3,552	**12,574**	22.5%
10	4,736	2,526	2,763	3,947	**13,971**	25.0%
11	5,209	2,778	3,039	4,341	**15,368**	27.5%
12	5,683	3,031	3,315	4,736	**16,765**	30.0%
13	6,157	3,284	3,591	5,131	**18,162**	32.5%
14	6,630	3,536	3,868	5,525	**19,559**	35.0%
15	7,104	3,789	4,144	5,920	**20,956**	37.5%
16	7,577	4,041	4,420	6,315	**22,353**	40.0%
17	8,051	4,294	4,696	6,709	**23,750**	42.5%
18	8,525	4,546	4,973	7,104	**25,147**	45.0%
19	8,998	4,799	5,249	7,498	**26,545**	47.5%
20	9,472	5,052	5,525	7,893	**27,942**	50.0%
21	9,945	5,304	5,801	8,288	**29,339**	52.5%
22	10,419	5,557	6,078	8,682	**30,736**	55.0%
23	10,893	5,809	6,354	9,077	**32,133**	57.5%
24	11,366	6,062	6,630	9,472	**33,530**	60.0%
25	11,840	6,315	6,906	9,866	**34,927**	62.5%
26	12,313	6,567	7,183	10,261	**36,324**	65.0%
27	12,787	6,820	7,459	10,656	**37,721**	67.5%
28	13,260	7,072	7,735	11,050	**39,118**	70.0%
29	13,734	7,325	8,012	11,445	**40,515**	72.5%
30	14,208	7,577	8,288	11,840	**41,912**	75.1%
31	14,681	7,830	8,564	12,234	**43,310**	77.6%
32	15,155	8,083	8,840	12,629	**44,707**	80.1%
33	15,628	8,335	9,117	13,024	**46,104**	82.6%
34	16,102	8,588	9,393	13,418	**47,501**	85.1%
35	16,576	8,840	9,669	13,813	**48,898**	87.6%
36	17,049	9,093	9,945	14,208	**50,295**	90.1%
37	17,523	9,345	10,222	14,602	**51,692**	92.6%
38	17,996	9,598	10,498	14,997	**53,089**	95.1%
39	18,470	9,851	10,774	15,392	**54,486**	97.6%
40	18,944	10,103	11,050	15,786	**55,883**	100.1%

Determination of Atrazine Application

Grain sorghum and cropland acreages for the entire Tuttle Creek watershed were determined using the SWAT model and acreage reports from the National Agricultural Statistics Survey (NASS). KSU agronomist Dan Devlin estimated that 1.25 pounds of Atrazine is applied to 100% and 50% of grain sorghum and corn acreages, respectively. Summing the numbers from SWAT and Devlin gives an estimate that 256,772 lbs of atrazine is applied to 205,418 acres of land annually within the watershed.

Data from the TMDL section of KDHE shows that 63,145 lbs. of atrazine ends up in the reservoir annually. Hence, roughly 25% of all atrazine applied within the watershed runs off the fields and into the reservoir. This number was used to weight the effectiveness of installing BMPs to reduce atrazine runoff. The cost of implementing every atrazine reducing BMP except vegetative buffers is assumed to be a onetime payment of $6 an acre, roughly the same program implemented by the Little Ark WRAPS. We did not assume that producers would receive additional cost-share for installing vegetative buffers since they already may be receiving cost-share from NRCS and the Tuttle Creek WRAPS.

In order to calculate atrazine savings for each individual practice, the estimated number of pounds of atrazine applied in the watershed (256,772) was multiplied times the additional adoption rate (30% for Alternative Herbicide) times the reduction efficiency of the BMP (100% for Alternative Herbicide) times the amount of atrazine that ends up in the reservoir (24.59% on average).

Total atrazine reduction from adopting Alternative Herbicides on 30% of all acres currently treated with atrazine:
256,772 lbs. * 30% adoption * 100% reduction efficiency * 24.59% of atrazine applied ends up in the reservoir = 18,944 lbs.

Refer to Section 7, “Costs of BMP Implementation” for specific BMP costs in order to meet the TMDL.

6.0 Information and Education in Support of BMPs

6.1 Information and Education Activities

The SLT has determined which information and education activities will be needed in the watershed. These activities are important in providing the residents of the watershed with a higher awareness of watershed issues. This will lead to an increase in adoption rates of BMPs. Listed below are the activities and events along with their costs and possible sponsoring agencies.

Table 32. Information and Education Activities and Events as Requested by the SLT to Address All TMDLs in the Watershed.

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Cropland BMP Implementation					
Buffers	Landowners and Farmers	Demonstration Project	Annual – Spring	$5,000 per demonstration project	Kansas Rural Center Buffer Coordinator
		Tour/Field Day to Highlight Grassed Buffer	Annual - Summer	$500 per tour or field day	Kansas Rural Center Buffer Coordinator
		Buffer/Riparian Area Tour/Field Day highlighting forested buffers	Annual - Summer	$1,700 per tour or field day	Kansas Forest Service
		Newspaper Articles	Annual – Fall	No Charge	Conservation Districts
		Extension Newsletter Article	Annual – Fall	No Charge	Conservation Districts and Kansas Research and Extension
		One on One Meetings with Producers	Annual - Ongoing	Cost included in Technical Assistance for Buffer Coordinator	Conservation Districts, Kansas Research and Extension and Buffer Coordinators

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Cropland BMP Implementation, Cont.					
No-till	Farmers and Rental Operators	No-Till Informational Meeting	Annual - Spring	$2,000 per meeting	No-Till on the Plains and Conservation Districts
		Newsletter article	Annual – Spring	No Charge	Conservation District and Kansas State Research and Extension
		One on One Meetings with Producers	Annual - Ongoing	Cost included with Technical Assistance for No-Till Coordinator	Conservation District and Kansas State Research and Extension
		Seasonal Informational Meeting (planting)	Annual - Spring	$2,750 per meeting	No-till on the Plains
		Seasonal Informational Meeting (harvesting)	Annual - Summer	$2,750 per meeting	No-till on the Plains
		Scholarships for 25 producers to attend No-Till Winter Conference	Annual – Winter	$3,750 ($150 per person)	No-till on the Plains
Nutrient Management	Farmers	Cost Share for 600 Soil Tests	Annual - Ongoing	$3,000 ($5 per test)	Conservation District and Kansas State Research and Extension
		Extension Newsletter Article	Annual - Ongoing	No Charge	Conservation District and Kansas State Research and Extension
		One on One Meetings with Producers	Annual - Ongoing	Cost included with Technical Assistance for Watershed Specialist	Kansas State Research and Extension
Subsurface Fertilizer Application	Farmers	Field Day showcasing the latest subsurface fertilizer equipment	Annual – Winter	No charge	Kansas State Research and Extension, Bruna Implement

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Livestock BMP Implementation					
Vegetative Filter Strips	Landowners and Ranchers	Demonstration Project	Annual – Spring	Combined with buffer demonstration	Kansas Rural Center Buffer Coordinator
		Tour/Field Day	Annual - Summer	Combined with buffer tour or field day	Kansas Rural Center Buffer Coordinator
		Workshop/Tour	Annual – Winter	$500 per workshop	Kansas Rural Center Buffer Coordinator
		Livestock Filter Strip and Feedlot Relocation Demonstration/Tour	Annual – Winter	$300 per demonstration or tour	Conservation Districts NCRS
Relocated Feedlot	Landowners and Small Feedlot Operators	Demonstration Project	Annual – Spring	$5,000 per demonstration project	Kansas Rural Center
		Tour/Field Day	Annual - Summer	$500 per tour or field day	Kansas Rural Center Conservation Districts
		EQIP Program Informational Meeting	Annual - Ongoing	No Charge	Conservation Districts NRCS

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Livestock BMP Implementation, Cont.					
Relocate Pasture Feeding Site	Ranchers	Demonstration Project	Annual – Spring	$5,000 per demonstration project	Kansas Rural Center
		Tour/Field Day	Annual - Summer	$500 per tour or field day	Kansas Rural Center Conservation Districts
		Grazing Informational Meeting featuring Jim Gerrish	Annual - Fall	$250 per meeting	Conservation Districts Kansas Rural Center
Off-Stream Watering System	Ranchers	Demonstration Project	Annual – Spring	$5,000 per demonstration project	Kansas Rural Center
		Tour/Field Day	Annual - Summer	$500 per tour or field day	Kansas Rural Center Conservation Districts
		Grazing Informational Meeting featuring Jim Gerrish	Annual - Fall	Combined with relocating pasture feeding site meeting	Conservation Districts Kansas Rural Center
		Demonstration project for pond construction and spring developments	Annual - Fall	$10,000 per project	Conservation Districts NRCS
Streambank BMP Implementation					
		One on one technical assistance	Annual – Ongoing	Included with Technical Assistance for Buffer Coordinator and Watershed Specialist	Conservation Districts, Buffer Coordinator, Kansas State Research and Extension
		Demonstration project focusing on streambank assessment methodology	Annual - Summer	$3,000 per project	Kansas Alliance for Wetlands and Streams
		Field day highlighting completed streambank assessment projects	Annual - Summer	$1,700 per field day	Kansas Forest Service

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Atrazine BMP Implementation					
Use of Alternative Herbicide	Farmers	Workshop highlighting use of organic or non-chemical weed control	Annual – Spring	$5,000 per workshop	Kansas Rural Center, NRCS (EQIP Organic Initiatives Provision)
Terraces and Grassed Waterways	Farmers	WRCSP, EQIP, CSP Programs Information Meeting	Annual – Ongoing	No charge	Conservation Districts, NRCS
All atrazine BMPs	Farmers	Workshop featuring Dr. Dan Devlin highlighting BMPs for atrazine reduction	Annual – Winter	$1,000 per workshop	Kansas State Research and Extension
Watershed Wide Information and Education					
Education of Youth	Educators, K-12 Students	Day on the Farm	Annual – Spring	$500 per event	Conservation Districts, Kansas Farm Bureaus, Kansas FFA Organization, Kansas State Research and Extension
		Poster, essay and speech contests	Annual – Spring	$200	Conservation Districts
		Envirothon	Annual - Spring	$250	Conservation Districts
Education of Adults	Educators, Adult Education	Extension newsletter article	Annual – Ongoing	No charge	Conservation District
		Presentation at annual meeting	Annual – Winter	No charge	Conservation District
		River Friendly Farms producer notebook Informational Meeting	Annual - Ongoing	$150 per meeting	Conservation Districts, Kansas Rural Center
		Media campaign to promote forestry practices (brochures, news releases, TV, radio, web-based)	Bi-annual – Ongoing	$500 per campaign	Kansas Forest Service

BMP	Target Audience	Information/Education Activity/Event	Time Frame	Estimated Costs	Sponsor/Responsible Agency
Watershed Wide Information and Education, Cont.					
Education of Watershed Residents	Watershed Residents	CoCoRaHS promotional event	Annual - Ongoing	$250 per event	Conservation Districts
		Meeting with Soil and Grassland Awards	Annual – Ongoing	No charge	Conservation Districts
		Media campaign to promote River Friendly Farms (news stories, features, farmer profiles)	Annual – Ongoing	$1,000 per campaign	Kansas Rural Center
		Media campaign to address urban nutrient runoff (flyers or handouts addressing phosphate and nitrate pollution from urban areas)	Annual – Ongoing	$500 per campaign	Local Environmental Protection Program
		Watershed display for area garden shows	Annual – Ongoing	No charge	Conservation Districts, Kansas State Research and Extension
Total annual cost for Information and Education if all events are implemented				**$63,050**	

6.2 Evaluation of Information and Education Activities

All service providers conducting Information and Education (I&E) activities funded through the Tuttle WRAPS will be required to include an evaluation component in their project proposals and PIPs. The evaluation methods will vary based on the activity.

At a minimum, all I&E projects must include participant learning objectives as the basis for the overall evaluation. Depending on the scope of the project, development of a basic logic model identifying long-term, medium-term, and short-term behavior changes or other outcomes that are expected to result from the I&E activity may be required.

Specific evaluation tools or methods may include (but are not limited to):

- Feedback forms allowing participants to provide rankings of the content, presenters, usefulness of information, etc.
- Pre and post surveys to determine amount of knowledge gained, anticipated behavior changes, need for further learning, etc.
- Follow up interviews (one-on-one contacts, phone calls, e-mails) with selected participants to gather more in-depth input regarding the effectiveness of the I&E activity.

All service providers will be required to submit a brief written evaluation of their I&E activity, summarizing how successful the activity was in achieving the learning objectives, and how the activity contributed to achieving the long-term WRAPS goals and/or objectives for pollutant load reductions.

7.0 Costs of implementing BMPs and Possible Funding Sources

The SLT has reviewed all the recommended BMPs listed in Section 5 of this report for each individual impairment. It has been determined by the SLT that specific BMPs will be the target of implementation funding for each category (cropland, livestock and streambank). Most of the BMPs that are targeted will be advantageous to more than one impairment, thus being more efficient.

Summarized Derivation of Cropland BMP Cost Estimates

Riparian Vegetative Buffer: The cost of $1,000 per acre was arrived at using average cost of installation figures from the conservation districts within the watershed and cost estimates from the KSU Vegetative Buffer Tool developed by Craig Smith.

No-Till: After being presented with information from K-State Research and Extension (Craig Smith and Josh Roe) on the costs and benefits of no-till, the SLT decided that a fair price to entice a producer to adopt no-till would be to pay them $10 per acre for 10 years, or a net present value of $77.69 per acre upfront assuming the NRCS discount rate of 4.75%.

Nutrient Management Plan: After being presented with information from K-State Research and Extension (Craig Smith and Josh Roe) on the costs and benefits of nutrient management plans, the SLT decided that a fair price to entice a producer to adopt nutrient management plans would be to pay them $7.30 per acre for 10 years, or a net present value of $56.71 per acre upfront assuming the NRCS discount rate of 4.75%.

Grassed Waterway: $2,200 per acre was arrived at using average cost of installation figures from the conservation districts within the watershed and updated costs of brome grass seeding from Josh Roe.

Subsurface Fertilizer Application: WRAPS groups and KSU Ag Economists have decided $3.50 an acre for 10 years is an adequate payment to entice producers to convert to subsurface fertilize application. Cost share is available through NRCS at 50%.

Summarized Derivation of Livestock BMP Cost Estimates

Vegetative Filter Strip: The cost of $714 an acre was calculated by Josh Roe and Mike Christian figuring the average filter strip in the watershed will require four hours of bulldozer work at $125 an hour plus the cost of seeding one acre in permanent vegetation estimated by Josh Roe.

Relocated Feedlot: The cost of moving a one acre feedlot of $6,621 was calculated by Josh Roe figuring the cost of fencing, a new watering system, concrete, and labor.

Relocated Pasture Feeding Site: The cost of moving a pasture feeding site of $2,203 was calculated by Josh Roe figuring the cost of building ¼ mile of fence, a permeable surface, and labor.

Off-Stream Watering System: The average cost of installing an alternative watering system of $3,500 was estimated by Herschel George, Marais des Cygnes Watershed Specialist who has installed numerous systems and has detailed average cost estimates.

Table 33. Estimated Acreages Treated, Costs and Net Costs for Cropland Implemented BMPs to Address the Tuttle Creek Lake Siltation TMDL and the Tuttle Creek Lake Eutrophication TMDL. Forty year estimations for each sub watershed are included in the Appendix. *Expressed in 2009 dollar amounts.*

Tuttle Creek Targeted Area, Adjusted Annual Cost*						
Acres Treated Annually	**2,739**	**4,564**	**4,564**	**1,826**	**913**	
Year	**Buffer**	**Continuous no-till**	**Nutrient Management**	**Waterways**	**Subsurface Fertilization**	**Total Annual Cost**
1	$182,570	$354,597	$258,839	$401,655	$24,820	**$1,222,482**
2	$188,048	$365,235	$266,604	$413,705	$25,565	**$1,259,157**
3	$193,689	$376,192	$274,603	$426,116	$26,332	**$1,296,932**
4	$199,500	$387,478	$282,841	$438,899	$27,122	**$1,335,840**
5	$205,485	$399,102	$291,326	$452,066	$27,936	**$1,375,915**
6	$211,649	$411,076	$300,066	$465,628	$28,774	**$1,417,192**
7	$217,999	$423,408	$309,068	$479,597	$29,637	**$1,459,708**
8	$224,539	$436,110	$318,340	$493,985	$30,526	**$1,503,499**
9	$231,275	$449,193	$327,890	$508,804	$31,442	**$1,548,604**
10	$238,213	$462,669	$337,726	$524,069	$32,385	**$1,595,062**
11	$245,359	$476,549	$347,858	$539,791	$33,357	**$1,642,914**
12	$252,720	$490,846	$358,294	$555,984	$34,357	**$1,692,202**
13	$260,302	$505,571	$369,043	$572,664	$35,388	**$1,742,968**
14	$268,111	$520,738	$380,114	$589,844	$36,450	**$1,795,257**
15	$276,154	$536,360	$391,518	$607,539	$37,543	**$1,849,114**
16	$284,439	$552,451	$403,263	$625,765	$38,669	**$1,904,588**
17	$292,972	$569,025	$415,361	$644,538	$39,830	**$1,961,725**
18	$301,761	$586,095	$427,822	$663,874	$41,024	**$2,020,577**
19	$310,814	$603,678	$440,656	$683,791	$42,255	**$2,081,194**
20	$320,138	$621,789	$453,876	$704,304	$43,523	**$2,143,630**
21	$329,742	$640,442	$467,492	$725,433	$44,828	**$2,207,939**
22	$339,635	$659,656	$481,517	$747,196	$46,173	**$2,274,177**
23	$349,824	$679,445	$495,963	$769,612	$47,559	**$2,342,403**
24	$360,319	$699,829	$510,842	$792,701	$48,985	**$2,412,675**
25	$371,128	$720,823	$526,167	$816,482	$50,455	**$2,485,055**
26	$382,262	$742,448	$541,952	$840,976	$51,969	**$2,559,607**
27	$393,730	$764,722	$558,210	$866,205	$53,528	**$2,636,395**
28	$405,542	$787,663	$574,957	$892,192	$55,133	**$2,715,487**
29	$417,708	$811,293	$592,205	$918,957	$56,787	**$2,796,951**
30	$430,239	$835,632	$609,972	$946,526	$58,491	**$2,880,860**
31	$443,146	$860,701	$628,271	$974,922	$60,246	**$2,967,286**
32	$456,441	$886,522	$647,119	$1,004,170	$62,053	**$3,056,304**

Tuttle Creek Targeted Area, Adjusted Annual Cost*, Cont.						
Acres Treated Annually	2,739	4,564	4,564	1,826	913	
Year	Buffer	Continuous no-till	Nutrient Management	Waterways	Subsurface Fertilization	Total Annual Cost
33	$470,134	$913,118		$1,034,295	$63,915	**$2,481,461**
34	$484,238	$940,511		$1,065,323	$65,832	**$2,555,905**
35	$498,765	$968,726		$1,097,283	$67,807	**$2,632,582**
36	$513,728	$997,788		$1,130,202	$69,841	**$2,711,559**
37	$529,140	$1,027,722		$1,164,108	$71,937	**$2,792,906**
38	$545,014	$1,058,554		$1,199,031	$74,095	**$2,876,693**
39	$561,365			$1,235,002	$76,318	**$1,872,684**
40	$578,205			$1,272,052	$78,607	**$1,928,864**

Tuttle Creek Targeted Area, Annual Cost Adjusted for Potential Cost-Share						
Acres Treated Annually	2,739	4,564	4,564	1,826	913	
Year	Buffer	Continuous no-till	Nutrient Management	Waterways	Subsurface Fertilization	Total Annual Cost
1	$18,257	$216,304	$129,420	$200,827	$24,820	**$589,629**
2	$18,805	$222,794	$133,302	$206,852	$25,565	**$607,318**
3	$19,369	$229,477	$137,301	$213,058	$26,332	**$625,537**
4	$19,950	$236,362	$141,420	$219,450	$27,122	**$644,303**
5	$20,548	$243,453	$145,663	$226,033	$27,936	**$663,633**
6	$21,165	$250,756	$150,033	$232,814	$28,774	**$683,542**
7	$21,800	$258,279	$154,534	$239,798	$29,637	**$704,048**
8	$22,454	$266,027	$159,170	$246,992	$30,526	**$725,169**
9	$23,127	$274,008	$163,945	$254,402	$31,442	**$746,924**
10	$23,821	$282,228	$168,863	$262,034	$32,385	**$769,332**
11	$24,536	$290,695	$173,929	$269,895	$33,357	**$792,412**
12	$25,272	$299,416	$179,147	$277,992	$34,357	**$816,184**
13	$26,030	$308,398	$184,521	$286,332	$35,388	**$840,670**
14	$26,811	$317,650	$190,057	$294,922	$36,450	**$865,890**
15	$27,615	$327,180	$195,759	$303,770	$37,543	**$891,867**
16	$28,444	$336,995	$201,632	$312,883	$38,669	**$918,623**
17	$29,297	$347,105	$207,680	$322,269	$39,830	**$946,181**
18	$30,176	$357,518	$213,911	$331,937	$41,024	**$974,567**
19	$31,081	$368,244	$220,328	$341,895	$42,255	**$1,003,804**
20	$32,014	$379,291	$226,938	$352,152	$43,523	**$1,033,918**
21	$32,974	$390,670	$233,746	$362,717	$44,828	**$1,064,935**

Tuttle Creek Targeted Area, Annual Cost Adjusted for Potential Cost-Share, Cont.						
Acres Treated Annually	2,739	4,564	4,564	1,826	913	
Year	Buffer	Continuous no-till	Nutrient Management	Waterways	Subsurface Fertilization	Total Annual Cost
22	$33,963	$402,390	$240,759	$373,598	$46,173	**$1,096,884**
23	$34,982	$414,462	$247,981	$384,806	$47,559	**$1,129,790**
24	$36,032	$426,895	$255,421	$396,350	$48,985	**$1,163,684**
25	$37,113	$439,702	$263,083	$408,241	$50,455	**$1,198,594**
26	$38,226	$452,893	$270,976	$420,488	$51,969	**$1,234,552**
27	$39,373	$466,480	$279,105	$433,103	$53,528	**$1,271,589**
28	$40,554	$480,475	$287,478	$446,096	$55,133	**$1,309,736**
29	$41,771	$494,889	$296,103	$459,479	$56,787	**$1,349,028**
30	$43,024	$509,736	$304,986	$473,263	$58,491	**$1,389,499**
31	$44,315	$525,028	$314,135	$487,461	$60,246	**$1,431,184**
32	$45,644	$540,778	$323,559	$502,085	$62,053	**$1,474,120**
33	$47,013	$557,002	$0	$517,147	$63,915	**$1,185,077**
34	$48,424	$573,712	$0	$532,662	$65,832	**$1,220,629**
35	$49,877	$590,923	$0	$548,642	$67,807	**$1,257,248**
36	$51,373	$608,651	$0	$565,101	$69,841	**$1,294,966**
37	$52,914	$626,910	$0	$582,054	$71,937	**$1,333,815**
38	$54,501	$645,718	$0	$599,515	$74,095	**$1,373,829**
39	$56,136	$0	$0	$617,501	$76,318	**$749,955**
40	$57,821	$0	$0	$636,026	$78,607	**$772,454**
		**Cost Inflation:*	*3.00%*			

Table 34. Estimated Livestock BMPs and Annual Costs in the Targeted Area Consisting of 200 foot Buffers of TMDL Waterways in the Fecal Coliform Impaired Watersheds to Address the Black Vermillion FCB TMDL and the Big Blue River FCB TMDL. *Expressed in 2009 dollar amounts.*

Annual Cost of Implementing Livestock BMPs								
			Relocate Pasture Feeding Site		Off-Stream Watering System			
Year	Vegetative Filter Strip	Relocated Feedlot	Native	Cool Season	Native	Cool Season	Cropland	Annual Cost
1	$714		$4,406		$7,590		$3,795	**$16,505**
2	$735	$6,820	$4,538	$2,269	$7,818	$3,909	$3,909	**$29,998**
3	$757		$4,674		$8,052		$4,026	**$17,510**
4	$780	$7,235	$4,815	$2,407	$8,294	$4,147	$4,147	**$31,825**
5	$804		$4,959		$8,543		$4,271	**$18,577**
6	$828	$7,676	$2,554	$2,554	$4,399	$4,399	$4,399	**$26,809**

Annual Cost of Implementing Livestock BMPs, Cont.								
			Relocate Pasture Feeding Site		Off-Stream Watering System			
Year	Vegetative Filter Strip	Relocated Feedlot	Native	Cool Season	Native	Cool Season	Cropland	Annual Cost
7	$853		$2,630		$4,531		$4,531	**$12,546**
8	$878	$8,143	$2,709	$2,709	$4,667	$4,667	$4,667	**$28,442**
9	$904		$2,791		$4,807		$4,807	**$13,310**
10	$932	$8,639	$2,874	$2,874	$4,952	$4,952	$4,952	**$30,174**
11	$960		$2,961		$5,100		$5,100	**$14,121**
12	$988	$9,165	$3,049	$3,049	$5,253	$5,253	$5,253	**$32,012**
13	$1,018		$3,141		$5,411		$5,411	**$14,980**
14	$1,049	$9,723	$3,235	$3,235	$5,573	$5,573	$5,573	**$33,961**
15	$1,080		$3,332		$5,740		$5,740	**$15,893**
16	$1,112	$10,315	$3,432	$3,432	$5,912	$5,912	$5,912	**$36,030**
17	$1,146		$3,535		$6,090		$6,090	**$16,861**
18	$1,180	$10,944	$3,641	$3,641	$6,273	$6,273	$6,273	**$38,224**
19	$1,216		$3,750		$6,461		$6,461	**$17,887**
20	$1,252	$11,610	$3,863	$3,863	$6,655	$6,655	$6,655	**$40,552**
21	$1,290		$3,979		$6,854		$6,854	**$18,977**
22	$1,328	$12,317	$4,098	$4,098	$7,060	$7,060	$7,060	**$43,021**
23	$1,368		$4,221		$7,272		$7,272	**$20,132**
24	$1,409	$13,067	$4,348	$4,348	$7,490	$7,490	$7,490	**$45,641**
25	$1,451		$4,478		$7,714		$7,714	**$21,359**
26	$1,495	$13,863	$4,613	$4,613	$7,946	$7,946	$7,946	**$48,421**
27	$1,540		$4,751		$8,184		$8,184	**$22,659**
28	$1,586	$14,707	$4,893	$4,893	$8,430	$8,430	$8,430	**$51,370**
29	$1,634		$5,040		$8,683		$8,683	**$24,039**
30	$1,683	$15,603	$5,192	$5,192	$8,943	$8,943	$8,943	**$54,498**
31	$1,733		$5,347		$9,211		$9,211	**$25,503**
32	$1,785	$16,553	$5,508	$5,508	$9,488	$9,488	$9,488	**$57,817**
33	$1,839		$5,673		$9,772		$9,772	**$27,056**
34	$1,894	$17,561	$5,843	$5,843	$10,066	$10,066	$10,066	**$61,338**
35	$1,951		$6,018		$10,368		$10,368	**$28,704**
36	$2,009	$18,631	$6,199	$6,199	$10,679	$10,679	$10,679	**$65,073**
37	$2,069		$6,385		$10,999		$10,999	**$30,452**
38	$2,131	$19,765	$6,576	$6,576	$11,329	$11,329	$11,329	**$69,036**
39	$2,195		$6,774		$11,669		$11,669	**$32,307**
40	$2,261	$20,969	$6,977	$6,977	$12,019	$12,019	$12,019	**$73,241**
3% Annual Cost Inflation								

Annual Cost of Implementing Livestock BMPs with 50% EQIP Cost-Share								
			Relocate Pasture Feeding		Off-Stream Watering System			
Year	Vegetative Filter Strip	Relocated Feedlot	Native	Cool Season	Native	Cool Season	Cropland	Annual Cost
1	$357		$2,203		$3,795		$1,898	**$8,253**
2	$368	$3,410	$2,269	$1,135	$3,909	$1,954	$1,954	**$14,999**
3	$379		$2,337		$4,026		$2,013	**$8,755**
4	$390	$3,617	$2,407	$1,204	$4,147	$2,073	$2,073	**$15,912**
5	$402		$2,479		$4,271		$2,136	**$9,288**
6	$414	$3,838	$1,277	$1,277	$2,200	$2,200	$2,200	**$13,405**
7	$426		$1,315		$2,266		$2,266	**$6,273**
8	$439	$4,071	$1,355	$1,355	$2,334	$2,334	$2,334	**$14,221**
9	$452		$1,395		$2,404		$2,404	**$6,655**
10	$466	$4,319	$1,437	$1,437	$2,476	$2,476	$2,476	**$15,087**
11	$480		$1,480		$2,550		$2,550	**$7,060**
12	$494	$4,583	$1,525	$1,525	$2,627	$2,627	$2,627	**$16,006**
13	$509		$1,570		$2,705		$2,705	**$7,490**
14	$524	$4,862	$1,618	$1,618	$2,787	$2,787	$2,787	**$16,981**
15	$540		$1,666		$2,870		$2,870	**$7,946**
16	$556	$5,158	$1,716	$1,716	$2,956	$2,956	$2,956	**$18,015**
17	$573		$1,768		$3,045		$3,045	**$8,430**
18	$590	$5,472	$1,821	$1,821	$3,136	$3,136	$3,136	**$19,112**
19	$608		$1,875		$3,230		$3,230	**$8,944**
20	$626	$5,805	$1,931	$1,931	$3,327	$3,327	$3,327	**$20,276**
21	$645		$1,989		$3,427		$3,427	**$9,488**
22	$664	$6,159	$2,049	$2,049	$3,530	$3,530	$3,530	**$21,511**
23	$684		$2,111		$3,636		$3,636	**$10,066**
24	$705	$6,534	$2,174	$2,174	$3,745	$3,745	$3,745	**$22,821**
25	$726		$2,239		$3,857		$3,857	**$10,679**
26	$747	$6,931	$2,306	$2,306	$3,973	$3,973	$3,973	**$24,210**
27	$770		$2,375		$4,092		$4,092	**$11,330**
28	$793	$7,354	$2,447	$2,447	$4,215	$4,215	$4,215	**$25,685**
29	$817		$2,520		$4,341		$4,341	**$12,020**
30	$841	$7,801	$2,596	$2,596	$4,472	$4,472	$4,472	**$27,249**
31	$867		$2,674		$4,606		$4,606	**$12,752**
32	$893	$8,277	$2,754	$2,754	$4,744	$4,744	$4,744	**$28,908**
33	$919		$2,836		$4,886		$4,886	**$13,528**
34	$947	$8,781	$2,922	$2,922	$5,033	$5,033	$5,033	**$30,669**
35	$975		$3,009		$5,184		$5,184	**$14,352**
36	$1,005	$9,315	$3,099	$3,099	$5,339	$5,339	$5,339	**$32,537**

Annual Cost of Implementing Livestock BMPs with 50% EQIP Cost-Share, Cont.								
			Relocate Pasture Feeding		Off-Stream Watering System			
Year	Vegetative Filter Strip	Relocated Feedlot	Native	Cool Season	Native	Cool Season	Cropland	Annual Cost
37	$1,035		$3,192		$5,499		$5,499	**$15,226**
38	$1,066	$9,883	$3,288	$3,288	$5,664	$5,664	$5,664	**$34,518**
39	$1,098		$3,387		$5,834		$5,834	**$16,153**
40	$1,131	$10,484	$3,488	$3,488	$6,009	$6,009	$6,009	**$36,620**

Table 35. Estimated Streambank Stabilization Costs and Net Costs for Implemented Projects to Address the Tuttle Creek Lake Siltation TMDL and the Tuttle Creek Lake Eutrophication TMDL. Costs cannot be determined due to the absence of specific site restoration projects. No targeting is available at the time of this report. Targeting specific streambank projects is determinate upon the KAWS assessment that is funded in the Implementation Grant and will be completed in 2010. Estimated annual streambank stabilization costs have been calculated below. However, the location of these projects will be determined by the SLT after results from the assessment. This table includes the cost of technical assistance.

Annual Streambank Stabilization Costs		
Year	Streambank Stabilization (feet)	Cost
1	3,275	$136,443
2	3,275	$140,536
3	3,275	$144,752
4	3,275	$149,095
5	3,275	$153,568
6	3,275	$158,175
7	3,275	$162,920
8	3,275	$167,808
9	3,275	$172,842
10	3,275	$178,027
11	3,275	$183,368
12	3,275	$188,869
13	3,275	$194,535
14	3,275	$200,371
15	3,275	$206,382
16	3,275	$212,574
17	3,275	$218,951
18	3,275	$225,519
19	3,275	$232,285
20	3,275	$239,254

Annual Streambank Stabilization Costs, Cont.		
Year	Streambank Stabilization (feet)	Cost
21	3,275	$246,431
22	3,275	$253,824
23	3,275	$261,439
24	3,275	$269,282
25	3,275	$277,360
26	3,275	$285,681
27	3,275	$294,252
28	3,275	$303,079
29	3,275	$312,172
30	3,275	$321,537
31	3,275	$331,183
32	3,275	$341,118
33	3,275	$351,352
34	3,275	$361,892
35	3,275	$372,749
36	3,275	$383,932
37	3,275	$395,450
38	3,275	$407,313
39	3,275	$419,532
40	3,275	$432,118

Table 36. Estimated Atrazine Costs for Implemented Projects to Address the Tuttle Creek Lake and Watershed Atrazine TMDL. Adjusted for 3% inflation.

Annual Atrazine Costs					
Year	Use Alternative Herbicide	Vegetative Buffers	Split Application	Apply Before April 15	Total Annual Costs
1	$9,244	$0	$15,406	$15,406	**$40,056**
2	$9,521	$0	$15,869	$15,869	**$41,258**
3	$9,807	$0	$16,345	$16,345	**$42,496**
4	$10,101	$0	$16,835	$16,835	**$43,771**
5	$10,404	$0	$17,340	$17,340	**$45,084**
6	$10,716	$0	$17,860	$17,860	**$46,436**
7	$11,038	$0	$18,396	$18,396	**$47,830**
8	$11,369	$0	$18,948	$18,948	**$49,264**
9	$11,710	$0	$19,516	$19,516	**$50,742**
10	$12,061	$0	$20,102	$20,102	**$52,265**
11	$12,423	$0	$20,705	$20,705	**$53,833**
12	$12,796	$0	$21,326	$21,326	**$55,448**

Annual Atrazine Costs, Cont.					
Year	Use Alternative Herbicide	Vegetative Buffers	Split Application	Apply Before April 15	Total Annual Costs
13	$13,179	$0	$21,966	$21,966	**$57,111**
14	$13,575	$0	$22,625	$22,625	**$58,824**
15	$13,982	$0	$23,303	$23,303	**$60,589**
16	$14,402	$0	$24,003	$24,003	**$62,407**
17	$14,834	$0	$24,723	$24,723	**$64,279**
18	$15,279	$0	$25,464	$25,464	**$66,207**
19	$15,737	$0	$26,228	$26,228	**$68,193**
20	$16,209	$0	$27,015	$27,015	**$70,239**
21	$16,695	$0	$27,826	$27,826	**$72,346**
22	$17,196	$0	$28,660	$28,660	**$74,517**
23	$17,712	$0	$29,520	$29,520	**$76,752**
24	$18,243	$0	$30,406	$30,406	**$79,055**
25	$18,791	$0	$31,318	$31,318	**$81,427**
26	$19,354	$0	$32,257	$32,257	**$83,869**
27	$19,935	$0	$33,225	$33,225	**$86,385**
28	$20,533	$0	$34,222	$34,222	**$88,977**
29	$21,149	$0	$35,249	$35,249	**$91,646**
30	$21,784	$0	$36,306	$36,306	**$94,396**
31	$22,437	$0	$37,395	$37,395	**$97,228**
32	$23,110	$0	$38,517	$38,517	**$100,144**
33	$23,804	$0	$39,673	$39,673	**$103,149**
34	$24,518	$0	$40,863	$40,863	**$106,243**
35	$25,253	$0	$42,089	$42,089	**$109,430**
36	$26,011	$0	$43,351	$43,351	**$112,713**
37	$26,791	$0	$44,652	$44,652	**$116,095**
38	$27,595	$0	$45,991	$45,991	**$119,578**
39	$28,423	$0	$47,371	$47,371	**$123,165**
40	$29,275	$0	$48,792	$48,792	**$126,860**

Table 37. Technical Assistance Needed to Implement BMPs.

BMP		*Technical Assistance*	*Projected Annual Cost*
Cropland	1. Buffers	Buffer Coordinator No-Till Coordinator WRAPS Coordinator River Friendly Farms Technician	Buffer Coordinator $15,000 No-Till Coordinator $15,000 WRAPS Coordinator $35,000 Watershed Specialist $45,000 KRC River Friendly Farms Technician $20,000 Kansas Rural Water Association Technician $20,000
	2. Continuous No-till	No-Till Coordinator WRAPS Coordinator River Friendly Farms Technician	
	3. Nutrient Management	Watershed Specialist River Friendly Farms Technician	
	4. Waterways	Buffer Coordinator River Friendly Farms Technician	
	5. Subsurface Irrigation	Watershed Specialist River Friendly Farms Technician	
Livestock	1. Vegetative filter strips	Buffer Coordinator River Friendly Farms Technician	
	2. Relocate small feedlots	Watershed Specialist River Friendly Farms Technician	
	3. Relocate pasture feeding sites	Watershed Specialist River Friendly Farms Technician	
	4. Establish off stream watering systems	Watershed Specialist River Friendly Farms Technician	
Streambank	1. Riparian buffers	Buffer Coordinator River Friendly Farms Technician	
	2. Field borders	Buffer Coordinator River Friendly Farms Technician	
	3. Bottomland timber in wetlands	Watershed Specialist River Friendly Farms Technician	
	4. Streambank restoration	WRAPS Coordinator River Friendly Farms Technician	
Source Water Protection	Write Source Water Protection Plans	KWRA Technician	
Total			**$150,000**

Table 38. Total Annual Costs for Implementing Entire WRAPS plan in Support of Attaining All TMDLs.

Total Annual Costs of Implementing Cropland, Livestock, Streambank and Atrazine BMPs, in addition to Information and Education and Technical Assistance							
	BMPs Implemented				**I&E and Technical Assistance**		
Year	**Cropland**	**Livestock**	**Streambank**	**Atrazine**	**I&E**	**Technical Assistance**	**Total**
1	$589,629	$8,253	$136,443	$40,056	$63,050	$150,000	**$987,431**
2	$607,318	$14,999	$140,536	$41,258	$64,942	$154,500	**$1,023,553**
3	$625,537	$8,755	$144,752	$42,496	$66,890	$159,135	**$1,047,565**

Total Annual Costs of Implementing Cropland, Livestock, Streambank and Atrazine BMPs, in addition to Information and Education and Technical Assistance, Cont.							
	BMPs Implemented				I&E and Technical Assistance		
Year	Cropland	Livestock	Streambank	Atrazine	I&E	Technical Assistance	Total
4	$644,303	$15,912	$149,095	$43,771	$68,896	$163,909	**$1,085,886**
5	$663,633	$9,288	$153,568	$45,084	$70,963	$168,826	**$1,111,363**
6	$683,542	$13,405	$158,175	$46,436	$73,092	$173,891	**$1,148,541**
7	$704,048	$6,273	$162,920	$47,830	$75,285	$179,108	**$1,175,464**
8	$725,169	$14,221	$167,808	$49,264	$77,544	$184,481	**$1,218,487**
9	$746,924	$6,655	$172,842	$50,742	$79,870	$190,016	**$1,247,048**
10	$769,332	$15,087	$178,027	$52,265	$82,266	$195,716	**$1,292,693**
11	$792,412	$7,060	$183,368	$53,833	$84,734	$201,587	**$1,322,994**
12	$816,184	$16,006	$188,869	$55,448	$87,276	$207,635	**$1,371,418**
13	$840,670	$7,490	$194,535	$57,111	$89,894	$213,864	**$1,403,564**
14	$865,890	$16,981	$200,371	$58,824	$92,591	$220,280	**$1,454,937**
15	$891,867	$7,946	$206,382	$60,589	$95,369	$226,888	**$1,489,041**
16	$918,623	$18,015	$212,574	$62,407	$98,230	$233,695	**$1,543,544**
17	$946,181	$8,430	$218,951	$64,279	$101,177	$240,706	**$1,579,724**
18	$974,567	$19,112	$225,519	$66,207	$104,212	$247,927	**$1,637,544**
19	$1,003,804	$8,944	$232,285	$68,193	$107,338	$255,365	**$1,675,929**
20	$1,033,918	$20,276	$239,254	$70,239	$110,559	$263,026	**$1,737,271**
21	$1,064,935	$9,488	$246,431	$72,346	$113,875	$270,917	**$1,777,992**
22	$1,096,884	$21,511	$253,824	$74,517	$117,292	$279,044	**$1,843,072**
23	$1,129,790	$10,066	$261,439	$76,752	$120,810	$287,416	**$1,886,273**
24	$1,163,684	$22,821	$269,282	$79,055	$124,435	$296,038	**$1,955,315**
25	$1,198,594	$10,679	$277,360	$81,427	$128,168	$304,919	**$2,001,147**
26	$1,234,552	$24,210	$285,681	$83,869	$132,013	$314,067	**$2,074,391**
27	$1,271,589	$11,330	$294,252	$86,385	$135,973	$323,489	**$2,123,018**
28	$1,309,736	$25,685	$303,079	$88,977	$140,052	$333,193	**$2,200,723**
29	$1,349,028	$12,020	$312,172	$91,646	$144,254	$343,189	**$2,252,309**
30	$1,389,499	$27,249	$321,537	$94,396	$148,581	$353,485	**$2,334,747**
31	$1,431,184	$12,752	$331,183	$97,228	$153,039	$364,089	**$2,389,475**
32	$1,474,120	$28,908	$341,118	$100,144	$157,630	$375,012	**$2,476,932**
33	$1,185,077	$13,528	$351,352	$103,149	$162,359	$386,262	**$2,201,727**
34	$1,220,629	$30,669	$361,892	$106,243	$167,230	$397,850	**$2,284,513**
35	$1,257,248	$14,352	$372,749	$109,430	$172,247	$409,786	**$2,335,811**
36	$1,294,966	$32,537	$383,932	$112,713	$177,414	$422,079	**$2,423,641**
37	$1,333,815	$15,226	$395,450	$116,095	$182,736	$434,742	**$2,478,064**

Total Annual Costs of Implementing Cropland, Livestock, Streambank and Atrazine BMPs, in addition to Information and Education and Technical Assistance, Cont.							
	BMPs Implemented				I&E and Technical Assistance		
Year	Cropland	Livestock	Streambank	Atrazine	I&E	Technical Assistance	Total
38	$1,373,829	$34,518	$407,313	$119,578	$188,219	$447,784	**$2,571,241**
39	$749,955	$16,153	$419,532	$123,165	$193,865	$461,218	**$1,963,888**
40	$772,454	$36,620	$432,118	$126,860	$199,681	$475,054	**$2,042,787**

Potential funding sources for these BMPs are (but not limited to) the following organizations:

Table 39. Potential BMP Funding Sources.

Potential Funding Sources	Potential Funding Programs
Natural Resources Conservation Service	Environmental Quality Incentives Program (EQIP) Wetland Reserve Program (WRP) Conservation Reserve Program (CRP) Wildlife Habitat Incentive Program (WHIP) Forestland Enhancement Program (FLEP) State Acres for Wildlife Enhancement (SAFE) Grassland Reserve Program (GRP) Farmable Wetlands Program (FWP)
EPA/KDHE	319 Funding Grants
Kansas Department of Wildlife and Parks	Partnering for Wildlife
Kansas Alliance for Wetlands and Streams	
State Conservation Commission	
Conservation Districts	
No-till on the Plains	
Kansas Forest Service	
US Fish and Wildlife	

Table 40. Potential Service Providers for BMP Implementation. *

<table>
<tr><th colspan="2" rowspan="2">BMP</th><th colspan="2">Services Needed to Implement BMP</th><th rowspan="2">Service Provider **</th></tr>
<tr><th>Technical Assistance</th><th>Information and Education</th></tr>
<tr><td rowspan="5">Cropland</td><td>1. Buffers</td><td>Design, cost share and maintenance</td><td>BMP workshops, tours, field days</td><td rowspan="5">NRCS
FSA
KRC
SCC
No-Till on the Plains
KFS
KSRE
CD
RC&D
KDWP</td></tr>
<tr><td>2. Continuous No-till</td><td>Design, cost share and maintenance</td><td>BMP workshops, tours, field days</td></tr>
<tr><td>3. Nutrient Management</td><td>Development of management plan</td><td>BMP workshops</td></tr>
<tr><td>4. Waterways</td><td>Design, cost share and maintenance</td><td>BMP workshops, field days, tours</td></tr>
<tr><td>5. Subsurface Irrigation</td><td>Design, cost share and maintenance</td><td>BMP workshops, field days, tours</td></tr>
<tr><td rowspan="4">Livestock</td><td>1. Vegetative filter strips</td><td>Design, cost share and maintenance</td><td>BMP workshops, field days, tours</td><td rowspan="4">KSRE
NRCS
SCC
KRC
No-Till on the Plains
KAWS
CD
RC&D
KDWP</td></tr>
<tr><td>2. Relocate small feedlots</td><td>Design, cost share and maintenance</td><td>BMP workshops, field days, tours</td></tr>
<tr><td>3. Relocate pasture feeding sites</td><td>Design, cost share and maintenance</td><td>BMP workshops, field days, tours</td></tr>
<tr><td>4. Establish off stream watering systems</td><td>Design, cost share and maintenance</td><td>BMP workshops, field days, tours</td></tr>
<tr><td rowspan="4">Streambank</td><td>1. Riparian buffers</td><td>Design, cost share and maintenance</td><td>BMP workshops, field days, tours</td><td rowspan="4">KAWS
NRCS
SCC
FSA
KFS
KRC
KSRE
CD
RC&D
KDWP</td></tr>
<tr><td>2. Field borders</td><td>Design, cost share and maintenance</td><td>BMP workshops, field days, tours</td></tr>
<tr><td>3. Bottomland timber in wetlands</td><td>Design, cost share and maintenance</td><td>BMP workshops, field days, tours</td></tr>
<tr><td>4. Streambank restoration</td><td>Design, cost share and maintenance</td><td>BMP workshops, field days, tours</td></tr>
<tr><td colspan="5">** See Appendix for service provider directory</td></tr>
</table>

** All service providers are responsible for evaluation of the installed or implemented BMPs and/or other services provided and will report to SLT for completion approval.*

8.0 Timeframe

The interim timeframe for initial BMP implementation would be ten years from the date of publication of this report. The plan will be reviewed every five years starting in 2015.

Table 41. Review Schedule for Pollutants and BMPs.

Review Year	Sediment	Phosphorus	Bacteria	Atrazine	BMP Placement
2015			X	X	X
2020	X	X	X	X	X
2025			X	X	X
2030	X	X	X	X	X
2035			X	X	X
2040	X	X	X	X	X
2045			X	X	X
2050	X	X	X	X	X

Targeting and BMP implementation might shift over time in order to achieve TMDLs.

- Timeframe for reaching the **sediment TMDL** will be forty years.
- The WRAPS estimate timeframe will not meet the **phosphorus TMDL**. Phosphorus reduction will have to be reduced by ninety-five percent in order to meet the TMDL in the watershed in Kansas alone. This amount does not include the reductions that must take place in the area of the watershed that exists in Nebraska. In the future, cooperation with Nebraska is needed to achieve phosphorus reduction adequate to meet the TMDL. A Targeted Watershed Grant exists between Kansas and Nebraska at this time, and needs to be supported by the WRAPS process. However, at this time, this SLT has no authority in BMP implementation in another state. There are two programs that address interstate water quality activity: an EPA Targeted Watershed Grant and the Blue River Compact. Both of these are discussed in Section 2 of this report.
- There is no timeframe estimate on **E. coli bacteria TMDL** reduction due to unavailability of an e. coli bacteria model.
- Timeframe for meeting the **atrazine** TMDL will be forty years.

9.0 Measureable Milestones

9.1 Measurable Milestones for BMP Implementation

Milestones will be determined by number of acres treated, projects installed, contacts made to residents of the watershed and water quality parameters at the end of every five years. The SLT will examine these criteria to determine if adequate progress has been made from the current BMP implementations. If they determine that adequate progress has not been made, they will readjust the implementation projects in order to achieve the TMDL by the end of forty years.

Table 42. Short, Medium and Long Term Goals for BMP Cropland Adoption Rate to Address the Tuttle Creek Lake Siltation TMDL and the Tuttle Creek Lake Eutrophication TMDL.

Total Acres of Cropland BMPs Adopted Each Year							
	Year	**Riparian Buffer**	**No-Till**	**Nutrient Management**	**Grassed Waterways**	**Subsurface Fertilizer**	**Total Treated Acreage**
Short Term	**1**	2,739	4,564	4,564	1,826	913	14,606
	2	2,739	4,564	4,564	1,826	913	14,606
	3	2,739	4,564	4,564	1,826	913	14,606
	4	2,739	4,564	4,564	1,826	913	14,606
	5	2,739	4,564	4,564	1,826	913	14,606
	Total	13,695	22,820	22,820	9,130	4,565	73,030
	6	2,739	4,564	4,564	1,826	913	14,606
	7	2,739	4,564	4,564	1,826	913	14,606
	8	2,739	4,564	4,564	1,826	913	14,606
	9	2,739	4,564	4,564	1,826	913	14,606
	10	2,739	4,564	4,564	1,826	913	14,606
Total		*27,386*	*45,643*	*45,643*	*18,257*	*9,129*	*146,056*
Medium Term	**11**	2,739	4,564	4,564	1,826	913	14,606
	12	2,739	4,564	4,564	1,826	913	14,606
	13	2,739	4,564	4,564	1,826	913	14,606
	14	2,739	4,564	4,564	1,826	913	14,606
	15	2,739	4,564	4,564	1,826	913	14,606
	Total	41,081	68,463	68,463	27,387	13,694	218,086
	16	2,739	4,564	4,564	1,826	913	14,606
	17	2,739	4,564	4,564	1,826	913	14,606
	18	2,739	4,564	4,564	1,826	913	14,606
	19	2,739	4,564	4,564	1,826	913	14,606
	20	2,739	4,564	4,564	1,826	913	14,606
Total		*54,771*	*91,285*	*91,285*	*36,514*	*18,257*	*292,113*
Long Term Goals on Next Page							

Total Acres of Cropland BMPs Adopted Each Year, Cont.							
	Year	**Riparian Buffer**	**No-Till**	**Nutrient Management**	**Grassed Waterways**	**Subsurface Fertilizer**	**Total Treated Acreage**
Long Term	**21**	2,739	4,564	4,564	1,826	913	14,606
	22	2,739	4,564	4,564	1,826	913	14,606
	23	2,739	4,564	4,564	1,826	913	14,606
	24	2,739	4,564	4,564	1,826	913	14,606
	25	2,739	4,564	4,564	1,826	913	14,606
	Total	68,466	114,105	114,105	45,644	22,822	365143
	26	2,739	4,564	4,564	1,826	913	14,606
	27	2,739	4,564	4,564	1,826	913	14,606
	28	2,739	4,564	4,564	1,826	913	14,606
	29	2,739	4,564	4,564	1,826	913	14,606
	30	2,739	4,564	4,564	1,826	913	14,606
	Total	*82,157*	*136,928*	*136,928*	*54,771*	*27,386*	*438,169*
	31	2,739	4,564	4,564	1,826	913	14,606
	32	2,739	4,564	4,564	1,826	913	14,606
	33	2,739	4,564		1,826	913	10,041
	34	2,739	4,564		1,826	913	10,041
	35	2,739	4,564		1,826	913	10,041
	Total	95,852	159,748	146,056	63,901	31,951	497,504
	36	2,739	4,564		1,826	913	10,041
	37	2,739	4,564		1,826	913	10,041
	38	2,739	4,564		1,826	913	10,041
	39	2,739			1,826	913	5,477
	40	2,739			1,826	913	5,477
Total		*109,542*	*173,442*	*146,056*	*73,028*	*36,514*	*538,583*

Table 43. Short, Medium and Long Term Goals for BMP Livestock Adoption Rate to Address the Tuttle Creek Lake Eutrophication TMDL, the Black Vermillion River FCB TMDL and the Big Blue River FCB TMDL.

Livestock BMPs Adopted Each Year								
				Relocate Pasture Feeding Site		Off-Stream Watering System		
	Year	Vegetative Filter Strip	Relocated Feedlot	Native	Cool Season	Native	Cool Season	Cropland
Short Term	1	1		2		2		1
	2	1	1	2	1	2	1	1
	3	1		2		2		1
	4	1		2	1	2	1	1
	5	1	1	2		2		1
	Total	*5*	*2*	*10*	*2*	*10*	*2*	*5*
	6	1		2	1	2	1	1
	7	1		2		2		1
	8	1	1	2	1	2	1	1
	9	1		2		2		1
	10	1		2	1	2	1	1
	Total	*10*	*4*	*20*	*4*	*20*	*4*	*10*
Medium Term	11	1	1	2		2		1
	12	1		2	1	2	1	1
	13	1		2		2		1
	14	1	1	2	1	2	1	1
	Total	*15*	*6*	*30*	*6*	*30*	*6*	*15*
	15	1		2		2		1
	16	1		2	1	2	1	1
	17	1	1	2		2		1
	18	1		2	1	2	1	1
	19	1		2		2		1
	20	1	1	2	1	2	1	1
	Total	*20*	*8*	*40*	*8*	*40*	*8*	*20*
Long Term Goals on Next Page								

Livestock BMPs Adopted Each Year, Cont.								
				Relocate Pasture Feeding Site		Off-Stream Watering System		
	Year	Vegetative Filter Strip	Relocated Feedlot	Native	Cool Season	Native	Cool Season	Cropland
Long Term	21	1		2		2		1
	22	1		2	1	2	1	1
	23	1	1	2		2		1
	24	1		2	1	2	1	1
	25	1		2		2		1
	Total	*25*	*10*	*50*	*10*	*50*	*10*	*25*
	26	1	1	2	1	2	1	1
	27	1		2		2		1
	28	1		2	1	2	1	1
	29	1	1	2		2		1
	30	1		2	1	2	1	1
	Total	*30*	*12*	*60*	*12*	*60*	*12*	*30*
	31	1		2		2		1
	32	1	1	2	1	2	1	1
	33	1		2		2		1
	34	1		2	1	2	1	1
	35	1	1	2		2		1
	Total	*35*	*14*	*70*	*14*	*70*	*14*	*35*
	36	1		2	1	2	1	1
	37	1		2		2		1
	38	1	1	2	1	2	1	1
	39	1		2		2		1
	40	1		2	1	2	1	1
	Total	**40**	**16**	**80**	**16**	**80**	**16**	**40**

Table 44. Short, Medium and Long Term Goals for Atrazine BMPs Adoption Rate to Address the Tuttle Creek Lake and Watershed Atrazine TMDL.

	Year	Use Alternative Herbicide	Vegetative Buffers	Split Application	Apply Before April 15
Short Term	1	1,541	2,054	2,568	2,568
	2	1,541	2,054	2,568	2,568
	3	1,541	2,054	2,568	2,568
	4	1,541	2,054	2,568	2,568
	5	1,541	2,054	2,568	2,568
	Total	*7,703*	*10,271*	*12,839*	*12,839*
	6	1,541	2,054	2,568	2,568
	7	1,541	2,054	2,568	2,568
	8	1,541	2,054	2,568	2,568
	9	1,541	2,054	2,568	2,568
	10	1,541	2,054	2,568	2,568
	Total	*15,406*	*20,542*	*25,677*	*25,677*
Medium Term	11	1,541	2,054	2,568	2,568
	12	1,541	2,054	2,568	2,568
	13	1,541	2,054	2,568	2,568
	14	1,541	2,054	2,568	2,568
	15	1,541	2,054	2,568	2,568
	Total	*23,109*	*30,813*	*38,516*	*38,516*
	16	1,541	2,054	2,568	2,568
	17	1,541	2,054	2,568	2,568
	18	1,541	2,054	2,568	2,568
	19	1,541	2,054	2,568	2,568
	20	1,541	2,054	2,568	2,568
	Total	*30,813*	*41,084*	*51,354*	*51,354*

Long Term Goals on Next Page

Atrazine BMP Short, Medium and Long Term Goals, Cont.					
	Year	Use Alternative Herbicide	Vegetative Buffers	Split Application	Apply Before April 15
Long Term	21	1,541	2,054	2,568	2,568
	22	1,541	2,054	2,568	2,568
	23	1,541	2,054	2,568	2,568
	24	1,541	2,054	2,568	2,568
	25	1,541	2,054	2,568	2,568
	Total	*38,516*	*51,354*	*64,193*	*64,193*
	26	1,541	2,054	2,568	2,568
	27	1,541	2,054	2,568	2,568
	28	1,541	2,054	2,568	2,568
	29	1,541	2,054	2,568	2,568
	30	1,541	2,054	2,568	2,568
	Total	*46,219*	*61,625*	*77,032*	*77,032*
	31	1,541	2,054	2,568	2,568
	32	1,541	2,054	2,568	2,568
	33	1,541	2,054	2,568	2,568
	34	1,541	2,054	2,568	2,568
	35	1,541	2,054	2,568	2,568
	Total	*53,922*	*71,896*	*89,870*	*89,870*
	36	1,541	2,054	2,568	2,568
	37	1,541	2,054	2,568	2,568
	38	1,541	2,054	2,568	2,568
	39	1,541	2,054	2,568	2,568
	40	1,541	2,054	2,568	2,568
	Total	*61,625*	*82,167*	*102,709*	*102,709*

Table 45. Short, Medium and Long Term Goals for Information and Education Adoption Rates to Address All TMDLs in the Watershed.

Information and Education BMPs Adopted Each Year												
	Year	**Demo Projects**	**Workshops**	**Tours**	**Field Days**	**Newsletter Inserts**	**Meetings Orgainized**	**Soil Tests, number**	**Conference Attendees**	**Educational Events**	**Media Campaign**	**Contacts made by Tech Assistance**
Short Term	1	7	3	3	4	5	12	600	35	4	4	500
	2	7	3	3	4	5	12	600	35	4	4	500
	3	7	3	3	4	5	12	600	35	4	4	500
	4	7	3	3	4	5	12	600	35	4	4	500
	5	7	3	3	4	5	12	600	35	4	4	500
	Total	*35*	*15*	*15*	*20*	*25*	*60*	*3,000*	*175*	*20*	*20*	*2,500*
	6	7	3	3	4	5	12	600	35	4	4	500
	7	7	3	3	4	5	12	600	35	4	4	500
	8	7	3	3	4	5	12	600	35	4	4	500
	9	7	3	3	4	5	12	600	35	4	4	500
	10	7	3	3	4	5	12	600	35	4	4	500
	Total	*70*	*30*	*30*	*40*	*50*	*120*	*6,000*	*350*	*40*	*40*	*5,000*
Medium Term	11	7	3	3	4	5	12	600	35	4	4	500
	12	7	3	3	4	5	12	600	35	4	4	500
	13	7	3	3	4	5	12	600	35	4	4	500
	14	7	3	3	4	5	12	600	35	4	4	500
	15	7	3	3	4	5	12	600	35	4	4	500
	Total	*105*	*45*	*45*	*60*	*75*	*180*	*9,000*	*525*	*60*	*60*	*7,500*
	16	7	3	3	4	5	12	600	35	4	4	500
	17	7	3	3	4	5	12	600	35	4	4	500
	18	7	3	3	4	5	12	600	35	4	4	500
	19	7	3	3	4	5	12	600	35	4	4	500
	20	7	3	3	4	5	12	600	35	4	4	500
	Total	*140*	*60*	*60*	*80*	*100*	*240*	*12,000*	*700*	*80*	*80*	*10,000*
Long Term Goals on Next Page												

Information and Education BMPs Adopted Each Year, Cont.												
	Year	Demo Projects	Workshops	Tours	Field Days	Newsletter Inserts	Meetings Orgainized	Soil Tests, number	Conference Attendees	Educational Events	Media Campaign	Contacts made by Tech Assistance
Long Term	21	7	3	3	4	5	12	600	35	4	4	500
	22	7	3	3	4	5	12	600	35	4	4	500
	23	7	3	3	4	5	12	600	35	4	4	500
	24	7	3	3	4	5	12	600	35	4	4	500
	25	7	3	3	4	5	12	600	35	4	4	500
	Total	*175*	*75*	*75*	*100*	*125*	*300*	*15,000*	*875*	*100*	*100*	*12,500*
	26	7	3	3	4	5	12	600	35	4	4	500
	27	7	3	3	4	5	12	600	35	4	4	500
	28	7	3	3	4	5	12	600	35	4	4	500
	29	7	3	3	4	5	12	600	35	4	4	500
	30	7	3	3	4	5	12	600	35	4	4	500
	Total	*210*	*90*	*90*	*120*	*150*	*360*	*18,000*	*1,050*	*120*	*120*	*15,000*
	31	7	3	3	4	5	12	600	35	4	4	500
	32	7	3	3	4	5	12	600	35	4	4	500
	33	7	3	3	4	5	12	600	35	4	4	500
	34	7	3	3	4	5	12	600	35	4	4	500
	35	7	3	3	4	5	12	600	35	4	4	500
	Total	*245*	*105*	*105*	*140*	*175*	*420*	*21,000*	*1,225*	*140*	*140*	*17,500*
	36	7	3	3	4	5	12	600	35	4	4	500
	37	7	3	3	4	5	12	600	35	4	4	500
	38	7	3	3	4	5	12	600	35	4	4	500
	39	7	3	3	4	5	12	600	35	4	4	500
	40	7	3	3	4	5	12	600	35	4	4	500
	Total	**280**	**120**	**120**	**160**	**200**	**480**	**24,000**	**1,400**	**160**	**160**	**20,000**

9.2 Benchmarks to Measure Water Quality and Social Progress

Over a ten to forty year time frame, this WRAPS project hopes to improve water quality throughout the watershed and in Tuttle Creek Lake. Measurements taken at Tuttle Creek Lake are important because it is the drainage endpoint of the watershed. Any water quality improvements will be observed by conducting tests in Tuttle Creek Lake. Social indicators will also be examined by tracking traffic in Tuttle Creek Lake Park. An example of a healthy lake ecosystem is frequent visits by the public to enjoy the outdoor recreation of the lake and park. After reviewing the criteria listed in the table below, the SLT will assess and revise the overall strategy plan for the watershed. New goals will be set and new BMPs will be implemented in order to achieve improved water quality. Coordination with KDHE TMDL staff, Water Plan staff and the SLT will be held every five years to discuss benchmarks and TMDL update plans. Using data obtained by KDHE, KSU or the Kansas City District, Army Corps of Engineers, the following indicator and parameter criteria shall be used to assess progress in successful implementation to abate pollutant loads.

Table 46. Benchmarks to Measure Water Quality Progress.

Impairment Addressed	Criteria to Measure Water Quality Progress	Information Source
Sediment	Number of acres of buffers and grassed waterways installed indicating that there would be a reduction in sediment into Tuttle Creek Lake	NRCS
	Post-2010 average TSS and TP data from KDHE field collection on all streams should show decline in values from those seen in 2000-2009	KDHE
	Tuttle Creek Lake TSS < 10 mg/L and turbidity < 20 NTU	KDHE
	In-stream TSS < 100 mg/L	KDHE
	Boat ramps should continue to function within the pool range of 1070-1075 feet msl	COE
	COE bathymetric survey in 2010 and KWO/KBS bathymetry in 2020 should be within 15% of one another	COE, KWO, KBS
	Fewer high event stream flow rates entering Tuttle Creek Lake indicating better retention and slower release of storm water in the upper end of the watershed	USGS
	Conservation storage in Tuttle Creek Lake will be 270,000 acre feet	COE
Sediment and Nutrients	Secchi disc depth > 1.0 meters in Tuttle Creek Lake	KDHE
	The difference in TSS and TP loads between the Stateline and Waterville and Blue Rapids should decline from those differences seen in 2000-2009	KDHE
Nutrients	No algal blooms are reported as the lake clarity improves	KDHE
	In-lake phosphorus levels should average < 200 ppb	KDHE
	In-stream phosphorus levels should average < 200 ppb	KDHE
	In-lake chlorophyll levels should average < 10 ppb as the lake becomes less turbid	KDHE

Benchmarks to Measure Water Quality Progress, Cont.		
Impairment Addressed	**Criteria to Measure Water Quality Progress**	**Information Source**
Fecal Coliform Bacteria	Number of livestock that have been relocated from close proximity to a stream indicating that there would be a reduction in fecal coliform bacteria into Tuttle Creek Lake	Watershed Specialist
	No beach closures at Tuttle Creek Lake	KDHE
	No health advisories will be issued warning citizens to stay out of the Big and Little Blue Rivers and tributaries because of high bacteria counts	KDHE
	Over time, the distribution of bacteria index values determined from routine KDHE sampling will shift downward such that the upper quartile (75%) will be in the vicinity of 1.03 (75% of the samples during April-October will be below 500 counts) and the upper decile (90%) will be 1.14 (90% of samples during April-October will be below 1,000 counts). However, because of the excessively large bacteria counts seen in the streams system currently, the shorter term indicator will simply be some reduction in the upper quartile and upper decile index values from current conditions seen above.	KDHE
	Bacteria levels should be reduced such that no more than 10% of samples taken between April and October exceed 300 on the Big Blue and 450 on the Little Blue, Mill Creek and the Black Vermillion.	KDHE
Atrazine	Reduction in the amount of atrazine that is applied to crops indicating that there would be lower rates of atrazine concentration in Tuttle Creek Lake	Farmer's Cooperatives and Herbicide Sales Businesses
	Average monthly atrazine levels should exceed 3 ppb once every three years and the running annual average should never exceed 3 ppb for Tuttle Creek and the Blue River drainage; no samples should ever exceed 170 ppb; and elevated atrazine should only be seen in Tuttle Creek Lake in May and June above the Randolph causeway while the lake is in flood pool; elevated atrazine should never be found in streams below mean daily flow.	KDHE
Impairment Addressed	**Social Indicators to Measure Water Quality Progress**	**Information Source**
Sediment Nutrients Fecal Coliform Bacteria Atrazine	Visitor traffic to Tuttle Creek Lake	KDWP
	Boating traffic in Tuttle Creek Lake	KDWP
	Quantity and quality of fishing in Tuttle Creek Lake	KDWP
	Economic indicators indicating effect of Tuttle Creek Lake's impact on local businesses	Riley County Economic Development
	Survey of water quality issues to determine whether information and education programs are having an effect on public perception	KSRE
	Number of attendees at workshops and field days	KSRE
	BMP adoptability rates	NRCS

The goals of the Tuttle Creek watershed plan will be to restore water quality for uses supportive of aquatic life, primary contact recreation and public water supply for Tuttle Creek Lake, the Big Blue, Little Blue and Black Vermillion rivers and their tributaries. This restoration plan will take forty years of BMP implementation.

* Stream phosphorus and TSS TMDLs are proposed for the streams in 2010, revised endpoints may be the result.

** KWO and KBS should be near completion of an updated bathymetry of Tuttle Creek Lake, results may alter the storage indicator.

9.3 Milestones Used to Determine Water Quality Improvements

9.3.1 Phosphorus and Sediment Milestones in 2020

At the end of ten years, the SLT will be able to examine water quality data for phosphorus (eutrophication determination) and suspended solids (sediment determination) to determine if progress has been made in improving water quality. It is estimated that it will require ten years to see progress after BMP implementation on phosphorus and sediment reduction in the waterways. KDHE has outlined water quality goals for total phosphorus and total suspended solids. These goals are presented below.

Table 47. Water Quality Goals for Phosphorus and Sediment

	Current Condition (2000-2009)	**Improved Condition (2010-2019)**	**Reduction Needed**	**Current Condition (2000-2009)**	**Improved Condition (2010-2019)**	**Reduction Needed**
Sampling Sites	**Total Phosphorus (median of data collected during indicated period), ppb**			**Total Suspended Solids (median of data collected during indicated period), ppm**		
Blue Rapids (Blue River)	623	560	**63**	107	70	**37**
Waterville (Little Blue River)	366	300	**66**	47	35	**12**
Black Vermillion River	259	230	**29**	55	40	**15**
Hanover (Mill Creek)	255	180	**75**	37	30	**7**

9.3.2 Bacteria Milestones in 2015

Bacteria reductions can be observed in five years after the onset of implementation of BMPs. KDHE has determined that the five year milestone for bacteria should be based on the percentage of April to October samples that are less than the 427 count criterion for Little Blue, Big Blue and Black Vermillion Rivers. At the end of five years, there should be at least 60 to 65 percent of the samples that are under 427. Current percentage (2009) is 50 to 55 percent. This will be a reduction of ten to fifteen percent in number of sample exceedances.

9.3.3 Atrazine Milestones in 2015

Atrazine milestones are to be reviewed at the end of five years. The impact of BMP implementations will be obvious by this time. KDHE has set the atrazine milestone as:

1. no exceedances of atrazine over 3ppb on any streams during the year except during the high flow months of May and June, and
2. when exceedances do occur in May and June, they happen when flows exceed the indicated monthly flows.

If atrazine does exceed 3 ppb during the months of May and June, then the stream flows should be greater than:

- i. Big Blue at Marysville – 1,900 cfs (cubic feet per second)
- ii. Little Blue River at Barnes – 1,000 cfs
- iii. Black Vermillion River at Frankfort – 300 cfs
- iv. Mill Creek near Hanover – 200 cfs

9.3.4 BMP Implementation Milestones from 2015 to 2050

The SLT will review the number of acres, projects or contacts made in the watershed every five years until the end of this WRAPS plan, which is the year 2050. At the end of each five year period, the SLT will have the option to reassess the goals and alter BMP implementations as they determine is best. Below is the outline of BMP implementations over a forty year period.

Table 48. BMP Implementation Milestones from 2015 to 2050.

	Cropland					Livestock							Atrazine				Information and Education	
	Cumulative Totals in Acres (a), Projects (p) or Numbers (n)																	
								Relocate Pasture Feeding Sites		Off Stream Watering System								
Year	Riparian Buffers, a	No –till, a	Nutrient Management, a	Grassed Waterways, a	Subsurface Fertilizer, a	Filter strips, a	Relocated Feedlot, p	Native, p	Cool season, p	Native, p	Cool season, p	Cropland, p	Alternative Herbicide, a	Vegetative Buffers, a	Split Application, a	Apply before April 15, a	Demonstrations/Workshops/ Tours/Field Days. n	I&E and Technical Assistance Contacts/Participants, n
2015	13,695	22,820	22,820	9,130	4,565	5	2	10	2	10	2	5	7,703	10,271	12,839	12,839	85	2,500
2020	27,386	45,643	45,643	18,257	9,129	10	4	20	4	20	4	10	15,406	20,542	25,677	25,677	170	5,000
2025	41,081	68,463	68,463	27,387	13,694	15	6	30	6	30	6	15	23,109	30,813	38,516	38,516	255	7,500
2030	54,771	91,285	91,285	36,514	18,257	20	8	40	8	40	8	20	30,813	41,084	51,354	51,354	340	10,000
2035	68,466	114,105	114,105	45,644	22,822	25	10	50	10	50	10	25	38,516	51,354	64,193	64,193	425	12,500
2040	82,157	136,928	136,928	54,771	27,386	30	12	60	12	60	12	30	46,219	61,625	77,032	77,032	510	15,000
2045	95,852	159,748	146,056	63,901	31,951	35	14	70	14	70	14	35	53,922	71,896	89,870	89,870	595	17,500
2050	109,542	173,442	146,056	73,028	36,514	40	16	80	16	80	16	40	61,625	82,167	102,709	102,709	680	20,000

10.0 Monitoring Water Quality Progress

The KDHE sampling data will be reviewed by the SLT every year. Data collected in the Targeted Area will be of special interest. A composite review of BMPs implemented and monitoring data will be analyzed for effects resulting from the BMPs. The SLT will also ask KDHE to review analyzed data from all monitoring sources on a yearly basis.

KDHE has ongoing monitoring sites in the watershed. There are two types of monitoring sites utilized by KDHE: permanent and rotational. Permanent sites are continuously sampled, whereas rotational sites are only sampled every fourth year. All sampling sites will be continued into the future. Each site is tested for nutrients, metals, ammonia, solid fractions, turbidity, alkalinity, pH, dissolved oxygen, e. coli bacteria and chemicals. Not all sites are tested for these pollutant indicators at each collection time. This is dependent upon the anticipated pollutant concern as well as other factors. For example, as discussed earlier in this publication, atrazine is primarily a concern during spring and summer rainfall events, so testing for atrazine in the winter is not necessary.

Stream flow data is collected by the USGS and will be available for SLT review. At publication time of this report, depending on the sampling site, up to six different parameters are sampled: water temperature, specific conductance, gage height, discharge, precipitation and turbidity. Samples are automatically taken every 15 minutes. Reviewing this data will indicate whether rainfall events in the upper reaches of the watershed have been slowed by BMPs such as dry ponds and sediment basins.

The Corps of Engineers have sampling sites in Tuttle Creek Lake. There are four sampling sites in the watershed that are sampled monthly during the months of April through September. Samples taken are analyzed for T-orthoP, total suspended solids, alkalinity, total phosphorus, total Kjeldahl nitrogen, ammonia, nitrate nitrogen and total organic carbon. In the spring the samples are also analyzed for atrazine and alachlor, temperature, pH, dissolved oxygen, turbidity and phycocyanin (chlorophyll determination).

Much of the evaluative information can be obtained through the existing networks and sampling plans of KDHE and the Kansas City District, Corps of Engineers. Public engagement can be obtained through observations of lake clarity, ease of boating and the physical appearance of Tuttle Creek Lake. Some communications with the Corps of Engineers will supplement any information on the conditions in the Blue River drainage and on Tuttle Creek Lake.

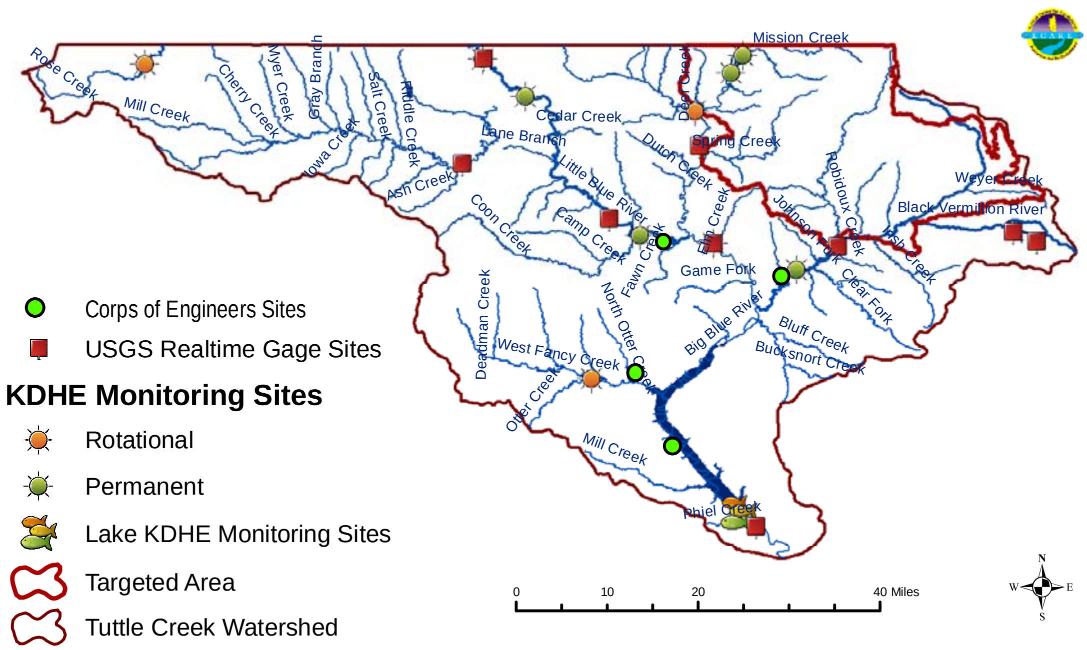


Figure 32. Monitoring Sites in the Watershed. *[39] Permanent and rotational KDHE monitoring sites provided by KDHE, 2009. Corps of Engineers provided sites 2009.*

Monitoring data will be used to direct the SLT in their evaluation of water quality progress. There are no sampling gaps that can be determined at this time. Water Quality milestones developed by KDHE and approved by the SLT thus far are sufficient. Adequate data is being generated in order to support BMP placement and further water quality improvement. Analysis of the data generated will be adequate to determine effectiveness of implemented BMPs. If the SLT decides at some point in the future that more data is required, they can discuss this with KDHE. All data will be shared with the SLT and can then be passed on to the watershed residents by way of the information and education efforts discussed previously in this report in Section 7.

KDHE will be requested to meet with the SLT to review the monitoring data accumulated by their sites on a yearly basis. However, the overall strategy and alterations of the WRAPS plan will be discussed with KDHE immediately after each update of the 303d list and subsequent TMDL designation. The upcoming years for this in the Tuttle Creek watershed is 2015 and 2020. At this time, the plan can be altered or modified in order to meet the water quality goals as assigned by the SLT in the beginning of the WRAPS process. In examining water quality progress in the watershed, Total Suspended Solids and Total Phosphorus will be reviewed and analyzed for progress every ten years due to the lag time of water quality effects after BMP implementation. E. coli bacteria and atrazine will be reviewed for progress every five years.

11.0 Review of the Watershed Plan in 2015

In the year 2015, the plan will be reviewed and revised according to results acquired from monitoring data. At this time, the SLT will review the following criteria in addition to any other concerns that may occur at that time:

1. The SLT will ask KDHE for a report on the milestone achievements in bacteria and atrazine load reductions.
    a. **Bacteria:** the 2015 milestone for bacteria should be based on the percentage of April to October samples that are less than the 427 count criterion for Little Blue, Big Blue and Black Vermillion Rivers. In 2015, there should be at least 60 to 65 percent of the samples that are under 427.
    b. **Atrazine:**
        i. no exceedances of atrazine over 3ppb on any streams during the year except during the high flow months of May and June, and
        ii. when exceedances do occur in May and June, they happen when flows exceed the indicated monthly flows.
2. The SLT will request a report from KDHE concerning revising the watershed TMDLs, including possible nutrient and/or sediment criteria, revised load allocations distributed between Kansas and Nebraska, and new wasteload allocations defined for the point sources in the Kansas portion of the drainage.
3. The SLT will request a report from KDHE and COE on trends in water quality in Tuttle Creek Lake
4. The SLT will request a report on emergence of nitrogen as pollutant of concern
5. The SLT will report on progress towards achieving the benchmarks listed in Section 9.2 of this report.
6. The SLT will report on progress towards achieving the BMP adoption rates in Section 9.1 of this report.
7. The SLT will discuss impairments on the 303d list and the possibility of addressing these impairments prior to them being listed as TMDLs.
8. The SLT will discuss the effect of implementing BMPs aimed at specific TMDLs on the impairments listed on the 303d list.
9. The SLT will discuss necessary adjustments and revisions needed in the targets listed in this plan.

12.0 Appendix

12.1 Service Providers

Table 49. Potential Service Provider Listing

Organization	Programs	Purpose	Technical or Financial Assistance	Phone	Website address
Environmental Protection Agency	Clean Water State Revolving Fund Program Watershed Protection	Provides low cost loans to communities for water pollution control activities. To conduct holistic strategies for restoring and protecting aquatic resources based on hydrology rather than political boundaries.	Financial	913-551-7003 913-551-7003	www.epa.gov
Glacial Hills RC&D	Natural resource development and protection	Plan and Implement projects and programs that improve environmental quality of life.	Technical	785-945-6292	http://www.glacialhillsrcd.com/
Kansas Alliance for Wetlands and Streams	Streambank Stabilization Wetland Restoration Cost share programs	The Kansas Alliance for Wetlands and Streams (KAWS) organized in 1996 to promote the protection, enhancement, restoration and establishment wetlands and streams in Kansas.	Technical	785-463-5804 NE Chapter	www.kaws.org
Kansas Dept. of Agriculture	Watershed structures permitting.	Available for watershed districts and multipurpose small lakes development.	Technical and Financial	785-296-2933	www.accesskansas.org/kda

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Phone	Website address
Kansas Dept. of Health and Environment	**Nonpoint Source Pollution Program** Municipal and livestock waste Livestock waste Municipal waste State Revolving Loan Fund	Provide funds for projects that will reduce nonpoint source pollution. Compliance monitoring. Makes low interest loans for projects to improve and protect water quality.	Technical and Financial	785-296-5500	www.kdhe.state.ks.us

Kansas Department of Wildlife and Parks	Land and Water Conservation Funds Conservation Easements for Riparian and Wetland Areas Wildlife Habitat Improvement Program North American Waterfowl Conservation Act MARSH program in coordination with Ducks Unlimited Chickadee Checkoff Walk In Hunting Program F.I.S.H. Program	Provides funds to preserve develop and assure access to outdoor recreation. To provide easements to secure and enhance quality areas in the state. To provide limited assistance for development of wildlife habitat. To provide up to 50 percent cost share for the purchase and/or development of wetlands and wildlife habitat. May provide up to 100 percent of funding for small wetland projects. Projects help with eagles, songbirds, threatened and endangered species, turtles, lizards, butterflies and stream darters. Funding is an optional donation line item on the KS Income Tax form. Landowners receive a payment incentive to allow public hunting on their property. Landowners receive a payment incentive to allow public fishing access to their ponds and streams.	Technical and Financial	620-672-5911 785-296-2780 620-672-5911 620-342-0658 620-672-5911	www.kdwp.state.ks.us/about/grants.html

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Phone	Website address
Kansas Forest Service	Conservation Tree Planting Program Riparian and Wetland Protection Program	Provides low cost trees and shrubs for conservation plantings. Work closely with other agencies to promote and assist with establishment of riparian forestland and manage existing stands.	Technical	785-532-3312 785-532-3310	www.kansasforests.org
Kansas Rural Center	The Heartland Network Clean Water Farms-River Friendly Farms Sustainable Food Systems Project Cost share programs	The Center is committed to economically viable, environmentally sound and socially sustainable rural culture.	Technical and Financial	785-873-3431	http://www.kansasruralcenter.org
Kansas Rural Water Association	Technical assistance for Water Systems with Source Water Protection Planning.	Provide education, technical assistance and leadership to public water and wastewater utilities to enhance the public health and to sustain Kansas' communities	Technical	785-336-3760	http://www.krwa.net

Kansas State Research and Extension	Water Quality Programs, Waste Management Programs Kansas Center for Agricultural Resources and Environment (KCARE) Kansas Environmental Leadership Program (KELP) Kansas Local Government Water Quality Planning and Management Rangeland and Natural Area Services (RNAS) WaterLINK Kansas Pride: Healthy Ecosystems/Healthy Communities Citizen Science	Provide programs, expertise and educational materials that relate to minimizing the impact of rural and urban activities on water quality. Educational program to develop leadership for improved water quality. Provide guidance to local governments on water protection programs. Reduce non-point source pollution emanating from Kansas grasslands. Service-learning projects available to college and university faculty and community watersheds in Kansas. Help citizens appraise their local natural resources and develop short and long term plans and activities to protect, sustain and restore their resources for the future. Education combined with volunteer soil and water testing for enhanced natural resource stewardship.	Technical	785-532-7108 785-532-5813 785-532-2643 785-532-0416 785-532-2732 785-532-3039 785-532-1443	www.kcare.ksu.edu www.ksre.ksu.edu/kelp www.ksre.ksu.edu/olg www.k-state.edu/waterlink/ www.kansasprideprogram.ksu.edu/healthyecosystems/ www.ksre.ksu.edu/kswater/

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Phone	Website address
Kansas Water Office	Public Information and Education	Provide information and education to the public on Kansas Water Resources	Technical and Financial	785-296-3185	www.kwo.org
No-Till on the Plains	Field days, seasonal meetings, tours and technical consulting.	Provide information and assistance concerning continuous no-till farming practices.	Technical	888-330-5142	www.notill.org

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Phone	Website address
State Conservation Commission and Conservation Districts	Water Resources Cost Share Nonpoint Source Pollution Control Fund Riparian and Wetland Protection Program Stream Rehabilitation Program Kansas Water Quality Buffer Initiative Watershed district and multipurpose lakes	Provide cost share assistance to landowners for establishment of water conservation practices. Provides financial assistance for nonpoint pollution control projects which help restore water quality. Funds to assist with wetland and riparian development and enhancement. Assist with streams that have been adversely altered by channel modifications. Compliments Conservation Reserve Program by offering additional financial incentives for grass filters and riparian forest buffers. Programs are available for watershed district and multipurpose small lakes.	Technical and Financial	Clay Co 785-632-3550 Marshall Co 785-562-3133 Nemaha Co 785-336-2186 Pottawatomie Co 785-457-3398 Riley Co 785-537-8764 Washington Co 785-325-2321	www.accesskansas.org/kscc http://www.kacdnet.org/

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Phone	Website address
US Army Corps of Engineers	Planning Assistance to States Environmental Restoration	Assistance in development of plans for development, utilization and conservation of water and related land resources of drainage Funding assistance for aquatic ecosystem restoration.	Technical	816-983-3157 816-983-3157	www.usace.army.mil
US Fish and Wildlife Service	Fish and Wildlife Enhancement Program Private Lands Program	Supports field operations which include technical assistance on wetland design. Contracts to restore, enhance, or create wetlands.	Technical	785-539-3474 785-539-3474	www.fws.gov

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Phone	Website address
USDA- Natural Resources Conservation Service and Farm Service Agency	Conservation Compliance Conservation Operations Watershed Planning and Operations Wetland Reserve Program Wildlife Habitat Incentives Program Grassland Reserve Program, EQIP, and Conservation Reserve Program	Primarily for the technical assistance to develop conservation plans on cropland. To provide technical assistance on private land for development and application of Resource Management Plans. Primarily focused on high priority areas where agricultural improvements will meet water quality objectives. Cost share and easements to restore wetlands. Cost share to establish wildlife habitat which includes wetlands and riparian areas. Improve and protect rangeland resources with cost-sharing practices, rental agreements, and easement purchases.	Technical and Financial	Clay Co 785-632-3550 Marshall Co 785-562-5343 Nemaha Co 785-336-2164 Pottawatomie Co 785-457-3661 Riley Co 785-776-7582 Washington Co 785-325-2253	www.ks.nrcs.usda.gov

12.2 BMP Definitions

Cropland

Vegetative Buffer
-Area of field maintained in permanent vegetation to help reduce nutrient and sediment loss from agricultural fields, improve runoff water quality, and provide habitat for wildlife.
-On average for Kansas fields, 1 acre buffer treats 15 acres of cropland.
-50% erosion reduction efficiency, 50% phosphorous reduction efficiency
-Approx. $1,000/acre, 90% cost-share available from NRCS.

Grassed Waterway
-Grassed strip used as an outlet to prevent silt and gully formation.
-Can also be used as outlets for water from terraces.
-On average for Kansas fields, 1 acre waterway will treat 10 acres of cropland.
-40% erosion reduction efficiency, 40% phosphorous reduction efficiency.
-$800 an acre, 50% cost-share available from NRCS.

No-Till
-A management system in which chemicals may be used for weed control and seedbed preparation.
-The soil surface is never disturbed except for planting or drilling operations in a 100% no-till system.
-75% erosion reduction efficiency, 40% phosphorous reduction efficiency.
-WRAPS groups and KSU Ag Economists have decided $10 an acre for 10 years is an adequate payment to entice producers to convert, 50% cost-share available from NRCS.

Conservation Crop Rotation
-Growing various crops on the same piece of land in a planned rotation.
-High residue crops (corn) with low residue crops (wheat, soybeans).
-Low residue crops in succession may encourage erosion.
-25% Erosion Reduction Efficiency, 25% phosphorous reduction efficiency
-WRAPS groups and KSU Ag Economists have decided $5 an acre for 10 years is an adequate payment to entice producers to convert.

Terraces
-Earth embankment and/or channel constructed across the slope to intercept runoff water and trap soil.
-One of the oldest/most common BMPs
-30% Erosion Reduction Efficiency, 30% phosphorous reduction efficiency
-$1.02 per linear foot, 50% cost-share available from NRCS

Nutrient Management Plan
-Managing the amount, source, placement, form and timing of the application of nutrients and soil amendments.
-Intensive soil testing
-25% erosion and 25% P reduction efficiency.
-WRAPS groups and KSU Ag Economists have decided $7.30 an acre for 10 years is an adequate payment to entice producers to convert, 50% cost-share is available from NRCS.

Subsurface Fertilizer Application
-Placing or injecting fertilizer beneath the soil surface.
-Reduces fertilizer runoff.
-0% soil and 50% P reduction efficiency.
-$3.50 an acre for 10 years, no cost-share.
-WRAPS groups and KSU Ag Economists have decided $3.50 an acre for 10 years is an adequate payment to entice producers to convert, 50% cost-share is available from NRCS.

Livestock

Vegetative Filter Strip
-A vegetated area that receives runoff during rainfall from an animal feeding operation.
-Often require a land area equal to or greater than the drainage area (needs to be as large as the feedlot).
-10 year lifespan, requires periodic mowing or haying, average P reduction: 50%.
-$714 an acre

Relocate Feeding Sites
-Feedlot- Move feedlot or pens away from a stream, waterway, or body of water to increase filtration and waste removal of manure. Highly variable in price, average of $6,600 per unit.
-Pasture- Move feeding site that is in a pasture away from a stream, waterway, or body of water to increase the filtration and waste removal (eg. move bale feeders away from stream). Highly variable in price, average of $2,203 per unit.
-Average P reduction: 30-80%

Alternative (Off-Stream) Watering System
-Watering system so that livestock do not enter stream or body of water.
-Studies show cattle will drink from tank over a stream or pond 80% of the time.
-10-25 year lifespan, average P reduction: 30-98% with greater efficiencies for limited stream access.
-$3,795 installed for solar system, including present value of maintenance costs.

Pond
-Water impoundment made by constructing an earthen dam.
-Traps sediment and nutrients from leaving edge of pasture.
-Provides source of water.
-50% P Reduction.
-Approximately $12,000

Rotational Grazing
-Rotating livestock within a pasture to spread manure more uniformly and allow grass to regenerate.
-May involve significant cross fencing and additional watering sites.
-50-75% P Reduction.
-Approximately $7,000 with complex systems significantly more expensive.

Stream Fencing
-Fencing out streams and ponds to prevent livestock from entering.
-95% P Reduction.
-25 year life expectancy.
-Approximately $4,106 per ¼ mile of fence, including labor, materials, and maintenance.

12.3 Forty Year Projection Tables by Sub Basin

12.3.1 Adoption Rates by Sub Basin

Table 50. Adoption Rates by Sub Basin.

	Sub Watershed #6 Total Acres of Cropland BMPs Adopted Each Year						
	Year	**Riparian Buffer**	**No-Till**	**Nutrient Management**	**Grassed Waterways**	**Subsurface Fertilizer**	**Total Treated Acreage**
Short Term	**1**	242	403	403	161	81	1,288
	2	242	403	403	161	81	1,288
	3	242	403	403	161	81	1,288
	4	242	403	403	161	81	1,288
	5	242	403	403	161	81	1,288
	6	242	403	403	161	81	1,288
	7	242	403	403	161	81	1,288
	8	242	403	403	161	81	1,288
	9	242	403	403	161	81	1,288
	10	242	403	403	161	81	1,288
Total		*2,415*	*4,026*	*4,026*	*1,610*	*805*	*12,882*
Medium Term	**11**	242	403	403	161	81	1,288
	12	242	403	403	161	81	1,288
	13	242	403	403	161	81	1,288

	14	242	403	403	161	81	1,288
	15	242	403	403	161	81	1,288
	16	242	403	403	161	81	1,288
	17	242	403	403	161	81	1,288
	18	242	403	403	161	81	1,288
	19	242	403	403	161	81	1,288
	20	242	403	403	161	81	1,288
Total		*4,831*	*8,051*	*8,051*	*3,220*	*1,610*	*25,763*
Long Term	**21**	242	403	403	161	81	1,288
	22	242	403	403	161	81	1,288
	23	242	403	403	161	81	1,288
	24	242	403	403	161	81	1,288
	25	242	403	403	161	81	1,288
	26	242	403	403	161	81	1,288
	27	242	403	403	161	81	1,288
	28	242	403	403	161	81	1,288
	29	242	403	403	161	81	1,288
	30	242	403	403	161	81	1,288
		7,246	*12,077*	*12,077*	*4,831*	*2,415*	*38,645*
	31	242	403	403	161	81	1,288
	32	242	403	403	161	81	1,288
	33	242	403		161	81	886
	34	242	403		161	81	886
	35	242	403		161	81	886
	36	242	403		161	81	886
	37	242	403		161	81	886
	38	242	403		161	81	886
	39	242			161	81	483
	40	242			161	81	483
Total		*9,661*	*15,297*	*12,882*	*6,441*	*3,220*	*47,501*

Sub Watershed #9 Total Acres of Cropland BMPs Adopted Each Year

	Year	Riparian Buffer	No-Till	Nutrient Management	Grassed Waterways	Subsurface Fertilizer	Total Treated Acreage
Short Term	**1**	629	1,048	1,048	419	210	3,355
	2	629	1,048	1,048	419	210	3,355
	3	629	1,048	1,048	419	210	3,355
	4	629	1,048	1,048	419	210	3,355
	5	629	1,048	1,048	419	210	3,355
	6	629	1,048	1,048	419	210	3,355
	7	629	1,048	1,048	419	210	3,355
	8	629	1,048	1,048	419	210	3,355

	9	629	1,048	1,048	419	210	3,355
	10	629	1,048	1,048	419	210	3,355
Total		*6,291*	*10,485*	*10,485*	*4,194*	*2,097*	*33,552*
Medium Term	**11**	629	1,048	1,048	419	210	3,355
	12	629	1,048	1,048	419	210	3,355
	13	629	1,048	1,048	419	210	3,355
	14	629	1,048	1,048	419	210	3,355
	15	629	1,048	1,048	419	210	3,355
	16	629	1,048	1,048	419	210	3,355
	17	629	1,048	1,048	419	210	3,355
	18	629	1,048	1,048	419	210	3,355
	19	629	1,048	1,048	419	210	3,355
	20	629	1,048	1,048	419	210	3,355
Total		*12,582*	*20,970*	*20,970*	*8,388*	*4,194*	*67,104*
Long Term	**21**	629	1,048	1,048	419	210	3,355
	22	629	1,048	1,048	419	210	3,355
	23	629	1,048	1,048	419	210	3,355
	24	629	1,048	1,048	419	210	3,355
	25	629	1,048	1,048	419	210	3,355
	26	629	1,048	1,048	419	210	3,355
	27	629	1,048	1,048	419	210	3,355
	28	629	1,048	1,048	419	210	3,355
	29	629	1,048	1,048	419	210	3,355
	30	629	1,048	1,048	419	210	3,355
		18,873	*31,455*	*31,455*	*12,582*	*6,291*	*100,655*
	31	629	1,048	1,048	419	210	3,355
	32	629	1,048	1,048	419	210	3,355
	33	629	1,048		419	210	2,307
	34	629	1,048		419	210	2,307
	35	629	1,048		419	210	2,307
	36	629	1,048		419	210	2,307
	37	629	1,048		419	210	2,307
	38	629	1,048		419	210	2,307
	39	629			419	210	1,258
	40	629			419	210	1,258
Total		*25,164*	*39,843*	*33,552*	*16,776*	*8,388*	*123,722*

Sub Watershed #8 Total Acres of Cropland BMPs Adopted Each Year

	Year	Riparian Buffer	No-Till	Nutrient Management	Grassed Waterways	Subsurface Fertilizer	Total Treated Acreage
Short Term	**1**	377	628	628	251	126	2,010
	2	377	628	628	251	126	2,010

	3	377	628	628	251	126	2,010
	4	377	628	628	251	126	2,010
	5	377	628	628	251	126	2,010
	6	377	628	628	251	126	2,010
	7	377	628	628	251	126	2,010
	8	377	628	628	251	126	2,010
	9	377	628	628	251	126	2,010
	10	377	628	628	251	126	2,010
Total		*3,768*	*6,280*	*6,280*	*2,512*	*1,256*	*20,095*
Medium Term	**11**	377	628	628	251	126	2,010
	12	377	628	628	251	126	2,010
	13	377	628	628	251	126	2,010
	14	377	628	628	251	126	2,010
	15	377	628	628	251	126	2,010
	16	377	628	628	251	126	2,010
	17	377	628	628	251	126	2,010
	18	377	628	628	251	126	2,010
	19	377	628	628	251	126	2,010
	20	377	628	628	251	126	2,010
Total		*7,536*	*12,559*	*12,559*	*5,024*	*2,512*	*40,190*
Long Term	**21**	377	628	628	251	126	2,010
	22	377	628	628	251	126	2,010
	23	377	628	628	251	126	2,010
	24	377	628	628	251	126	2,010
	25	377	628	628	251	126	2,010
	26	377	628	628	251	126	2,010
	27	377	628	628	251	126	2,010
	28	377	628	628	251	126	2,010
	29	377	628	628	251	126	2,010
	30	377	628	628	251	126	2,010
		11,304	*18,839*	*18,839*	*7,536*	*3,768*	*60,285*
	31	377	628	628	251	126	2,010
	32	377	628	628	251	126	2,010
	33	377	628		251	126	1,382
	34	377	628		251	126	1,382
	35	377	628		251	126	1,382
	36	377	628		251	126	1,382
	37	377	628		251	126	1,382
	38	377	628		251	126	1,382
	39	377			251	126	754
	40	377			251	126	754
Total		*15,071*	*23,863*	*20,095*	*10,048*	*5,024*	*74,101*

	Sub Watershed #26 Total Acres of Cropland BMPs Adopted Each Year						
	Year	Riparian Buffer	No-Till	Nutrient Management	Grassed Waterways	Subsurface Fertilizer	Total Treated Acreage
Short Term	1	194	323	323	129	65	1,033
	2	194	323	323	129	65	1,033
	3	194	323	323	129	65	1,033
	4	194	323	323	129	65	1,033
	5	194	323	323	129	65	1,033
	6	194	323	323	129	65	1,033
	7	194	323	323	129	65	1,033
	8	194	323	323	129	65	1,033
	9	194	323	323	129	65	1,033
	10	194	323	323	129	65	1,033
Total		*1,938*	*3,230*	*3,230*	*1,292*	*646*	*10,335*
Medium Term	11	194	323	323	129	65	1,033
	12	194	323	323	129	65	1,033
	13	194	323	323	129	65	1,033
	14	194	323	323	129	65	1,033
	15	194	323	323	129	65	1,033
	16	194	323	323	129	65	1,033
	17	194	323	323	129	65	1,033
	18	194	323	323	129	65	1,033
	19	194	323	323	129	65	1,033
	20	194	323	323	129	65	1,033
Total		*3,876*	*6,459*	*6,459*	*2,584*	*1,292*	*20,670*
Long Term	21	194	323	323	129	65	1,033
	22	194	323	323	129	65	1,033
	23	194	323	323	129	65	1,033
	24	194	323	323	129	65	1,033
	25	194	323	323	129	65	1,033
	26	194	323	323	129	65	1,033
	27	194	323	323	129	65	1,033
	28	194	323	323	129	65	1,033
	29	194	323	323	129	65	1,033
	30	194	323	323	129	65	1,033
		5,813	*9,689*	*9,689*	*3,876*	*1,938*	*31,005*
	31	194	323	323	129	65	1,033
	32	194	323	323	129	65	1,033
	33	194	323		129	65	711
	34	194	323		129	65	711
	35	194	323		129	65	711

	36	194	323		129	65	711
	37	194	323		129	65	711
	38	194	323		129	65	711
	39	194			129	65	388
	40	194			129	65	388
Total		*7,751*	*12,273*	*10,335*	*5,167*	*2,584*	*38,110*

Sub Watershed #28 Total Acres of Cropland BMPs Adopted Each Year

	Year	Riparian Buffer	No-Till	Nutrient Management	Grassed Waterways	Subsurface Fertilizer	Total Treated Acreage
Short Term	**1**	576	961	961	384	192	3,074
	2	576	961	961	384	192	3,074
	3	576	961	961	384	192	3,074
	4	576	961	961	384	192	3,074
	5	576	961	961	384	192	3,074
	6	576	961	961	384	192	3,074
	7	576	961	961	384	192	3,074
	8	576	961	961	384	192	3,074
	9	576	961	961	384	192	3,074
	10	576	961	961	384	192	3,074
Total		*5,765*	*9,608*	*9,608*	*3,843*	*1,922*	*30,744*
Medium Term	**11**	576	961	961	384	192	3,074
	12	576	961	961	384	192	3,074
	13	576	961	961	384	192	3,074
	14	576	961	961	384	192	3,074
	15	576	961	961	384	192	3,074
	16	576	961	961	384	192	3,074
	17	576	961	961	384	192	3,074
	18	576	961	961	384	192	3,074
	19	576	961	961	384	192	3,074
	20	576	961	961	384	192	3,074
Total		*11,529*	*19,215*	*19,215*	*7,686*	*3,843*	*61,488*
Long Term	**21**	576	961	961	384	192	3,074
	22	576	961	961	384	192	3,074
	23	576	961	961	384	192	3,074
	24	576	961	961	384	192	3,074
	25	576	961	961	384	192	3,074
	26	576	961	961	384	192	3,074
	27	576	961	961	384	192	3,074
	28	576	961	961	384	192	3,074
	29	576	961	961	384	192	3,074
	30	576	961	961	384	192	3,074

	Year	Riparian Buffer	No-Till	Nutrient Management	Grassed Waterways	Subsurface Fertilizer	Total Treated Acreage
		17,294	*28,823*	*28,823*	*11,529*	*5,765*	*92,232*
	31	576	961	961	384	192	3,074
	32	576	961	961	384	192	3,074
	33	576	961		384	192	2,114
	34	576	961		384	192	2,114
	35	576	961		384	192	2,114
	36	576	961		384	192	2,114
	37	576	961		384	192	2,114
	38	576	961		384	192	2,114
	39	576			384	192	1,153
	40	576			384	192	1,153
Total		*23,058*	*36,509*	*30,744*	*15,372*	*7,686*	*113,369*

Sub Watershed #15 Total Acres of Cropland BMPs Adopted Each Year

	Year	Riparian Buffer	No-Till	Nutrient Management	Grassed Waterways	Subsurface Fertilizer	Total Treated Acreage
Short Term	**1**	721	1,202	1,202	481	240	3,845
	2	721	1,202	1,202	481	240	3,845
	3	721	1,202	1,202	481	240	3,845
	4	721	1,202	1,202	481	240	3,845
	5	721	1,202	1,202	481	240	3,845
	6	721	1,202	1,202	481	240	3,845
	7	721	1,202	1,202	481	240	3,845
	8	721	1,202	1,202	481	240	3,845
	9	721	1,202	1,202	481	240	3,845
	10	721	1,202	1,202	481	240	3,845
Total		*7,209*	*12,015*	*12,015*	*4,806*	*2,403*	*38,449*
Medium Term	**11**	721	1,202	1,202	481	240	3,845
	12	721	1,202	1,202	481	240	3,845
	13	721	1,202	1,202	481	240	3,845
	14	721	1,202	1,202	481	240	3,845
	15	721	1,202	1,202	481	240	3,845
	16	721	1,202	1,202	481	240	3,845
	17	721	1,202	1,202	481	240	3,845
	18	721	1,202	1,202	481	240	3,845
	19	721	1,202	1,202	481	240	3,845
	20	721	1,202	1,202	481	240	3,845
Total		*14,418*	*24,030*	*24,030*	*9,612*	*4,806*	*76,897*
Long Term	**21**	721	1,202	1,202	481	240	3,845
	22	721	1,202	1,202	481	240	3,845
	23	721	1,202	1,202	481	240	3,845
	24	721	1,202	1,202	481	240	3,845

	25	721	1,202	1,202	481	240	3,845
	26	721	1,202	1,202	481	240	3,845
	27	721	1,202	1,202	481	240	3,845
	28	721	1,202	1,202	481	240	3,845
	29	721	1,202	1,202	481	240	3,845
	30	721	1,202	1,202	481	240	3,845
		21,627	*36,046*	*36,046*	*14,418*	*7,209*	*115,346*
	31	721	1,202	1,202	481	240	3,845
	32	721	1,202	1,202	481	240	3,845
	33	721	1,202		481	240	2,643
	34	721	1,202		481	240	2,643
	35	721	1,202		481	240	2,643
	36	721	1,202		481	240	2,643
	37	721	1,202		481	240	2,643
	38	721	1,202		481	240	2,643
	39	721			481	240	1,442
	40	721			481	240	1,442
Total		*28,837*	*45,658*	*38,449*	*19,224*	*9,612*	*141,779*

12.3.2 Pollutant Reductions by Sub Basin

Table 51. Sediment Reductions by Sub Basin.

Sub Watershed #6 Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Load Reduction
1	814	2,036	679	434	0	3,963
2	1,629	4,072	1,357	869	0	7,927
3	2,443	6,108	2,036	1,303	0	11,890
4	3,258	8,144	2,715	1,737	0	15,853
5	4,072	10,180	3,393	2,172	0	19,817
6	4,886	12,216	4,072	2,606	0	23,780
7	5,701	14,252	4,751	3,040	0	27,743
8	6,515	16,288	5,429	3,475	0	31,706
9	7,329	18,323	6,108	3,909	0	35,670
10	8,144	20,359	6,786	4,343	0	39,633
11	8,958	22,395	7,465	4,778	0	43,596
12	9,773	24,431	8,144	5,212	0	47,560
13	10,587	26,467	8,822	5,646	0	51,523
14	11,401	28,503	9,501	6,081	0	55,486
15	12,216	30,539	10,180	6,515	0	59,450
16	13,030	32,575	10,858	6,949	0	63,413
17	13,844	34,611	11,537	7,384	0	67,376

18	14,659	36,647	12,216	7,818	0	71,339
19	15,473	38,683	12,894	8,252	0	75,303
20	16,288	40,719	13,573	8,687	0	79,266
21	17,102	42,755	14,252	9,121	0	83,229
22	17,916	44,791	14,930	9,555	0	87,193
23	18,731	46,827	15,609	9,990	0	91,156
24	19,545	48,863	16,288	10,424	0	95,119
25	20,359	50,899	16,966	10,858	0	99,083
26	21,174	52,935	17,645	11,293	0	103,046
27	21,988	54,970	18,323	11,727	0	107,009
28	22,803	57,006	19,002	12,161	0	110,973
29	23,617	59,042	19,681	12,596	0	114,936
30	24,431	61,078	20,359	13,030	0	118,899
31	25,246	63,114	21,038	13,464	0	122,862
32	26,060	65,150	21,717	13,899	0	126,826
33	26,874	67,186	21,717	14,333	0	130,110
34	27,689	69,222	21,717	14,767	0	133,395
35	28,503	71,258	21,717	15,202	0	136,680
36	29,318	73,294	21,717	15,636	0	139,964
37	30,132	75,330	21,717	16,070	0	143,249
38	30,946	77,366	21,717	16,505	0	146,534
39	31,761	77,366	21,717	16,939	0	147,782
40	32,575	77,366	21,717	17,373	0	149,031

Sub Watershed #9 Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Load Reduction
1	2,066	5,165	1,722	1,102	0	10,055
2	4,132	10,331	3,444	2,204	0	20,110
3	6,198	15,496	5,165	3,306	0	30,166
4	8,265	20,661	6,887	4,408	0	40,221
5	10,331	25,827	8,609	5,510	0	50,276
6	12,397	30,992	10,331	6,612	0	60,331
7	14,463	36,158	12,053	7,714	0	70,387
8	16,529	41,323	13,774	8,816	0	80,442
9	18,595	46,488	15,496	9,917	0	90,497
10	20,661	51,654	17,218	11,019	0	100,552
11	22,728	56,819	18,940	12,121	0	110,608
12	24,794	61,984	20,661	13,223	0	120,663

13	26,860	67,150	22,383	14,325	0	130,718
14	28,926	72,315	24,105	15,427	0	140,773
15	30,992	77,480	25,827	16,529	0	150,829
16	33,058	82,646	27,549	17,631	0	160,884
17	35,124	87,811	29,270	18,733	0	170,939
18	37,191	92,977	30,992	19,835	0	180,994
19	39,257	98,142	32,714	20,937	0	191,050
20	41,323	103,307	34,436	22,039	0	201,105
21	43,389	108,473	36,158	23,141	0	211,160
22	45,455	113,638	37,879	24,243	0	221,215
23	47,521	118,803	39,601	25,345	0	231,271
24	49,587	123,969	41,323	26,447	0	241,326
25	51,654	129,134	43,045	27,549	0	251,381
26	53,720	134,299	44,766	28,651	0	261,436
27	55,786	139,465	46,488	29,752	0	271,491
28	57,852	144,630	48,210	30,854	0	281,547
29	59,918	149,796	49,932	31,956	0	291,602
30	61,984	154,961	51,654	33,058	0	301,657
31	64,051	160,126	53,375	34,160	0	311,712
32	66,117	165,292	55,097	35,262	0	321,768
33	68,183	170,457	55,097	36,364	0	330,101
34	70,249	175,622	55,097	37,466	0	338,435
35	72,315	180,788	55,097	38,568	0	346,768
36	74,381	185,953	55,097	39,670	0	355,101
37	76,447	191,118	55,097	40,772	0	363,435
38	78,514	196,284	55,097	41,874	0	371,768
39	80,580	196,284	55,097	42,976	0	374,936
40	82,646	196,284	55,097	44,078	0	378,105

Sub Watershed #8 Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Load Reduction
1	1,175	2,939	980	627	0	5,721
2	2,351	5,877	1,959	1,254	0	11,441
3	3,526	8,816	2,939	1,881	0	17,162
4	4,702	11,755	3,918	2,508	0	22,882
5	5,877	14,693	4,898	3,135	0	28,603
6	7,053	17,632	5,877	3,761	0	34,323
7	8,228	20,570	6,857	4,388	0	40,044

8	9,404	23,509	7,836	5,015	0	45,764
9	10,579	26,448	8,816	5,642	0	51,485
10	11,755	29,386	9,795	6,269	0	57,205
11	12,930	32,325	10,775	6,896	0	62,926
12	14,105	35,264	11,755	7,523	0	68,646
13	15,281	38,202	12,734	8,150	0	74,367
14	16,456	41,141	13,714	8,777	0	80,088
15	17,632	44,079	14,693	9,404	0	85,808
16	18,807	47,018	15,673	10,031	0	91,529
17	19,983	49,957	16,652	10,657	0	97,249
18	21,158	52,895	17,632	11,284	0	102,970
19	22,334	55,834	18,611	11,911	0	108,690
20	23,509	58,773	19,591	12,538	0	114,411
21	24,685	61,711	20,570	13,165	0	120,131
22	25,860	64,650	21,550	13,792	0	125,852
23	27,035	67,589	22,530	14,419	0	131,572
24	28,211	70,527	23,509	15,046	0	137,293
25	29,386	73,466	24,489	15,673	0	143,013
26	30,562	76,404	25,468	16,300	0	148,734
27	31,737	79,343	26,448	16,927	0	154,454
28	32,913	82,282	27,427	17,553	0	160,175
29	34,088	85,220	28,407	18,180	0	165,896
30	35,264	88,159	29,386	18,807	0	171,616
31	36,439	91,098	30,366	19,434	0	177,337
32	37,614	94,036	31,345	20,061	0	183,057
33	38,790	96,975	31,345	20,688	0	187,798
34	39,965	99,913	31,345	21,315	0	192,539
35	41,141	102,852	31,345	21,942	0	197,280
36	42,316	105,791	31,345	22,569	0	202,021
37	43,492	108,729	31,345	23,196	0	206,762
38	44,667	111,668	31,345	23,823	0	211,503
39	45,843	111,668	31,345	24,449	0	213,306
40	47,018	111,668	31,345	25,076	0	215,108

Sub Watershed #26 Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Load Reduction
1	544	1,361	454	290	0	2,650
2	1,089	2,722	907	581	0	5,299

3	1,633	4,083	1,361	871	0	7,949
4	2,178	5,445	1,815	1,162	0	10,599
5	2,722	6,806	2,269	1,452	0	13,248
6	3,267	8,167	2,722	1,742	0	15,898
7	3,811	9,528	3,176	2,033	0	18,548
8	4,356	10,889	3,630	2,323	0	21,198
9	4,900	12,250	4,083	2,613	0	23,847
10	5,445	13,611	4,537	2,904	0	26,497
11	5,989	14,973	4,991	3,194	0	29,147
12	6,533	16,334	5,445	3,485	0	31,796
13	7,078	17,695	5,898	3,775	0	34,446
14	7,622	19,056	6,352	4,065	0	37,096
15	8,167	20,417	6,806	4,356	0	39,745
16	8,711	21,778	7,259	4,646	0	42,395
17	9,256	23,139	7,713	4,936	0	45,045
18	9,800	24,501	8,167	5,227	0	47,694
19	10,345	25,862	8,621	5,517	0	50,344
20	10,889	27,223	9,074	5,808	0	52,994
21	11,434	28,584	9,528	6,098	0	55,644
22	11,978	29,945	9,982	6,388	0	58,293
23	12,523	31,306	10,435	6,679	0	60,943
24	13,067	32,667	10,889	6,969	0	63,593
25	13,611	34,029	11,343	7,259	0	66,242
26	14,156	35,390	11,797	7,550	0	68,892
27	14,700	36,751	12,250	7,840	0	71,542
28	15,245	38,112	12,704	8,131	0	74,191
29	15,789	39,473	13,158	8,421	0	76,841
30	16,334	40,834	13,611	8,711	0	79,491
31	16,878	42,195	14,065	9,002	0	82,140
32	17,423	43,557	14,519	9,292	0	84,790
33	17,967	44,918	14,519	9,582	0	86,986
34	18,512	46,279	14,519	9,873	0	89,182
35	19,056	47,640	14,519	10,163	0	91,378
36	19,600	49,001	14,519	10,454	0	93,574
37	20,145	50,362	14,519	10,744	0	95,770
38	20,689	51,723	14,519	11,034	0	97,966
39	21,234	51,723	14,519	11,325	0	98,801
40	21,778	51,723	14,519	11,615	0	99,636

Sub Watershed #28 Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Load Reduction
1	1,593	3,982	1,327	849	0	7,751
2	3,185	7,963	2,654	1,699	0	15,502
3	4,778	11,945	3,982	2,548	0	23,253
4	6,371	15,926	5,309	3,398	0	31,003
5	7,963	19,908	6,636	4,247	0	38,754
6	9,556	23,890	7,963	5,096	0	46,505
7	11,148	27,871	9,290	5,946	0	54,256
8	12,741	31,853	10,618	6,795	0	62,007
9	14,334	35,834	11,945	7,645	0	69,758
10	15,926	39,816	13,272	8,494	0	77,509
11	17,519	43,798	14,599	9,344	0	85,259
12	19,112	47,779	15,926	10,193	0	93,010
13	20,704	51,761	17,254	11,042	0	100,761
14	22,297	55,742	18,581	11,892	0	108,512
15	23,890	59,724	19,908	12,741	0	116,263
16	25,482	63,706	21,235	13,591	0	124,014
17	27,075	67,687	22,562	14,440	0	131,765
18	28,668	71,669	23,890	15,289	0	139,515
19	30,260	75,651	25,217	16,139	0	147,266
20	31,853	79,632	26,544	16,988	0	155,017
21	33,445	83,614	27,871	17,838	0	162,768
22	35,038	87,595	29,198	18,687	0	170,519
23	36,631	91,577	30,526	19,536	0	178,270
24	38,223	95,559	31,853	20,386	0	186,021
25	39,816	99,540	33,180	21,235	0	193,771
26	41,409	103,522	34,507	22,085	0	201,522
27	43,001	107,503	35,834	22,934	0	209,273
28	44,594	111,485	37,162	23,783	0	217,024
29	46,187	115,467	38,489	24,633	0	224,775
30	47,779	119,448	39,816	25,482	0	232,526
31	49,372	123,430	41,143	26,332	0	240,277
32	50,965	127,411	42,470	27,181	0	248,027
33	52,557	131,393	42,470	28,031	0	254,451
34	54,150	135,375	42,470	28,880	0	260,875
35	55,742	139,356	42,470	29,729	0	267,298
36	57,335	143,338	42,470	30,579	0	273,722
37	58,928	147,319	42,470	31,428	0	280,146
38	60,520	151,301	42,470	32,278	0	286,569
39	62,113	151,301	42,470	33,127	0	289,011
40	63,706	151,301	42,470	33,976	0	291,454

Sub Watershed #15 Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Load Reduction
1	1,961	4,902	1,634	1,046	0	9,542
2	3,921	9,804	3,268	2,091	0	19,084
3	5,882	14,705	4,902	3,137	0	28,627
4	7,843	19,607	6,536	4,183	0	38,169
5	9,804	24,509	8,170	5,229	0	47,711
6	11,764	29,411	9,804	6,274	0	57,253
7	13,725	34,313	11,438	7,320	0	66,795
8	15,686	39,215	13,072	8,366	0	76,338
9	17,647	44,116	14,705	9,411	0	85,880
10	19,607	49,018	16,339	10,457	0	95,422
11	21,568	53,920	17,973	11,503	0	104,964
12	23,529	58,822	19,607	12,549	0	114,506
13	25,489	63,724	21,241	13,594	0	124,049
14	27,450	68,625	22,875	14,640	0	133,591
15	29,411	73,527	24,509	15,686	0	143,133
16	31,372	78,429	26,143	16,732	0	152,675
17	33,332	83,331	27,777	17,777	0	162,217
18	35,293	88,233	29,411	18,823	0	171,760
19	37,254	93,135	31,045	19,869	0	181,302
20	39,215	98,036	32,679	20,914	0	190,844
21	41,175	102,938	34,313	21,960	0	200,386
22	43,136	107,840	35,947	23,006	0	209,929
23	45,097	112,742	37,581	24,052	0	219,471
24	47,057	117,644	39,215	25,097	0	229,013
25	49,018	122,545	40,848	26,143	0	238,555
26	50,979	127,447	42,482	27,189	0	248,097
27	52,940	132,349	44,116	28,234	0	257,640
28	54,900	137,251	45,750	29,280	0	267,182
29	56,861	142,153	47,384	30,326	0	276,724
30	58,822	147,055	49,018	31,372	0	286,266
31	60,783	151,956	50,652	32,417	0	295,808
32	62,743	156,858	52,286	33,463	0	305,351
33	64,704	161,760	52,286	34,509	0	313,259
34	66,665	166,662	52,286	35,555	0	321,167
35	68,625	171,564	52,286	36,600	0	329,075

36	70,586	176,465	52,286	37,646	0	336,984
37	72,547	181,367	52,286	38,692	0	344,892
38	74,508	186,269	52,286	39,737	0	352,800
39	76,468	186,269	52,286	40,783	0	355,807
40	78,429	186,269	52,286	41,829	0	358,813

Table 52. Phosphorus Reductions by Sub Basin.

Sub Watershed #6 Annual Phosphorous Runoff Reduction (pounds), Cropland BMPs

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Load Reduction
1	374	499	312	200	125	1,510
2	749	998	624	399	250	3,020
3	1,123	1,497	936	599	374	4,530
4	1,497	1,997	1,248	799	499	6,040
5	1,872	2,496	1,560	998	624	7,550
6	2,246	2,995	1,872	1,198	749	9,060
7	2,621	3,494	2,184	1,398	874	10,570
8	2,995	3,993	2,496	1,597	998	12,080
9	3,369	4,492	2,808	1,797	1,123	13,590
10	3,744	4,992	3,120	1,997	1,248	15,100
11	4,118	5,491	3,432	2,196	1,373	16,610
12	4,492	5,990	3,744	2,396	1,497	18,120
13	4,867	6,489	4,056	2,596	1,622	19,630
14	5,241	6,988	4,368	2,795	1,747	21,140
15	5,616	7,487	4,680	2,995	1,872	22,650
16	5,990	7,987	4,992	3,195	1,997	24,159
17	6,364	8,486	5,304	3,394	2,121	25,669
18	6,739	8,985	5,616	3,594	2,246	27,179
19	7,113	9,484	5,928	3,794	2,371	28,689
20	7,487	9,983	6,240	3,993	2,496	30,199
21	7,862	10,482	6,552	4,193	2,621	31,709
22	8,236	10,982	6,863	4,393	2,745	33,219
23	8,611	11,481	7,175	4,592	2,870	34,729
24	8,985	11,980	7,487	4,792	2,995	36,239
25	9,359	12,479	7,799	4,992	3,120	37,749
26	9,734	12,978	8,111	5,191	3,245	39,259
27	10,108	13,477	8,423	5,391	3,369	40,769
28	10,482	13,977	8,735	5,591	3,494	42,279
29	10,857	14,476	9,047	5,790	3,619	43,789
30	11,231	14,975	9,359	5,990	3,744	45,299
31	11,606	15,474	9,671	6,190	3,869	46,809
32	11,980	15,973	9,983	6,389	3,993	48,319

33	12,354	16,472	9,983	6,589	4,118	49,517
34	12,729	16,972	9,983	6,789	4,243	50,715
35	13,103	17,471	9,983	6,988	4,368	51,913
36	13,477	17,970	9,983	7,188	4,492	53,111
37	13,852	18,469	9,983	7,388	4,617	54,309
38	14,226	18,968	9,983	7,587	4,742	55,507
39	14,601	18,968	9,983	7,787	4,867	56,206
40	14,975	18,968	9,983	7,987	4,992	56,905

Sub Watershed #9 Annual Phosphorous Runoff Reduction (pounds), Cropland BMPs

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Load Reduction
1	912	1,216	760	487	304	3,679
2	1,824	2,433	1,520	973	608	7,358
3	2,737	3,649	2,280	1,460	912	11,037
4	3,649	4,865	3,041	1,946	1,216	14,717
5	4,561	6,081	3,801	2,433	1,520	18,396
6	5,473	7,298	4,561	2,919	1,824	22,075
7	6,385	8,514	5,321	3,406	2,128	25,754
8	7,298	9,730	6,081	3,892	2,433	29,433
9	8,210	10,946	6,841	4,379	2,737	33,112
10	9,122	12,163	7,602	4,865	3,041	36,792
11	10,034	13,379	8,362	5,352	3,345	40,471
12	10,946	14,595	9,122	5,838	3,649	44,150
13	11,858	15,811	9,882	6,325	3,953	47,829
14	12,771	17,028	10,642	6,811	4,257	51,508
15	13,683	18,244	11,402	7,298	4,561	55,187
16	14,595	19,460	12,163	7,784	4,865	58,867
17	15,507	20,676	12,923	8,271	5,169	62,546
18	16,419	21,893	13,683	8,757	5,473	66,225
19	17,332	23,109	14,443	9,244	5,777	69,904
20	18,244	24,325	15,203	9,730	6,081	73,583
21	19,156	25,541	15,963	10,217	6,385	77,262
22	20,068	26,758	16,723	10,703	6,689	80,942
23	20,980	27,974	17,484	11,190	6,993	84,621
24	21,893	29,190	18,244	11,676	7,298	88,300
25	22,805	30,406	19,004	12,163	7,602	91,979
26	23,717	31,623	19,764	12,649	7,906	95,658
27	24,629	32,839	20,524	13,136	8,210	99,337

28	25,541	34,055	21,284	13,622	8,514	103,017
29	26,454	35,271	22,045	14,109	8,818	106,696
30	27,366	36,488	22,805	14,595	9,122	110,375
31	28,278	37,704	23,565	15,082	9,426	114,054
32	29,190	38,920	24,325	15,568	9,730	117,733
33	30,102	40,136	24,325	16,055	10,034	120,652
34	31,014	41,353	24,325	16,541	10,338	123,571
35	31,927	42,569	24,325	17,028	10,642	126,490
36	32,839	43,785	24,325	17,514	10,946	129,409
37	33,751	45,001	24,325	18,001	11,250	132,328
38	34,663	46,218	24,325	18,487	11,554	135,247
39	35,575	46,218	24,325	18,974	11,858	136,950
40	36,488	46,218	24,325	19,460	12,163	138,653

Sub Watershed #8 Annual Phosphorous Runoff Reduction (pounds), Cropland BMPs

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Load Reduction
1	509	678	424	271	170	2,052
2	1,017	1,356	848	543	339	4,103
3	1,526	2,035	1,272	814	509	6,155
4	2,035	2,713	1,696	1,085	678	8,206
5	2,543	3,391	2,119	1,356	848	10,258
6	3,052	4,069	2,543	1,628	1,017	12,310
7	3,561	4,747	2,967	1,899	1,187	14,361
8	4,069	5,426	3,391	2,170	1,356	16,413
9	4,578	6,104	3,815	2,442	1,526	18,464
10	5,087	6,782	4,239	2,713	1,696	20,516
11	5,595	7,460	4,663	2,984	1,865	22,567
12	6,104	8,139	5,087	3,255	2,035	24,619
13	6,613	8,817	5,510	3,527	2,204	26,671
14	7,121	9,495	5,934	3,798	2,374	28,722
15	7,630	10,173	6,358	4,069	2,543	30,774
16	8,139	10,851	6,782	4,341	2,713	32,825
17	8,647	11,530	7,206	4,612	2,882	34,877
18	9,156	12,208	7,630	4,883	3,052	36,929
19	9,665	12,886	8,054	5,154	3,222	38,980
20	10,173	13,564	8,478	5,426	3,391	41,032
21	10,682	14,242	8,902	5,697	3,561	43,083
22	11,190	14,921	9,325	5,968	3,730	45,135

23	11,699	15,599	9,749	6,240	3,900	47,187
24	12,208	16,277	10,173	6,511	4,069	49,238
25	12,716	16,955	10,597	6,782	4,239	51,290
26	13,225	17,633	11,021	7,053	4,408	53,341
27	13,734	18,312	11,445	7,325	4,578	55,393
28	14,242	18,990	11,869	7,596	4,747	57,444
29	14,751	19,668	12,293	7,867	4,917	59,496
30	15,260	20,346	12,716	8,139	5,087	61,548
31	15,768	21,025	13,140	8,410	5,256	63,599
32	16,277	21,703	13,564	8,681	5,426	65,651
33	16,786	22,381	13,564	8,952	5,595	67,279
34	17,294	23,059	13,564	9,224	5,765	68,906
35	17,803	23,737	13,564	9,495	5,934	70,534
36	18,312	24,416	13,564	9,766	6,104	72,162
37	18,820	25,094	13,564	10,038	6,273	73,789
38	19,329	25,772	13,564	10,309	6,443	75,417
39	19,838	25,772	13,564	10,580	6,613	76,367
40	20,346	25,772	13,564	10,851	6,782	77,316

Sub Watershed #26 Annual Phosphorous Runoff Reduction (pounds), Cropland BMPs

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Load Reduction
1	223	297	186	119	74	899
2	446	594	371	238	149	1,798
3	669	891	557	357	223	2,696
4	891	1,189	743	475	297	3,595
5	1,114	1,486	929	594	371	4,494
6	1,337	1,783	1,114	713	446	5,393
7	1,560	2,080	1,300	832	520	6,292
8	1,783	2,377	1,486	951	594	7,191
9	2,006	2,674	1,671	1,070	669	8,089
10	2,228	2,971	1,857	1,189	743	8,988
11	2,451	3,268	2,043	1,307	817	9,887
12	2,674	3,566	2,228	1,426	891	10,786
13	2,897	3,863	2,414	1,545	966	11,685
14	3,120	4,160	2,600	1,664	1,040	12,583
15	3,343	4,457	2,786	1,783	1,114	13,482
16	3,566	4,754	2,971	1,902	1,189	14,381
17	3,788	5,051	3,157	2,020	1,263	15,280

18	4,011	5,348	3,343	2,139	1,337	16,179
19	4,234	5,645	3,528	2,258	1,411	17,077
20	4,457	5,943	3,714	2,377	1,486	17,976
21	4,680	6,240	3,900	2,496	1,560	18,875
22	4,903	6,537	4,086	2,615	1,634	19,774
23	5,125	6,834	4,271	2,734	1,708	20,673
24	5,348	7,131	4,457	2,852	1,783	21,572
25	5,571	7,428	4,643	2,971	1,857	22,470
26	5,794	7,725	4,828	3,090	1,931	23,369
27	6,017	8,022	5,014	3,209	2,006	24,268
28	6,240	8,320	5,200	3,328	2,080	25,167
29	6,463	8,617	5,385	3,447	2,154	26,066
30	6,685	8,914	5,571	3,566	2,228	26,964
31	6,908	9,211	5,757	3,684	2,303	27,863
32	7,131	9,508	5,943	3,803	2,377	28,762
33	7,354	9,805	5,943	3,922	2,451	29,475
34	7,577	10,102	5,943	4,041	2,526	30,188
35	7,800	10,400	5,943	4,160	2,600	30,901
36	8,022	10,697	5,943	4,279	2,674	31,615
37	8,245	10,994	5,943	4,398	2,748	32,328
38	8,468	11,291	5,943	4,516	2,823	33,041
39	8,691	11,291	5,943	4,635	2,897	33,457
40	8,914	11,291	5,943	4,754	2,971	33,873

Sub Watershed #28 Annual Phosphorous Runoff Reduction (pounds), Cropland BMPs

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Load Reduction
1	663	884	552	354	221	2,674
2	1,326	1,768	1,105	707	442	5,348
3	1,989	2,652	1,657	1,061	663	8,021
4	2,652	3,536	2,210	1,414	884	10,695
5	3,315	4,419	2,762	1,768	1,105	13,369
6	3,978	5,303	3,315	2,121	1,326	16,043
7	4,640	6,187	3,867	2,475	1,547	18,716
8	5,303	7,071	4,419	2,828	1,768	21,390
9	5,966	7,955	4,972	3,182	1,989	24,064
10	6,629	8,839	5,524	3,536	2,210	26,738
11	7,292	9,723	6,077	3,889	2,431	29,412
12	7,955	10,607	6,629	4,243	2,652	32,085

13	8,618	11,491	7,182	4,596	2,873	34,759
14	9,281	12,375	7,734	4,950	3,094	37,433
15	9,944	13,258	8,287	5,303	3,315	40,107
16	10,607	14,142	8,839	5,657	3,536	42,780
17	11,270	15,026	9,391	6,010	3,757	45,454
18	11,933	15,910	9,944	6,364	3,978	48,128
19	12,595	16,794	10,496	6,718	4,198	50,802
20	13,258	17,678	11,049	7,071	4,419	53,476
21	13,921	18,562	11,601	7,425	4,640	56,149
22	14,584	19,446	12,154	7,778	4,861	58,823
23	15,247	20,330	12,706	8,132	5,082	61,497
24	15,910	21,213	13,258	8,485	5,303	64,171
25	16,573	22,097	13,811	8,839	5,524	66,845
26	17,236	22,981	14,363	9,193	5,745	69,518
27	17,899	23,865	14,916	9,546	5,966	72,192
28	18,562	24,749	15,468	9,900	6,187	74,866
29	19,225	25,633	16,021	10,253	6,408	77,540
30	19,888	26,517	16,573	10,607	6,629	80,213
31	20,551	27,401	17,125	10,960	6,850	82,887
32	21,213	28,285	17,678	11,314	7,071	85,561
33	21,876	29,169	17,678	11,667	7,292	87,682
34	22,539	30,052	17,678	12,021	7,513	89,804
35	23,202	30,936	17,678	12,375	7,734	91,925
36	23,865	31,820	17,678	12,728	7,955	94,046
37	24,528	32,704	17,678	13,082	8,176	96,168
38	25,191	33,588	17,678	13,435	8,397	98,289
39	25,854	33,588	17,678	13,789	8,618	99,527
40	26,517	33,588	17,678	14,142	8,839	100,764

Sub Watershed #15 Annual Phosphorous Runoff Reduction (pounds), Cropland BMPs

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Load Reduction
1	901	1,202	751	481	300	3,635
2	1,802	2,403	1,502	961	601	7,269
3	2,703	3,605	2,253	1,442	901	10,904
4	3,605	4,806	3,004	1,922	1,202	14,538
5	4,506	6,008	3,755	2,403	1,502	18,173
6	5,407	7,209	4,506	2,884	1,802	21,808
7	6,308	8,411	5,257	3,364	2,103	25,442

8	7,209	9,612	6,008	3,845	2,403	29,077
9	8,110	10,814	6,759	4,325	2,703	32,711
10	9,011	12,015	7,510	4,806	3,004	36,346
11	9,913	13,217	8,260	5,287	3,304	39,981
12	10,814	14,418	9,011	5,767	3,605	43,615
13	11,715	15,620	9,762	6,248	3,905	47,250
14	12,616	16,821	10,513	6,729	4,205	50,884
15	13,517	18,023	11,264	7,209	4,506	54,519
16	14,418	19,224	12,015	7,690	4,806	58,154
17	15,319	20,426	12,766	8,170	5,106	61,788
18	16,221	21,627	13,517	8,651	5,407	65,423
19	17,122	22,829	14,268	9,132	5,707	69,057
20	18,023	24,030	15,019	9,612	6,008	72,692
21	18,924	25,232	15,770	10,093	6,308	76,327
22	19,825	26,433	16,521	10,573	6,608	79,961
23	20,726	27,635	17,272	11,054	6,909	83,596
24	21,627	28,837	18,023	11,535	7,209	87,230
25	22,529	30,038	18,774	12,015	7,510	90,865
26	23,430	31,240	19,525	12,496	7,810	94,500
27	24,331	32,441	20,276	12,976	8,110	98,134
28	25,232	33,643	21,027	13,457	8,411	101,769
29	26,133	34,844	21,778	13,938	8,711	105,403
30	27,034	36,046	22,529	14,418	9,011	109,038
31	27,935	37,247	23,279	14,899	9,312	112,673
32	28,837	38,449	24,030	15,379	9,612	116,307
33	29,738	39,650	24,030	15,860	9,913	119,191
34	30,639	40,852	24,030	16,341	10,213	122,075
35	31,540	42,053	24,030	16,821	10,513	124,958
36	32,441	43,255	24,030	17,302	10,814	127,842
37	33,342	44,456	24,030	17,783	11,114	130,725
38	34,243	45,658	24,030	18,263	11,414	133,609
39	35,144	45,658	24,030	18,744	11,715	135,291
40	36,046	45,658	24,030	19,224	12,015	136,973

12.3.3 Costs of Implementing BMPs by Sub Basin

Table 53. Total Costs by Sub Basin.

	Sub Watershed #6 Tuttle Creek, Adjusted Annual Cost*					
Year	**Buffer**	**No-Till**	**Nutrient Mgmt**	**Waterways**	**Subsurface Fert**	**Total Annual Cost**
1	$16,102	$31,274	$22,829	$35,424	$2,189	**$107,818**
2	$16,585	$32,212	$23,514	$36,487	$2,255	$111,053

3	$17,083	$33,179	$24,219	$37,582	$2,322	$114,385
4	$17,595	$34,174	$24,945	$38,709	$2,392	$117,816
5	$18,123	$35,199	$25,694	$39,871	$2,464	$121,351
6	$18,667	$36,255	$26,465	$41,067	$2,538	$124,991
7	$19,227	$37,343	$27,259	$42,299	$2,614	$128,741
8	$19,803	$38,463	$28,076	$43,568	$2,692	$132,603
9	$20,398	$39,617	$28,919	$44,875	$2,773	$136,581
10	$21,010	$40,806	$29,786	$46,221	$2,856	$140,679
11	$21,640	$42,030	$30,680	$47,608	$2,942	$144,899
12	$22,289	$43,291	$31,600	$49,036	$3,030	$149,246
13	$22,958	$44,589	$32,548	$50,507	$3,121	$153,723
14	$23,646	$45,927	$33,525	$52,022	$3,215	$158,335
15	$24,356	$47,305	$34,530	$53,583	$3,311	$163,085
16	$25,086	$48,724	$35,566	$55,190	$3,411	$167,978
17	$25,839	$50,186	$36,633	$56,846	$3,513	$173,017
18	$26,614	$51,691	$37,732	$58,551	$3,618	$178,207
19	$27,413	$53,242	$38,864	$60,308	$3,727	$183,554
20	$28,235	$54,839	$40,030	$62,117	$3,839	$189,060
21	$29,082	$56,485	$41,231	$63,981	$3,954	$194,732
22	$29,955	$58,179	$42,468	$65,900	$4,072	$200,574
23	$30,853	$59,925	$43,742	$67,877	$4,194	$206,591
24	$31,779	$61,722	$45,054	$69,913	$4,320	$212,789
25	$32,732	$63,574	$46,406	$72,011	$4,450	$219,173
26	$33,714	$65,481	$47,798	$74,171	$4,583	$225,748
27	$34,726	$67,446	$49,232	$76,396	$4,721	$232,520
28	$35,767	$69,469	$50,709	$78,688	$4,863	$239,496
29	$36,840	$71,553	$52,230	$81,049	$5,008	$246,681
30	$37,945	$73,700	$53,797	$83,480	$5,159	$254,081
31	$39,084	$75,911	$55,411	$85,984	$5,313	$261,704
32	$40,256	$78,188	$57,073	$88,564	$5,473	$269,555
33	$41,464	$80,534		$91,221	$5,637	$277,641
34	$42,708	$82,950		$93,958	$5,806	$285,971
35	$43,989	$85,438		$96,776	$5,980	$294,550
36	$45,309	$88,001		$99,680	$6,160	$303,386
37	$46,668	$90,641		$102,670	$6,345	$312,488
38	$48,068	$93,360		$105,750	$6,535	$321,862
39	$49,510			$108,923	$6,731	$331,518
40	$50,996			$112,190	$6,933	$341,464

3% Annual Cost Inflation

Sub Watershed #9 Tuttle Creek, Adjusted Annual Cost*

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Annual Cost
1	$41,940	$81,458	$59,460	$92,267	$5,702	**$280,827**
2	$43,198	$83,901	$61,244	$95,036	$5,873	$289,251
3	$44,494	$86,418	$63,081	$97,887	$6,049	$297,929
4	$45,829	$89,011	$64,974	$100,823	$6,230	$306,867
5	$47,204	$91,681	$66,923	$103,848	$6,417	$316,073
6	$48,620	$94,432	$68,931	$106,963	$6,610	$325,555
7	$50,078	$97,265	$70,998	$110,172	$6,808	$335,322
8	$51,581	$100,182	$73,128	$113,477	$7,012	$345,381
9	$53,128	$103,188	$75,322	$116,882	$7,223	$355,743
10	$54,722	$106,284	$77,582	$120,388	$7,439	$366,415
11	$56,364	$109,472	$79,909	$124,000	$7,663	$377,407
12	$58,054	$112,756	$82,307	$127,720	$7,893	$388,730
13	$59,796	$116,139	$84,776	$131,551	$8,129	$400,392
14	$61,590	$119,623	$87,319	$135,498	$8,373	$412,403
15	$63,438	$123,212	$89,939	$139,563	$8,624	$424,775
16	$65,341	$126,908	$92,637	$143,750	$8,883	$437,519
17	$67,301	$130,715	$95,416	$148,062	$9,150	$450,644
18	$69,320	$134,637	$98,278	$152,504	$9,424	$464,164
19	$71,400	$138,676	$101,227	$157,079	$9,707	$478,088
20	$73,542	$142,836	$104,264	$161,792	$9,998	$492,431
21	$75,748	$147,121	$107,392	$166,645	$10,298	$507,204
22	$78,020	$151,535	$110,613	$171,645	$10,607	$522,420
23	$80,361	$156,081	$113,932	$176,794	$10,925	$538,093
24	$82,772	$160,763	$117,350	$182,098	$11,253	$554,236
25	$85,255	$165,586	$120,870	$187,561	$11,590	$570,863
26	$87,813	$170,554	$124,496	$193,188	$11,938	$587,988
27	$90,447	$175,671	$128,231	$198,983	$12,296	$605,628
28	$93,160	$180,941	$132,078	$204,953	$12,665	$623,797
29	$95,955	$186,369	$136,040	$211,101	$13,045	$642,511
30	$98,834	$191,960	$140,122	$217,434	$13,436	$661,786
31	$101,799	$197,719	$144,325	$223,957	$13,840	$681,640
32	$104,853	$203,650	$148,655	$230,676	$14,255	$702,089
33	$107,998	$209,760		$237,596	$14,682	$723,152
34	$111,238	$216,053		$244,724	$15,123	$744,846
35	$114,575	$222,534		$252,066	$15,577	$767,192
36	$118,013	$229,210		$259,628	$16,044	$790,207
37	$121,553	$236,087		$267,417	$16,525	$813,914
38	$125,200	$243,169		$275,439	$17,021	$838,331
39	$128,956			$283,703	$17,532	$863,481
40	$132,824			$292,214	$18,057	$889,385

3% Annual Cost Inflation

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Annual Cost
	Sub Watershed #8 Tuttle Creek, Adjusted Annual Cost*					
1	$25,119	$48,787	$35,612	$55,262	$3,415	**$168,195**
2	$25,872	$50,251	$36,681	$56,919	$3,517	$173,241
3	$26,649	$51,758	$37,781	$58,627	$3,623	$178,438
4	$27,448	$53,311	$38,915	$60,386	$3,732	$183,791
5	$28,272	$54,910	$40,082	$62,197	$3,844	$189,305
6	$29,120	$56,558	$41,284	$64,063	$3,959	$194,984
7	$29,993	$58,255	$42,523	$65,985	$4,078	$200,834
8	$30,893	$60,002	$43,799	$67,965	$4,200	$206,859
9	$31,820	$61,802	$45,113	$70,004	$4,326	$213,064
10	$32,775	$63,656	$46,466	$72,104	$4,456	$219,456
11	$33,758	$65,566	$47,860	$74,267	$4,589	$226,040
12	$34,770	$67,533	$49,296	$76,495	$4,727	$232,821
13	$35,814	$69,559	$50,775	$78,790	$4,869	$239,806
14	$36,888	$71,646	$52,298	$81,154	$5,015	$247,000
15	$37,995	$73,795	$53,867	$83,588	$5,165	$254,410
16	$39,134	$76,009	$55,483	$86,096	$5,320	$262,042
17	$40,309	$78,289	$57,147	$88,679	$5,480	$269,904
18	$41,518	$80,638	$58,862	$91,339	$5,644	$278,001
19	$42,763	$83,057	$60,628	$94,079	$5,814	$286,341
20	$44,046	$85,549	$62,446	$96,902	$5,988	$294,931
21	$45,368	$88,115	$64,320	$99,809	$6,168	$303,779
22	$46,729	$90,759	$66,249	$102,803	$6,353	$312,892
23	$48,130	$93,481	$68,237	$105,887	$6,543	$322,279
24	$49,574	$96,286	$70,284	$109,064	$6,740	$331,948
25	$51,062	$99,174	$72,393	$112,336	$6,942	$341,906
26	$52,593	$102,150	$74,564	$115,706	$7,150	$352,163
27	$54,171	$105,214	$76,801	$119,177	$7,365	$362,728
28	$55,796	$108,371	$79,105	$122,752	$7,586	$373,610
29	$57,470	$111,622	$81,479	$126,435	$7,813	$384,818
30	$59,194	$114,970	$83,923	$130,228	$8,047	$396,363
31	$60,970	$118,419	$86,441	$134,135	$8,289	$408,254
32	$62,799	$121,972	$89,034	$138,159	$8,538	$420,501
33	$64,683	$125,631		$142,303	$8,794	$433,116
34	$66,624	$129,400		$146,572	$9,058	$446,110
35	$68,623	$133,282		$150,970	$9,329	$459,493

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Annual Cost
36	$70,681	$137,281		$155,499	$9,609	$473,278
37	$72,802	$141,399		$160,164	$9,897	$487,476
38	$74,986	$145,641		$164,969	$10,194	$502,100
39	$77,235			$169,918	$10,500	$517,163
40	$79,552			$175,015	$10,815	$532,678

3% Annual Cost Inflation

	Sub Watershed #26 Tuttle Creek, Adjusted Annual Cost*					
Year	**Buffer**	**No-Till**	**Nutrient Mgmt**	**Waterways**	**Subsurface Fert**	**Total Annual Cost**
1	$12,919	$25,091	$18,315	$28,421	$1,756	**$86,503**
2	$13,306	$25,844	$18,865	$29,274	$1,809	$89,098
3	$13,705	$26,619	$19,431	$30,152	$1,863	$91,771
4	$14,117	$27,418	$20,014	$31,056	$1,919	$94,524
5	$14,540	$28,240	$20,614	$31,988	$1,977	$97,360
6	$14,976	$29,088	$21,233	$32,948	$2,036	$100,280
7	$15,426	$29,960	$21,870	$33,936	$2,097	$103,289
8	$15,888	$30,859	$22,526	$34,954	$2,160	$106,387
9	$16,365	$31,785	$23,201	$36,003	$2,225	$109,579
10	$16,856	$32,738	$23,897	$37,083	$2,292	$112,866
11	$17,362	$33,721	$24,614	$38,196	$2,360	$116,252
12	$17,882	$34,732	$25,353	$39,341	$2,431	$119,740
13	$18,419	$35,774	$26,113	$40,522	$2,504	$123,332
14	$18,971	$36,847	$26,897	$41,737	$2,579	$127,032
15	$19,541	$37,953	$27,704	$42,989	$2,657	$130,843
16	$20,127	$39,091	$28,535	$44,279	$2,736	$134,768
17	$20,731	$40,264	$29,391	$45,607	$2,818	$138,811
18	$21,353	$41,472	$30,273	$46,976	$2,903	$142,976
19	$21,993	$42,716	$31,181	$48,385	$2,990	$147,265
20	$22,653	$43,998	$32,116	$49,836	$3,080	$151,683
21	$23,333	$45,318	$33,080	$51,332	$3,172	$156,233
22	$24,033	$46,677	$34,072	$52,872	$3,267	$160,920
23	$24,753	$48,077	$35,094	$54,458	$3,365	$165,748
24	$25,496	$49,520	$36,147	$56,091	$3,466	$170,720
25	$26,261	$51,005	$37,231	$57,774	$3,570	$175,842
26	$27,049	$52,536	$38,348	$59,507	$3,677	$181,117
27	$27,860	$54,112	$39,499	$61,293	$3,788	$186,551
28	$28,696	$55,735	$40,684	$63,131	$3,901	$192,147
29	$29,557	$57,407	$41,904	$65,025	$4,018	$197,912
30	$30,444	$59,129	$43,161	$66,976	$4,139	$203,849

31	$31,357	$60,903	$44,456	$68,985	$4,263	$209,965
32	$32,298	$62,730	$45,790	$71,055	$4,391	$216,264
33	$33,267	$64,612		$73,187	$4,523	$222,752
34	$34,265	$66,550		$75,382	$4,658	$229,434
35	$35,293	$68,547		$77,644	$4,798	$236,317
36	$36,351	$70,603		$79,973	$4,942	$243,407
37	$37,442	$72,721		$82,372	$5,090	$250,709
38	$38,565	$74,903		$84,843	$5,243	$258,230
39	$39,722			$87,389	$5,400	$265,977
40	$40,914			$90,010	$5,562	$273,956

3% Annual Cost Inflation

	Sub Watershed #28 Tuttle Creek, Adjusted Annual Cost*					
Year	**Buffer**	**No-Till**	**Nutrient Mgmt**	**Waterways**	**Subsurface Fert**	**Total Annual Cost**
1	$38,430	$74,641	$54,484	$84,546	$5,225	**$257,327**
2	$39,583	$76,880	$56,119	$87,083	$5,381	$265,046
3	$40,771	$79,187	$57,803	$89,695	$5,543	$272,998
4	$41,994	$81,562	$59,537	$92,386	$5,709	$281,188
5	$43,254	$84,009	$61,323	$95,158	$5,880	$289,623
6	$44,551	$86,529	$63,162	$98,012	$6,057	$298,312
7	$45,888	$89,125	$65,057	$100,953	$6,238	$307,261
8	$47,264	$91,799	$67,009	$103,981	$6,426	$316,479
9	$48,682	$94,553	$69,019	$107,101	$6,618	$325,974
10	$50,143	$97,390	$71,090	$110,314	$6,817	$335,753
11	$51,647	$100,311	$73,222	$113,623	$7,021	$345,825
12	$53,196	$103,321	$75,419	$117,032	$7,232	$356,200
13	$54,792	$106,420	$77,682	$120,543	$7,449	$366,886
14	$56,436	$109,613	$80,012	$124,159	$7,672	$377,893
15	$58,129	$112,901	$82,413	$127,884	$7,903	$389,230
16	$59,873	$116,288	$84,885	$131,721	$8,140	$400,907
17	$61,669	$119,777	$87,431	$135,672	$8,384	$412,934
18	$63,519	$123,370	$90,054	$139,742	$8,635	$425,322
19	$65,425	$127,071	$92,756	$143,935	$8,895	$438,081
20	$67,388	$130,884	$95,539	$148,253	$9,161	$451,224
21	$69,409	$134,810	$98,405	$152,700	$9,436	$464,761
22	$71,491	$138,854	$101,357	$157,281	$9,719	$478,703
23	$73,636	$143,020	$104,398	$162,000	$10,011	$493,064
24	$75,845	$147,311	$107,530	$166,860	$10,311	$507,856
25	$78,121	$151,730	$110,756	$171,865	$10,621	$523,092

26	$80,464	$156,282	$114,078	$177,021	$10,939	$538,785
27	$82,878	$160,970	$117,501	$182,332	$11,267	$554,948
28	$85,365	$165,799	$121,026	$187,802	$11,605	$571,597
29	$87,925	$170,773	$124,656	$193,436	$11,953	$588,745
30	$90,563	$175,897	$128,396	$199,239	$12,312	$606,407
31	$93,280	$181,173	$132,248	$205,216	$12,681	$624,599
32	$96,079	$186,609	$136,215	$211,373	$13,062	$643,337
33	$98,961	$192,207		$217,714	$13,454	$662,637
34	$101,930	$197,973		$224,245	$13,857	$682,517
35	$104,988	$203,912		$230,973	$14,273	$702,992
36	$108,137	$210,030		$237,902	$14,701	$724,082
37	$111,381	$216,331		$245,039	$15,142	$745,804
38	$114,723	$222,820		$252,390	$15,597	$768,178
39	$118,165			$259,962	$16,064	$791,224
40	$121,709			$267,761	$16,546	$814,960

3% Annual Cost Inflation

Sub Watershed #15 Tuttle Creek, Adjusted Annual Cost*

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Annual Cost
1	$48,061	$93,346	$68,138	$105,734	$6,534	**$321,813**
2	$49,503	$96,147	$70,182	$108,906	$6,730	$331,467
3	$50,988	$99,031	$72,288	$112,173	$6,932	$341,411
4	$52,517	$102,002	$74,457	$115,538	$7,140	$351,654
5	$54,093	$105,062	$76,690	$119,004	$7,354	$362,203
6	$55,716	$108,214	$78,991	$122,575	$7,575	$373,069
7	$57,387	$111,460	$81,361	$126,252	$7,802	$384,262
8	$59,109	$114,804	$83,801	$130,039	$8,036	$395,789
9	$60,882	$118,248	$86,316	$133,940	$8,277	$407,663
10	$62,709	$121,796	$88,905	$137,959	$8,525	$419,893
11	$64,590	$125,449	$91,572	$142,097	$8,781	$432,490
12	$66,527	$129,213	$94,319	$146,360	$9,044	$445,464
13	$68,523	$133,089	$97,149	$150,751	$9,316	$458,828
14	$70,579	$137,082	$100,063	$155,274	$9,595	$472,593
15	$72,696	$141,194	$103,065	$159,932	$9,883	$486,771
16	$74,877	$145,430	$106,157	$164,730	$10,180	$501,374
17	$77,124	$149,793	$109,342	$169,672	$10,485	$516,415
18	$79,437	$154,287	$112,622	$174,762	$10,799	$531,908
19	$81,820	$158,916	$116,001	$180,005	$11,123	$547,865
20	$84,275	$163,683	$119,481	$185,405	$11,457	$564,301

21	$86,803	$168,594	$123,065	$190,967	$11,801	$581,230
22	$89,407	$173,651	$126,757	$196,696	$12,155	$598,667
23	$92,090	$178,861	$130,560	$202,597	$12,520	$616,627
24	$94,852	$184,227	$134,477	$208,675	$12,895	$635,126
25	$97,698	$189,754	$138,511	$214,935	$13,282	$654,180
26	$100,629	$195,446	$142,666	$221,383	$13,680	$673,805
27	$103,648	$201,310	$146,946	$228,025	$14,091	$694,019
28	$106,757	$207,349	$151,355	$234,865	$14,514	$714,840
29	$109,960	$213,569	$155,895	$241,911	$14,949	$736,285
30	$113,259	$219,976	$160,572	$249,169	$15,397	$758,373
31	$116,656	$226,576	$165,389	$256,644	$15,859	$781,125
32	$120,156	$233,373	$170,351	$264,343	$16,335	$804,558
33	$123,761	$240,374		$272,273	$16,825	$828,695
34	$127,473	$247,585		$280,442	$17,330	$853,556
35	$131,298	$255,013		$288,855	$17,850	$879,163
36	$135,237	$262,663		$297,521	$18,385	$905,538
37	$139,294	$270,543		$306,446	$18,937	$932,704
38	$143,473	$278,659		$315,640	$19,505	$960,685
39	$147,777			$325,109	$20,090	$989,505
40	$152,210			$334,862	$20,693	$1,019,191

Sub Watershed #6 Tuttle Creek, Annual Cost Adjusted for Cost-Share

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Annual Cost
1	$1,610	$19,077	$11,414	$17,712	$2,189	**$52,003**
2	$1,659	$19,650	$11,757	$18,244	$2,255	**$53,563**
3	$1,708	$20,239	$12,109	$18,791	$2,322	**$55,170**
4	$1,760	$20,846	$12,473	$19,355	$2,392	**$56,825**
5	$1,812	$21,472	$12,847	$19,935	$2,464	**$58,530**
6	$1,867	$22,116	$13,232	$20,533	$2,538	**$60,286**
7	$1,923	$22,779	$13,629	$21,149	$2,614	**$62,094**
8	$1,980	$23,463	$14,038	$21,784	$2,692	**$63,957**
9	$2,040	$24,166	$14,459	$22,437	$2,773	**$65,876**
10	$2,101	$24,891	$14,893	$23,110	$2,856	**$67,852**
11	$2,164	$25,638	$15,340	$23,804	$2,942	**$69,888**
12	$2,229	$26,407	$15,800	$24,518	$3,030	**$71,984**
13	$2,296	$27,200	$16,274	$25,253	$3,121	**$74,144**
14	$2,365	$28,016	$16,762	$26,011	$3,215	**$76,368**
15	$2,436	$28,856	$17,265	$26,791	$3,311	**$78,659**
16	$2,509	$29,722	$17,783	$27,595	$3,411	**$81,019**
17	$2,584	$30,613	$18,317	$28,423	$3,513	**$83,450**
18	$2,661	$31,532	$18,866	$29,276	$3,618	**$85,953**
19	$2,741	$32,478	$19,432	$30,154	$3,727	**$88,532**

20	$2,824	$33,452	$20,015	$31,059	$3,839	**$91,188**
21	$2,908	$34,456	$20,616	$31,990	$3,954	**$93,923**
22	$2,995	$35,489	$21,234	$32,950	$4,072	**$96,741**
23	$3,085	$36,554	$21,871	$33,938	$4,194	**$99,643**
24	$3,178	$37,651	$22,527	$34,957	$4,320	**$102,633**
25	$3,273	$38,780	$23,203	$36,005	$4,450	**$105,712**
26	$3,371	$39,944	$23,899	$37,085	$4,583	**$108,883**
27	$3,473	$41,142	$24,616	$38,198	$4,721	**$112,149**
28	$3,577	$42,376	$25,355	$39,344	$4,863	**$115,514**
29	$3,684	$43,647	$26,115	$40,524	$5,008	**$118,979**
30	$3,795	$44,957	$26,899	$41,740	$5,159	**$122,549**
31	$3,908	$46,305	$27,706	$42,992	$5,313	**$126,225**
32	$4,026	$47,695	$28,537	$44,282	$5,473	**$130,012**
33	$4,146	$49,125	$0	$45,610	$5,637	**$104,519**
34	$4,271	$50,599	$0	$46,979	$5,806	**$107,655**
35	$4,399	$52,117	$0	$48,388	$5,980	**$110,885**
36	$4,531	$53,681	$0	$49,840	$6,160	**$114,211**
37	$4,667	$55,291	$0	$51,335	$6,345	**$117,638**
38	$4,807	$56,950	$0	$52,875	$6,535	**$121,167**
39	$4,951	$0	$0	$54,461	$6,731	**$66,143**
40	$5,100	$0	$0	$56,095	$6,933	**$68,128**

3% Annual Cost Inflation

Sub Watershed #9 Tuttle Creek, Annual Cost Adjusted for Cost-Share

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Annual Cost
1	$4,194	$49,689	$29,730	$46,134	$5,702	**$135,449**
2	$4,320	$51,180	$30,622	$47,518	$5,873	**$139,512**
3	$4,449	$52,715	$31,541	$48,943	$6,049	**$143,697**
4	$4,583	$54,297	$32,487	$50,412	$6,230	**$148,008**
5	$4,720	$55,925	$33,461	$51,924	$6,417	**$152,449**
6	$4,862	$57,603	$34,465	$53,482	$6,610	**$157,022**
7	$5,008	$59,331	$35,499	$55,086	$6,808	**$161,733**
8	$5,158	$61,111	$36,564	$56,739	$7,012	**$166,585**
9	$5,313	$62,945	$37,661	$58,441	$7,223	**$171,582**
10	$5,472	$64,833	$38,791	$60,194	$7,439	**$176,730**
11	$5,636	$66,778	$39,955	$62,000	$7,663	**$182,032**
12	$5,805	$68,781	$41,153	$63,860	$7,893	**$187,492**
13	$5,980	$70,845	$42,388	$65,776	$8,129	**$193,117**
14	$6,159	$72,970	$43,660	$67,749	$8,373	**$198,911**

15	$6,344	$75,159	$44,969	$69,781	$8,624	**$204,878**
16	$6,534	$77,414	$46,318	$71,875	$8,883	**$211,024**
17	$6,730	$79,736	$47,708	$74,031	$9,150	**$217,355**
18	$6,932	$82,128	$49,139	$76,252	$9,424	**$223,876**
19	$7,140	$84,592	$50,613	$78,540	$9,707	**$230,592**
20	$7,354	$87,130	$52,132	$80,896	$9,998	**$237,510**
21	$7,575	$89,744	$53,696	$83,323	$10,298	**$244,635**
22	$7,802	$92,436	$55,307	$85,822	$10,607	**$251,974**
23	$8,036	$95,209	$56,966	$88,397	$10,925	**$259,533**
24	$8,277	$98,066	$58,675	$91,049	$11,253	**$267,319**
25	$8,525	$101,008	$60,435	$93,780	$11,590	**$275,339**
26	$8,781	$104,038	$62,248	$96,594	$11,938	**$283,599**
27	$9,045	$107,159	$64,116	$99,492	$12,296	**$292,107**
28	$9,316	$110,374	$66,039	$102,476	$12,665	**$300,870**
29	$9,596	$113,685	$68,020	$105,551	$13,045	**$309,897**
30	$9,883	$117,096	$70,061	$108,717	$13,436	**$319,193**
31	$10,180	$120,608	$72,163	$111,979	$13,840	**$328,769**
32	$10,485	$124,227	$74,328	$115,338	$14,255	**$338,632**
33	$10,800	$127,953	$0	$118,798	$14,682	**$272,234**
34	$11,124	$131,792	$0	$122,362	$15,123	**$280,401**
35	$11,458	$135,746	$0	$126,033	$15,577	**$288,813**
36	$11,801	$139,818	$0	$129,814	$16,044	**$297,477**
37	$12,155	$144,013	$0	$133,708	$16,525	**$306,402**
38	$12,520	$148,333	$0	$137,720	$17,021	**$315,594**
39	$12,896	$0	$0	$141,851	$17,532	**$172,278**
40	$13,282	$0	$0	$146,107	$18,057	**$177,447**

3% Annual Cost Inflation

Sub Watershed #8 Tuttle Creek, Annual Cost Adjusted for Cost-Share

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Annual Cost
1	$2,512	$29,760	$17,806	$27,631	$3,415	**$81,124**
2	$2,587	$30,653	$18,340	$28,460	$3,517	**$83,558**
3	$2,665	$31,573	$18,891	$29,314	$3,623	**$86,064**
4	$2,745	$32,520	$19,457	$30,193	$3,732	**$88,646**
5	$2,827	$33,495	$20,041	$31,099	$3,844	**$91,306**
6	$2,912	$34,500	$20,642	$32,032	$3,959	**$94,045**
7	$2,999	$35,535	$21,262	$32,993	$4,078	**$96,866**
8	$3,089	$36,601	$21,899	$33,982	$4,200	**$99,772**
9	$3,182	$37,699	$22,556	$35,002	$4,326	**$102,765**

10	$3,277	$38,830	$23,233	$36,052	$4,456	**$105,848**
11	$3,376	$39,995	$23,930	$37,134	$4,589	**$109,024**
12	$3,477	$41,195	$24,648	$38,248	$4,727	**$112,295**
13	$3,581	$42,431	$25,387	$39,395	$4,869	**$115,663**
14	$3,689	$43,704	$26,149	$40,577	$5,015	**$119,133**
15	$3,799	$45,015	$26,933	$41,794	$5,165	**$122,707**
16	$3,913	$46,365	$27,741	$43,048	$5,320	**$126,389**
17	$4,031	$47,756	$28,574	$44,339	$5,480	**$130,180**
18	$4,152	$49,189	$29,431	$45,670	$5,644	**$134,086**
19	$4,276	$50,665	$30,314	$47,040	$5,814	**$138,108**
20	$4,405	$52,185	$31,223	$48,451	$5,988	**$142,251**
21	$4,537	$53,750	$32,160	$49,904	$6,168	**$146,519**
22	$4,673	$55,363	$33,125	$51,401	$6,353	**$150,915**
23	$4,813	$57,024	$34,118	$52,944	$6,543	**$155,442**
24	$4,957	$58,734	$35,142	$54,532	$6,740	**$160,105**
25	$5,106	$60,496	$36,196	$56,168	$6,942	**$164,908**
26	$5,259	$62,311	$37,282	$57,853	$7,150	**$169,856**
27	$5,417	$64,181	$38,401	$59,588	$7,365	**$174,951**
28	$5,580	$66,106	$39,553	$61,376	$7,586	**$180,200**
29	$5,747	$68,089	$40,739	$63,217	$7,813	**$185,606**
30	$5,919	$70,132	$41,961	$65,114	$8,047	**$191,174**
31	$6,097	$72,236	$43,220	$67,067	$8,289	**$196,909**
32	$6,280	$74,403	$44,517	$69,079	$8,538	**$202,817**
33	$6,468	$76,635	$0	$71,152	$8,794	**$163,049**
34	$6,662	$78,934	$0	$73,286	$9,058	**$167,940**
35	$6,862	$81,302	$0	$75,485	$9,329	**$172,978**
36	$7,068	$83,741	$0	$77,749	$9,609	**$178,168**
37	$7,280	$86,253	$0	$80,082	$9,897	**$183,513**
38	$7,499	$88,841	$0	$82,484	$10,194	**$189,018**
39	$7,724	$0	$0	$84,959	$10,500	**$103,182**
40	$7,955	$0	$0	$87,508	$10,815	**$106,278**

3% Annual Cost Inflation

Sub Watershed #26 Tuttle Creek, Annual Cost Adjusted for Cost-Share

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Annual Cost
1	$1,292	$15,306	$9,158	$14,211	$1,756	**$41,722**
2	$1,331	$15,765	$9,432	$14,637	$1,809	**$42,974**
3	$1,371	$16,238	$9,715	$15,076	$1,863	**$44,263**
4	$1,412	$16,725	$10,007	$15,528	$1,919	**$45,591**

5	$1,454	$17,227	$10,307	$15,994	$1,977	**$46,959**
6	$1,498	$17,743	$10,616	$16,474	$2,036	**$48,367**
7	$1,543	$18,276	$10,935	$16,968	$2,097	**$49,818**
8	$1,589	$18,824	$11,263	$17,477	$2,160	**$51,313**
9	$1,636	$19,389	$11,601	$18,001	$2,225	**$52,852**
10	$1,686	$19,970	$11,949	$18,542	$2,292	**$54,438**
11	$1,736	$20,570	$12,307	$19,098	$2,360	**$56,071**
12	$1,788	$21,187	$12,676	$19,671	$2,431	**$57,753**
13	$1,842	$21,822	$13,057	$20,261	$2,504	**$59,486**
14	$1,897	$22,477	$13,448	$20,869	$2,579	**$61,270**
15	$1,954	$23,151	$13,852	$21,495	$2,657	**$63,108**
16	$2,013	$23,846	$14,267	$22,140	$2,736	**$65,002**
17	$2,073	$24,561	$14,695	$22,804	$2,818	**$66,952**
18	$2,135	$25,298	$15,136	$23,488	$2,903	**$68,960**
19	$2,199	$26,057	$15,590	$24,192	$2,990	**$71,029**
20	$2,265	$26,839	$16,058	$24,918	$3,080	**$73,160**
21	$2,333	$27,644	$16,540	$25,666	$3,172	**$75,355**
22	$2,403	$28,473	$17,036	$26,436	$3,267	**$77,615**
23	$2,475	$29,327	$17,547	$27,229	$3,365	**$79,944**
24	$2,550	$30,207	$18,074	$28,046	$3,466	**$82,342**
25	$2,626	$31,113	$18,616	$28,887	$3,570	**$84,812**
26	$2,705	$32,047	$19,174	$29,754	$3,677	**$87,357**
27	$2,786	$33,008	$19,749	$30,646	$3,788	**$89,977**
28	$2,870	$33,998	$20,342	$31,566	$3,901	**$92,677**
29	$2,956	$35,018	$20,952	$32,513	$4,018	**$95,457**
30	$3,044	$36,069	$21,581	$33,488	$4,139	**$98,321**
31	$3,136	$37,151	$22,228	$34,493	$4,263	**$101,270**
32	$3,230	$38,265	$22,895	$35,527	$4,391	**$104,308**
33	$3,327	$39,413	$0	$36,593	$4,523	**$83,856**
34	$3,426	$40,596	$0	$37,691	$4,658	**$86,372**
35	$3,529	$41,814	$0	$38,822	$4,798	**$88,963**
36	$3,635	$43,068	$0	$39,986	$4,942	**$91,632**
37	$3,744	$44,360	$0	$41,186	$5,090	**$94,381**
38	$3,857	$45,691	$0	$42,422	$5,243	**$97,212**
39	$3,972	$0	$0	$43,694	$5,400	**$53,067**
40	$4,091	$0	$0	$45,005	$5,562	**$54,659**

3% Annual Cost Inflation

Sub Watershed #28 Tuttle Creek, Annual Cost Adjusted for Cost-Share

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface	Total Annual

					Fert	Cost
1	$3,843	$45,531	$27,242	$42,273	$5,225	**$124,114**
2	$3,958	$46,897	$28,059	$43,541	$5,381	**$127,837**
3	$4,077	$48,304	$28,901	$44,848	$5,543	**$131,673**
4	$4,199	$49,753	$29,768	$46,193	$5,709	**$135,623**
5	$4,325	$51,246	$30,661	$47,579	$5,880	**$139,691**
6	$4,455	$52,783	$31,581	$49,006	$6,057	**$143,882**
7	$4,589	$54,366	$32,529	$50,476	$6,238	**$148,199**
8	$4,726	$55,997	$33,504	$51,991	$6,426	**$152,645**
9	$4,868	$57,677	$34,510	$53,550	$6,618	**$157,224**
10	$5,014	$59,408	$35,545	$55,157	$6,817	**$161,941**
11	$5,165	$61,190	$36,611	$56,812	$7,021	**$166,799**
12	$5,320	$63,026	$37,710	$58,516	$7,232	**$171,803**
13	$5,479	$64,916	$38,841	$60,271	$7,449	**$176,957**
14	$5,644	$66,864	$40,006	$62,080	$7,672	**$182,266**
15	$5,813	$68,870	$41,206	$63,942	$7,903	**$187,734**
16	$5,987	$70,936	$42,442	$65,860	$8,140	**$193,366**
17	$6,167	$73,064	$43,716	$67,836	$8,384	**$199,167**
18	$6,352	$75,256	$45,027	$69,871	$8,635	**$205,142**
19	$6,542	$77,514	$46,378	$71,967	$8,895	**$211,296**
20	$6,739	$79,839	$47,769	$74,126	$9,161	**$217,635**
21	$6,941	$82,234	$49,202	$76,350	$9,436	**$224,164**
22	$7,149	$84,701	$50,679	$78,641	$9,719	**$230,889**
23	$7,364	$87,242	$52,199	$81,000	$10,011	**$237,815**
24	$7,585	$89,859	$53,765	$83,430	$10,311	**$244,950**
25	$7,812	$92,555	$55,378	$85,933	$10,621	**$252,298**
26	$8,046	$95,332	$57,039	$88,511	$10,939	**$259,867**
27	$8,288	$98,192	$58,750	$91,166	$11,267	**$267,663**
28	$8,536	$101,138	$60,513	$93,901	$11,605	**$275,693**
29	$8,793	$104,172	$62,328	$96,718	$11,953	**$283,964**
30	$9,056	$107,297	$64,198	$99,620	$12,312	**$292,483**
31	$9,328	$110,516	$66,124	$102,608	$12,681	**$301,257**
32	$9,608	$113,831	$68,108	$105,686	$13,062	**$310,295**
33	$9,896	$117,246	$0	$108,857	$13,454	**$249,453**
34	$10,193	$120,764	$0	$112,123	$13,857	**$256,937**
35	$10,499	$124,386	$0	$115,486	$14,273	**$264,645**
36	$10,814	$128,118	$0	$118,951	$14,701	**$272,584**
37	$11,138	$131,962	$0	$122,520	$15,142	**$280,762**
38	$11,472	$135,920	$0	$126,195	$15,597	**$289,184**
39	$11,816	$0	$0	$129,981	$16,064	**$157,862**
40	$12,171	$0	$0	$133,880	$16,546	**$162,598**

3% Annual Cost Inflation

Sub Watershed #15 Tuttle Creek, Annual Cost Adjusted for Cost-Share

Year	Buffer	No-Till	Nutrient Mgmt	Waterways	Subsurface Fert	Total Annual Cost
1	$4,806	$56,941	$34,069	$52,867	$6,534	**$155,217**
2	$4,950	$58,649	$35,091	$54,453	$6,730	**$159,874**
3	$5,099	$60,409	$36,144	$56,087	$6,932	**$164,670**
4	$5,252	$62,221	$37,228	$57,769	$7,140	**$169,610**
5	$5,409	$64,088	$38,345	$59,502	$7,354	**$174,698**
6	$5,572	$66,010	$39,495	$61,287	$7,575	**$179,939**
7	$5,739	$67,991	$40,680	$63,126	$7,802	**$185,337**
8	$5,911	$70,030	$41,901	$65,020	$8,036	**$190,898**
9	$6,088	$72,131	$43,158	$66,970	$8,277	**$196,624**
10	$6,271	$74,295	$44,452	$68,979	$8,525	**$202,523**
11	$6,459	$76,524	$45,786	$71,049	$8,781	**$208,599**
12	$6,653	$78,820	$47,160	$73,180	$9,044	**$214,857**
13	$6,852	$81,184	$48,574	$75,376	$9,316	**$221,303**
14	$7,058	$83,620	$50,032	$77,637	$9,595	**$227,942**
15	$7,270	$86,129	$51,533	$79,966	$9,883	**$234,780**
16	$7,488	$88,712	$53,079	$82,365	$10,180	**$241,823**
17	$7,712	$91,374	$54,671	$84,836	$10,485	**$249,078**
18	$7,944	$94,115	$56,311	$87,381	$10,799	**$256,550**
19	$8,182	$96,939	$58,000	$90,002	$11,123	**$264,247**
20	$8,427	$99,847	$59,740	$92,702	$11,457	**$272,174**
21	$8,680	$102,842	$61,533	$95,484	$11,801	**$280,340**
22	$8,941	$105,927	$63,379	$98,348	$12,155	**$288,750**
23	$9,209	$109,105	$65,280	$101,299	$12,520	**$297,412**
24	$9,485	$112,378	$67,238	$104,337	$12,895	**$306,335**
25	$9,770	$115,750	$69,256	$107,468	$13,282	**$315,525**
26	$10,063	$119,222	$71,333	$110,692	$13,680	**$324,990**
27	$10,365	$122,799	$73,473	$114,012	$14,091	**$334,740**
28	$10,676	$126,483	$75,677	$117,433	$14,514	**$344,782**
29	$10,996	$130,277	$77,948	$120,956	$14,949	**$355,126**
30	$11,326	$134,186	$80,286	$124,584	$15,397	**$365,779**
31	$11,666	$138,211	$82,695	$128,322	$15,859	**$376,753**
32	$12,016	$142,357	$85,176	$132,172	$16,335	**$388,055**
33	$12,376	$146,628	$0	$136,137	$16,825	**$311,966**
34	$12,747	$151,027	$0	$140,221	$17,330	**$321,325**
35	$13,130	$155,558	$0	$144,427	$17,850	**$330,965**
36	$13,524	$160,225	$0	$148,760	$18,385	**$340,894**
37	$13,929	$165,031	$0	$153,223	$18,937	**$351,121**

38	$14,347	$169,982	$0	$157,820	$19,505	**$361,654**
39	$14,778	$0	$0	$162,554	$20,090	**$197,422**
40	$15,221	$0	$0	$167,431	$20,693	**$203,345**

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