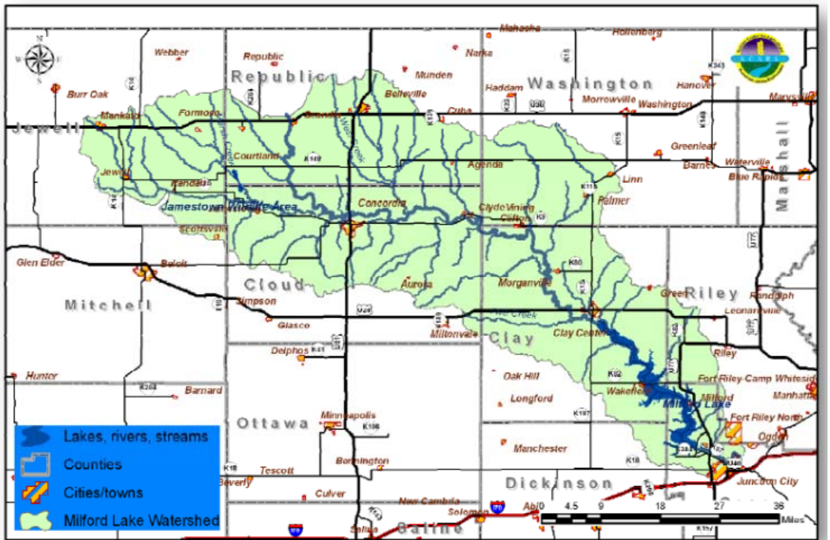
Milford Reservoir – Lower Republican Watershed

9 Element Watershed Plan Overview

Impairments to be addressed



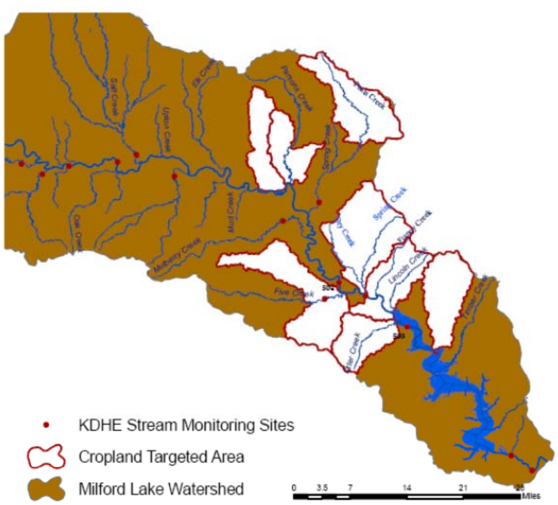
Directly addressing High and Low Priority TMDLs for:

- Bacteria – Salt Creek near Hollis (High)
- Dissolved Oxygen – Salt Creek near Hollis (High)
- Eutrophication – Belleville City Lake (Low)

Directly addressing 303d listed impairments for:

- Total Phosphorus –Buffalo Creek near Concordia
- Total Phosphorus – Mulberry Creek near Clifton
- Total Phosphorus – Peats Creek near Clifton
- Total Suspended Solids – Republican River near Clay Center (Station 504)
- Total Suspended Solids – Republican River near Clay Center (Station 503)
- Total Suspended Solids – Salt Creek near Hollis

Additionally, Milford Reservoir WRAPS has a 30% phosphorus and TSS reduction goal.



Targeting Determinations

- Cropland BMP Targeted areas were identified through SWAT (Soil and Water Assessment Tool) modeling to determine areas of high overland runoff contributing sediment and nutrients to the watershed and Milford Reservoir.

- Livestock BMP Targeted areas were identified through analysis of grazing density in the watershed and correlation with SWAT identified areas for high phosphorus runoff potential and the locations of existing bacteria impairments.

- Streambank Targeted areas were identified through GIS analyses of the main stem of the Republican River targeting riparian areas that were considered "barren".

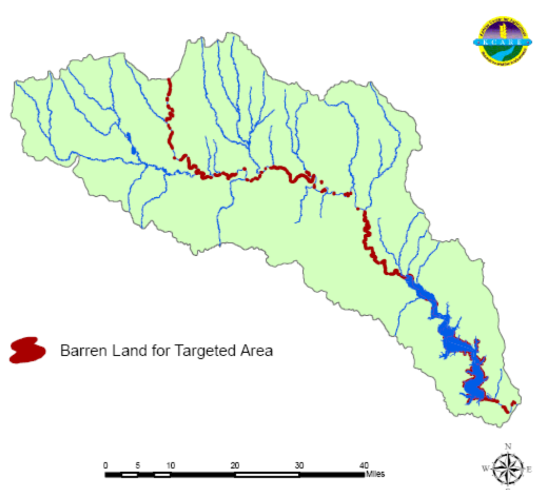


Figure 20 Streambank Targeted Areas [25]

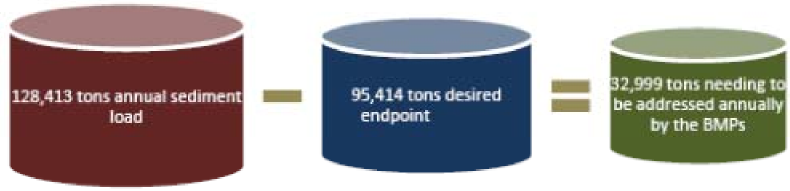
Best Management Practices and Load Reduction Goals

Best Management Practices (BMPs) to address phosphorus, sediment, and bacteria in the watershed were chosen by the SLT based on local acceptance/adoption rate and amount of load reduction gained per dollar spent.

Sediment Reducing Cropland/Riparian BMPs:

- Buffers
- Encouragement of Continuous No-till
- Preparation of Nutrient Management Plans
- Grassed Waterways
- Encouragement of Conservation Rotation
- Streambank Stabilization

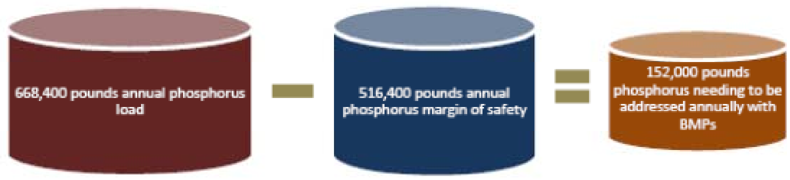
32,999 tons of sediment must be reduced annually to achieve a 30% load reduction to Milford Reservoir.



Phosphorus Reducing Cropland, Streambank and Livestock BMPs:

- Buffers
- Encouragement of Continuous No-till
- Preparation of Nutrient Management Plans
- Grassed Waterways
- Streambank Stabilization
- Encouragement of Conservation Rotation
- Vegetative filter strips between small feeding operations and streams
- Relocation of small feeding operations away from streams
- Relocation of pasture feeding sites away from streams
- Promotion of alternative watering sites away from streams
- Implement rotational grazing practices

668,400 lbs of phosphorus must be reduced annually to achieve a 30% load reduction to Milford Reservoir.



Bacteria Reducing Livestock BMPs:

- Vegetative filter strips between small feeding operations and streams
- Relocation of small feeding operations away from streams
- Relocation of pasture feeding sites away from streams
- Promotion of alternative watering sites away from streams
- Implement rotational grazing practices

Photo provided by Gary May.

MILFORD RESERVOIR

Watershed Restoration and Protection Strategy

Lower Republican Watershed

Final Draft Plan February 3, 2011

Funding for the development of this plan was provided through an EPA 319 grant 2004-0034 from the Kansas Department of Health and Environment.

K-State Research and Extension Project Staff

Robert Wilson, Watershed Planner, Office of Local Government
Josh Roe, Watershed Economist, Department of Agricultural Economics
Susan Brown, Kansas Center for Agricultural Resources and the Environment
Aleksey Sheshukov, Watershed Modeler, Department of Biological and Agricultural Engineering

Stakeholder Leadership Team

Landowners and Residents:
Mary Howell; Kansas Rural Center, Producer, Landowner; Frankfort
Josh Lloyd; Producer, Landowner; Clay Center
Jeff Head; Recreational user; Manhattan
Jeffrey Morgan; Producer, Landowner; Clyde
James Walker; Landowner; Concordia
Bill Mason; Landowner; Concordia
Clifford and Luisa White; Landowners; Milford
Dallas and Evelyn Nelson; Landowners; Wakefield
Vern Swanson; Landowner; Clay Center
Brent Rundell; Producer, Landowner; Morganville
Christine L'Ecuyer; Business and Industrial Interest; Washington
John Bond; KAWS, Landowner; Milford

Local Agency Staff:
John Forshee; Kansas Crossroads RC&D, City resident; Clay Center
Sharon Brown; Clay Center City Commission; Clay Center
Rolf Harms; US Army Corps of Engineers – Milford Office; Milford
Jan Boyles; Jewell County Conservation District; Mankato
Mike Waite; Jewell County NRCS; Mankato
Tom Meek; Clay County Conservation District; Clay Center
Gerald Gray; Clay County NRCS; Clay Center
Arlene Bray; Cloud County Conservation District; Concordia
Todd Whitney; River Valley Extension District; Concordia
Chuck Otte; Geary County Extension; Junction City
Bob Lienemann; Riley County Conservation District; Manhattan
Lori Siemsen; Republic County Conservation District; Belleville
Terry Alstatt; Republic County NRCS; Belleville
Gary Satter; Kansas Crossroads RC&D; Seneca
Sherry Koster; Phillips County Health Department; Philipsburg
Gary May; Rural Lakes Region LEPP; Junction City

Kansas Department of Health and Environment Project Officer
Amanda Reed, Watershed Management Section

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Bureau of Water
Watershed Management Section
1000 SW Jackson, Suite 420
Topeka, KS 66612-1367

Kansas

Phone: 785-296-4195
Fax: 785-296-5509
nps@ks.gov
www.kdheks.gov/water

Robert Moser, MD, Acting Secretary — Department of Health & Environment — Sam Brownback, Governor

February 4, 2011

Robert Wilson
Office of Local Government
K-State Research and Extension
10E Umberger Hall
Manhattan KS 66506

Dear Mr. Wilson:

I am pleased to inform you that the Kansas Department of Health and Environment has completed the review process for **The Watershed Restoration and Protection Strategy for Milford Reservoir (Final Draft Plan, February 3, 2011)**. The plan has met the KDHE requirements and is hereby approved for future funding consideration. Applications for WRAPS funding to implement components of the plan may be submitted to KDHE during the grant application period. Decisions on funding of plan components will be made as part of the grant application process.

Please provide two hardcopies and one digital copy of the final plan to:

Kansas Department of Health and Environment
Bureau of Water, Watershed Management Section
1000 SW Jackson St., Suite 420
Topeka, KS 66612-1367

I want to express my sincere appreciation to you and the Stakeholder Leadership Team in putting together a quality plan that will guide future watershed restoration and protection activities in your watershed. Thank you for all your efforts in protecting and restoring Kansas watersheds.

Sincerely,

Kerry Wedel
Chief, Watershed Management Section
Bureau of Water, Kansas Department of Health and Environment

cc: Amanda Reed

Glossary of Terms

Best Management Practices (BMP): Environmental protection practices used to control pollutants, such as sediment or nutrients, from common agricultural or urban land use activities.

Biological Oxygen Demand (BOD): Measure of the amount of oxygen removed from aquatic environments by aerobic microorganisms for their metabolic requirements.

Biota: Plant and animal life of a particular region.

Chlorophyll a: Common pigment found in algae and other aquatic plants that is used in photosynthesis

Designated Uses: Recognized uses by KDHE that should be attained in a water body.

Dissolved Oxygen (DO): Amount of oxygen dissolved in water.

E. coli bacteria (ECB): Bacteria normally found in gastrointestinal tracts of animals. Some strains cause diarrheal diseases.

Eutrophication (E): Excess of mineral and organic nutrients that promote a proliferation of plant life in lakes and ponds.

Fecal coliform bacteria (FCB): Bacteria that originate in the intestines of all warm-blooded animals.

Municipal Water System: Water system that serves at least 25 people or has more than 15 service connections.

National Pollutant Discharge Elimination System (NPDES) Permit: Required by Federal law for all point source discharges into waters.

Nitrates: Final product of ammonia's biochemical oxidation. Primary source of nitrogen for plants. Contained in manure and fertilizers.

Nitrogen (N or TN): Element that is essential for plants and animals. TN or total nitrogen is a chemical measurement of all nitrogen forms in a water sample.

Nutrients: Nitrogen and phosphorus in water source.

Phosphorus (P or TP): Element in water that, in excess, can lead to increased biological activity.

Riparian Zone: Margin of vegetation within approximately 100 feet of waterway.

Sedimentation: Deposition of slit, clay or sand in slow moving waters.

Secchi Disk: Circular plate 10-12" in diameter with alternating black and white quarters used to measure water clarity by measuring the depth at which it can be seen.

Stakeholder Leadership Team (SLT): Organization of watershed residents, landowners, farmers, ranchers, agency personnel and all persons with an interest in water quality.

Total Maximum Daily Load (TMDL): 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.

Total Suspended Solids (TSS): Measure of the suspended organic and inorganic solids in water. Used as an indicator of sediment or silt.

Water Quality Standard (WQS): Mandated in the Clean Water Act. Defines goals for a waterbody by designating its uses, setting criteria to protect those uses and establishing provisions to protect waterbodies from pollutants.

1.0 Preface

The purpose of this Watershed Restoration and Protection Strategy (WRAPS) report for the Lower Republican 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 Republican Watershed.

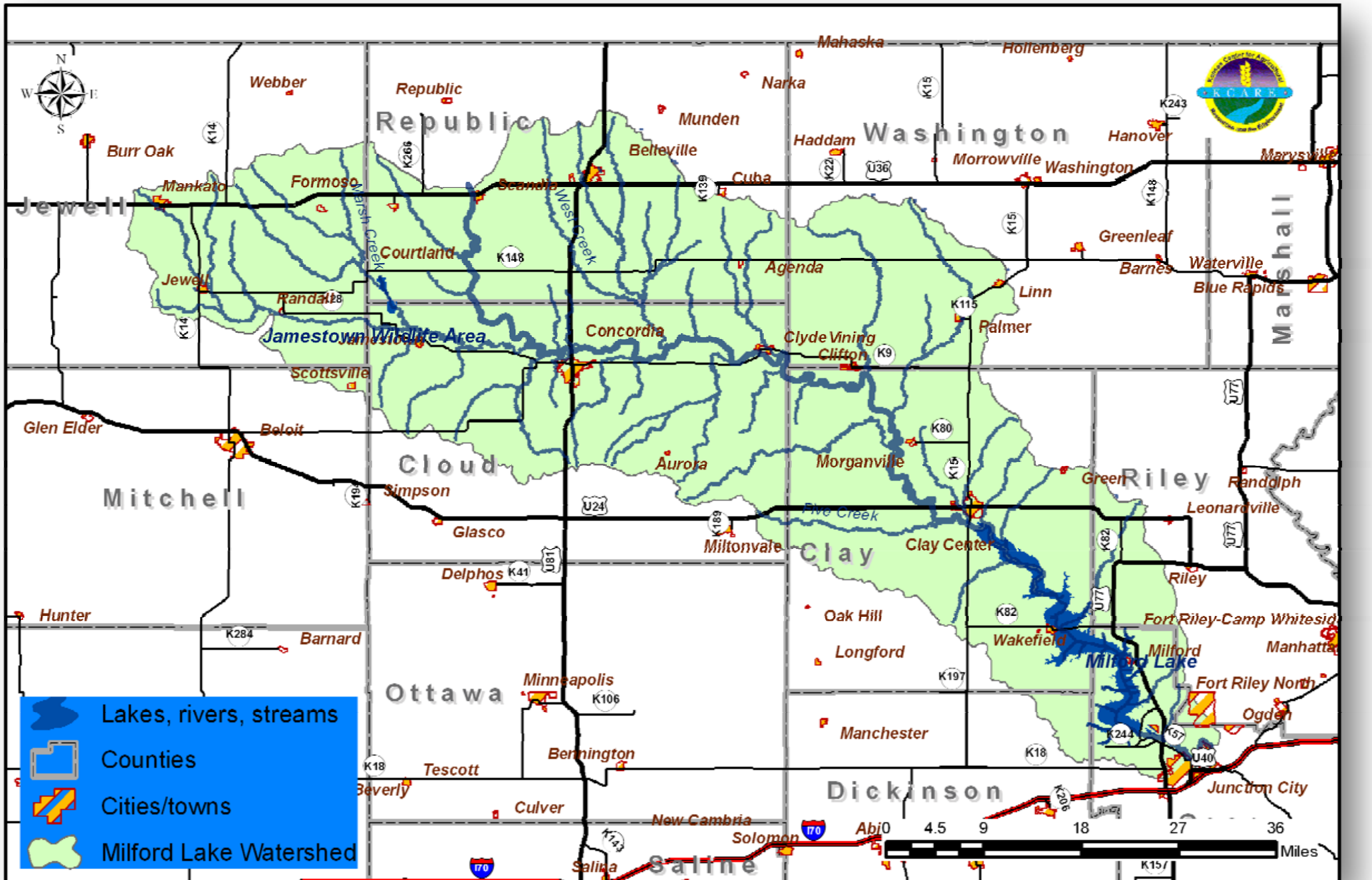
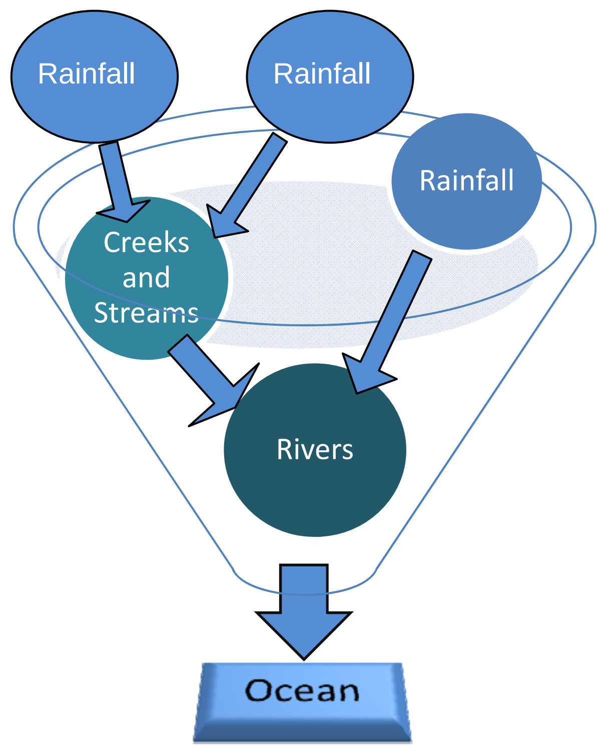


Figure 1. Map of Lower Republican Watershed

2.0 Background Information

2.1 What is a Watershed?

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.



Elevation determines the watershed boundaries. The upper boundary of the Lower Republican Watershed has an elevation of 580 meters (1,903 feet) and the lowest point of the watershed, which is the confluence of the Republican and Kansas Rivers, has an elevation of 252 meters (826 feet) above sea level.

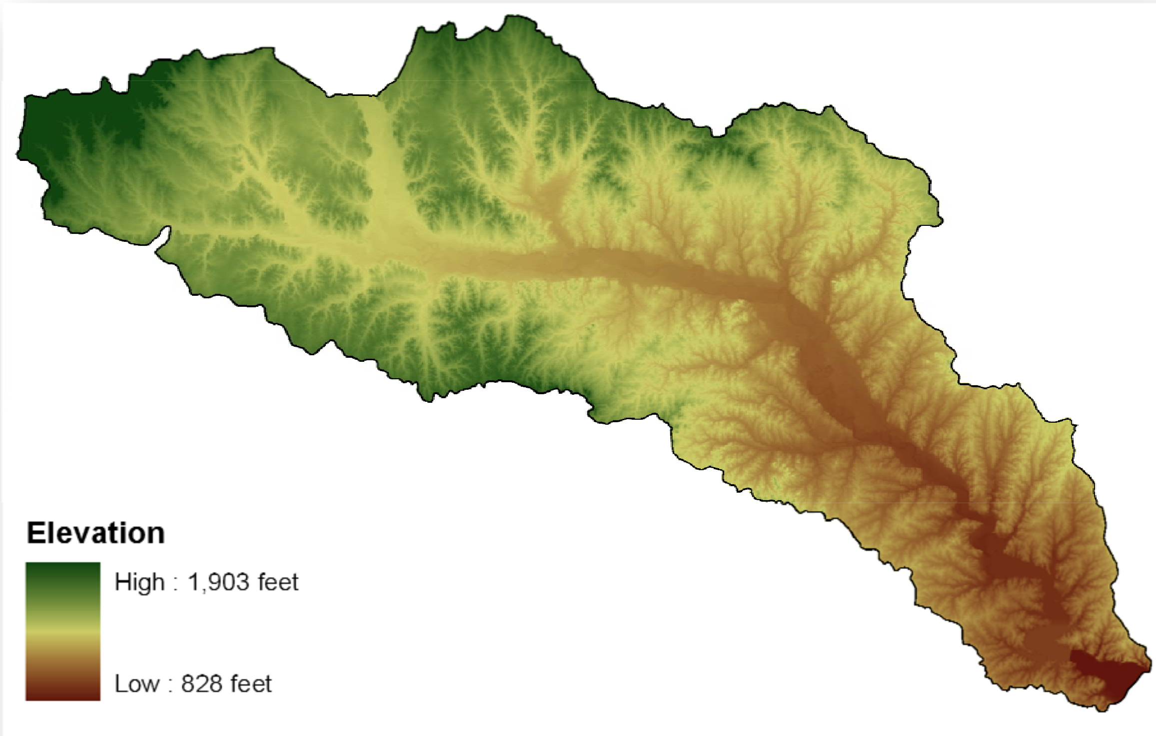


Figure 2 Relief Map of the Lower Republican Watershed [1]

2.2 Where is the Milford Watershed?

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-east Kansas. The entire basin drains the Kansas River and its tributaries into Missouri and eventually empties into the Gulf of Mexico. The extent of the WRAPS area is the Republican River and its tributaries upstream of and including Milford Reservoir. The confluence of the Republican River and the Kansas River downstream from the dam at Milford Reservoir is the geographical endpoint of this WRAPS project.

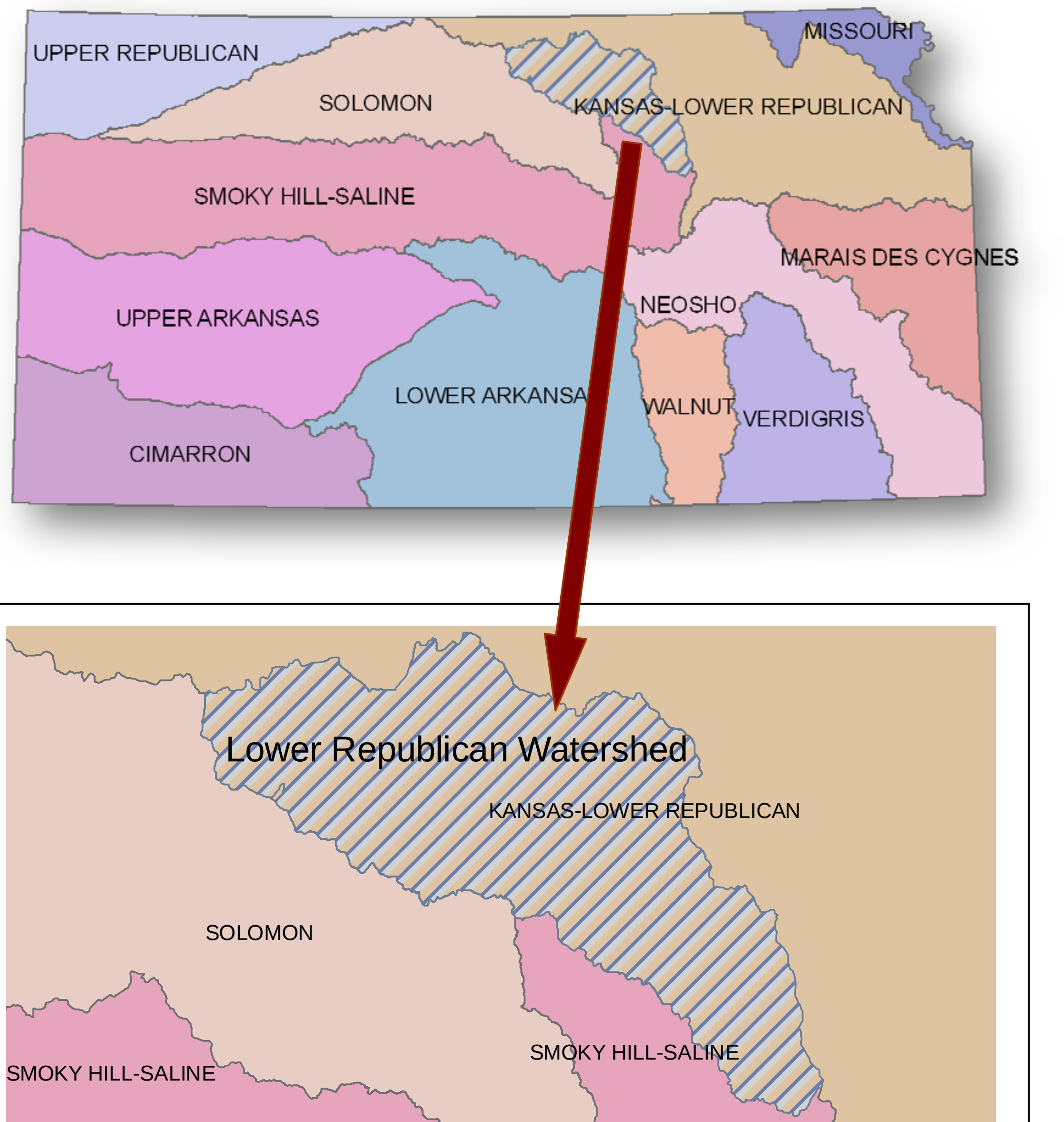


Figure 3 Milford Watershed in Kansas

2.3 What is a HUC?

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. The Lower Republican Watershed is classified as a HUC 8, meaning it has an 8 digit identifying code. Its HUC number is 10250017. The first 2 numbers in the code refer to the drainage region, the second 2 digits refer to the drainage subregion, the third 2 digits refer to the accounting unit and the fourth set of digits is the cataloging unit. As watersheds become smaller, the HUC number will become larger. HUC 8s are further divided into smaller watersheds with HUC 10 and HUC 12 delineations. The Lower Republican Watershed is divided into fifty three HUC 12 delineations.

The Lower Republican Watershed categories are as follows:
10250017 = Drainage of the Missouri River basin
10**25**0017= Drainage of the Republican River basin in Colorado, Kansas and Nebraska
1025**00**17 = Drainage of the Republican River basin
102500**17**= Drainage of the section of the Republican River named the Lower Republican

Map of the Lower Republican Watershed HUC 12s is shown on next page.

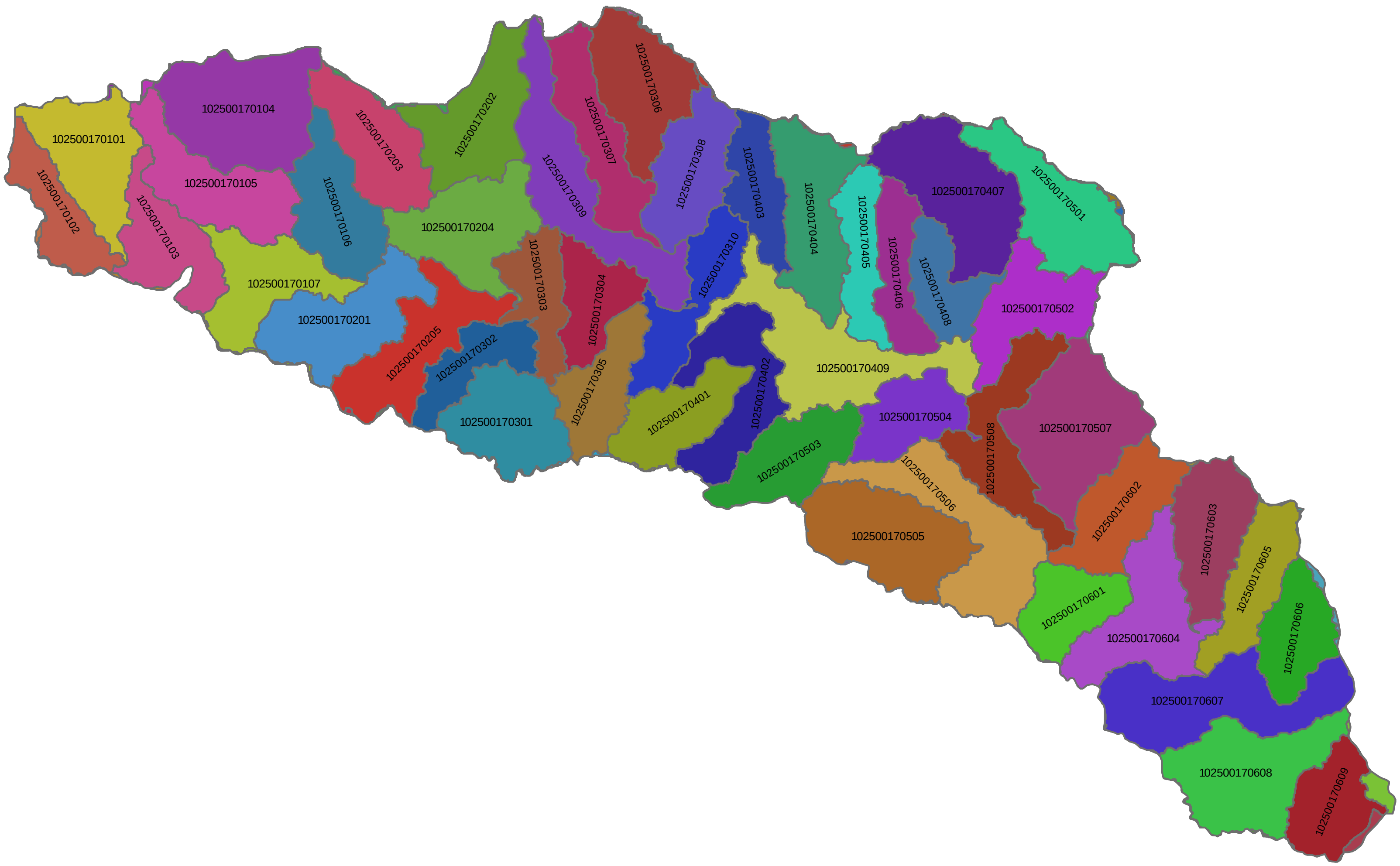


Figure 4 HUC 12 Delineations of the Lower Republican Watershed

3.0 Watershed History

3.1 Stakeholder Leadership Team (SLT) History

A group of concerned citizens in the Lower Republican River Watershed began meeting in 2008 out of concern for the health and lifespan of Milford Reservoir, which is the geographic endpoint of this WRAPS plan. They formed two Stakeholder Leadership Teams (SLT) under the guidance of Kansas State Research and Extension personnel. These two teams are located in the Upper Milford and the Lower Milford watersheds. Size of the watershed and convenience to the members of the SLT prompted having two meeting places. In discussing BMPs for cropland, there are differences in the BMPs adopted by the Upper and Lower SLTs. These BMPs are listed in Tables 17 and 22 in this report. All other data refers to the entire watershed.

3.2 Milford Reservoir History

Construction of the dam for Milford Reservoir began in 1962 by the US Army Corps of Engineers (USACE) and the multipurpose pool was filled in 1967. In 1962, the reservoir had a storage capacity of 415,403 acre feet. The capacity of the latest survey year (1994) is 372,341 acre feet. Estimated current capacity (2010) is 346,785 acre feet. This represents a loss of 16.52% due to sediment that has entered the Reservoir from the watershed with a calculated sedimentation rate of 1,597 acre feet per year. Milford Reservoir is ranked tenth of all Kansas reservoirs in percentage of capacity loss. See figure below.

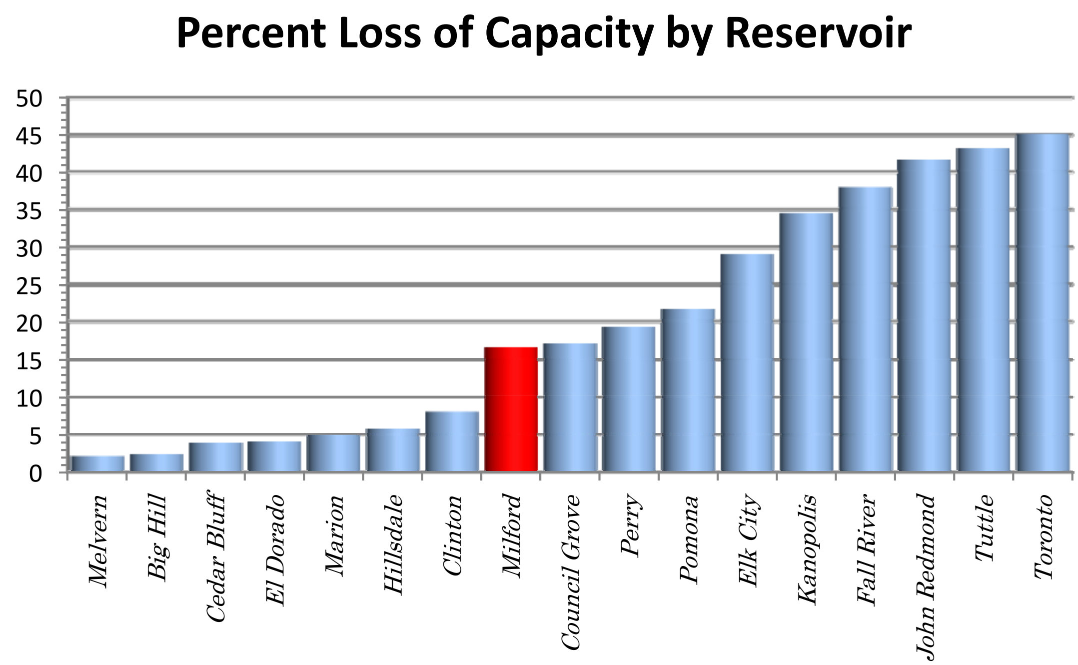


Figure 5 Percent of Reservoir Loss Due to Sedimentation (1990) [2]

3.3 Watershed Overview

The Lower Republican Watershed is designated as a Category I watershed indicating that it is in need of restoration as defined by the Kansas Unified Watershed Assessment 1999 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 Republican is ranked eleventh in priority out of ninety-two watersheds in the state.

The Lower Republican Watershed covers 1,252,480 acres with 891 stream miles. There are numerous towns and cities in this watershed in addition to developed areas surrounding Milford Reservoir, the largest reservoir in the watershed. Milford Reservoir is a 16,000 acre Reservoir, located in the Flint Hills Region of Kansas and has an average water depth of approximately 24 feet. Construction was completed by the USACE, Kansas City District, in 1964 by damming the Republican River and the multipurpose pool was filled in 1967.

Since the Republican River provides water to three states (Colorado, Nebraska and Kansas), it was set up to be governed in 1943 by an interstate compact called the **Republican River Compact** that determines consumptive use for each state**.** This agreement allocates water resources between the three states. In 2000, the Supreme Court ruled that groundwater pumping for irrigation should not have an effect on river flow. Each state is required to keep its water usage within its allotment. Kansas has subsequently sued Nebraska and Colorado over lack of river flow and the case is still in arbitration. [4]

3.4 Issues and Goals of the Watershed

The charge of the SLTs has been to create a plan of restoration and protection measures for the watershed. During the time period that they have been meeting, they have had speakers and discussions to review and study watershed issues and concerns. The SLT then set **priority watershed issues and concerns.**

The priority issues that the SLT consider most important to the health of the watershed are (in no particular order):

- Cropland erosion,
- Rangeland or pasture erosion,
- Sedimentation and eutrophication in Milford Reservoir and its impacts on drinking water, recreation and storage capacity,
- Stormwater runoff,
- Streambank erosion and riparian area degradation,
- Manure management at small (non-permitted) livestock operations,
- Failing septic systems, and
- Pollution loading from the watershed portion located in the State of Nebraska.

In order to address the watershed issues, the SLT has set certain **watershed restoration and protection goals** as (in no particular order):

- Protection of long-term water storage capacity, water quality and recreational uses at Milford Reservoir,
- Protection of water quality in the Republican River and tributary streams,
- Protection of water quality in Jamestown Wildlife Area, Lake Jewell, Belleville City Lake and Salt Creek,
- Restoration and protection of streambanks and riparian areas along the Republican River and tributary streams, and
- Protection of public drinking water supplied (including the City of Milford).

The purpose of this WRAPS plan is to address these issues and concerns of the SLT, to address and mitigate current TMDLs in the watershed and to proactively improve conditions so that the impairments on the current 303d list will not reach the stage of TMDL development.

NOTE: In this report, the term BMP (Best Management Practice) will be used frequently. A BMP is defined as an environmental protection practice used to control pollutants, such as sediment or nutrients, from common agricultural or urban land use activities. Common agricultural BMPs are buffer strips, terraces, grassed waterways, utilizing no-till or minimum tillage, conservation crop rotation and nutrient management plans. Definitions of each of these BMPs are found in the appendix of this report.

4.0 Watershed Review

4.1 Land Cover/Land Uses

Land use activities have a significant impact on the types and quantity of pollutants in the watershed. The major land use for the Lower Republican Watershed is cropland (50 percent) which can contribute sediment and nutrients into the watershed. Sources of sediment originating from cropland can originate from overland flow across conventional tilled crop fields and ephemeral gullies that are plowed through each year. Cropland nutrients can originate from application of fertilizers prior to a rainfall event or over application of fertilizers and manure when used as fertilizer. The second major land use is grassland (37 percent), which can also contribute nutrients into the watershed. Nutrients can originate from grasslands through overgrazing and allowing livestock access to streams and creeks. Failing and sloughing streambanks with undercuts will contribute to sediment loading. The remaining land uses in the watershed is woodlands (5 percent), water (2 percent) and other (6 percent).

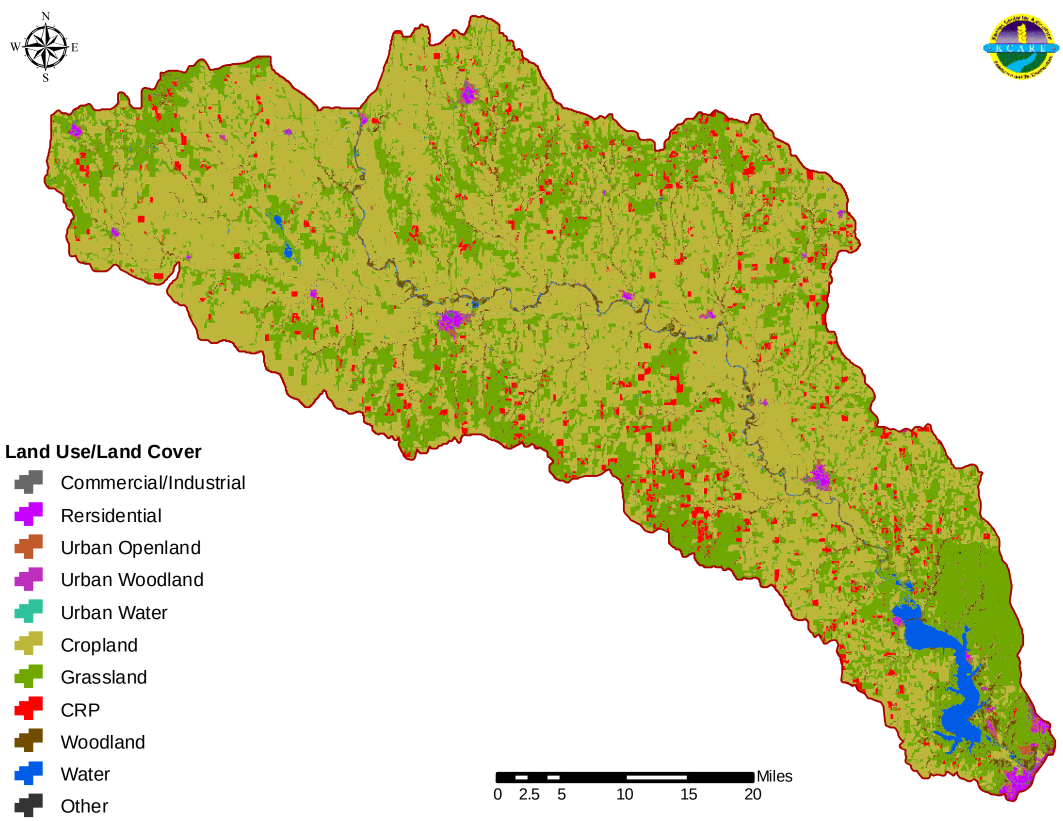


Figure 6 Land Cover of the Watershed, 2005 [5]. Kansas Applied Remote Sensing Program, Kansas Geospatial Community Commons.

Table 1 Land Use Calculations, 2001 [24] Calculated from Kansas Applied Remote Sensing program, Kansas Geospatial Community Commons

Lower Republican Watershed		
Land Use	***Acres***	***Percentage***
Agricultural Row Crops	629,310	49.68
Range-Grasses	462,773	36.53
Forest-Deciduous	60,175	4.75
Residential-Low	51,753	4.09
Water	25,550	2.02
Residential-Medium	12,212	0.96
Hay	10,137	0.80
Wetlands-Forested	8,289	0.65
Wetlands-Non-Forested	2,389	0.19
Residential-High	1,845	0.15
Forest-Mixed	917	0.07
Industrial	587	0.05
Forest-Evergreen	560	0.04
Southwestern	140	0.01
Range-Brush	75	0.01
Total	**1,266,712**	**100.00**

4.2 Designated Uses

All surface waters in this watershed are generally used for aquatic life support (fish), human health purposes, domestic water supply, recreation (fishing, boating, and swimming), groundwater recharge, industrial water supply, irrigation or 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 Republican River Watershed [6] Kansas Surface Water Register, 2004, KDHE.

Designated Uses Table								
Stream Name	**AL**	**CR**	**DS**	**FP**	**GR**	**IW**	**IR**	**LW**
Beaver Cr, Buffalo Cr seg.29, Elk Cr, W.Fk, Marsh Cr E, Marsh Cr W, Mulberry Cr, Riley Cr, Salt Cr W, Whites Cr,	E	b		X				
Buffalo Cr seg.37, Buffalo Cr Middle, Elk Cr, Elm Cr, Salt Cr, Wolf Cr	E	C		X				
Buffalo Cr E, Cheyenne Cr, Coal Cr, Cool Cr, Dry Cr, East Cr, Elm Cr E Br, Elm Cr W Br, Finney Cr, Five Cr, Hay Cr, Lincoln Cr, Mud Cr, Oak Cr, Parsons Cr, Peats Cr, Rush Cr, Spring Cr, Turkey Cr, Upton Cr	E	b						
Fourmile Cr, Otter Cr	E	C						
Huntress Cr	E	B						

Designated Uses Table, Cont.								
Stream Name	**AL**	**CR**	**DS**	**FP**	**GR**	**IW**	**IR**	**LW**
Marsh Cr,	E	A		X				
Timber Cr	E	C	X					
Republican River	S	C	X	X	X	X	X	X
Belleville City Lake	E	B		X				
Jamestown WA	E		X					
Milford Reservoir	E	A	X	X		X		
Milford WA	E			X				
Rimrock Park Lake	E	B	O	X		O	O	O

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 recreation lakes that have a posted public swimming area
B=Primary contact recreation stream segment is by law or written permission of the landowner open to and accessible by the public
b=Secondary contact recreation stream segment is not open to and accessible by the public under Kansas law
C=Primary contact recreation lakes 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 is assigned the indicated designated use
O = Referenced stream segment does not support the indicated beneficial use
Blank=Capacity of the referenced stream segment to support the indicated

4.3 Special Aquatic Life Use Waters and Exceptional State 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 Republican Watershed has a special aquatic life use designation in the Republican River. **Exceptional state waters** are waters that are defined as “any of the surface waters or surface water segments that are of remarkable quality or of significant recreational or ecological value”. The Jamestown Wildlife Area has an exceptional state waters designation.

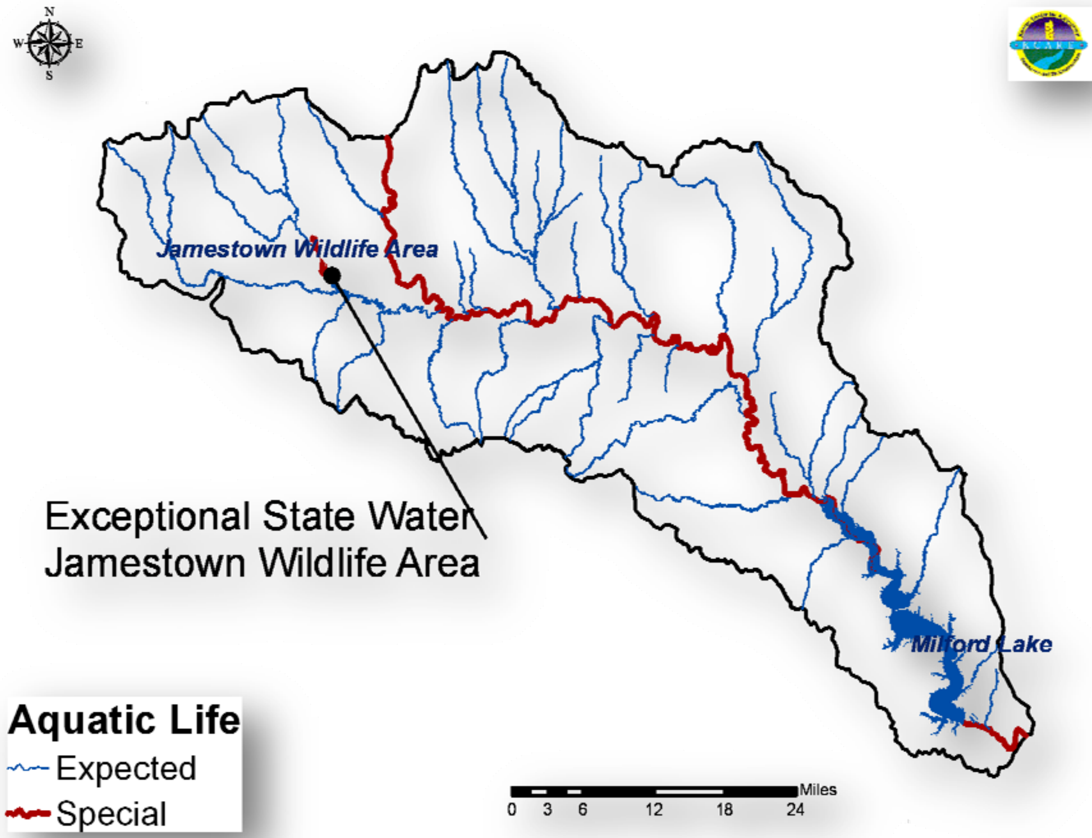


Figure 7 Special Aquatic Life Use Waters and Exceptional State Waters [7] Kansas Department of Health and Environment.

The special aquatic life use waters are located in an area that is primarily cropland, as can be seen by the figure below. Pollutants that might threaten the health of these waters would be sediment or nutrient related. Sediment in the Republican River would destroy habitat for mussels and fish. Fertilizer or manure in the streams would concentrate nutrients and alter dissolved oxygen concentrations, pH, and phosphorus concentrations.

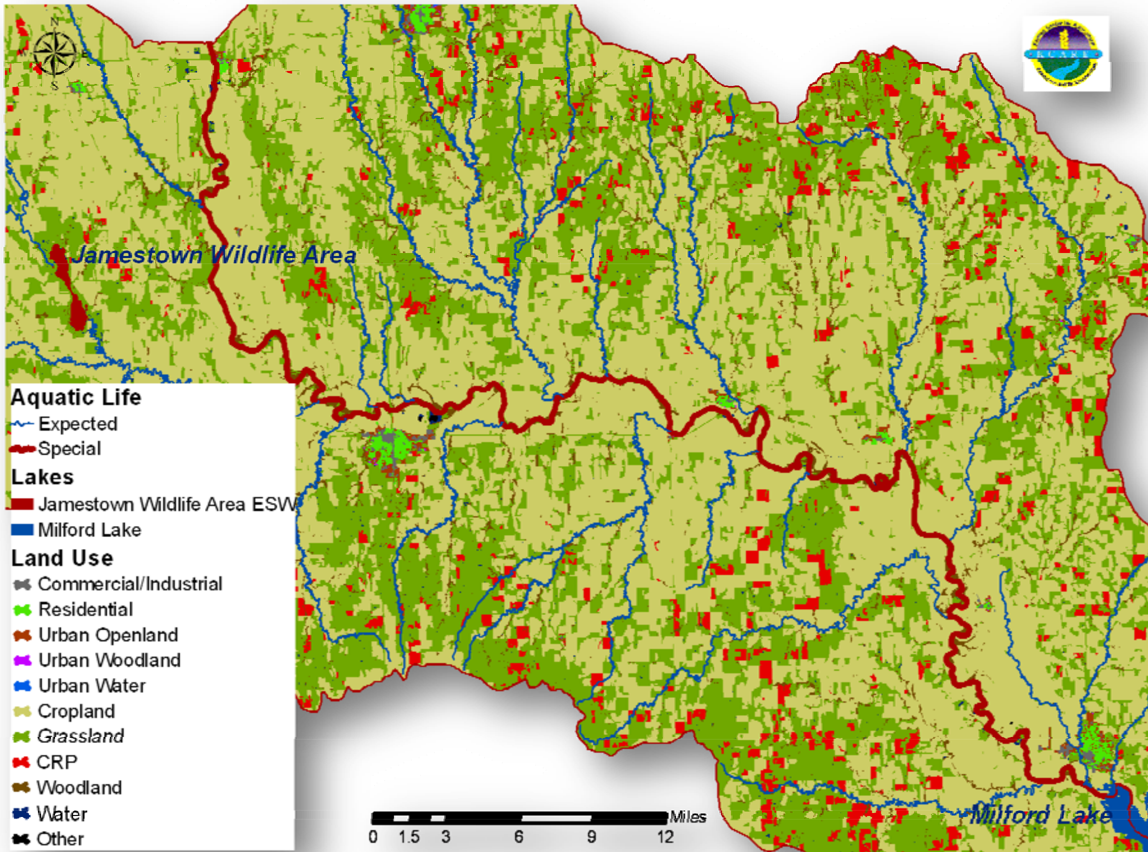


Figure 8 Special Aquatic Life Use Waters and Exceptional State Waters in the Watershed with Land Use. [75]

4.4 Public Water Supply and National Pollutant Discharge Elimination System

A Public Water Supply (PWS) that derives its water from a surface water supply can be affected by sediment by:

- removing excess sediment buildup at the water intake, or
- performing additional treatment procedures for sediment removal prior to consumption.

Nutrients and fecal coliform bacteria will also affect surface water supplies causing excess cost in treatment prior to public consumption. The City of Milford is the only surface water PWS in the watershed. All other water supply points are groundwater wells. The table below lists the public water supplies in the Lower Republican Watershed. Even though the following PWS service customers are in the watershed, not all intake wells are located within the watershed.

Table 3 PWS Serving the Lower Republican Watershed [8]

PWS	County Served	Source (number of active wells, 2010, in parenthesis)	Source Basin*	2007 Pop Served	KWO 2010 Pop (Estimate)
Agenda	RP	2 Wells (1), Republic RWD 02	Kr	72	
Aurora	CD	2 Wells (2)	Kr	74	
Belleville	RP	2 Wells (2)	Kr	2,222	
Clay Center	CY	10 Wells (6)	Kr	4,668	
Clay RWD 01	CY	1 Well (1)	Kr	103	
Clay RWD 02	CY	5 Wells (5) (wells located outside the watershed)	Ss	829	
Clifton	WS	4 Wells (4)	Kr	590	
Cloud RWD 01	CD	4 Wells (4)	Kr	408	
Clyde	CD	3 Wells (3)	Kr	705	
Concordia	CD	6 Wells (5)	Kr	5,203	
Courtland	RP	Republic RWD 1	Kr	304	
Cuba	RP	2 Wells (1) (wells located outside the watershed), Republic RWD 2	Kr	194	
Formoso	JW	1 Well (1), Republic RWD 1	Kr	117	
Geary RWD 01	GE	Junction City	Kr	NA	234
Geary RWD 02	GE	1 Well (1)	Kr	78	
Geary RWD 04	GE	2 Wells (2)	Kr	1,084	
Green	CY	6 Wells (1)	Kr	137	
Jamestown	CD	2 Wells (2), (Cloud RWD 1)	Kr	387	
Jewell	JW	Mitchell RWD 3	Kr	432	
Jewell RWD 01	JW	2 Wells (2)	Kr	472	
Junction City	GE	9 Wells (9)	Kr	20,000	
Linn	WS	2 Wells (2)	Kr	412	
Mankato	JW	5 Wells (3) (wells located outside the watershed)	Kr	933	
Milford	GE	Milford Reservoir	Kr	502	
Mitchell RWD 03	MC, CD, JW	Mitchell RWD 2 (wells located outside the watershed)	So	NA	1,039
Morganville	CY	2 Wells (1)	Kr	194	
Palmer	WS	3 Wells (3)	Kr	112	

PWS, Cont.					
PWS	**County Served**	**Source (number of active wells, 2010, in parenthesis)**	**Source Basin***	**2007 Pop Served**	**KWO 2010 Pop (Estimate)**
Randall	JW	1 Well (1), Mitchell RWD 3	Kr	73	
Republic RWD 01	RP, JW	3 Wells (3) (wells located outside the watershed)	Kr	426	
Republic RWD 02	RP, WS	2 Wells (2) (wells located outside the watershed)	Kr	1,250	
Scandia	RP	3 Wells (2)	Kr	377	
Wakefield	CY	3 Wells (3)	Kr	859	
Washington RWD 02	WS, CY	4 Wells (4)	Kr	650	

*Kr=Kansas/Republican Basin, Ss= Smoky Hill/Saline Basin. Not all water supplies distributed in the Lower Republican Watershed originate in the Lower Republican Watershed.

Wastewater treatment facilities are permitted and regulated through KDHE. They are considered point sources of pollutants. National Pollutant Discharge Elimination System (NPDES) permits specify the maximum amount of pollutants allowed to be discharged to surface waters. Having theses 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. [9] Any pollutant discharge from point sources that is allowed by the state is considered to be Wasteload Allocation.

In this watershed, there are numerous municipalities that have NPDES sites in close proximity with PWS sites. There could be a possible threat of nitrates and bacteria in the PWS from the NPDES site. Industrial NPDES sites can contribute specific pollutants that could threaten the water supply. The cities that have both a NPDES site and public water supply diversion point are highlighted in the table below in tan.

Table 4 Permitted Point Source Facilities [10] Municipalities that have both NPDES and PWS sites are highlighted in tan.

NPDES	Facility Name	Ownership	Description	Industrial Classification	City	County
KS0001988	Northern Natural Gas Clifton	Private	Natural Gas Transmissio n	Not ON Elg	Clifton	WS

NPDES, Cont.						
NPDES	**Facility Name**	**Ownership**	**Description**	**Industrial Classification**	**City**	**County**
KS0002682	General Finance Inc Clay Pits	Private	Clay, Ceramic & Refrac Mat Nec	ON Elg	Concordia	CL
KS0021385	Mankato City Of Stp	Public	Sewerage Systems	Municipal	Mankato	JW
KS0022403	Clyde City Of Stp	Public	Sewerage Systems	Municipal	Clyde	CS
KS0024678	Morganville City Of Stp	Public	Sewerage Systems	Municipal	Morganville	CY
KS0025577	Concordia City Of Stp	Public	Sewerage Systems	Municipal	Concordia	CL
KS0027529	Belleville City Of Stp	Public	Sewerage Systems	Municipal	Belleville	RP
KS0027545	Wakefield City Of Stp	Public	Sewerage Systems	Municipal	Wakefield	CY
KS0034011	Junction City-City Of Stp	Public	Sewerage Systems	Municipal	Junction City	GE
KS0048399	Clay Center City Of Stp	Public	Sewerage Systems	Municipal	Clay Center	CL
KS0048437	Clifton City Of Stp	Public	Sewerage Systems	Municipal	Clifton	WS
KS0079197	Geary Cnty Sewer Dist #4	Public	Sewerage Systems	Municipal	Geary County	GE
KS0083275	Milford Fish Hatchery	Private	Fish Hatcheries And Preserves	Not On El	Milford	GE
KS0083399	Courtland Wwt Facility	Private	Sewerage Systems	Not On El	Courtland	RP
KS0085898	Fina Oil \7	Private	Petroleum Refining	Primary O		
KS0086231	Milford Wwtf	Public	Sewerage Systems	Municipal	Milford	GE
KS0090018	Valley Fertilizer	Pub /Pri			Clay Center	CL
KS0090891	Ps Quarry	Private			Chapman	GE
KS0117340	Hamm N R Quarry Wakefield #80	Private	Crushed & Broken Limestone	On Elg	Clay Center	CL

Numerous onsite wastewater systems exist in the watershed. There is no accurate accounting number of these systems and their functional condition is generally unknown. EPA estimates "10 to 20 percent of onsite wastewater systems malfunction each year". [11] The KSU technical team used best professional guess to claim the number of failing septic systems to be 10 percent. All counties in the watershed have sanitary codes.

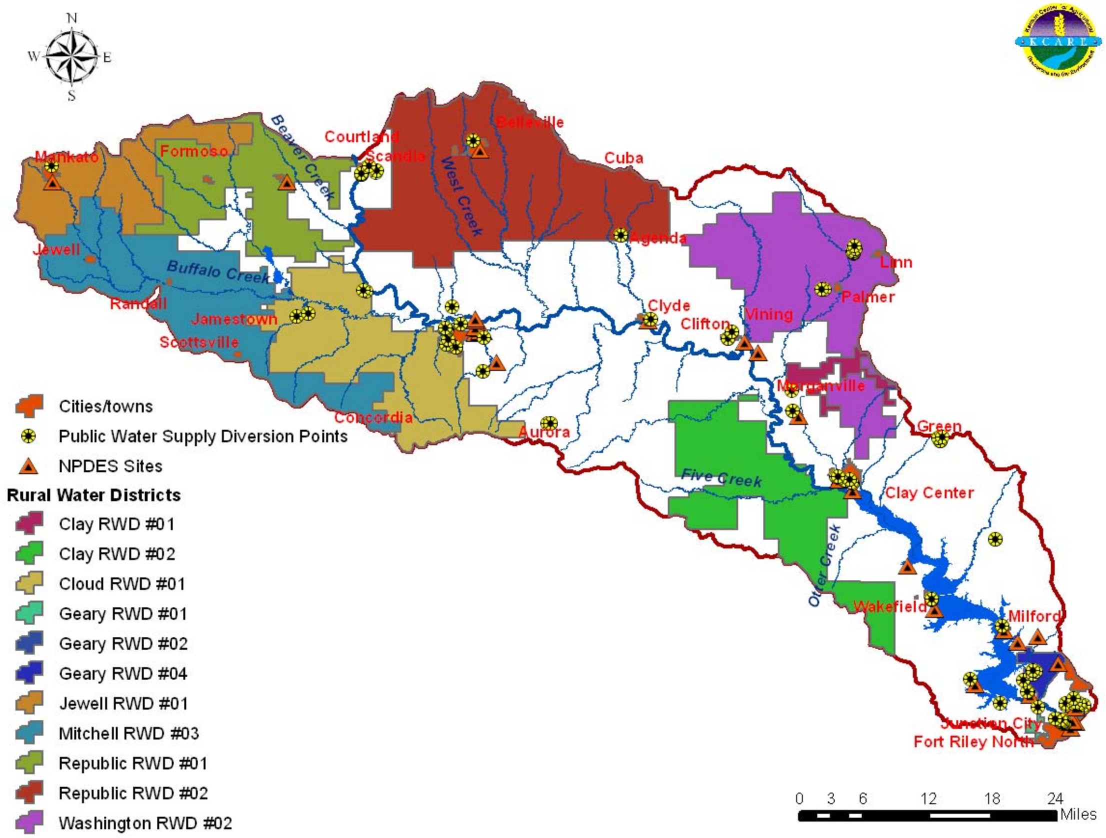


Figure 9 PWS Diversion Points and NPDES sites in the Watershed. [12]

4.5 Aquifers

Two 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 Republican River has an alluvial aquifer that lies along and below the river and some of its tributaries.
- 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.

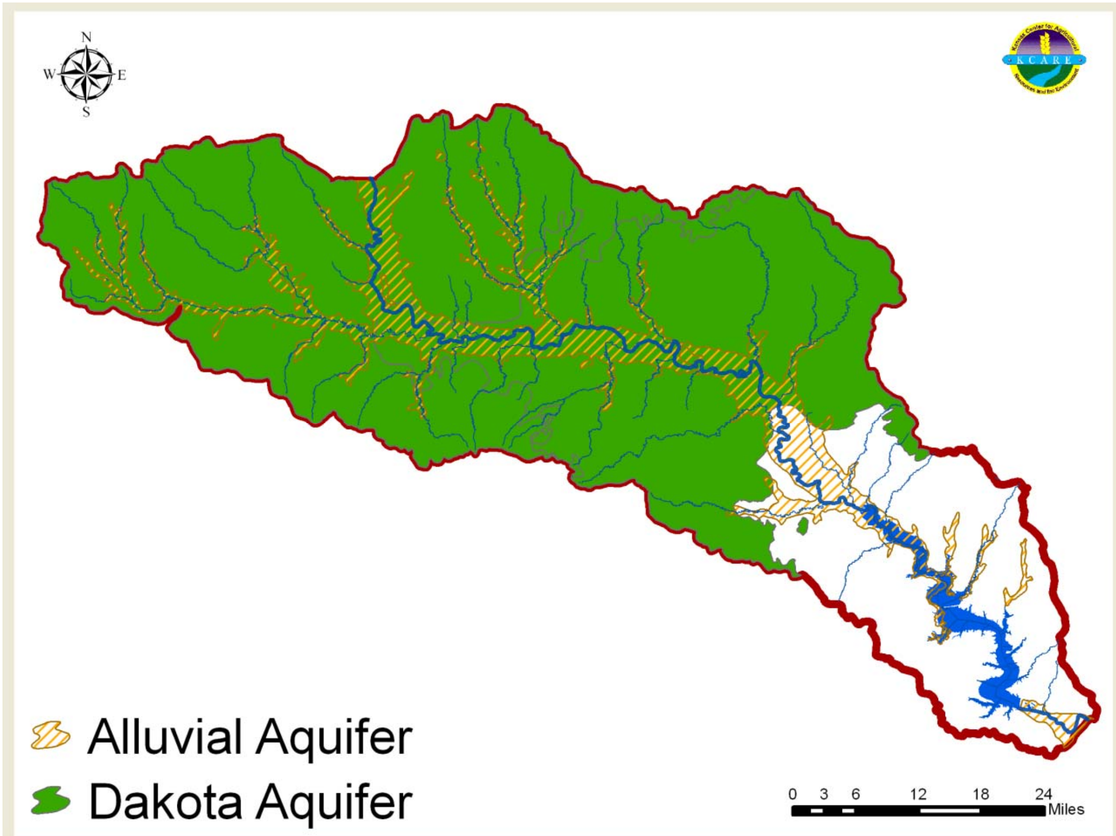


Figure 10 Aquifers in the Watershed [13]

4.6 TMDLs in the Watershed

A Total Maximum Daily Load (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 provide a tool to target and reduce point and nonpoint pollution sources. 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. [14] 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.

Kansas Department of Health and Environment (KDHE) reviews TMDLs assigned in each of the twelve basins of Kansas every five years on a rotational schedule. The table below includes the review schedule for the Kansas – Lower Republican Basin.

Table 5 TMDLs Review Schedule for the Kansas Lower Republican Basin [15]

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 the table below.

Table 6 TMDLs in the Lower Republican Watershed [16] The shaded lines indicate high, medium or low priority priorities. The TMDLs in **bold** print indicate existing TMDLs that will be addressed by this WRAPS plan.

Water Segment	TMDL Pollutant	Water Quality Standard	Endgoal of TMDL	Priority	Sampling Station
High Priority TMDLs					
Salt Creek near Hollis	**Dissolved Oxygen**	**5 mg/l**	**Reduce ammonia < 0.05mg/l which results in no excursions of DO < 5**	**High**	**SC650**
Salt Creek near Hollis	**Fecal Coliform Bacteria**	• **Primary Contact < 900 colonies per 100 ml water** • **Secondary Contact < 2,000 colonies per 100 ml water**	**Maintain percent of samples over applicable criteria < 10%**	**High**	**SC650**
Medium Priority TMDLs					
Republican River near Clay Center	Fecal Coliform Bacteria	• Primary Contact < 900 colonies per 100 ml water • Secondary Contact < 2,000 colonies per 100 ml water	Maintain percent of samples over applicable criteria < 10%	Medium	SC503 and SC504

TMDLs, Cont.					
Water Segment	**TMDL Pollutant**	**Water Quality Standard**	**Endgoal of TMDL**	**Priority**	**Sampling Station**
Republican River near Rice	Fecal Coliform Bacteria	• Primary Contact < 900 colonies per 100 ml water • Secondary Contact < 2,000 colonies per 100 ml water	Maintain percent of samples over applicable criteria < 10%	Medium	SC510
Lake Jewell – ***The Lake Jewell dam was breached, but has been repaired. However, the TMDL remains inactive until future assessment can occur.***	Aquatic Plants, Eutrophication and Dissolved Oxygen	• Nutrients shall be controlled to prevent accelerated succession of aquatic biota or aquatic life, and development of objectionable concentrations of algae or algal by-products • DO 5mg/l	Summer Chlorophyll concentrations = or < 20ug/l	Medium	LM062901 in Lake Jewell
Rimrock Park Lake	Dissolved Oxygen	***Rimrock Park Lake lies on the watershed border with Lower Smoky Hill Watershed. It is not incorporated in this WRAPS plan due to the fact that it is downstream of Milford Reservoir. The TMDLs imply that it is applicable to the Smoky Hill Watershed not the Lower Republican.***		Medium	LM070501
Rimrock Park Lake	Eutrophication			Medium	LM070501
Low Priority TMDLs					
Buffalo Creek near Concordia	Fecal Coliform Bacteria	• Primary Contact < 900 colonies per 100 ml water • Secondary Contact < 2,000 colonies per 100 ml water	Maintain percent of samples over applicable criteria < 10%	Low	SC509
Buffalo Creek near Concordia	Chloride	352 mg/l	Maintain percent of samples over applicable criteria < 10%	Low	SC509

TMDLs, Cont.					
Water Segment	**TMDL Pollutant**	**Water Quality Standard**	**Endgoal of TMDL**	**Priority**	**Sampling Station**
Belleville City Lake	**Eutrophication**	**Nutrients shall be controlled to prevent accelerated succession of aquatic biota or aquatic life, and development of objectionable concentrations of algae or algal by-products**	**Summer Chlorophyll concentrations = or < 20ug/l**	**Low**	**LM060701**
Jamestown Wildlife Management Area	Eutrophication and pH	• Nutrients shall be controlled to prevent accelerated succession of aquatic biota or aquatic life, and development of objectionable concentrations of algae or algal by-products • pH > 6.5 and < 8.5	Summer Chlorophyll concentrations = or < 20ug/l and pH between 6.5 and 8.5	Low	LM052801 in Jamestown WMA
Jamestown Wildlife Management Area	Siltation	Suspended solids shall not interfere with the behavior, reproduction, physical habitat or other factor related to the survival and propagation of aquatic or semi-aquatic or terrestrial wildlife	10% or less of samples taken from wetland > 100mg/l TSS	Low	LM052801 in Jamestown WMA
Jamestown Wildlife Management Area	Fecal Coliform Bacteria	2,000 colonies per 100ml water	All FCB samples < 2,000 colonies per 100ml water	Low	LM 052801 in Jamestown WMA

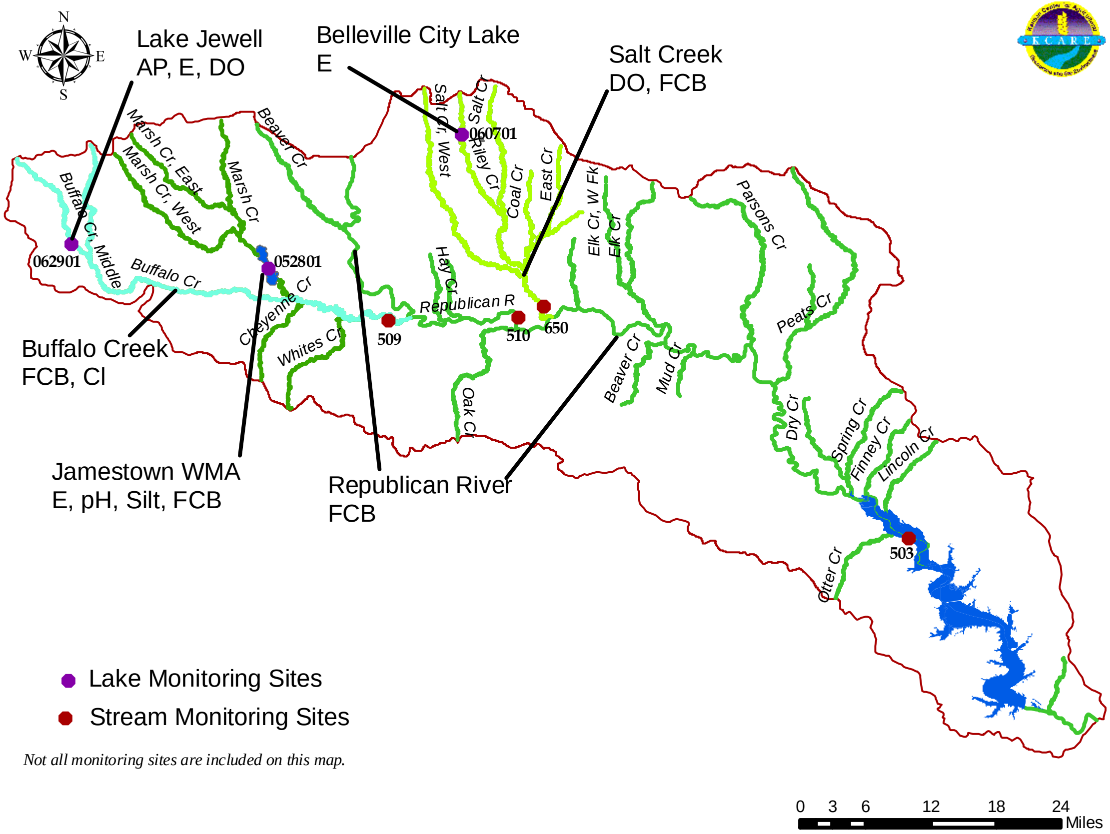


Figure 11 TMDLs in the Lower Republican Watershed [17]

4.7 303d Listings in the Watershed

The Lower Republican Watershed has numerous new listings on the 2010 "303d list". [18] 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. TMDL development and revision for waters of the Lower Republican Watershed is scheduled for 2010. TMDLs will be developed over the subsequent 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 the pollutant can be assessed, the priority will be listed as "low". Water bodies are assigned "categories" based on impairment status:

- Category 5 – Waters needing TMDLs
- Category 4a – Waters that have TMDLs developed for them and remain impaired
- Category 4b – NPDES permits addressed impairment or watershed planning is addressing atrazine problem

- Category 4c – Pollution (typically insufficient hydrology) is causing impairment
- Category 3 – Waters that are indeterminate and need more data or information
- Category 2 – Waters that are now compliant with certain water quality standards
- Category 1 – All designated uses are supported, no use is threatened.

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 7 2010 303d List of Impaired Waters in the Lower Republican Watershed. [19] The shaded lines indicate medium or low priority impairments. The **bold** impairments indicate ones that will be addressed by this WRAPS plan.

Category	Water Segment	Impairment	Priority	Sampling Station
Medium Priority				
5 –needing TMDL	Republican River near Clay Center	Biology	Medium	SC503
Low Priority				
5 –needing TMDL	Salt Creek near Hollis	Chloride	Low	SC650
5 –needing TMDL	Elm Creek near Ames	Copper	Low	SC709
5 –needing TMDL	Mulberry Creek near Clifton	Copper	Low	SC710
5 –needing TMDL	Peats Creek near Clifton	Copper	Low	SC649
5 –needing TMDL	Milford Reservoir	Dissolved Oxygen	Low	LM019001
5 –needing TMDL	Elm Creek near Ames	Lead	Low	SC709
5 –needing TMDL	Mulberry Creek near Clifton	Lead	Low	SC710
5 –needing TMDL	Peats Creek near Clifton	Lead	Low	SC649
5 –needing TMDL	Republican River near Clay Center	Lead	Low	SC504
5 –needing TMDL	Republican River near Clay Center	Lead	Low	SC503
5 –needing TMDL	Republican River near Rice	pH	Low	SC510
5 –needing TMDL	Buffalo Creek near Concordia	Sulfate	Low	SC509
5 –needing TMDL	Five Creek near Clay Center	Sulfate	Low	SC711

303d List, Cont.				
Category	**Water Segment**	**Impairment**	**Priority**	**Sampling Station**
5 –needing TMDL	**Buffalo Creek near Concordia**	**Total Phosphorus**	**Low**	**SC509**
5 –needing TMDL	Elm Creek near Ames	Total Phosphorus	Low	SC709
5 –needing TMDL	**Mulberry Creek near Clifton**	**Total Phosphorus**	**Low**	**SC710**
5 –needing TMDL	**Peats Creek near Clifton**	**Total Phosphorus**	**Low**	**SC649**
5 –needing TMDL	Republican River near Clay Center	Total Phosphorus	Low	SC504
5 –needing TMDL	Republican River near Clay Center	Total Phosphorus	Low	SC503
5 –needing TMDL	Republican River near Rice	Total Phosphorus	Low	SC510
5 –needing TMDL	Salt Creek near Hollis	Total Phosphorus	Low	SC650
5 –needing TMDL	Wolf Creek near Concordia	Total Phosphorus	Low	SC707
5 –needing TMDL	Buffalo Creek near Concordia	Total Suspended Solids	Low	SC509
5 –needing TMDL	**Republican River near Clay Center**	**Total Suspended Solids**	**Low**	**SC504**
5 –needing TMDL	**Republican River near Clay Center**	**Total Suspended Solids**	**Low**	**SC503**
5 –needing TMDL	**Salt Creek near Hollis**	**Total Suspended Solids**	**Low**	**SC650**
5 –needing TMDL	Mulberry Creek near Clifton	Zinc	Low	SC710
3 – need more information	Buffalo Creek	Ammonia	Permit Pending	NPDES95231
3 – need more information	Jamestown WMA	Arsenic	Small sample size	LM052801
3 – need more information	Wolf Creek near Concordia	Arsenic		SC707
3 – need more information	Peats Creek near Clifton	Atrazine	Last exceedance 2007	SC649

As of the 2010 303d listing, some water segments have been removed from the list.

Table 8 2010 303d List of Formerly Impaired Waters [20]

Category	Water Segment	Impairment	Comments	Sampling Station
2 – no longer needing TMDL	Republican River below Milford Dam	Ammonia	No longer impaired	NPDES34011
2 – no longer needing TMDL	Salt Creek	Ammonia	No longer impaired	NPDES27529
2 – no longer needing TMDL	Milford Reservoir	Eutrophication	Adequate water quality	LM019001

303d Delisted, Cont.				
Category	**Water Segment**	**Impairment**	**Comments**	**Sampling Station**
2 – no longer needing TMDL	Peats Creek near Clifton	FCB	Typographic error	SC649
2 – no longer needing TMDL	Republican River below Milford Dam	FCB	No longer impaired	NPDES34011

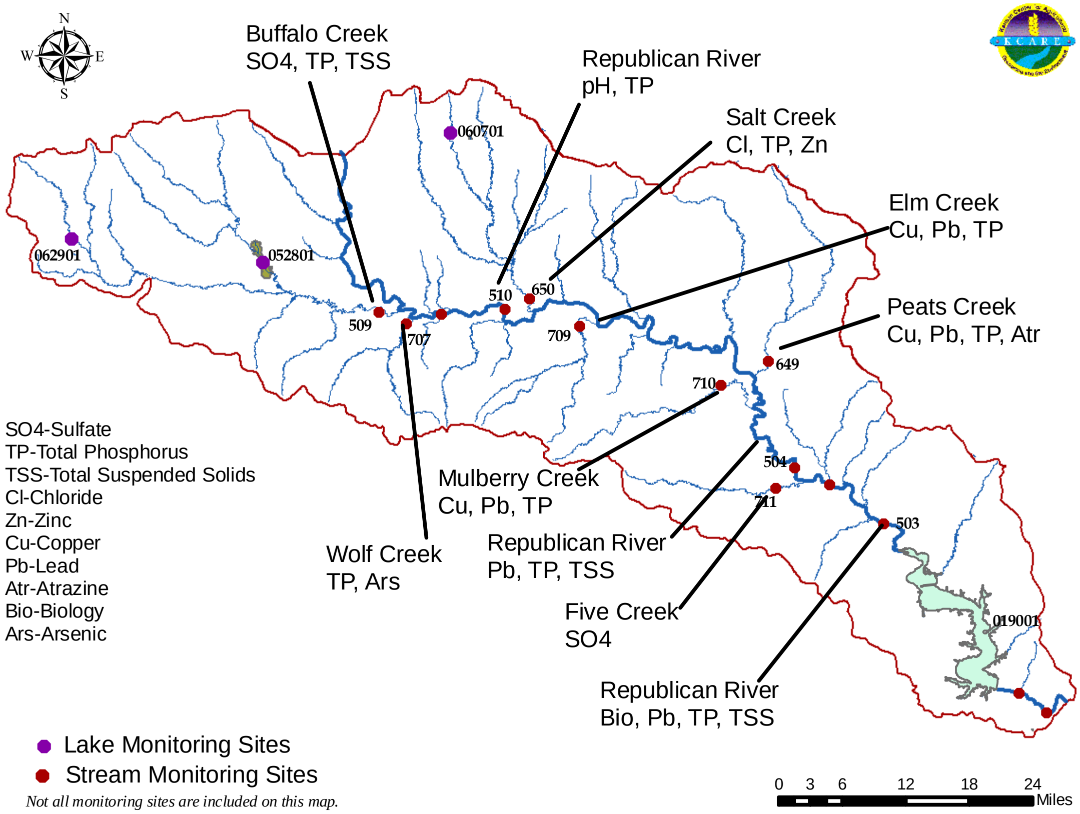


Figure 12 303d Listings in the Watershed, 2010. [21]

4.8 Load Reductions Needed [22]

The initial goals are to reduce the intervening loads from the upper and lower watersheds by 30 percent; this will result in a somewhat less reduction entering Milford Reservoir unless there is reduction from Nebraska on flows entering Kansas.

Load Reductions Needed for Milford Reservoir Summary:

1) **Total Suspended Solids (TSS) nonpoint source load allocation = 32,999 tons/year**
2) **Total Phosphorus (TP) nonpoint source load allocation = 152,000 lbs/year**

4.8.1 Sediment

Estimated annual loads for the Republican River were determined from average annual flows at Hardy, Concordia and Clay Center and average Total Suspended Solids (TSS) values from stations in the vicinity of these gages. Only Buffalo Creek and Salt Creek are impaired by total suspended solids. Only the portion of the Republican River below the confluence of Salt Creek is impaired by TSS.

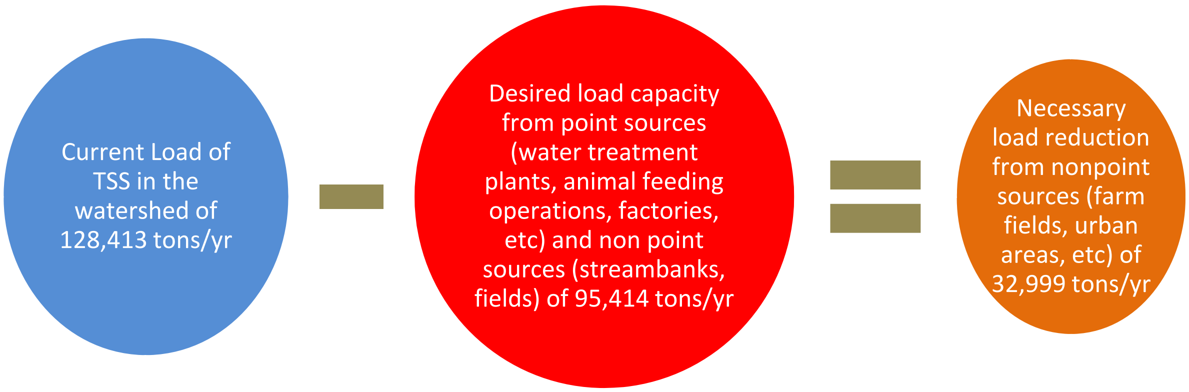


Table 9 Milford Reservoir Summary for TSS

TSS Load	TSS tons/year
Current Load	128,413
Desired Load Capacity	95,414
Reduction in TSS Nonpoint Load	***32,999***

4.8.2 Phosphorus

Estimated annual loads for the Republican River were determined from average annual flows at Hardy, Concordia and Clay Center and average TP values from stations in the vicinity of these gages. Most tributaries to the Republican River are impaired by excessive TP.

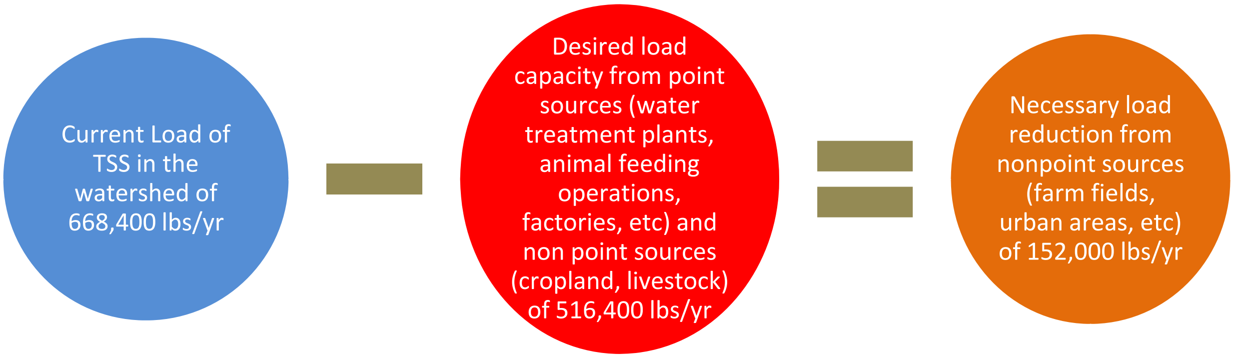


Table 10 Milford Reservoir Summary for TP

TP Load	TP pounds/year
Current Load	668,400
Desired Load Capacity	516,400
Reduction in TP Nonpoint Load	***152,000***

4.8.3 E. Coli Bacteria

Bacteria Load Reductions should result in less frequent exceedance of the nominal ECB criterion (427 counts in these cases); and in lowered magnitude of those exceedances.

In order to assess the impact of BMPs addressing bacteria impairments; an index will be used to ascertain the relative frequency and magnitude of bacteria concentrations seen in the receiving streams, monitored by KDHE on a routine or rotational basis.

The calculated index will be the natural logarithm of each sample value taken during the April-October primary recreation season, divided by the natural logarithm of the bacteria criterion [ln(427)]

$$\text{Index} = \ln(\text{ECB count}) / \ln(427)$$

The plot of the cumulative frequency of the samples' index value creates a profile of estimated current frequency and magnitude of bacteria counts in the stream relative to the stream's bacteria criterion. Ideally the post-implementation profile of future samples will plot below the current profile and cross the index value = 1 at the 90th percentile. This indicates that at least 90% of sampled values are under the criterion value and more intensive sampling would likely show attainment of the water quality standard.

Ultimately, compliance with water quality standards will require sampling 5 times within 30 days during several periods during the primary recreation season, and calculating the geometric mean of those samplings. Meeting that test will be justification for delisting the stream impairment.

Salt Creek has been sampled twice for *E. coli* bacteria, in 2005 and 2009. As such, there are only seven samples collected during the primary recreation season of April to October of both years. Five of the seven samples were over the nominal criterion value of 427 (index = 1), thus, elevated bacteria during primary recreation season is the norm. The profile derived from the seven samples, shown below, tends to be weighed toward showing excessive bacteria.

The future profile, developed from samples taken during the primary recreation seasons of 2013 and 2017 should plot below the current profile and a subsequent profile from data collected in 2021 and 2025 should approach that shown as the TMDL profile. At that time, less than 10 percent of samples should exceed the nominal criterion value and intensive (5 in 30 day) sampling should commence to determine if Salt Creek complies with water quality standards.

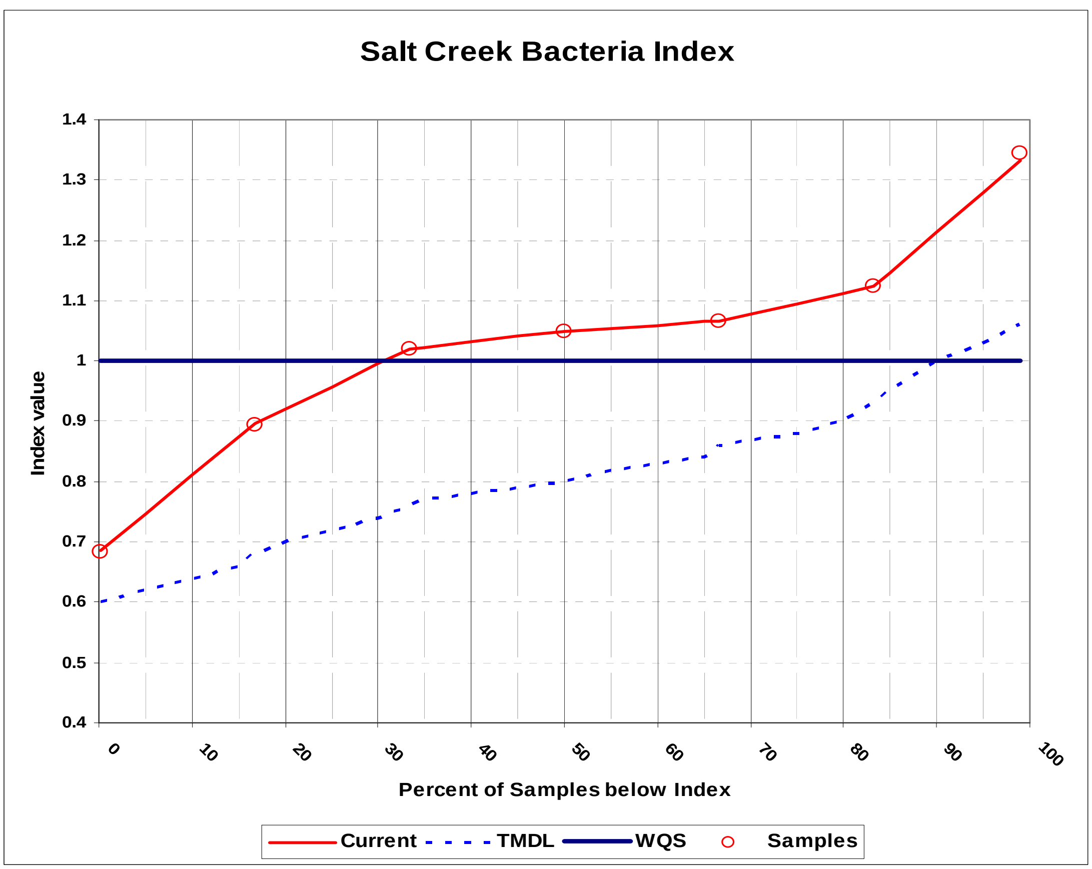


Figure 13 Salt Creek Bacteria Index

5.0 Targeted Areas and Load Reduction Methodology

5.1 Targeted Areas

The Lower Republican 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 sub watershed. Some subbasins have higher loads than the others. All subbasins are ranked based on the values of an average annual load, sorted from highest to lowest, and form the ranking list. Subbasins within the top 20-30 percent of the list are selected as critical (targeted) areas for cropland and livestock BMPs implementation.

The SWAT model was developed by USDA-Agricultural Research Service (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 sub watersheds. 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-ARS. 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 sub watersheds using digital elevation data according to the drainage area specified by the user. Sub watersheds 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 sub watershed having similar soil, land use, and slope characteristics. The use of HRUs allows slope, soil, and land-use heterogeneity to be simulated within each sub watershed, but ignores pollutant attenuation between the source area and stream and limits spatial representation of wetlands, buffers, and other BMPs within a sub watershed.

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 that is provided in the crop database.
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 sub watershed 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 targeted areas.

Data for the Lower Republican 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. The SWAT targeted area will be used for cropland BMP placement. The livestock targeted area was set by the SLT through their knowledge of the watershed and will focus BMP placement for nutrient runoff. In the absence of a streambank assessment, the streambank targeted areas consist of barren land alongside the Republican River as determined by the Riparian Buffer layer obtained from Kansas Geospatial Community Commons using GIS. Streambank will target sediment and nutrients. Targeting for this watershed will be accomplished in three different areas:

1. Cropland will be targeted for sediment and nutrients,
2. Livestock areas will be targeted for nutrients, and
3. Streambanks will be targeted for sediment and nutrients.

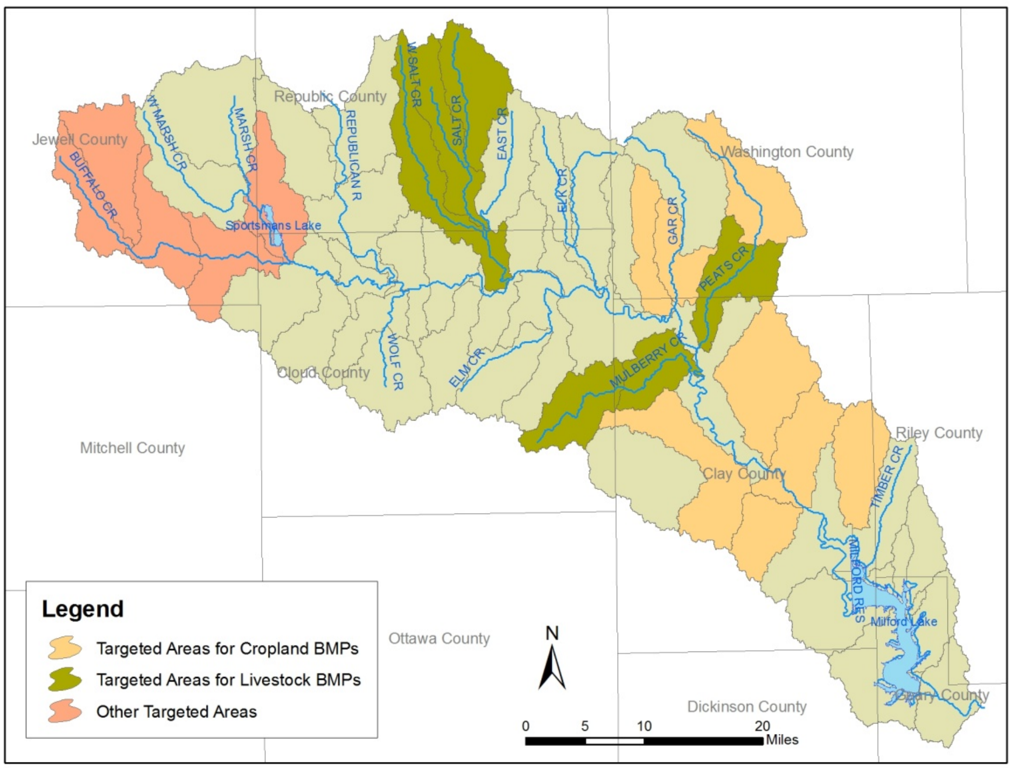


Figure 14 Composite of Targeted Areas for Cropland, Livestock and Streambank BMP Placement [23]

The maps produced by the modeling are displayed below. It is noted that the darker the shading in the map, the greater the potential for nitrogen, phosphorus or sediment runoff. The sub watersheds in the central portion of the watershed, mainly contained in Clay County show the highest potential for erosion, phosphorous, and nitrogen runoff. As stated earlier, this model accounts for land use, soil type, slope, and current conservation practices. This is the area of the watershed with the greatest percentage of cropland, which leads to a higher potential for erosion compared to areas that are mainly composed of grassland.

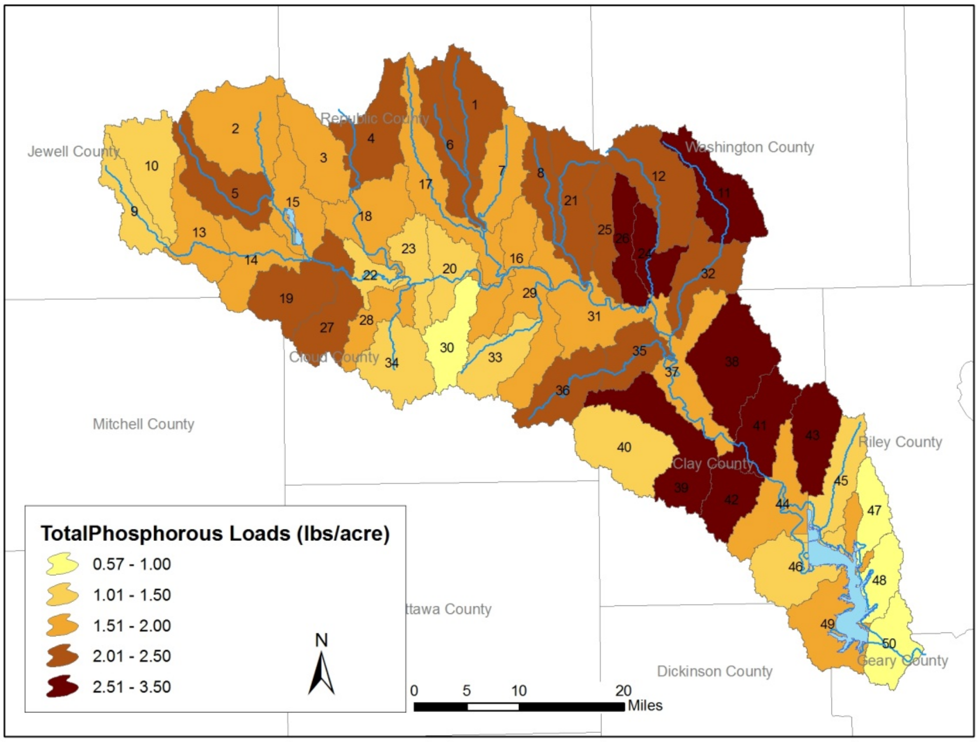


Figure 15 Phosphorus (lbs/acre) Yield as Determined by SWAT

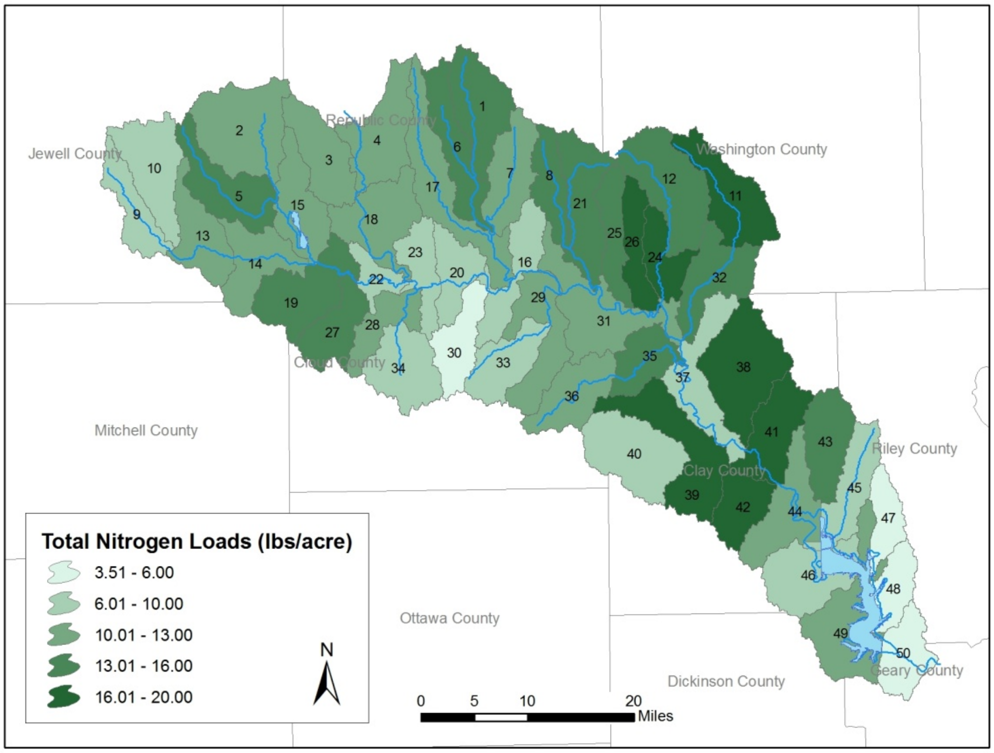


Figure 16 Nitrogen (lbs/acre) Yield as Determined by SWAT

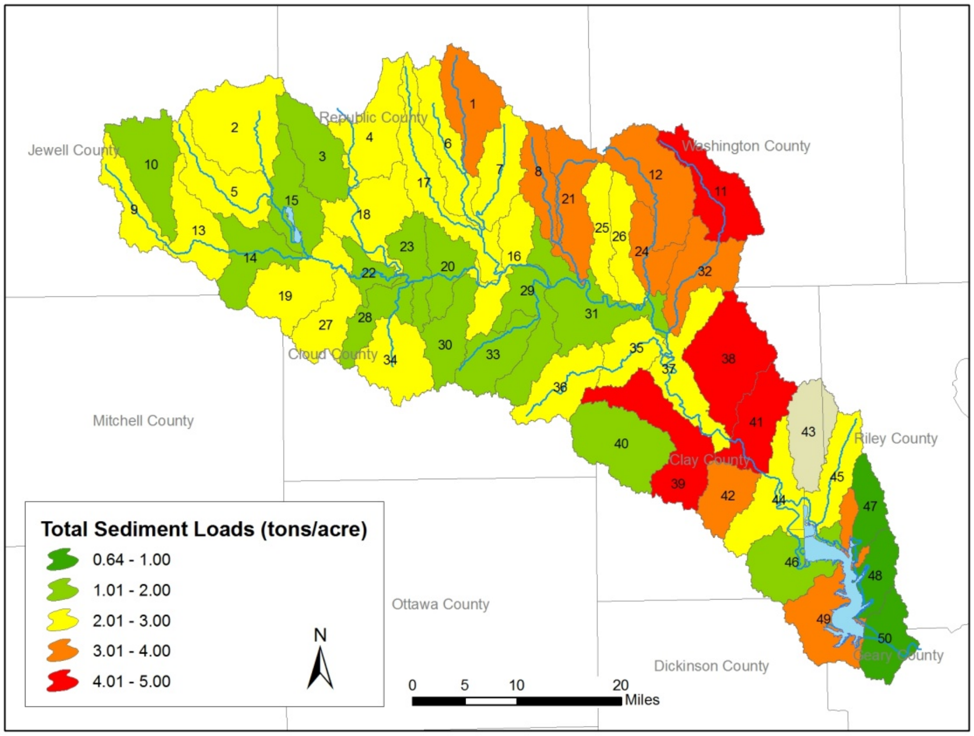


Figure 17 Sediment (tons/acre) Yield as Determined by SWAT

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 2009, the groundtruthing provided the current adoption rates for four common BMPs (conservation crop rotation, grassed waterways, no-till, and vegetative buffers) in the cropland targeted area of the watershed averaged across counties. The results are as follows:

- Conservation Crop Rotation – current adoption rate of 96 percent
- Grassed waterways – current adoption rate of 82 percent
- No-till cultivation – current adoption rate of 52 percent
- Vegetative buffer strips – current adoption rate of 6 percent

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 provided in Tables 14 and 19.

5.2 Cropland Erosion

The SWAT delineated (primary ranked) Targeted Area of this project is to be used for the determination of BMP placement for sediment (overland origin). This area includes a portion of the Five Creek, Mall Creek, Lincoln Creek, Finney Creek, Otter Creek, Dry Creek and Peats Creek. This area contains HUC numbers:

- 102500170501 (subbasin 11)
- 102500170408 (subbasin 24)
- 102500170406 (subbasin 26)
- 102500170507 (subbasin 38)
- 102500170506 (subbasin 39)
- 102500170602 (subbasin 41)
- 102500170601 (subbasin 42)
- 102500170603 (subbasin 43)

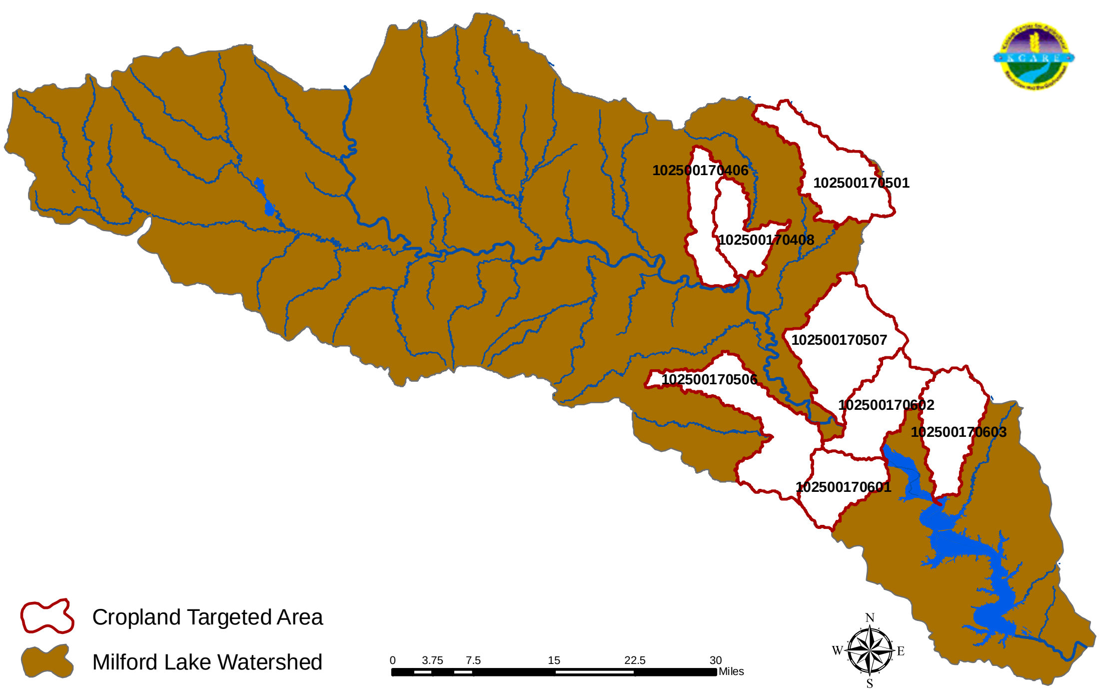


Figure 18 SWAT Targeted Area for Cropland in the Watershed

Table 11 Land use in the SWAT Delineated Cropland Targeted Area [24]

Subbasin 11 (102500170501)			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	15,567	1.23	51.21
Range-Grasses	11,417	0.90	37.56
Forest-Deciduous	1,366	0.11	4.49
Residential-Low Density	1,205	0.10	3.96
Hay -	333	0.03	1.10
Residential-Medium Density	252	0.02	0.83
Water	96	0.01	0.31
Forest-Mixed	76	0.01	0.25
Residential-High Density	37	0.00	0.12
Wetlands-Forested	34	0.00	0.11
Industrial	8	0.00	0.03
Wetlands-Non-Forested	6	0.00	0.02
Range-Brush	3	0.00	0.01
Total	**30,401**	**2.41**	**100.00**
Subbasin 24 (102500170408)			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	10,412	0.82	65.05
Range-Grasses	4,072	0.32	25.44
Residential-Low Density	638	0.05	3.99
Forest-Deciduous	574	0.05	3.59
Hay	132	0.01	0.82
Wetlands-Forested	76	0.01	0.47
Residential-Medium Density	46	0.00	0.29
Water	35	0.00	0.22
Forest-Mixed	12	0.00	0.07
Range-Brush	6	0.00	0.03
Wetlands-Non-Forested	3	0.00	0.02
Residential-High Density	2	0.00	0.01
Total	**16,006**	**1.26**	**100.00**
Subbasin 26 (102500170406)			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	11,928	0.94	71.73
Range-Grasses	3,011	0.24	18.11
Residential-Low Density	722	0.06	4.34
Forest-Deciduous	677	0.05	4.07
Residential-Medium Density	154	0.01	0.92
Wetlands-Forested	53	0.00	0.32

Subbasin 26 (102500170406), Cont.

LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Water	28	0.00	0.17
Hay	24	0.00	0.14
Residential-High Density	21	0.00	0.13
Forest-Mixed	8	0.00	0.05
Industrial	5	0.00	0.03
Total	**16,630**	**1.30**	**100.01**

Subbasin 38 (102500170507)

LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	24,090	1.90	58.83
Range-Grasses	11,871	0.94	28.99
Residential-Low Density	1,697	0.13	4.15
Forest-Deciduous	1,612	0.13	3.94
Residential-Medium Density	848	0.07	2.07
Hay	406	0.03	0.99
Residential-High Density	157	0.01	0.38
Industrial	106	0.01	0.26
Water	96	0.01	0.23
Wetlands-Forested	34	0.00	0.08
Forest-Mixed	26	0.00	0.06
Southwestern US (arid) range	3	0.00	0.01
Wetlands-Non Forested	2	0.00	0.00
Total	**40,947**	**3.23**	**99.99**

Subbasin 39 (102500170506)

LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	21,081	1.66	56.38
Range-Grasses	12,505	0.99	33.45
Forest-Deciduous	1,620	0.13	4.33
Residential-Low Density	1,399	0.11	3.74
Hay	522	0.04	1.39
Water	114	0.01	0.31
Residential-Medium Density	64	0.01	0.17
Wetlands-Forested	65	0.01	0.17
Forest-Mixed	17	0.00	0.05
Range-Brush	2	0.00	0.00
Total	**37,389**	**2.96**	**99.99**

Subbasin 41 (102500170602)			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	13,653	1.08	53.30
Range-Grasses	8,694	0.69	33.94
Residential-Low Density	1,082	0.09	4.22
Forest-Deciduous	856	0.07	3.34
Water	401	0.03	1.56
Hay	363	0.03	1.42
Residential-Medium Density	344	0.03	1.34
Wetlands-Forested	174	0.01	0.68
Residential-High Density	34	0.00	0.13
Industrial	6	0.00	0.02
Forest-Evergreen	5	0.00	0.02
Southwestern US (arid) range	3	0.00	0.01
Forest-Mixed	1	0.00	0.01
Total	**25,616**	**2.03**	**99.99**

Subbasin 42 (102500170601)			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	9,367	0.74	53.22
Range-Grasses	6,504	0.51	36.95
Forest-Deciduous	718	0.06	4.08
Residential-Low Density	673	0.05	3.82
Hay	170	0.01	0.96
Residential-Medium Density	63	0.00	0.36
Wetlands-Forested	62	0.00	0.35
Water	45	0.00	0.26
Total	**17,601**	**1.37**	**100.00**

Subbasin 43 (102500170603)			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Range-Grasses	11,530	0.91	48.71
Agricultural Land-Row Crops	9,027	0.71	38.14
Forest-Deciduous	1,124	0.09	4.75
Residential-Low Density	1,075	0.08	4.54
Hay	540	0.04	2.28
Residential-Medium Density	143	0.01	0.60
Water	124	0.01	0.53
Wetlands-Forested	62	0.00	0.26
Southwestern US (arid) range	17	0.00	0.07
Forest-Evergreen	11	0.00	0.05
Residential-High Density	8	0.00	0.04

Subbasin 43 (102500170603), Cont.			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Forest-Mixed	6	0.00	0.03
Industrial	2	0.00	0.01
Total	**23,669**	**1.85**	**100.01**

5.3 Livestock Targeted Areas

The targeted areas for livestock BMP implementation were selected by the KDHE TMDL section based on past monitoring data. A presentation of common livestock BMPs to reduce phosphorous and bacteria runoff from livestock facilities was given to the SLT. Livestock producers within these areas as well as local agency personnel familiar with these areas then discussed which BMPs were needed in the area. The top five livestock BMPs were selected by need, cost-effectiveness, and producer acceptability. Adoption rate goals were set for the next 20 years based on their overall need and what can be feasibly adopted.

The SLT has determined an area for targeting **livestock** related phosphorus pollutants. Livestock BMPs will be placed in this area. The HUC 12 areas and correlated SWAT delineated areas are:

- 102500170306 (subbasin 1)
- 102500170307 (subbasin 6)
- 102500170102 (subbasin 9)
- 102500170101 (subbasin 10)
- 102500170103 (subbasin 13)
- 102500170107 (subbasin 14)
- 102500170309 (subbasin 17)
- 102500170502 (subbasin 32)
- 102500170504 (subbasin 35)
- 102500170503 (subbasin 36)

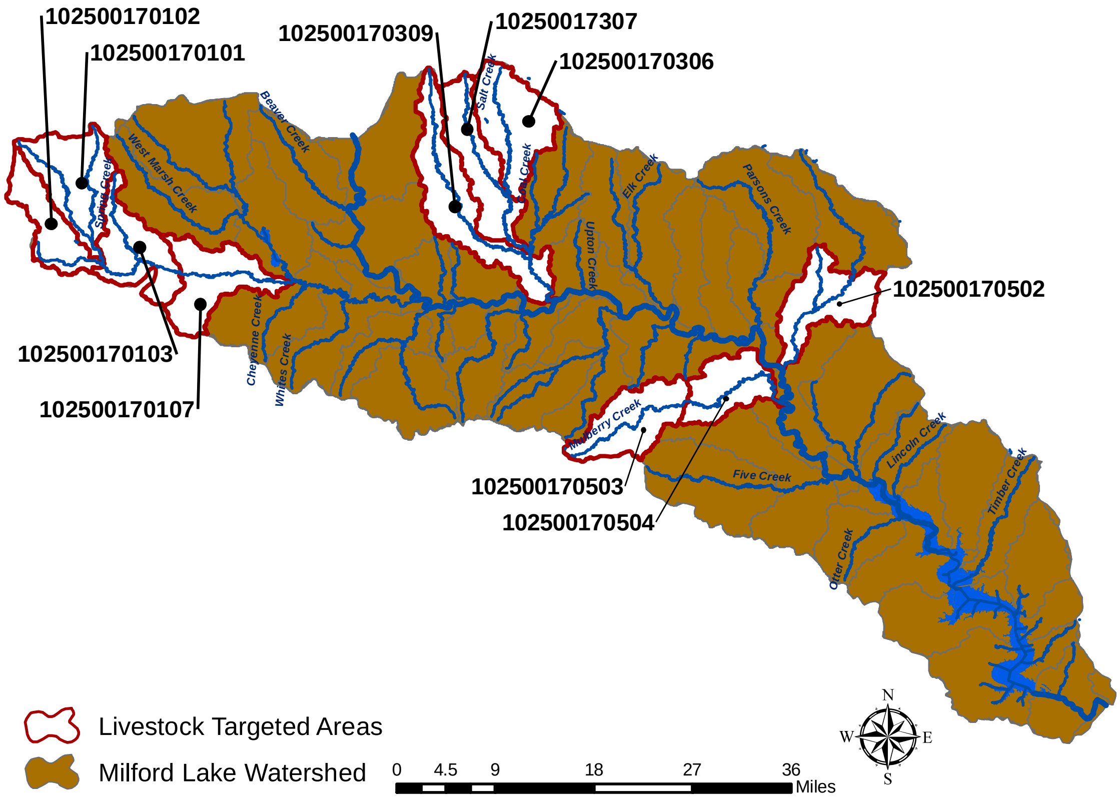


Figure 19 SLT Determined Livestock Targeted Areas

Table 12 Land Use in the Livestock Targeted Area [24]

Subbasin 1 (102500170306)			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	13,487	1.06	47.95
Range-Grasses	10,889	0.86	38.72
Forest-Deciduous	1,408	0.11	5.01
Residential-Low Density	1,402	0.11	4.98
Residential-Medium Density	471	0.04	1.67
Residential-High Density	163	0.01	0.58
Wetlands-Forested	161	0.01	0.57
Water	112	0.01	0.40
Industrial	15	0.00	0.05
Wetlands-Non-Forested	13	0.00	0.05
Southwestern US (arid) range	2	0.00	0.01
Range-Brush	2	0.00	0.01
Total	**28,125**	**2.21**	**100.00**

Subbasin 6 (102500170307)

LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	12,883	1.02	51.83
Range-Grasses	8,179	0.65	32.91
Forest-Deciduous	1,321	0.10	5.32
Residential-Low Density	1,206	0.10	4.85
Residential-Medium Density	425	0.03	1.71
Wetlands-Forested	264	0.02	1.06
Hay	259	0.02	1.04
Residential-High Density	189	0.01	0.76
Water	76	0.01	0.30
Industrial	40	0.00	0.16
Wetlands-Non-Forested	9	0.00	0.04
Forest-Mixed	3	0.00	0.01
Range-Brush	2	0.00	0.01
Total	**24,855**	**1.96**	**100.00**

Subbasin 9 (102500170102)

LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	10,018	0.79	55.07
Range-Grasses	6,671	0.53	36.67
Forest-Deciduous	677	0.05	3.72
Residential-Low Density	553	0.04	3.04
Residential-Medium Density	165	0.01	0.91
Water	50	0.00	0.28
Wetlands-Forested	26	0.00	0.15
Residential-High Density	18	0.00	0.10
Southwestern US (arid) range	5	0.00	0.03
Wetlands-Non-Forested	3	0.00	0.02
Industrial	2	0.00	0.01
Total	**18,190**	**1.42**	**100.00**

Subbasin 10 (102500170101)

LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	13,232	1.04	45.27
Range-Grasses	12,421	0.98	42.49
Forest-Deciduous	1,495	0.12	5.11
Residential-Low Density	1,151	0.09	3.94
Residential-Medium Density	654	0.05	2.24
Wetlands-Forested	90	0.01	0.31
Residential-High Density	71	0.01	0.24
Water	66	0.01	0.22

Subbasin 10 (102500170101), Cont.			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Wetlands-Non-Forested	28	0.00	0.10
Industrial	17	0.00	0.06
Southwestern US (arid) range	7	0.00	0.02
Total	**29,232**	**2.31**	**100.00**
Subbasin 13 (102500170103)			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	16,532	1.31	72.47
Range-Grasses	4,442	0.35	19.47
Residential-Low Density	830	0.07	3.64
Forest-Deciduous	634	0.05	2.78
Residential-Medium Density	149	0.01	0.65
Hay	148	0.01	0.65
Water	36	0.00	0.16
Wetlands-Forested	24	0.00	0.11
Residential-High Density	7	0.00	0.03
Wetlands-Non-Forested	5	0.00	0.02
Southwestern US (arid) range	3	0.00	0.01
Range-Brush	1	0.00	0.00
Total	**22,811**	**1.80**	**99.99**
Subbasin 14 (102500170107)			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	16,735	1.32	69.67
Range-Grasses	5,475	0.43	22.79
Residential-Low Density	903	0.07	3.76
Forest-Deciduous	556	0.04	2.31
Hay	223	0.02	0.93
Residential-Medium Density	82	0.01	0.34
Wetlands-Forested	28	0.00	0.12
Water	17	0.00	0.07
Wetlands-Non-Forested	1	0.00	0.01
Total	**24,020**	**1.89**	**100.00**
Subbasin 17 (102500170309)			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	20,899	1.65	56.55
Range-Grasses	11,744	0.93	31.78
Forest-Deciduous	1,704	0.13	4.61

Subbasin 17 (102500170309), Cont.			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Residential-Low Density	1,684	0.13	4.56
Wetlands-Forested	315	0.02	0.85
Hay	232	0.02	0.63
Residential-Medium Density	165	0.01	0.45
Water	95	0.01	0.26
Residential-High Density	90	0.01	0.24
Forest-Mixed	12	0.00	0.03
Wetlands-Non-Forested	12	0.00	0.03
Southwestern US (arid) range	5	0.00	0.01
Range-Brush	1	0.00	0.00
Total	**36,958**	**2.91**	**100.00**

Subbasin 32 (102500170502)			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	12,500	0.99	47.40
Range-Grasses	10,775	0.85	40.86
Forest-Deciduous	1,109	0.09	4.21
Residential-Low Density	960	0.08	3.64
Hay	653	0.05	2.48
Residential-Medium Density	119	0.01	0.45
Water	113	0.01	0.43
Forest-Mixed	93	0.01	0.35
Wetlands-Forested	44	0.00	0.17
Wetlands-Non-Forested	4	0.00	0.01
Residential-High Density	1	0.00	0.00
Total	**26,370**	**2.09**	**100.00**

Subbasin 35 (102500170504)			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Agricultural Land-Row Crops	9,843	0.78	54.88
Range-Grasses	6,568	0.52	36.62
Forest-Deciduous	687	0.05	3.83
Residential-Low Density	670	0.05	3.73
Wetlands-Forested	68	0.01	0.38
Water	39	0.00	0.22
Residential-Medium Density	20	0.00	0.11
Forest-Mixed	18	0.00	0.10
Hay	13	0.00	0.07
Wetlands-Non-Forested	5	0.00	0.03
Residential-High Density	1	0.00	0.01

Subbasin 35 (102500170504), Cont.			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Range-Brush	2	0.00	0.01
Total	**17,937**	**1.41**	**99.99**

Subbasin 36 (102500170503)			
LANDUSE:	Area[acres]	Percent Watershed Area	Percent Subbasin Area
Range-Grasses	13,815	1.09	57.20
Agricultural Land-Row Crops	8,498	0.67	35.19
Residential-Low Density	896	0.07	3.71
Forest-Deciduous	690	0.05	2.86
Water	113	0.01	0.47
Hay	82	0.01	0.34
Forest-Mixed	30	0.00	0.12
Wetlands-Forested	15	0.00	0.06
Residential-Medium Density	9	0.00	0.04
Range-Brush	1	0.00	0.00
Total	**24,150**	**1.90**	**99.99**

5.3 Streambank Erosion

In the absence of a streambank assessment, the SLT has determined that the targeted area for **streambank** restoration will be the barren lands that lie along the Republican River. This area is determined by the 1991 USDA/NRCS GIS Riparian layer originating from the Kansas Geospatial Community Commons. It will be targeted for sediment and nutrients that originate from streambank failures and lack of riparian cover. There are approximately 1259 acres of a 100 foot buffer along the river that are considered barren which converts to 104 miles of streambank.

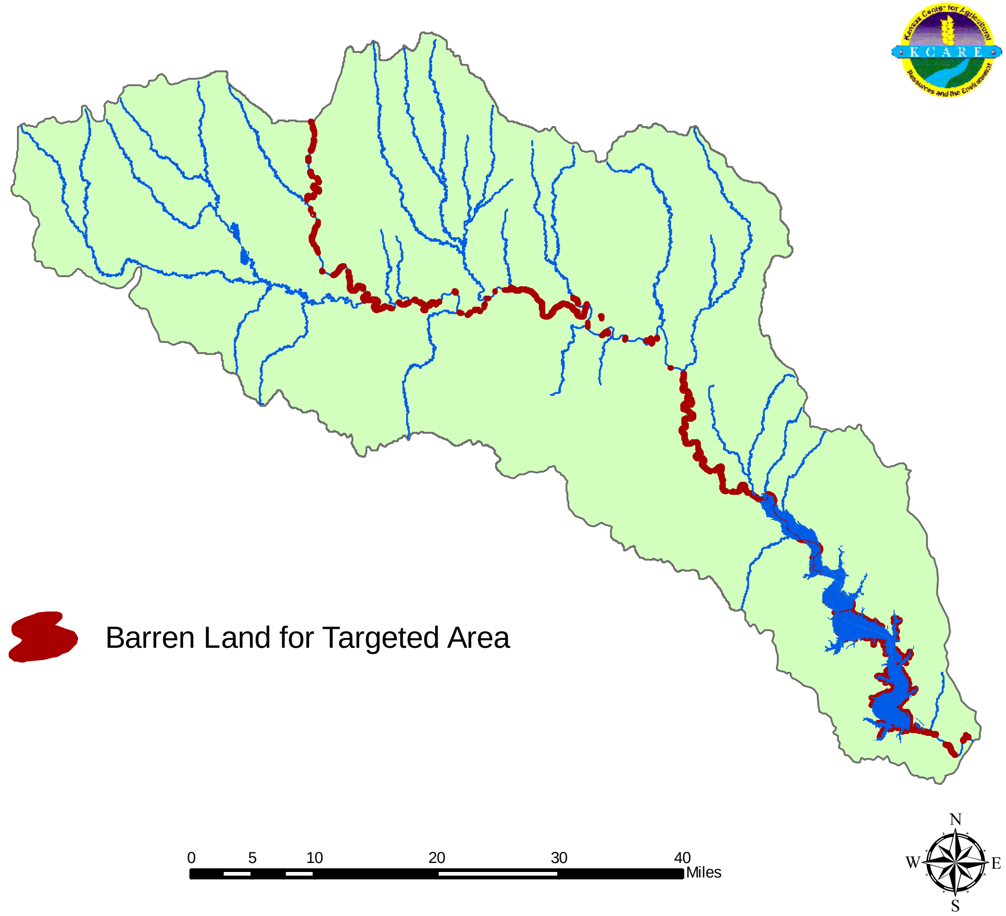


Figure 20 Streambank Targeted Areas [25]

5.4 Load Reduction Estimate Methodology

5.4.1 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. [26] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

5.4.2 Livestock

Baseline nutrient loadings per animal unit are calculated using the Livestock Waste Facilities Handbook.[27] Livestock management practice load reduction efficiencies are derived from numerous sources including K-State Research and Extension Publication MF-2737 and MF-2454.[28] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

5.4.3 Estimating Annual Loads [29]

An analysis of the 1991 USDA/NRCS Riparian Inventory concluded that 104 miles of streambank along the main stem of the Republican River contained barren land. Within this area are prime spots to target streambank stabilization. Baseline soil erosion values were arrived at assuming a soil erosion value of 2 tons per linear foot of degraded buffer taken from TWI assessments on the Cottonwood and Neosho Rivers.

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

Additional assessments to finely tune streambank targeting and to derive more accurate streambank erosion estimates are needed in the Lower Republican Watershed. Possible service providers for the assessment are the Kansas Alliance for Wetlands and Streams (KAWS) and The Watershed Institute (TWI).

NOTE: The SLT of the Lower Republican Watershed has determined that the focus of this WRAPS process will be on two key concerns of the watershed listed in order of importance:

1. **Sedimentation**
    a. **Cropland erosion**
    b. **Streambank erosion**
2. **Nutrients**
    a. **Cropland runoff of fertilizer**
    b. **Livestock runoff of manure (including ECB)**
    c. **Streambank erosion with soil adhered nutrient runoff**

All goals and best management practices will be aimed at restoring water quality or protecting the watershed from further degradation. The following sections in this report will address these concerns.

6.0 Impairments Addressed by the SLT

6.1 Sediment

Jamestown Wildlife Management Area has a TMDL for **siltation** or sediment. This is the only siltation TMDL in the watershed. According to the TMDL reference, between 1989 and 1998 Jamestown Wildlife Management Area had elevated total suspended solids concentration seventy percent of the time. The average concentration was 133mg/L whereas it is desired to maintain concentrations below 100mg/L.

Jamestown Wildlife Management Area is a collection of wetlands and marshes. Dams were constructed on the lower end of the two largest marshes in the early 1900s to provide a more reliable source of water. Hunting is the predominant recreation in addition to fishing and wildlife viewing of numerous migratory fowl. Silt or sediment accumulation in the shallow marshes restricts habitat for birds and fish, reduces wetland volume and therefore, limits public access to the lakes because of inaccessibility to boat ramps 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. Jamestown Wildlife Management Area also has TMDLs for eutrophication and pH indicating that phosphorus runoff is occurring. Reducing erosion is necessary for a reduction in sediment. The watershed of this area is primarily row crops. 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.

Even though Milford Reservoir does not have a TMDL at this time for sediment, all load reductions are directed at the Reservoir since it is close to the endpoint of the watershed and is a major geographic feature in this watershed. All cropland and streambank BMPs implemented within the watershed will reduce the amount of sediment that enters the reservoir, positively impacting water quality.

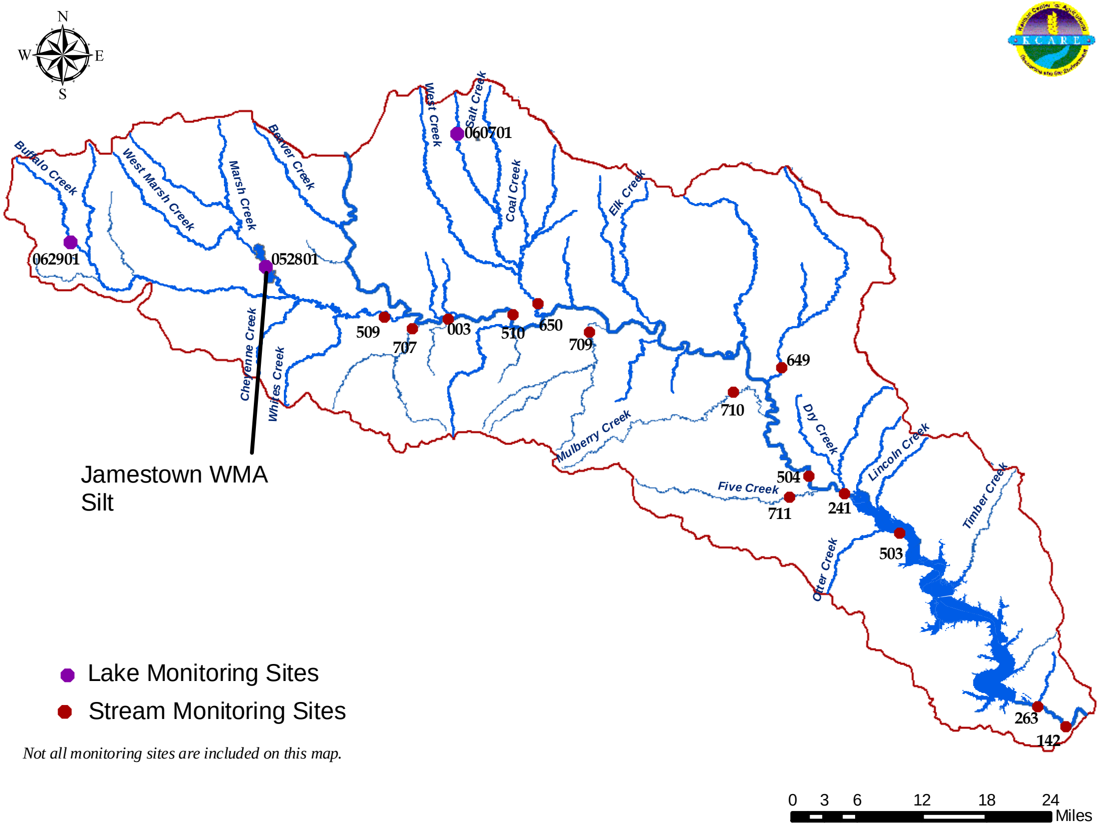


Figure 21 Lower Republican Watershed Siltation TMDL. [30]

Possible Sources of Sediment in the Entire Watershed

Activities performed on the land affects sediment that is transported downstream to the lakes. Physical components of the terrain are important in sediment movement.

- Slope of the land, propensity to generate runoff and soil type.
- 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.
- Cropland that does not have conservation practices will have a greater amount of sediment runoff than those fields with waterways or buffer strips in addition to practicing no-till or conservation tillage.
- Silt that is present in the stream from past activities and is gradually moving downstream with each high intensity rainfall event.

Activities performed on the land affects sediment that is transported downstream to the lakes. Agricultural BMPs that will help reduce sediment deposition in waterways are (in no particular order, many other BMPs exist):

- No-till
- Minimum tillage
- Vegetative buffers and riparian areas

- Grassed waterways
- Grassed terraces
- Wetland creation
- Establishing permanent vegetative cover
- Farming on the contour
- Conservation crop rotation

BMPs that have been selected by the SLT based on acceptability by the landowners, cost effectiveness and pollutant load reduction effectiveness are:

- Vegetative buffers
- No-till cropping practices
- Grassed waterways
- Conservation crop rotation
- Develop nutrient management plans

This section will review several potential sources or environmental actions that have the potential of increasing sediment in the waters. They are (in no particular order of importance):

- Land use
- T-factor or soil loss
- Hydrologic soil groups
- Riparian quality
- Precipitation distribution

6.1.1 Cropland Erosion

Cropland erosion Targeted Areas have been selected by SWAT modeling analysis. This area was chosen due to land use or the high density of cropland, soil types, soil slope and weather. The Targeted Areas for cropland in this watershed lie in HUC 12s that drain Parsons Creek, Peats Creek, Dry Creek, Spring Creek, Finney Creek, Lincoln Creek, Five Creek and Otter Creek. Causes of erosion are discussed in more detail in the rest of this section.

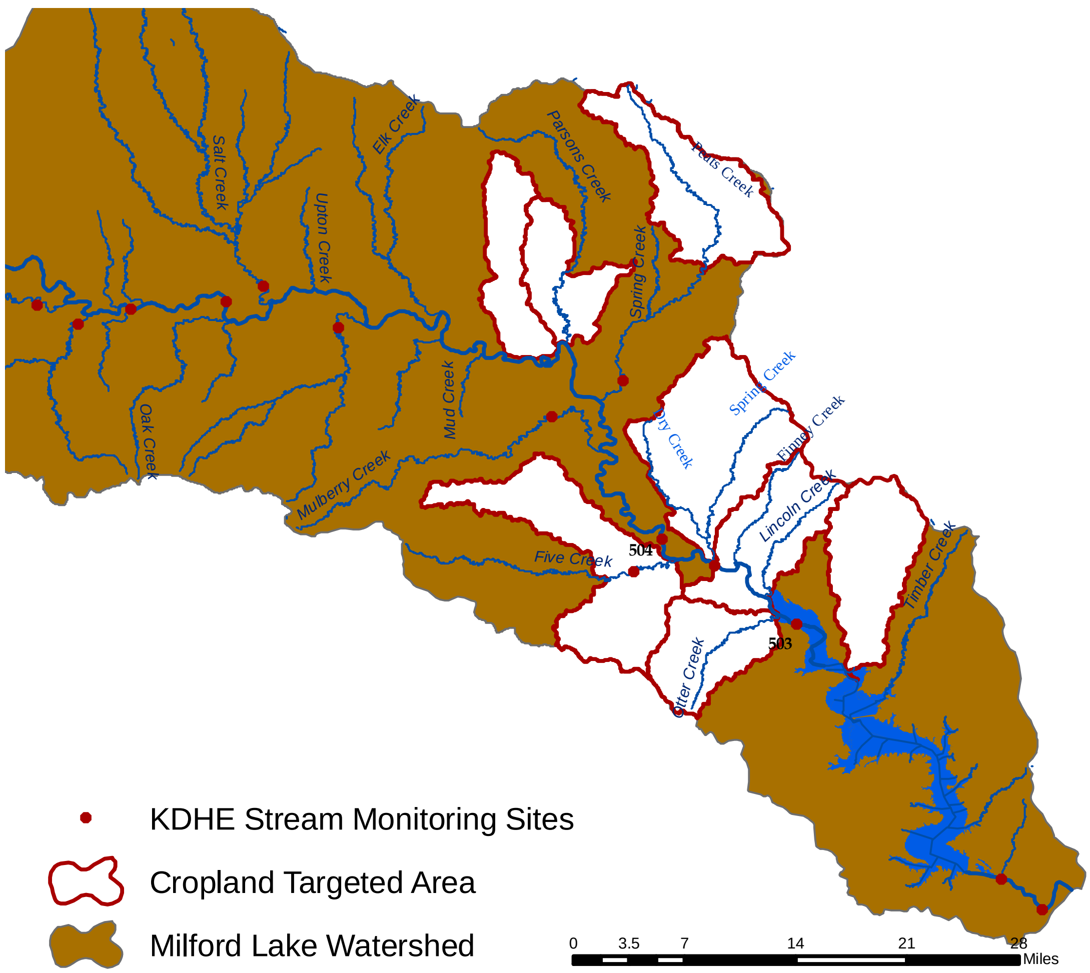


Figure 22 Targeted Area for Cropland in the Watershed as Determined by SWAT Analysis.

The Targeted Area encompasses 208,263 acres and is 16.4 percent of the entire watershed. The predominant land use is row crops at 55 percent. Implementing BMPs in the Cropland Targeted Area will reduce siltation impairments that are listed on the 2010 303d list for the Republican River near Clay Center at KDHE sample sites 503 and 504. It is hoped that the need to develop a siltation TMDL in these sections of the river will be averted.

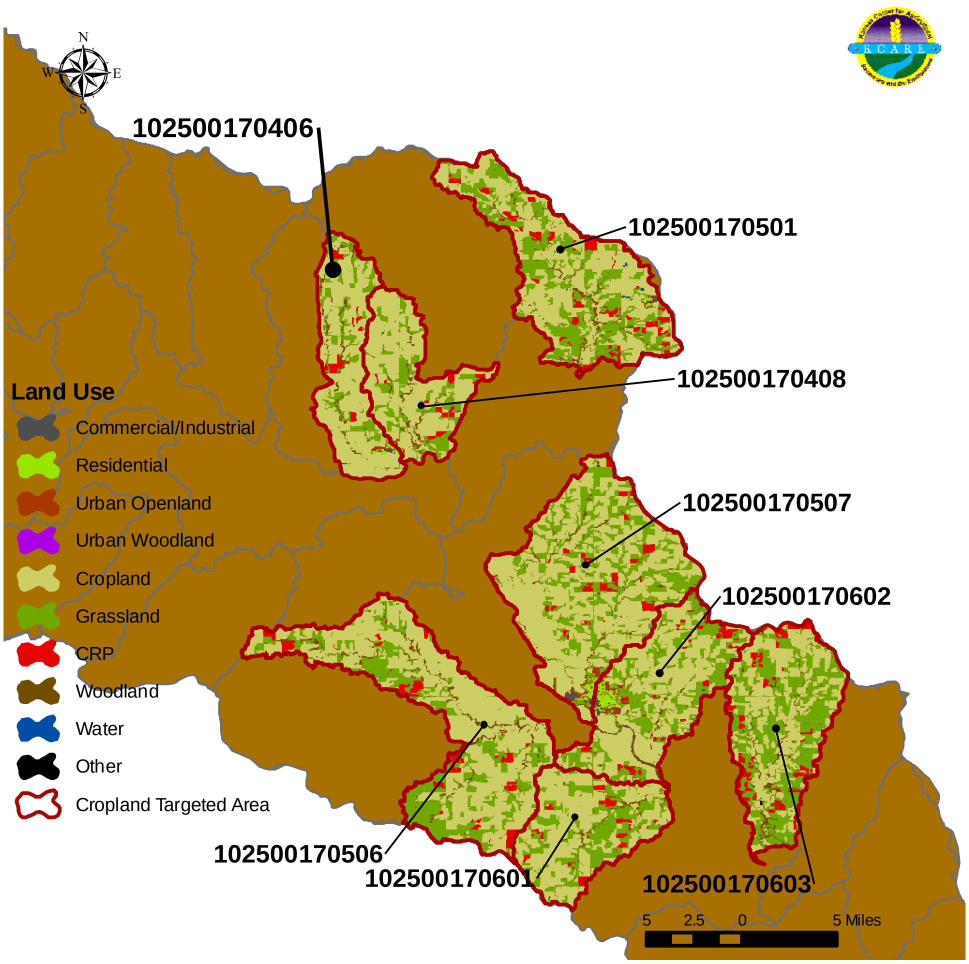


Figure 23 Land Use in the Cropland Targeted Area [5]

Table 13 Land Use in the Cropland Targeted Area [24]

Land Use	Acres	Percent of Targeted Area
Agricultural Land-Row Crops	115,125	55.28
Range-Grasses	69,604	33.42
Forest-Deciduous	8,547	4.10
Residential-Low Density	8,491	4.08
Hay	2,490	1.20
Residential-Medium Density	1,914	0.92
Water	939	0.45
Wetlands-Forested	560	0.27
Residential-High Density	259	0.12
Forest-Mixed	146	0.07
Industrial	127	0.06
Southwestern US (Arid) Range	23	0.01
Forest-Evergreen	16	0.01
Range-Brush	11	0.01
Wetlands-Non-Forested	11	0.01
Total	**208,263**	**100.00**

6.1.1. A Soil Erosion Caused 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 rate of annual soil loss that will permit crop productivity to be sustained economically and indefinitely on a given soil. 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. [31] Erosion is considered to be greater than T if either the water (sheet and rill) erosion or the wind erosion rate exceeds the soil loss tolerance rate.

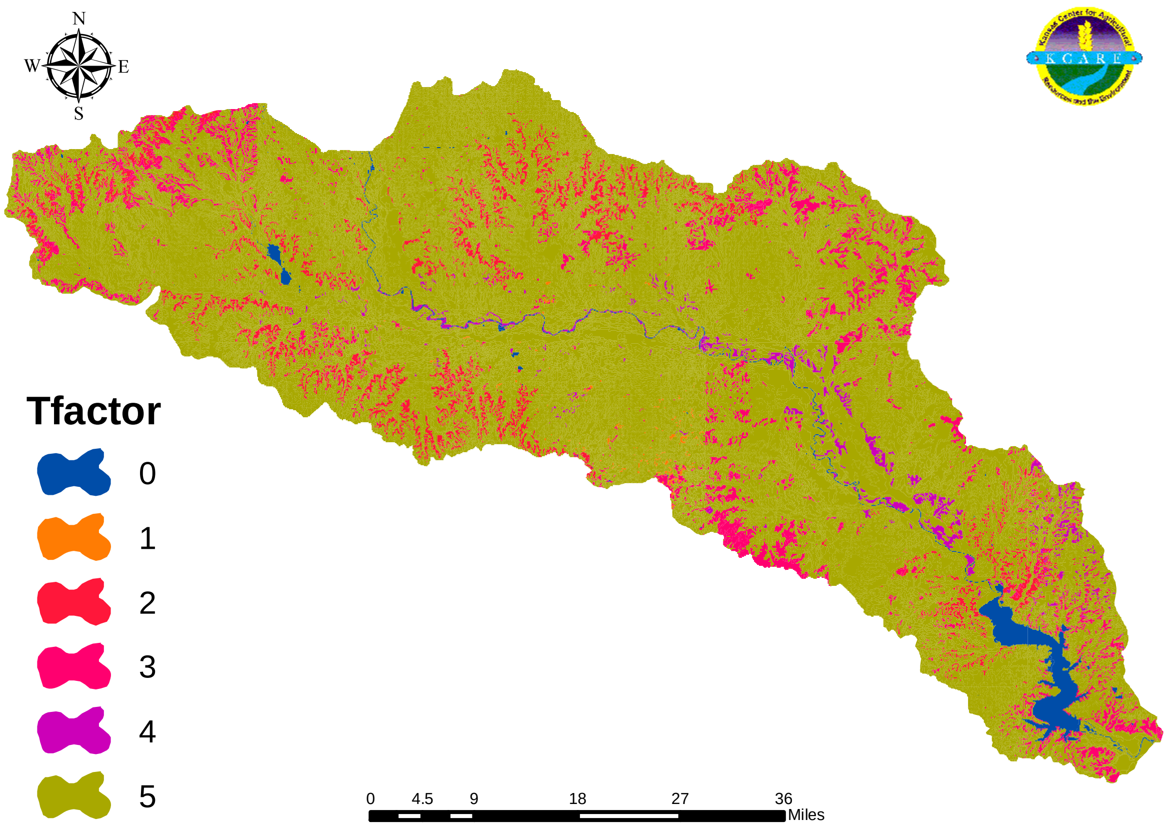


Figure 24 T Factor of the Watershed, tons/acre [32]

The predominant soil loss tolerance category in the watershed is 5. This is in 85 percent of the soils of the watershed. This indicates that the soils are deep and can be highly erosive and highlights the importance of proper conservation techniques.

Table 14 T Factor Summarization in the Watershed [32]

T Factor, tons/acre	Acres in Watershed	Percent of Watershed
0	22,177	1.75
1	2,063	0.16
2	63,830	5.03
3	83,585	6.59
4	19,415	1.53
5	1,077,943	84.94
Total	**1,269,013**	**100.00**

6.1.1. B Soil Erosion Influenced by 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.

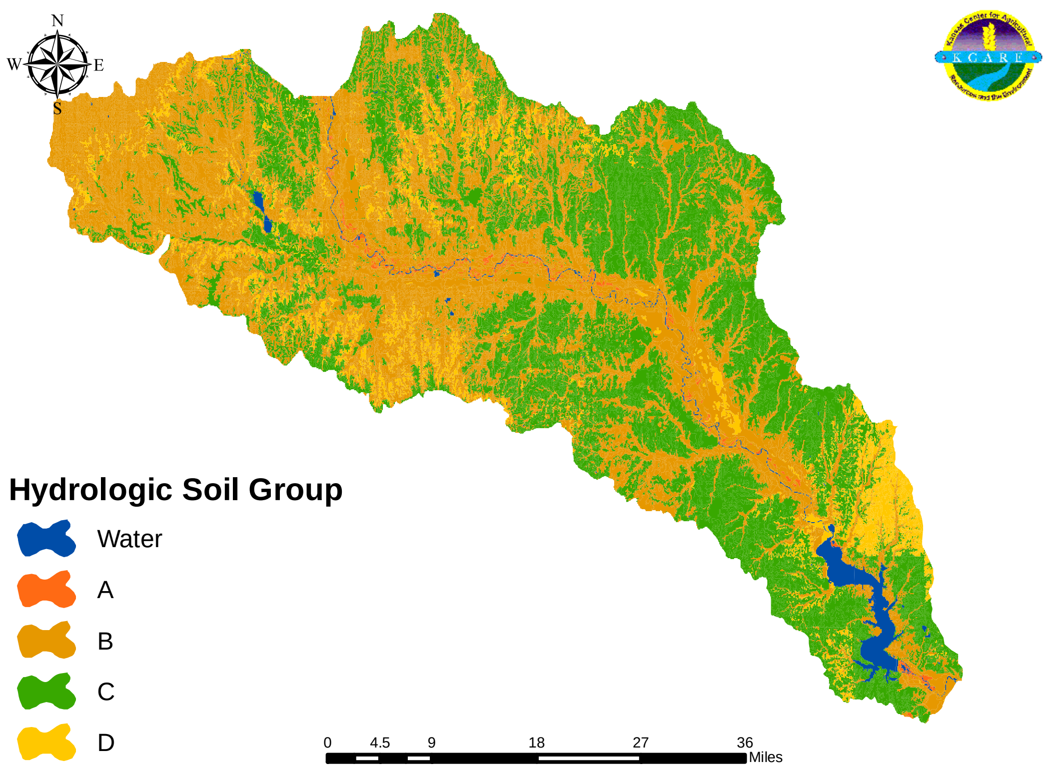


Figure 25 Hydrologic Soil Groups of the Watershed [32]

The watershed is comprised of 48 percent Soil Group B. These soils have a moderate infiltration rate. Forty one percent of the soils are Group C with a slower infiltration rate. This highlights the importance of slowing water flow from rainfall events to allow the soil adequate time to absorb the water before it flushes into creeks and streams causing erosion and degradation of the streambanks.

Table 15 Hydrologic Soil Groups of the Watershed [32]

Hydrologic Soil Group	Definition	Acres of Watershed in HSG	Percentage of Watershed 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.	7,230	0.57
B	Soils having moderate infiltration rates even when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well drained to sell drained soils with moderately fine to moderately coarse textures.	619,126	48.79
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.	520,515	41.02
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.	99,964	7.88
Other	Water, dams, pits, sewage lagoons	22,177	1.75
Total		**1,269,013**	**100.00**

6.1.2 Streambank Erosion

Sediment can originate from streambank erosion and sloughing of the sides of the river and stream bank or a lack of riparian cover can cause washing on the banks of streams or rivers and enhance erosion. It is important to have an adequate plant covered riparian area next to a stream or river that can absorb and buffer the water pressure of high flow events.

6.1.2. A Riparian Quality

An adequately functioning and healthy riparian area will stop the sediment flow from cropland and rangeland. Cropland lying adjacent to the river without buffer protection will cause erosion along the streambanks. The SLT has chosen the 100 foot barren land classification that lies along the Republican River and surrounds Milford Reservoir as determined by USDA/NRCS GIS data, 1991, to be the Streambank Targeted Areas. There is approximately 104 stream miles of barren land along the Republican River and Milford Reservoir. Land use within 1 mile of each of the targeted sections of streambank consists of primarily cropland at 50 percent. It is important that this cropland has buffers and filter strips along with forested riparian areas to impede erosion and streambank sloughing. The SLT has decided because of this, that they will incorporate BMPs aimed at streambank restoration into the WRAPS plan. Two listings on the 303d list will be addressed by stabilizing streambanks and implementing adequate buffers. They are

- Total Suspended Solids at the Republican River near Clay Center, sampling station #504
- Total Suspended Solids at the Republican River near Clay Center, sampling station #503

It is hoped that by improving conditions along the Republican River, these impairments on the 303d list will not need TMDL development.

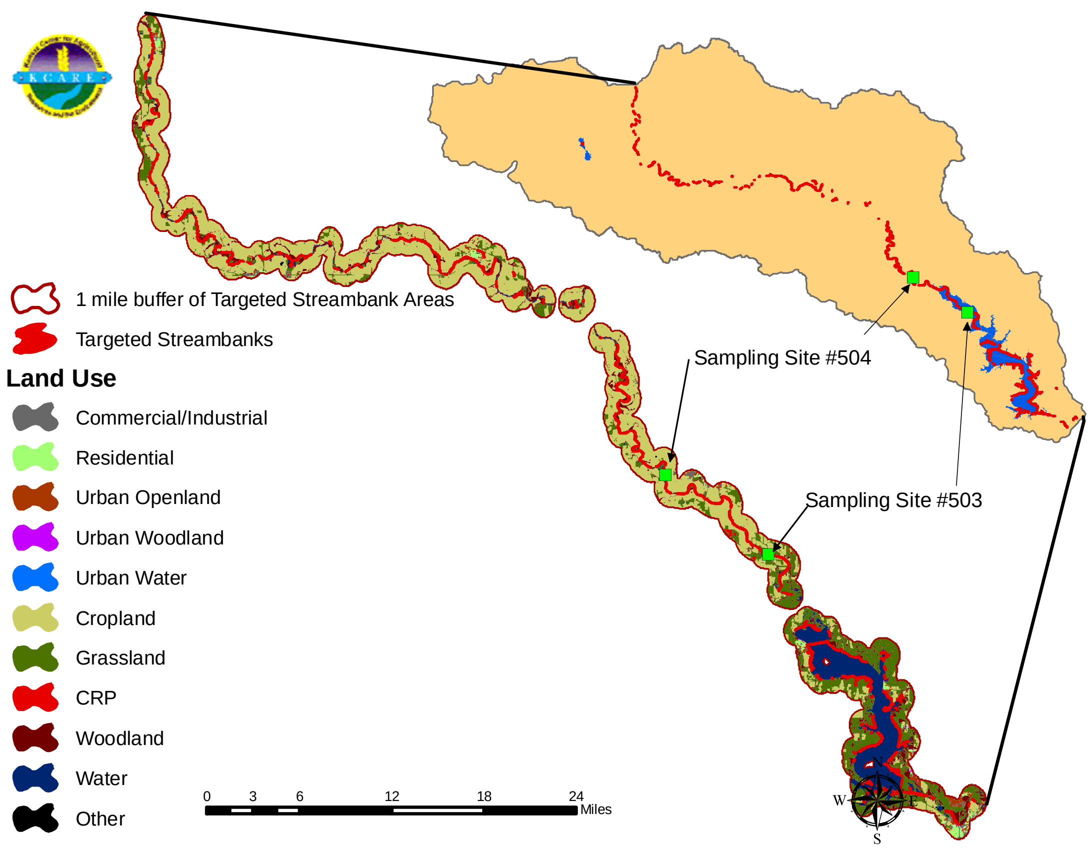


Figure 26 Land Use within 1 mile of Targeted Streambank Area [5]. Targeted Area [25] Barren Land* 100 feet of Republican River.

***Barren Land** - Areas adjacent to a stream where 51 percent of the 100 foot buffer contains land without any discernible vegetative cover, including quarries, borrows pits, and dry ponds. [25]

Table 16 Land Use in a 1 Mile Buffer Area [5] of Streambank Targeted Areas - Barren Land along the Republican River [25]

Land Use	Acres	Percent of Buffer Area
Cropland	72,428	50.80
Grassland	32,090	22.51
Water	17,740	12.44
Woodland	14,801	10.38
Urban Openland	1,826	1.28
Residential	1,798	1.26
Commercial/Industrial	967	0.68
CRP	535	0.38
Other	243	0.17
Urban Woodland	155	0.11
Urban Water	3	0.00
Total	**142,586**	**100.00**

6.1.2. 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 sediment runoff from agricultural cropland. These events can cause cropland erosion, rangeland gully erosion and sloughing of streambanks, which add sediment to streams, rivers and reservoirs. High intensity rainfall events primarily occur in the late spring and early summer in this watershed. See Figure below. This emphasizes the importance of stable river banks and cropland conservation practices to prevent soil loss.

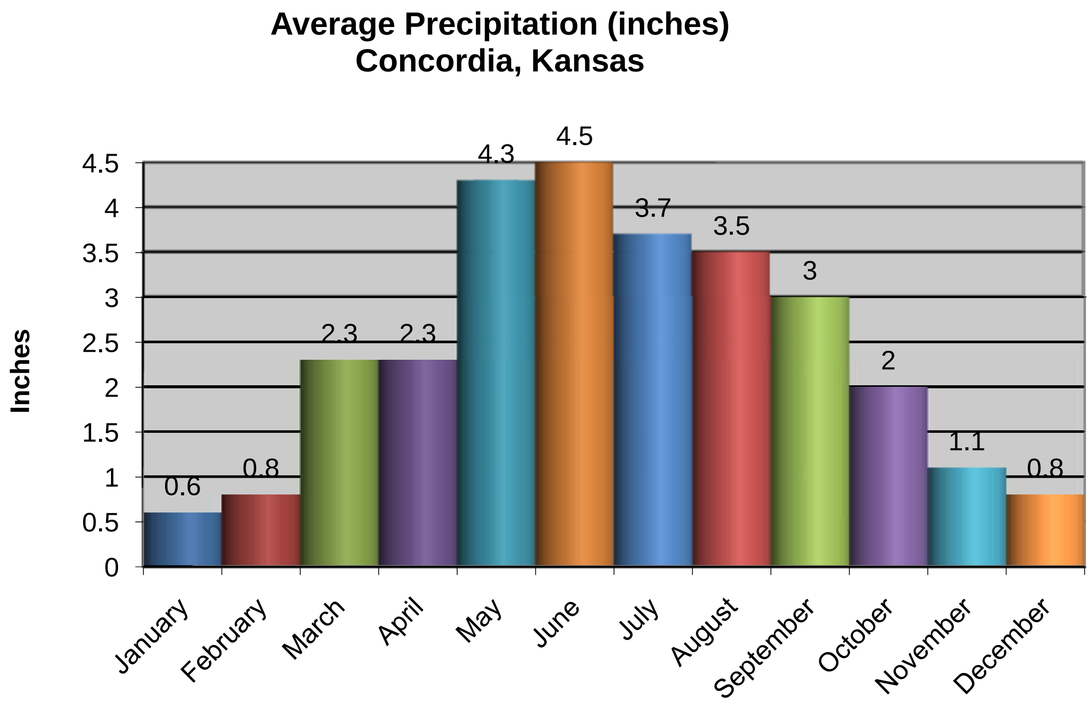
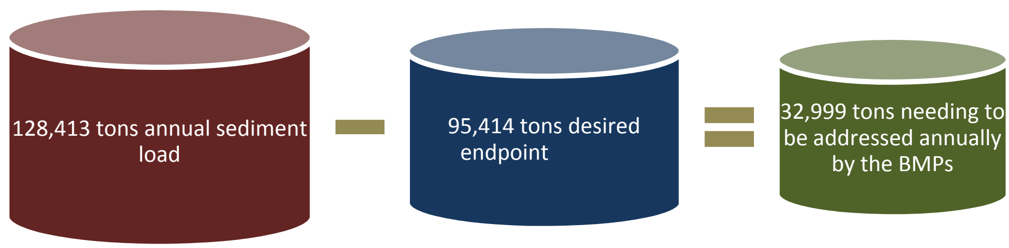


Figure 27 Average Precipitation by Month. [33] Concordia, Kansas

6.1.3 Sediment Pollutant Loads and Load Reductions

The current estimated Total Suspended Solids load in the Milford Watershed is **128,413** tons per year according to the TMDL section of KDHE. The overall goal of this WRAPS as set by KDHE is to reduce sediment by 30 percent which would be 32,999 tons. This is the amount of sediment reduction that will have to be met by implemented BMPs in the watershed. Another goal is to prevent sediment or TSS TMDLs from being developed at sampling sites #503 and 504 in the Republican River. These sites are listed on the 303d list.



The SLT has laid out specific BMPs that they have determined will be acceptable to watershed residents as listed below. **These BMPs will be implemented in the cropland and streambank targeted areas.** Specific acreages or projects that need to be implemented have been determined through modeling and economic analysis and approved by the SLT as listed below. The duration of this plan is twenty years as determined by the time required to meet the Nutrient goals. The sediment goal will be met in the first year of the plan if all BMPs are implemented. At this time, the sediment goal will be "protection" instead of "restoration".

Table 17 BMPs in Support of the Management Practices to Reduce Sediment Contribution Aimed at Reducing the Need for Implementing New TSS TMDLs for the Republican River at Sampling Sites #503 and 504 and Reduce Sediment in Milford Reservoir by 30 percent.

Protection Measures	Best Management Practices and Other Actions	Acres or Projects to be Implemented at the End of Twenty Years		
		Cropland Groundtruthing Determined by Adoption Rates		
1.0 Prevention of sediment (TSS) contribution from **cropland**	1.1 Establish conservation crop rotation	Current adoption rate = 96%	Adoption rate goal = 97%	1,883 acres
	1.2 Establish grassed waterways in crop fields	Current adoption rate = 82%	Adoption rate goal = 95%	37,668 acres treated
	1.3 Encourage continuous no-till cultivation practices	Current adoption rate = 52%	Adoption rate goal = 82%	28,251 acres
	1.4 Establish buffers strips along crop fields	Current adoption rate = 6%	Adoption rate goal = 55%	16,157 acres treated
	1.5 Develop nutrient management plans	Current adoption rate = 25%	Adoption rate goal = 73%	2,973 acres treated

BMPs, Cont.		
Protection Measures	**Best Management Practices and Other Actions**	**Acres or Projects to be Implemented at the End of Twenty Years**
2. Prevention of sediment (TSS) contribution from **streambank** erosion	Stabilize Streambanks	10,000 Linear Feet 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 18 Estimated Sediment Load Reductions for Implemented BMPs on Cropland Aimed at Reducing the Need for Implementing New TSS TMDLs for the Republican River at Sampling Sites #503 and 504 and Reduce Sediment in Milford Reservoir by 30 percent.

Milford Watershed SWAT Identified Targeted Areas					
Annual Soil Erosion Reduction (tons), Cropland BMPs					
Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total Load Reduction
1	413	13,201	18,564	5,775	37,953
2	825	26,402	37,128	11,551	75,906
3	1,238	39,603	55,692	17,326	113,859
4	1,650	52,804	74,256	23,102	151,811
5	2,063	66,005	92,820	28,877	189,764
6	2,475	79,206	111,383	34,653	227,717
7	2,888	92,407	129,947	40,428	265,670
8	3,300	105,608	148,511	46,203	303,623
9	3,713	118,809	167,075	51,979	341,576
10	4,125	132,010	185,639	57,754	379,529
11	4,538	145,211	204,203	63,530	417,482
12	4,950	158,412	222,767	69,305	455,434
13	5,363	171,613	241,331	75,081	493,387
14	5,775	184,814	259,895	80,856	531,340
15	6,188	198,015	278,459	86,632	569,293
16	6,600	211,216	297,022	92,407	607,246
17	7,013	224,417	315,586	98,182	645,199
18	7,426	237,618	334,150	103,958	683,152
19	7,838	250,819	352,714	109,733	721,105
20	8,251	264,020	371,278	115,509	759,057

Upper Milford Watershed Targeted Area			
Annual Soil Erosion Reduction (tons), Cropland BMPs			
Year	Nutrient Management Plan	Vegetative Buffers	Total Load Reduction
1	444	2,422	2,866
2	887	4,844	5,731
3	1,331	7,265	8,597
4	1,775	8,153	9,928
5	2,219	9,040	11,259
6	2,662	9,928	12,590
7	3,106	10,815	13,921
8	3,550	11,703	15,252
9	3,993	12,590	16,583
10	4,437	13,477	17,915
11	4,881	14,365	19,246
12	5,325	15,252	20,577
13	5,768	16,140	21,908
14	6,212	17,027	23,239
15	6,656	17,915	24,570
16	7,100	18,802	25,902
17	7,543	19,690	27,233
18	7,987	20,577	28,564
19	8,431	21,464	29,895
20	8,874	22,352	31,226

The table below demonstrates the sediment load reductions attained by implementing all of the streambank BMPs.

Table 19 Estimated Sediment Load Reductions for Implemented BMPs on Streambanks Aimed at Reducing the Need for Implementing New TSS TMDLs for the Republican River at Sampling Sites #503 and 504 and Reduce Sediment in Milford Reservoir by 30 percent.

Annual Streambank Stabilization Sedimentation Reduction			
Year	Streambank Stabilization (feet)	Soil Load Reduction (tons)	Cumulative Load Reduction (tons)
1	500	1,000	1,000
2	500	1,000	2,000
3	500	1,000	3,000
4	500	1,000	4,000
5	500	1,000	5,000
6	500	1,000	6,000

Annual Streambank Stabilization Sedimentation Reduction, Cont.			
Year	Streambank Stabilization (feet)	Soil Load Reduction (tons)	Cumulative Load Reduction (tons)
7	500	1,000	7,000
8	500	1,000	8,000
9	500	1,000	9,000
10	500	1,000	10,000
11	500	1,000	11,000
12	500	1,000	12,000
13	500	1,000	13,000
14	500	1,000	14,000
15	500	1,000	15,000
16	500	1,000	16,000
17	500	1,000	17,000
18	500	1,000	18,000
19	500	1,000	19,000
20	500	1,000	20,000

The table below shows the combined load reduction for sediment that is attained by implementing all cropland and streambank BMPs annually. The percent of achievement is illustrated in the right column. At the end of the first year, if all BMPs are implemented, the need for implementing new TSS TMDLs in the Republican River will be reduced as the goal of reducing sediment in Milford Reservoir by 30 percent will be achieved.

Table 20 Combined Cropland and Streambank Sediment Reductions Aimed at Reducing the Need to Implement New TSS TMDLs in the Republican River at Sampling Sites #503 and 504 and Reduce Sediment in Milford Reservoir by 30 percent.

Combination of Cropland and Streambank BMPs to Meet a 30 Percent Sediment Reduction				
Year	Streambank Reduction (tons)	Cropland Reduction (tons)	Total Reduction (tons)	Percent of Required Reduction
1	1,000	40,818	41,818	127%
2	2,000	81,637	83,637	253%
3	3,000	122,455	125,455	380%
4	4,000	161,739	165,739	502%
5	5,000	201,023	206,023	624%
6	6,000	240,307	246,307	746%
7	7,000	279,591	286,591	868%
8	8,000	318,875	326,875	991%

TSS goal has been met

Combination of Cropland and Streambank BMPs to Meet a 30 Percent Sediment Reduction, Cont.				
Year	Streambank Reduction (tons)	Cropland Reduction (tons)	Total Reduction (tons)	Percent of Required Reduction
9	9,000	358,159	367,159	1113%
10	10,000	397,443	407,443	1235%
11	11,000	436,727	447,727	1357%
12	12,000	476,011	488,011	1479%
13	13,000	515,295	528,295	1601%
14	14,000	554,580	568,580	1723%
15	15,000	593,864	608,864	1845%
16	16,000	633,148	649,148	1967%
17	17,000	672,432	689,432	2089%
18	18,000	711,716	729,716	2211%
19	19,000	751,000	770,000	2333%
20	20,000	790,284	810,284	2455%

Table 21 Twenty Year Sediment Load Reduction by Category Aimed at Reducing the Need for Implementing New TSS TMDLs in the Republican River at Sampling Sites #503 and 504 and Reduce Sediment in Milford Reservoir by 30 percent.

Best Management Practice Category	Total Load Reduction (tons)	Percent of Sediment Reduction Goal
Cropland	790,284	2,395
Streambank	20,000	61
Total	**810,284**	**2,455**

Refer to Section 8, "Costs of BMP Implementation" for specific BMP costs in order to meet the Sediment Reduction Goal.

6.2 Nutrients

Nutrient related TMDLs in the watershed are found in Salt Creek, Lake Jewell, Belleville City Lake and Jamestown Wildlife Management Area.

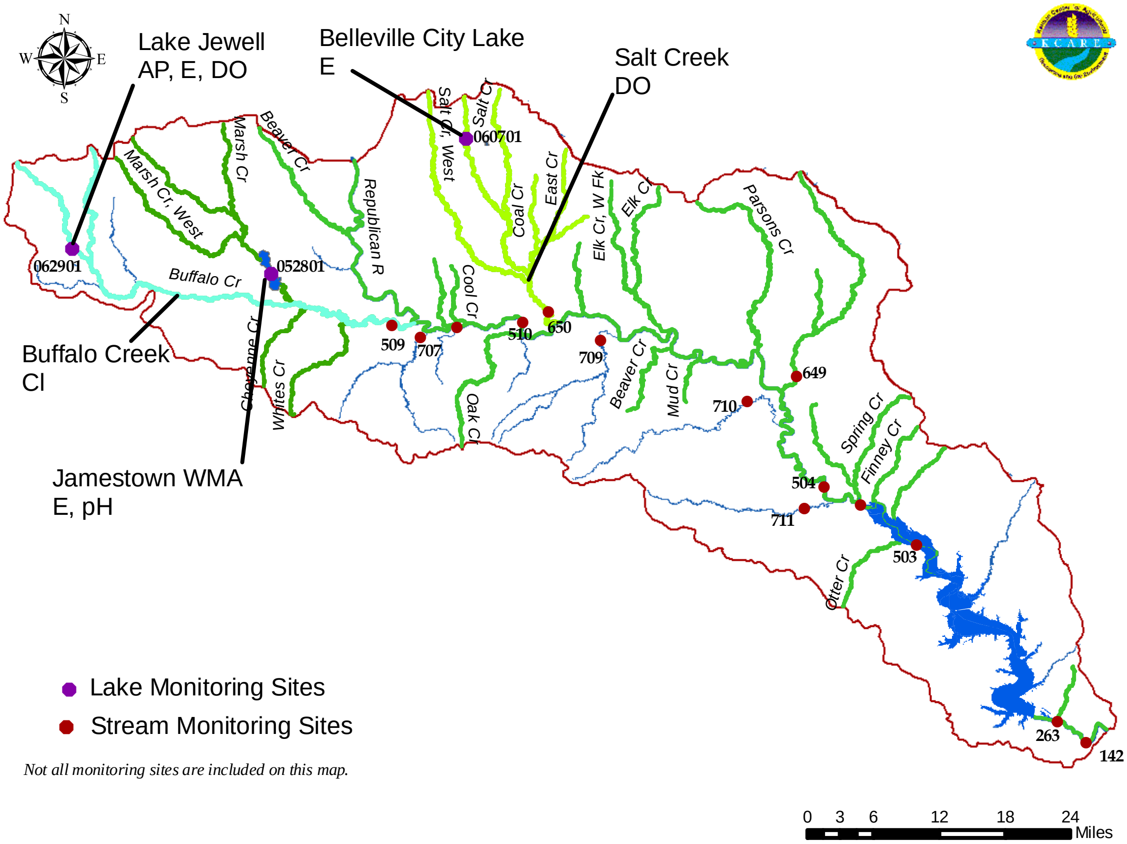


Figure 28 Nutrient Related TMDLS in the Watershed [16]

Nutrient related impairments that are listed on the 303d list are found in the Republican River, Peats Creek, Buffalo Creek, Elm Creek, Mulberry Creek, Salt Creek and Wolf Creek.

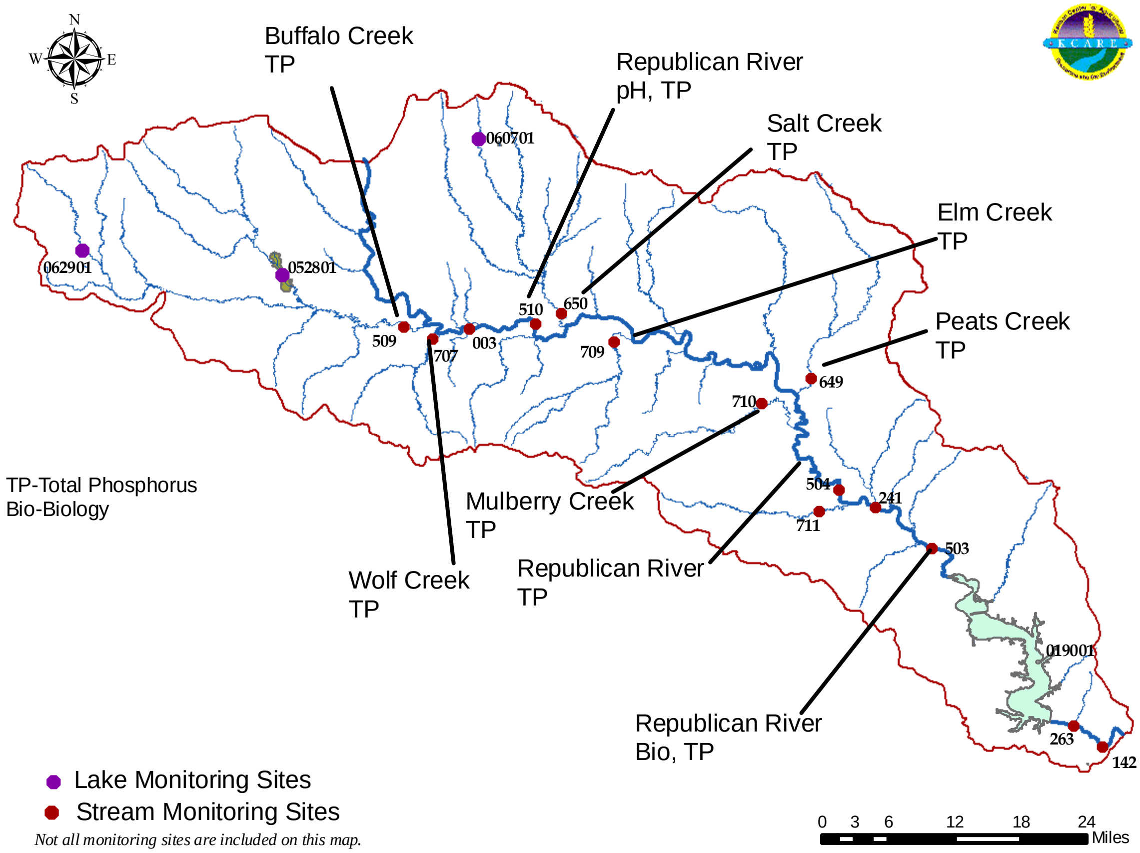


Figure 29 Nutrient Related Impairments on the 303d List [19]

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. Lake Jewell, Belleville City Lake and Jamestown Wildlife Management 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. Salt Creek and Lake Jewell have TMDLs for low dissolved oxygen concentration. Desirable criteria for a healthy water profile includes dissolved oxygen (DO) 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. **pH** is another indicator of excess organic matter. Jamestown Wildlife Management Area has a TMDL for pH. Lake Jewell also has a TMDL for **aquatic plants** which covers submersed, floating or emergent aquatic vegetation. Excess nutrients can originate from failing septic systems and manure and fertilizer runoff in rural and urban areas.

6.2.1 Possible Sources of the Impairment

An excess in nutrients can be caused by any land practice that will contribute 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 streams and lakes of the watershed. Land use in this watershed is primarily agricultural 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 that have been selected by the SLT are based on acceptability by the landowners, cost effectiveness and pollutant load reduction effectiveness. The BMPs from cropland that are also related to nutrient runoff are:

- Conservation crop rotation
- Grassed waterways
- Continuous no-till
- Vegetative buffers
- Develop nutrient management plans

The selected BMPs from livestock sources that are related to nutrient runoff are:

- Vegetative filter strips
- Relocate feedlots
- Relocate pasture feeding sites
- Off-stream watering systems
- Rotational grazing

This section will review several potential sources or environmental actions that have the potential of increasing nutrients in the waters. They are (in no order of importance):

1) Crops
   - Land use distribution in the watershed
2) Livestock
   - Grazing density and Confined Animal Feeding Operations as it relates to nutrients and fecal coliform bacteria
3) Streambank

- Precipitation

It must be noted that not all phosphorus and nitrogen contributions can be attributed to agricultural practices. Excess fertilization of lawns, golf courses and urban areas can easily transport nitrogen and phosphorus downstream. However, for this WRAPS process, targeting will be for livestock.

6.2.1. A Land Use

Cropland commonly has manure applied from livestock confinement operations. This manure can wash into streams and creeks if applied too thickly, on frozen ground or immediately prior to a rainfall event. Phosphorus and nitrogen can runoff during rainfall events from fertilized fields and urban yards and contribute to eutrophication. In this watershed, the cropland is distributed mainly in the central and northern areas. Logically, most cropland is located in river and stream flood plains because over time flooding has deposited the most fertile soils. If cropland is located near a stream or river, it is important that conservation practices be employed to prevent nutrient runoff. Cropland consists of 50 percent of the watershed.

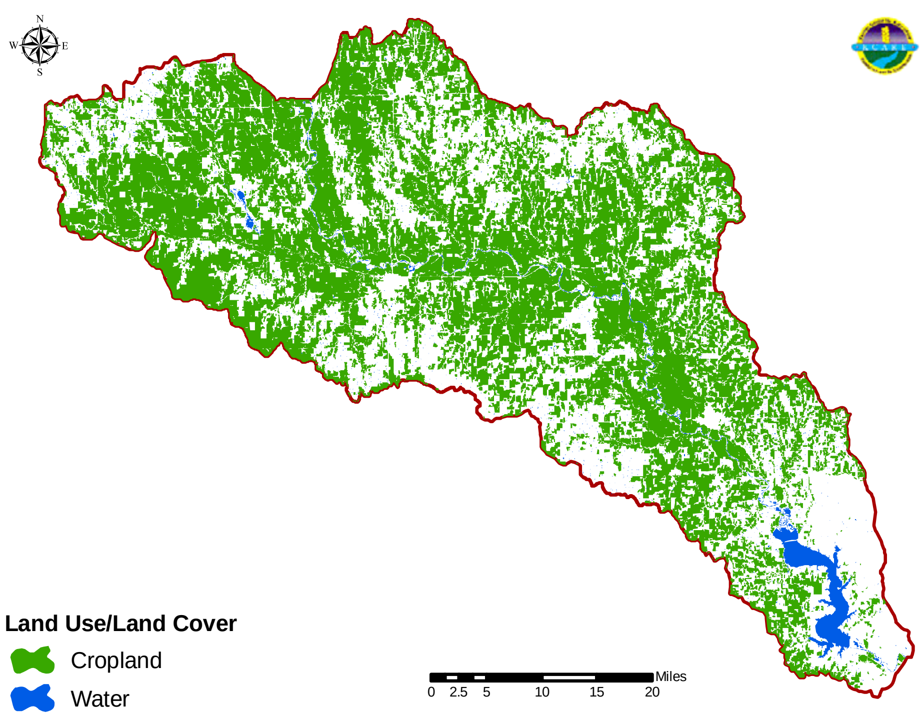


Figure 30 Cropland Distribution within the Watershed [33]

Grassland with livestock that have access to streams and creeks can contribute to phosphorus loading. Cattle that are allowed to loaf in the water source during the hot summer months contribute phosphorus and fecal coliform bacteria by defecating directly in the streams. Overgrazing will lead to faster runoff of manure since there is not adequate biomass to slow water flow. Similarly, livestock that are housed in close proximity to a stream will also contribute phosphorus and fecal coliform bacteria during a runoff rainfall event. All BMPs that are to be implemented under the direction of the SLT will be directed towards restricting nutrient runoff, but will have a similar effect on fecal coliform bacteria runoff as an additional bonus. Grassland in this watershed is mainly concentrated in the southern portion and consists of 36 percent of this watershed.

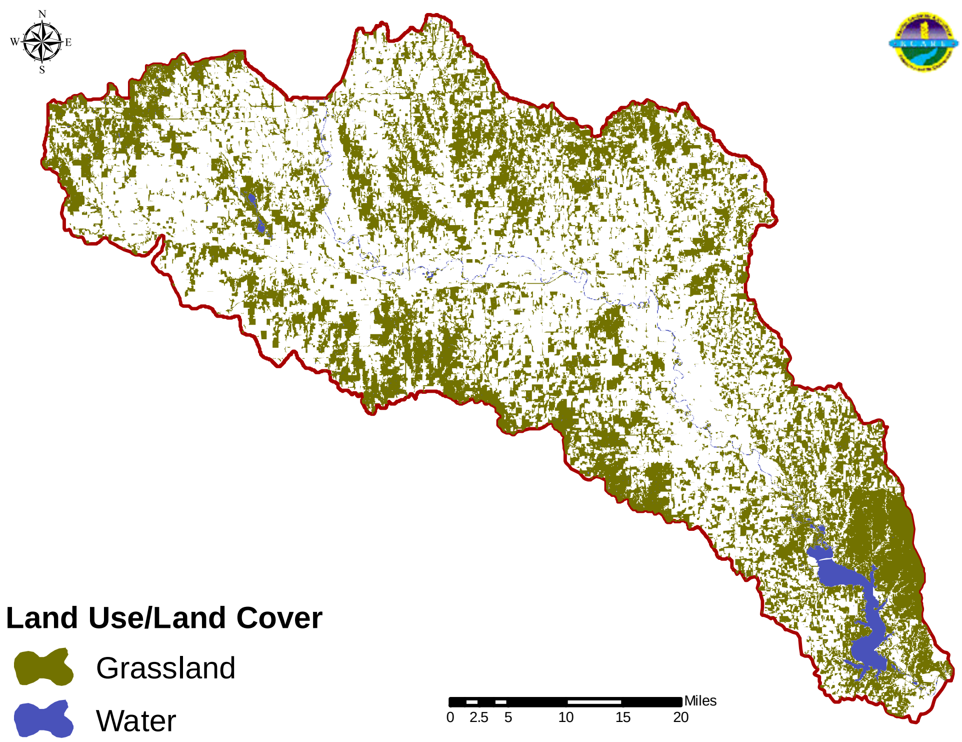


Figure 31 Grassland Distribution within the Watershed [33]

The **Conservation Reserve Program** (CRP) is a USDA program that removes cropland from production. The land is required to be established into permanent grass cover and the owner receives a yearly payment for the duration of the contract. This land cannot be grazed and therefore, is not fertilized so there will be no nutrient runoff or fecal coliform bacteria runoff. For this reason, CRP land is the least likely to contribute to phosphorus and eutrophication. A major concern is that with the recent high price of corn and soybeans, much of the CRP land will be returned to cropping when contracts expire. This will be a detriment to water quality. CRP is distributed equally throughout and consists of 3.5 percent of the watershed.

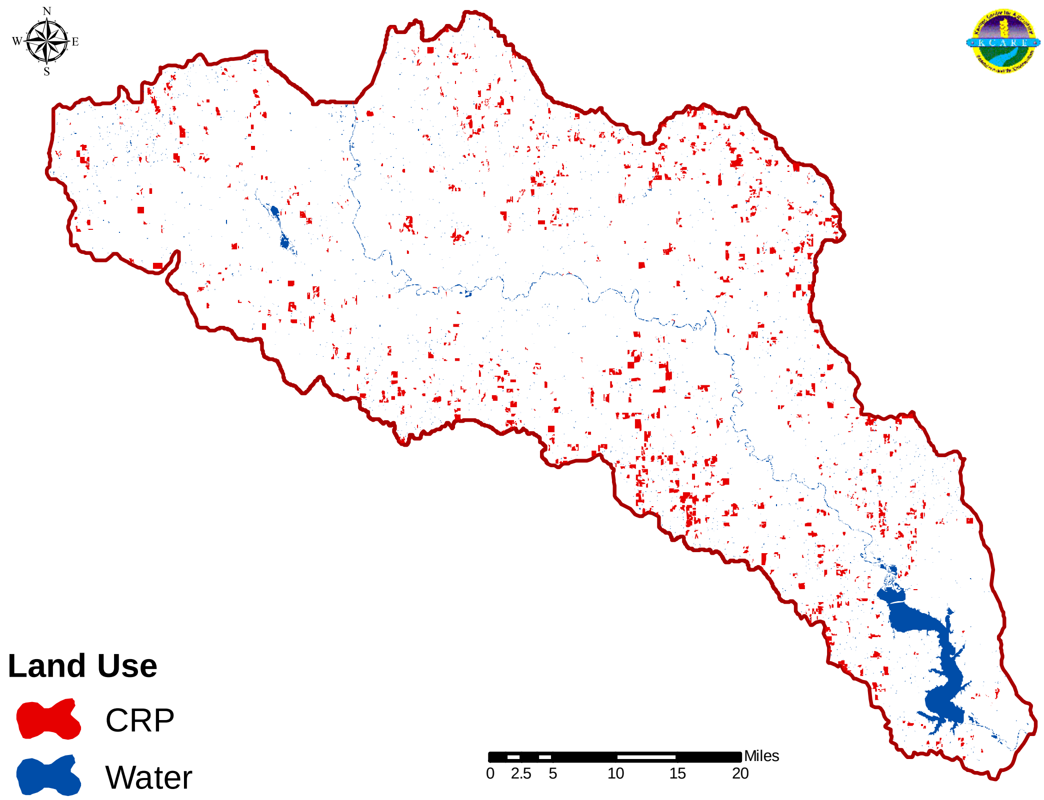


Figure 32 CRP Distribution within the Watershed [33]

6.2.1. B Grazing Density and Confined Animal Feeding Operations

Grasslands cover approximately 36 percent of the watershed. This area is part of the Flint Hills ecosystem which 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. This area also contains numerous livestock confinement 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). 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 CAFO 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 not only as ortho phosphate, but also as phosphorus that is attached to soil particles. Therefore, prevention of erosion is a part of reduction of phosphorus in surface water. The SLT considered grazing density and CAFO placements when deciding on livestock BMPs.

Fecal coliform bacteria (FCB) is a high priority TMDL in Salt Creek. **All livestock BMPs aimed at reducing nutrients in this watershed will have a positive effect on FCB as well.** FCB are a broad spectrum of bacteria species which includes E. coli bacteria. While FCB is present in the digestive tract of all warm blooded animals including humans and animals (domestic and wild), its presence in water indicates that the water has been in contact with human or animal waste. FCB is not itself harmful to humans, but its presence indicates that disease causing organisms, or pathogens, may also be present. A few of these are Giardia, Hepatitis, and Cryptosporidium. In the past, KDHE has measured fecal coliform bacteria in determination of issuance of a TMDL. Currently, KDHE is transitioning from measuring FCB to measuring levels of E. coli bacteria (ECB) due to its being 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 month's 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. Presence of E. coli 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. E. coli 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. **It must be noted that not all FCB or ECBcan be attributed to livestock. Wildlife has a contribution to ECB loads. In addition, failing septic systems can be a source of ECBfrom humans.**

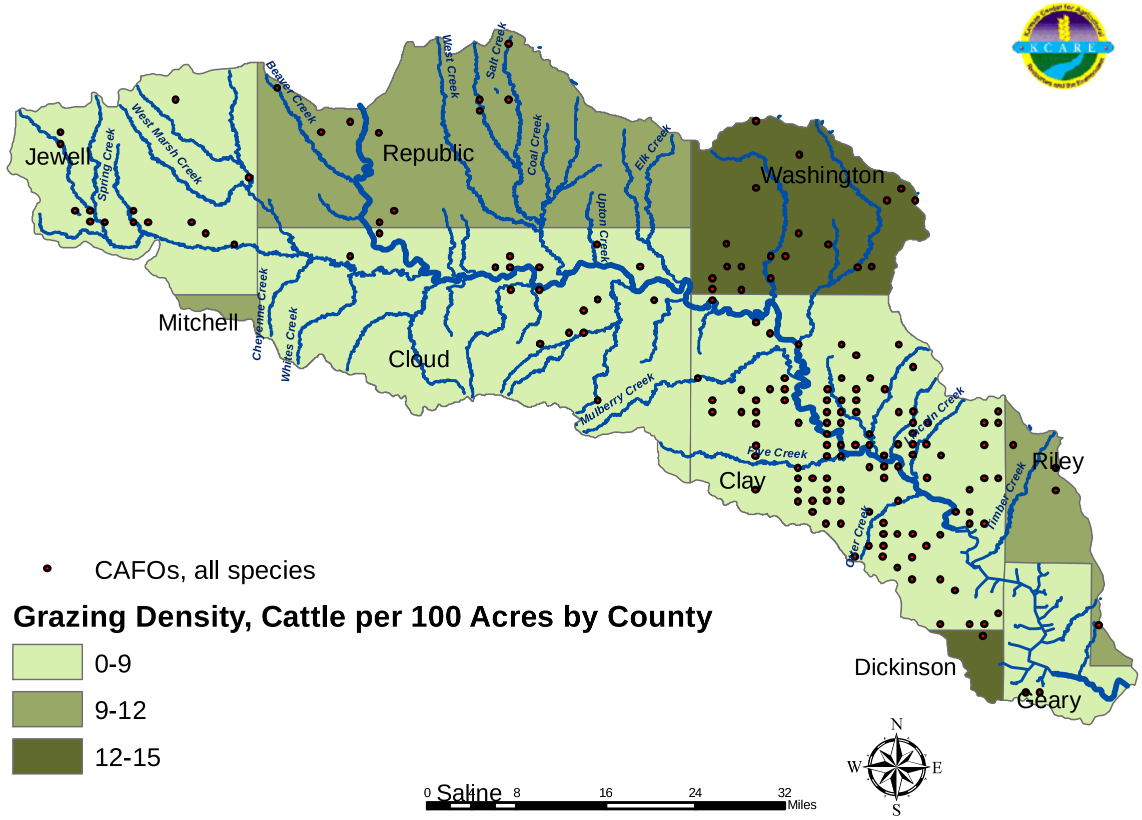


Figure 33 Grazing Density and CAFOs in the Watershed [34]

6.2.1. C Rainfall and Runoff

Rainfall amounts and subsequent runoff along with flooding outside the stream channel can affect nutrient concentrations in rivers and Milford Reservoir. Manure runoff from livestock that are allowed access to a stream or manure applied before a rainfall or on frozen ground is washed into the stream causing a spike in phosphorus concentration. The same is true for fertilizer runoff in the streams and ultimately the Reservoir.

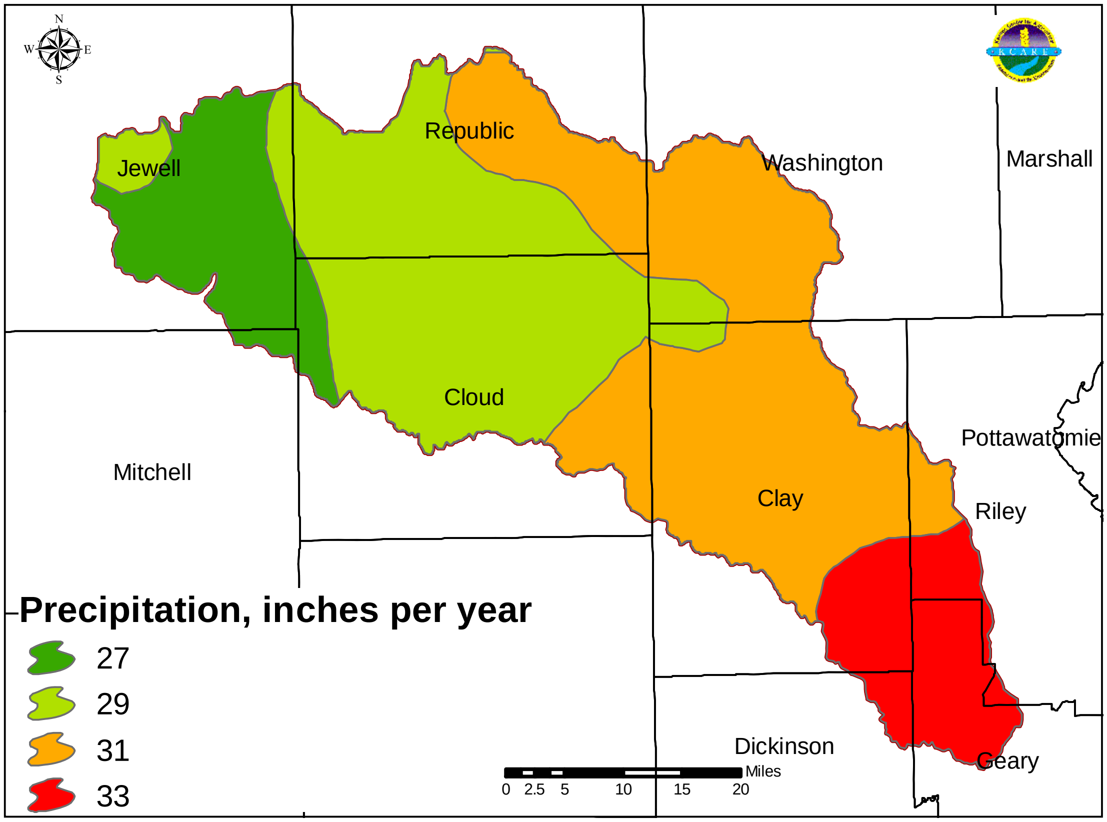
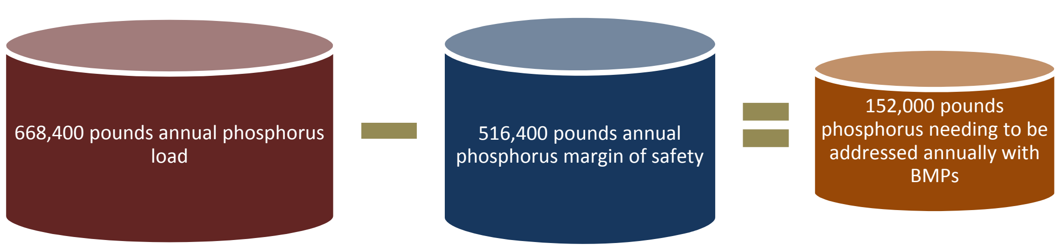


Figure 34 Average Yearly Precipitation in the Watershed. [35]

6.2.2 Pollutant Loads and Load Reductions

All BMPs aimed at phosphorus, nitrogen and ECBreductions will be expressed with a focus on phosphorus only. Sampling for phosphorus improvements in water quality is currently being monitored and changes in concentrations will be determined. All phosphorus BMPs will have a positive effect on ECBand nitrogen concentrations

Total annual average phosphorus loads in Milford Reservoir since 1990 are **668,400 pounds** according to the TMDL section of KDHE. This WRAPS will achieve as set by KDHE a 30 percent reduction or 152,000 lbs, annually in phosphorous entering Milford Reservoir. This is the amount of phosphorus reduction that will have to be met by implemented BMPs in the watershed.



It is to be noted that the phosphorus related BMPs also support the fecal coliform bacteria and sediment TMDLs. The SLT has laid out specific BMPs that they have determined will be acceptable to watershed residents. **These BMPs will be implemented in the cropland, livestock and streambank targeted areas.** Implementation of these BMPs is necessary to meet the required load reduction. These BMPs are listed in the table below. The acres and number of projects have been approved by the SLT. It will require seventeen years to meet the phosphorus goal if all BMPs are implemented.

Table 22 BMPs and Acreages or Projects to be Implemented in Support of Meeting the Dissolved Oxygen and FCB TMDLs in Salt Creek, the Eutrophication TMDL in Belleville City Lake and a 30 Percent Reduction in Phosphorus in Milford Reservoir

Protection Measures	Best Management Practices and Other Actions	Acres or Projects to be Implemented at the End of Twenty Years		
		Cropland Groundtruthing Determined by Adoption Rates		
1.0 Prevention of phosphorus (TP) contribution from **cropland**	1.1 Establish conservation crop rotation	Current adoption rate = 96%	Adoption rate goal = 97%	1,883 acres
	1.2 Establish grassed waterways in crop fields	Current adoption rate = 82%	Adoption rate goal = 95%	37,668 acres treated
	1.3 Encourage continuous no-till cultivation practices	Current adoption rate = 52%	Adoption rate goal = 82%	28,251 acres
	1.4 Establish buffers strips along crop fields	Current adoption rate = 6%	Adoption rate goal = 55%	16,157 acres treated
	1.5 Develop nutrient management plans	Current adoption rate = 25%	Adoption rate goal = 73%	2,973 acres treated
2.0 Prevention of phosphorus (TP) contribution from **livestock**	2.1 Encourage vegetative filter strips	20, one acre sites		
	2.2 Relocate feedlots	17 sites		
	2.3 Relocate pasture feeding sites	10 sites		
	2.4 Develop off-stream watering systems	30 sites		
	2.5 Encourage implementation of rotational grazing	10 sites		
2. Prevention of phosphorus (TP) contribution from **streambank** erosion	Stabilize Streambanks	10,000 Linear Feet of Streambank Stabilization		

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

Table 23 Estimated Load Reductions for Implemented Cropland BMPs Aimed at Meeting the Dissolved Oxygen and FCB TMDLs in Salt Creek, the Eutrophication TMDL in Belleville City Lake and a 30 Percent Reduction in Phosphorus in Milford Reservoir

Milford Watershed Targeted Area					
Annual Phosphorous Reduction (lbs), Cropland BMPs					
Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total Load Reduction
1	100	3,188	2,391	1,395	7,073
2	199	6,376	4,782	2,789	14,146
3	299	9,564	7,173	4,184	21,219
4	398	12,751	9,564	5,579	28,292
5	498	15,939	11,954	6,973	35,365
6	598	19,127	14,345	8,368	42,438
7	697	22,315	16,736	9,763	49,511
8	797	25,503	19,127	11,157	56,584
9	897	28,691	21,518	12,552	63,657
10	996	31,878	23,909	13,947	70,730
11	1,096	35,066	26,300	15,342	77,803
12	1,195	38,254	28,691	16,736	84,876
13	1,295	41,442	31,082	18,131	91,950
14	1,395	44,630	33,472	19,526	99,023
15	1,494	47,818	35,863	20,920	106,096
16	1,594	51,006	38,254	22,315	113,169
17	1,694	54,193	40,645	23,710	120,242
18	1,793	57,381	43,036	25,104	127,315
19	1,893	60,569	45,427	26,499	134,388
20	1,992	63,757	47,818	27,894	141,461

Upper Milford Watershed Targeted Area			
Annual Phosphorous Reduction (lbs), Cropland BMPs			
Year	Nutrient Management Plan	Vegetative Buffers	Total Load Reduction
1	74	425	499
2	148	849	997
3	222	1,274	1,496
4	296	1,422	1,717
5	370	1,569	1,939
6	444	1,717	2,161
7	518	1,865	2,383
8	592	2,013	2,605
9	666	2,161	2,827
10	740	2,309	3,049
11	813	2,457	3,270

Upper Milford Watershed Targeted Area			
Annual Phosphorous Reduction (lbs), Cropland BMPs, Cont.			
Year	Nutrient Management Plan	Vegetative Buffers	Total Load Reduction
12	887	2,605	3,492
13	961	2,753	3,714
14	1,035	2,901	3,936
15	1,109	3,049	4,158
16	1,183	3,196	4,380
17	1,257	3,344	4,602
18	1,331	3,492	4,823
19	1,405	3,640	5,045
20	1,479	3,788	5,267

The table below lists the livestock BMPs and associated phosphorus load reductions attained by implementing all of these BMPs.

Table 24 Estimated Phosphorus Load Reductions for Implemented Livestock BMPs Aimed at Meeting the Dissolved Oxygen and FCB TMDLs in Salt Creek, the Eutrophication TMDL in Belleville City Lake and a 30 Percent Reduction in Phosphorus in Milford Reservoir

Annual Phosphorous Load Reductions (lbs)						
Year	Vegetative Filter Strip	Relocate Feedlot	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Total Load Reduction
1	638	957	0	153	0	**1,748**
2	1,276	2,871	76	306	76	**4,605**
3	1,914	4,785	76	459	76	**7,310**
4	2,552	5,742	153	611	153	**9,210**
5	3,189	6,699	153	764	153	**10,958**
6	3,827	6,699	229	917	229	**11,902**
7	4,465	7,656	229	1,070	229	**13,649**
8	5,103	8,612	306	1,223	306	**15,550**
9	5,741	8,612	306	1,376	306	**16,341**
10	6,379	9,569	382	1,529	382	**18,241**
11	7,017	10,526	382	1,605	382	**19,912**
12	7,655	10,526	459	1,682	459	**20,780**
13	8,292	11,483	459	1,758	459	**22,451**
14	8,930	12,440	535	1,834	535	**24,275**
15	9,568	12,440	535	1,911	535	**24,989**
16	10,206	13,397	611	1,987	611	**26,813**
17	10,844	14,354	611	2,064	611	**28,485**
18	11,482	14,354	688	2,140	688	**29,352**
19	12,120	15,311	688	2,217	688	**31,023**

Annual Phosphorous Load Reductions (lbs), Cont.						
Year	Vegetative Filter Strip	Relocate Feedlot	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Total Load Reduction
20	12,758	16,268	764	2,293	764	**32,847**

The table below lists the streambank phosphorus load reductions attained by implementing streambank restoration BMPs.

Table 25 Estimated Phosphorus Load Reductions for Implemented Streambank BMPs Aimed at Meeting the Dissolved Oxygen and FCB TMDLs in Salt Creek, the Eutrophication TMDL in Belleville City Lake and a 30 Percent Reduction in Phosphorus in Milford Reservoir

Annual Streambank Stabilization Load Reductions			
Year	Streambank Stabilization (feet)	Phosphorous Load Reduction (lbs)	Cumulative Phosphorous Load Reduction (lbs)
1	500	40	40
2	500	40	80
3	500	40	120
4	500	40	160
5	500	40	200
6	500	40	240
7	500	40	280
8	500	40	320
9	500	40	360
10	500	40	400
11	500	40	440
12	500	40	480
13	500	40	520
14	500	40	560
15	500	40	600
16	500	40	640
17	500	40	680
18	500	40	720
19	500	40	760
20	500	40	800

The table below demonstrates the combined load reduction for phosphorus that is attained if all cropland, livestock and streambank BMPs are implemented. The percent of TMDL achievement is illustrated in the right column. At the end of twenty years phosphorus will be reduced to a level that will include the goal of meeting the Dissolved Oxygen TMDL in Salt Creek, and the Eutrophication

TMDL in Belleville City Lake in addition to a 30 percent reduction in Milford Reservoir.

Table 26 Combined Cropland, Livestock and Streambank BMP Phosphorus Load Reductions Aimed at Meeting the Dissolved Oxygen and FCB TMDLs in Salt Creek, the Eutrophication TMDL in Belleville City Lake and a 30 Percent Reduction in Phosphorus in Milford Reservoir

Combination of Cropland and Streambank BMPs to Meet a 30 Percent Phosphorous Reduction					
Year	Streambank Reduction (lbs)	Cropland Reduction (lbs)	Livestock Reduction (lbs)	Total Reduction (lbs)	Percent of Required Reduction
1	40	7,572	1,748	9,359	6%
2	80	15,143	4,605	19,828	13%
3	120	22,715	7,310	30,144	20%
4	160	30,010	9,210	39,380	26%
5	200	37,304	10,958	48,463	32%
6	240	44,599	11,902	56,741	37%
7	280	51,894	13,649	65,824	43%
8	320	59,189	15,550	75,059	49%
9	360	66,484	16,341	83,185	55%
10	400	73,779	18,241	92,420	61%
11	440	81,074	19,912	101,426	67%
12	480	88,369	20,780	109,628	72%
13	520	95,664	22,451	118,635	78%
14	560	102,959	24,275	127,794	84%
15	600	110,253	24,989	135,843	89%
16	640	117,548	26,813	145,002	95%
17	680	124,843	28,485	154,008	101%
18	720	132,138	29,352	162,210	107%
19	760	139,433	31,023	171,216	113%
20	800	146,728	32,847	180,375	119%

P goal has been met

Table 27 Twenty Year Phosphorus Load Reductions by Category Aimed at Meeting the Dissolved Oxygen and FCB TMDLs in Salt Creek, the Eutrophication TMDL in Belleville City Lake and a 30 Percent Reduction in Phosphorus in Milford Reservoir

Best Management Practice Category	Total Load Reduction (pounds)	Percent of Phosphorous Reduction Goal
Cropland	146,728	97
Livestock	32,847	22
Streambank	800	1
Total	**180,375**	**119**

Refer to Section 8, “Costs of BMP Implementation” for specific BMP costs.

7.0 Information and Education in Support of BMPs

7.1 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 28 Information and Education Activities and Events as Requested by the SLT.

Cropland BMP Implementation					
BMP	**Target Audience**	**Activity/Event**	**Time Frame**	**Estimated Costs**	**Service Providers**
Buffers	Landowners and farmers	Demonstration Projects	Annual – Spring	$5,000 per project	KAWS Conservation Districts
		Tour/Field Day highlighting grassed buffers	Annual - Summer	$1,000 per tour	KAWS Conservation Districts
		Tour/Field Day highlighting forested buffers	Annual - Summer	$1,700 per tour	Kansas Forest Service
		One-on-One Technical Assistance for Landowners	Annual - Ongoing	No cost	Conservation Technician or Buffer Coordinator
No-Till	Farmers and Rental Operators	Scholarships for 2 farmers to attend No-Till Winter Conference	Annual – Winter	$300 ($150 per person)	No-till on the Plains
		Tour/Field Day	Annual – Summer	$1,500	Conservation Districts County Extension Offices
		One on One Technical Assistance for Farmers	Annual - Ongoing	$2,000 per year	County Extension Offices
		Seasonal Informational Meetings	Annual – spring (planting) summer (harvest)	$5,500 ($2,750/meeting)	County Extension Offices No-till on the Plains

Cropland BMP Implementation, Cont.					
BMP	**Target Audience**	**Activity/Event**	**Time Frame**	**Estimated Costs**	**Service Providers**
Grassed Waterways	Farmers	Tour/Field Day	Annual – Summer	$1,500 per tour	Conservation Districts County Extension Offices
Conservation Crop Rotations	Farmers and Rental Operators	Workshop	Annual – Summer	$1,500 per workshop	County Extension Offices
Nutrient Management Plans	Farmers and Rental Operators	Workshop	Annual – Summer	$1,500 per workshop	County Extension Offices

Livestock BMP Implementation					
BMP	**Target Audience**	**Activity/Event**	**Time Frame**	**Estimated Costs**	**Service Providers**
Vegetative Filter Strips	Ranchers	Tour/Field Day	Annual - Summer	$2,000 per tour	Kansas Rural Center
		Workshop	Annual - Summer	$2,000 per tour	Kansas Rural Center
		One-on-One Technical Assistance	Ongoing	$5,000 per year	Kansas Rural Center
Relocate Pasture Feeding Sites & Feedlots	Ranchers	Demonstration Project	Annual – Spring	$5,000 per project	Kansas Rural Center
		Tour/Field Day	Annual - Summer	$500 per tour	Kansas Rural Center
		Informational Meeting/ Workshop	Annual - Fall	$500 per meeting	Kansas Rural Center
		One-on-One Technical Assistance	Ongoing	$5,000 per year	Kansas Rural Center
Off-Stream Watering Systems	Ranchers	Demonstration projects for pond construction and spring developments	Annual - Fall	$10,000 per project	Kansas Rural Center
		Tour/Field Day	Annual - Summer	$500 per tour	Kansas Rural Center
		Informational Meeting/ Workshop	Annual - Fall	Combine with relocating pasture feeding sites meeting	Kansas Rural Center
		One-on-One Technical Assistance	Ongoing	$5,000 per year	Kansas Rural Center

Livestock BMP Implementation, Cont.					
BMP	**Target Audience**	**Activity/Event**	**Time Frame**	**Estimated Costs**	**Service Providers**
Rotational Grazing	Landowners and Ranchers	Tour/Field Day	Annual - Summer	Combine with relocated feeding	Kansas Rural Center County Extension Offices
Streambank Restoration/Stabilization Projects					
BMP	**Target Audience**	**Activity/Event**	**Time Frame**	**Estimated Costs**	**Service Providers**
Streambank Projects	Landowners	Demonstration Projects	Annual –Ongoing (1 per year)	$10,000 per project	KAWS Conservation Districts Crossroads RC&D
		Tour/Field Day highlighting successful projects	Annual – Summer (1 per year)	$1,000 per tour	KAWS Conservation Districts Crossroads RC&D
		Engineering Services	Ongoing	Varies by project (approx. $10K - $20K)	Watershed Institute
		Educational outreach and One-on-One Technical Assistance for Landowners	Ongoing	$2,500 per year	Conservation Districts KAWS
General / Watershed Wide Information and Education					
BMP	**Target Audience**	**Activity/Event**	**Time Frame**	**Estimated Costs**	**Service Providers**
Educational Activities Targeting Youth	Educators, K-12 Students	Day on the Farm	Annual – Spring	$500 per event	Conservation Districts Kansas FFA County Extension Office s
		Poster, essay, speech contests promoting WQ	Annual – Spring	$200	Conservation Districts
		Envirothon	Annual - Spring	$250	Conservation Districts
		Curriculum workshop for K-12 educators	Annual – Summer	$2,000 per workshop	KACEE
		Environmental education	Ongoing	$5,000 per year	Project EARTH
		Service learning project	Ongoing	$10,000 per year	Water Link

General / Watershed Wide Information and Education, Cont.					
BMP	**Target Audience**	**Activity/Event**	**Time Frame**	**Estimated Costs**	**Service Providers**
Educational Activities Targeting Adults	Watershed residents	Newspaper/newsletter articles	Annual – Ongoing	No cost	Conservation Districts, County Extension Offices
		Presentation about water quality issues & WRAPS update at annual meetings	Annual – Winter	No cost	Conservation Districts, County Extension Offices, Flint Hills RC&D
		River Friendly Farms Informational Meetings	Annual - Ongoing	$150 per meeting	Kansas Rural Center
		Educational campaign to promote forestry practices	Ongoing	$1,500 per year	Kansas Forest Service
		Educational campaign about leaking/failing septic systems	Ongoing	$1,500 per year	Local Environmental Protection Programs
		Healthy Ecosystems – Healthy Communities Program	Ongoing	$15,000 per year	Kansas PRIDE Program
	Watershed residents living in cities/towns	KS Healthy Yards & Communities training	Ongoing	$2,500 per year	K-State Horticulture Dept.
Total Cost per Year				**$124,100**	

7.2 Evaluation of Information and Education Activities

All service providers conducting Information and Education (I&E) activities funded through the Lower Republican WRAPS will be required to include an evaluation component in their project proposals and Project Implementation Plans. 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, useful 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.

8.0 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

Conservation Crop Rotation: After being presented with information from K-State Research and Extension (Josh Roe) on the costs and benefits of conservation crop rotations, the SLT decided that a fair price to entice a producer to adopt a conservation crop rotation would be to pay them $5 an acre for 10 years, or a net present value of $38.84 per acre upfront assuming the NRCS discount rate of 4.75 percent.

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.

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 percent.

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.

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 percent.

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.

Rotational Grazing: The average cost of implementing a rotational grazing system for $7,000 was estimated by Herschel George, Marais des Cygnes Watershed Specialist who has installed numerous systems and has detailed average cost estimates. More complex systems that require significant cross fencing and buried water lines will come with a much higher price.

Prices below reflect current prices (2010) for implementation and also include technical assistance costs such as NRCS planning and engineering design in the case of streambank stabilization. All BMPs will be applied in the targeted areas.

Table 29 Estimated Costs and Net Costs for Cropland Implemented BMPs in Targeted Areas.

SWAT Identified Targeted Areas Annual Cost, Cropland BMPs					
Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
1	$3,658	$150,672	$109,741	$43,946	$308,016
2	$3,767	$155,192	$113,033	$45,264	$317,257
3	$3,880	$159,848	$116,424	$46,622	$326,774
4	$3,997	$164,643	$119,917	$48,021	$336,578
5	$4,117	$169,582	$123,514	$49,462	$346,675
6	$4,240	$174,670	$127,220	$50,945	$357,075
7	$4,367	$179,910	$131,036	$52,474	$367,787
8	$4,498	$185,307	$134,967	$54,048	$378,821
9	$4,633	$190,867	$139,016	$55,669	$390,186
10	$4,772	$196,593	$143,187	$57,339	$401,891

SWAT Identified Targeted Areas Annual Cost, Cropland BMPs, Cont.					
Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
11	$4,915	$202,490	$147,483	$59,060	$413,948
12	$5,063	$208,565	$151,907	$60,831	$426,366
13	$5,215	$214,822	$156,464	$62,656	$439,157
14	$5,371	$221,267	$161,158	$64,536	$452,332
15	$5,532	$227,905	$165,993	$66,472	$465,902
16	$5,698	$234,742	$170,973	$68,466	$479,879
17	$5,869	$241,784	$176,102	$70,520	$494,275
18	$6,045	$249,038	$181,385	$72,636	$509,104
19	$6,227	$256,509	$186,826	$74,815	$524,377
20	$6,414	$264,204	$192,431	$77,059	$540,108

SWAT Identified Targeted Annual Cost After Cost-Share, Cropland BMPs					
Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
1	$3,658	$75,336	$66,942	$4,395	$150,330
2	$3,767	$77,596	$68,950	$4,526	$154,840
3	$3,880	$79,924	$71,019	$4,662	$159,485
4	$3,997	$82,322	$73,149	$4,802	$164,270
5	$4,117	$84,791	$75,344	$4,946	$169,198
6	$4,240	$87,335	$77,604	$5,095	$174,274
7	$4,367	$89,955	$79,932	$5,247	$179,502
8	$4,498	$92,654	$82,330	$5,405	$184,887
9	$4,633	$95,433	$84,800	$5,567	$190,434
10	$4,772	$98,296	$87,344	$5,734	$196,147
11	$4,915	$101,245	$89,964	$5,906	$202,031
12	$5,063	$104,282	$92,663	$6,083	$208,092
13	$5,215	$107,411	$95,443	$6,266	$214,335
14	$5,371	$110,633	$98,306	$6,454	$220,765
15	$5,532	$113,952	$101,256	$6,647	$227,388
16	$5,698	$117,371	$104,293	$6,847	$234,209
17	$5,869	$120,892	$107,422	$7,052	$241,235
18	$6,045	$124,519	$110,645	$7,264	$248,473
19	$6,227	$128,254	$113,964	$7,482	$255,927
20	$6,414	$132,102	$117,383	$7,706	$263,605

Upper Milford Watershed Targeted Area			
Annual Cost, Cropland BMPs			
Year	Nutrient Management Plan	Vegetative Buffers	Total Cost
1	$8,430	$26,962	$35,392
2	$8,683	$27,771	$36,454
3	$8,943	$28,604	$37,547
4	$9,212	$10,829	$38,674
5	$9,488	$11,154	$39,834
6	$9,773	$11,488	$41,029
7	$10,066	$11,833	$42,260
8	$10,368	$12,188	$43,528
9	$10,679	$12,554	$44,834
10	$10,999	$12,930	$46,179
11	$11,329	$13,318	$47,564
12	$11,669	$13,718	$48,991
13	$12,019	$14,129	$50,461
14	$12,380	$14,553	$51,974
15	$12,751	$14,990	$53,534
16	$13,134	$15,439	$55,140
17	$13,528	$15,903	$56,794
18	$13,933	$16,380	$58,498
19	$14,351	$16,871	$60,253
20	$14,782	$17,377	$62,060

Upper Milford Watershed Targeted Area			
Annual Cost After Cost-Share, Cropland BMPs			
Year	Nutrient Management Plan	Vegetative Buffers	Total Cost
1	$4,215	$2,696	$6,911
2	$4,341	$2,777	$7,119
3	$4,472	$2,860	$7,332
4	$4,606	$1,083	$7,552
5	$4,744	$1,115	$7,779
6	$4,886	$1,149	$8,012
7	$5,033	$1,183	$8,252
8	$5,184	$1,219	$8,500
9	$5,339	$1,255	$8,755
10	$5,500	$1,293	$9,018
11	$5,665	$1,332	$9,288
12	$5,835	$1,372	$9,567
13	$6,010	$1,413	$9,854

Upper Milford Watershed Targeted Area			
Annual Cost After Cost-Share, Cropland BMPs, Cont.			
Year	Nutrient Management Plan	Vegetative Buffers	Total Cost
14	$6,190	$1,455	$10,149
15	$6,376	$1,499	$10,454
16	$6,567	$1,544	$10,767
17	$6,764	$1,590	$11,090
18	$6,967	$1,638	$11,423
19	$7,176	$1,687	$11,766
20	$7,391	$1,738	$12,119

Table 30 Estimated Costs of Implementing Livestock BMPs in Targeted Areas.

Annual Cost of Implementing Livestock BMPs						
Year	Vegetative Filter Strip	Relocate Feedlot	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Annual Cost
1	$357	$3,311	$0	$3,795	$0	**$7,463**
2	$368	$6,820	$1,135	$3,909	$3,605	**$15,836**
3	$379	$7,024	$0	$4,026	$0	**$11,429**
4	$390	$3,617	$1,204	$4,147	$3,825	**$13,183**
5	$402	$3,726	$0	$4,271	$0	**$8,399**
6	$414	$0	$1,277	$4,399	$4,057	**$10,148**
7	$426	$3,953	$0	$4,531	$0	**$8,911**
8	$439	$4,071	$1,355	$4,667	$4,305	**$14,837**
9	$452	$0	$0	$4,807	$0	**$5,260**
10	$466	$4,319	$1,437	$4,952	$4,567	**$15,741**
11	$480	$4,449	$0	$2,550	$0	**$7,479**
12	$494	$0	$1,525	$2,627	$4,845	**$9,490**
13	$509	$4,720	$0	$2,705	$0	**$7,934**
14	$524	$4,862	$1,618	$2,787	$5,140	**$14,930**
15	$540	$0	$0	$2,870	$0	**$3,410**
16	$556	$5,158	$1,716	$2,956	$5,453	**$15,839**
17	$573	$5,312	$0	$3,045	$0	**$8,930**
18	$590	$0	$1,821	$3,136	$5,785	**$11,332**
19	$608	$5,636	$0	$3,230	$0	**$9,474**
20	$626	$5,805	$1,931	$3,327	$6,137	**$17,827**
3% Annual Cost Inflation						

Table 31 Estimated Costs of Implementing Streambank BMPs in Targeted Areas.

Year	Cost
1	$20,830
2	$21,455
3	$22,099
4	$22,762
5	$23,444
6	$24,148
7	$24,872
8	$25,618
9	$26,387
10	$27,178
11	$27,994
12	$28,834
13	$29,699
14	$30,590
15	$31,507
16	$32,452
17	$33,426
18	$34,429
19	$35,462
20	$36,526

Table 32 Technical Assistance Needed to Implement BMPs.

BMP		***Technical Assistance***	***Projected Annual Cost***
Cropland	1. Conservation Crop Rotation	SCC Buffer Technician KRC River Friendly Farms Technician Watershed Specialist	NRCS District Conservationist No Charge Conservation District Soil Technician No Charge SCC Buffer Technician No Charge WRAPS Coordinator $25,000 Watershed Specialist $11,500 KRC River Friendly Farms Technician $20,000 Kansas State Forester No Charge
	2. Grassed Waterways	SCC Buffer Technician KRC River Friendly Farms Technician Watershed Specialist	
	3. No-till	WRAPS Coordinator KRC River Friendly Farms Technician Watershed Specialist	
	4. Buffers	SCC Buffer Technician WRAPS Coordinator KRC River Friendly Farms Technician Watershed Specialist	
	5. Nutrient Management Plans	Watershed Specialist KRC River Friendly Farms Technician	
Livestock	1. Vegetative filter strips	SCC Buffer Technician KRC River Friendly Farms Technician Watershed Specialist	
	2. Relocate feedlots	KRC River Friendly Farms Technician Watershed Specialist	
	3. Relocate pasture feeding sites	KRC River Friendly Farms Technician Watershed Specialist	
	4. Establish off stream watering systems	KRC River Friendly Farms Technician Watershed Specialist	
	5. Rotational grazing	KRC River Friendly Farms Technician Watershed Specialist	
Streambank	4. Streambank restoration	SCC Buffer Technician WRAPS Coordinator KRC River Friendly Farms Technician Watershed Specialist	
Total			**$56,500**

Table 33 Total Annual Costs in Targeted Areas for Implementing Entire WRAPS Plan in Support of Attaining TMDLs and Improvement in Impairments on the 303d List.

Total Annual Costs of Implementing Cropland, Livestock, Streambank and Rangeland BMPs, in addition to Information and Education and Technical Assistance						
	BMPs Implemented			I&E and Technical Assistance		
Year	Cropland	Livestock	Streambank	I&E	Technical Assistance	Total
1	$157,241	$7,463	$20,830	$124,100	$56,500	$366,134
2	$161,958	$15,836	$21,455	$127,823	$58,195	$385,267
3	$166,817	$11,429	$22,099	$131,658	$59,941	$391,944

Total Annual Costs of Implementing Cropland, Livestock, Streambank and Rangeland BMPs, in addition to Information and Education and Technical Assistance, Cont.						
	BMPs Implemented			I&E and Technical Assistance		
Year	Cropland	Livestock	Streambank	I&E	Technical Assistance	Total
4	$171,822	$13,183	$22,762	$135,607	$61,739	$405,113
5	$176,976	$8,399	$23,444	$139,676	$63,591	$412,086
6	$182,286	$10,148	$24,148	$143,866	$65,499	$425,947
7	$187,754	$8,911	$24,872	$148,182	$67,464	$437,183
8	$193,387	$14,837	$25,618	$152,627	$69,488	$455,957
9	$199,188	$5,260	$26,387	$157,206	$71,573	$459,614
10	$205,164	$15,741	$27,178	$161,922	$73,720	$483,725
11	$211,319	$7,479	$27,994	$166,780	$75,931	$489,503
12	$217,659	$9,490	$28,834	$171,783	$78,209	$505,976
13	$224,188	$7,934	$29,699	$176,937	$80,555	$519,313
14	$230,914	$14,930	$30,590	$182,245	$82,972	$541,651
15	$237,841	$3,410	$31,507	$187,712	$85,461	$545,932
16	$244,977	$15,839	$32,452	$193,344	$88,025	$574,637
17	$252,326	$8,930	$33,426	$199,144	$90,666	$584,492
18	$259,896	$11,332	$34,429	$205,118	$93,386	$604,161
19	$267,693	$9,474	$35,462	$211,272	$96,187	$620,088
20	$275,723	$17,827	$36,526	$217,610	$99,073	$646,759

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

Table 34 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)

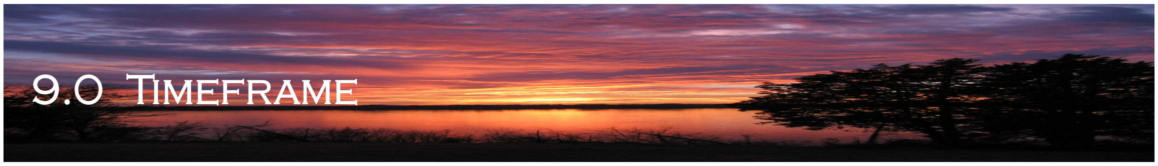
Funding Sources, Cont.	
Potential Funding Sources	**Potential Funding Programs**
EPA/KDHE	319 Funding Grants WRAPS Grants Clean Water Neighbor Grants
Kansas Department of Wildlife and Parks	Partnering for Wildlife
Kansas Alliance for Wetlands and Streams	
State Conservation Commission	
Conservation Districts	
No-till on the Plains	
Kansas Forest Service	
US Fish and Wildlife	

Table 35 Potential Service Providers for BMP Implementation

BMP		Services Needed to Implement BMP		Service Provider **
		Technical Assistance	***Information and Education***	
Cropland	1. Conservation Crop Rotation	Design, cost share and maintenance	BMP workshops, tours, field days	NRCS KRC SCC No-Till on the Plains KSRE CD RC&D KDWP
	2. Grassed Waterways	Design, cost share and maintenance	BMP workshops, tours, field days	
	3. No-till	Design, cost share and maintenance	BMP workshops	
	4. Buffers	Design, cost share and maintenance	BMP workshops, field days, tours	
	5. Nutrient Management Plans	Design, cost share and maintenance	BMP workshops, field days, tours	
Livestock	1. Vegetative filter strips	Design, cost share and maintenance	BMP workshops, field days, tours	KSRE NRCS SCC KRC CD RC&D KDWP
	2. Relocate feedlots	Design, cost share and maintenance	BMP workshops, field days, tours	
	3. Relocate pasture feeding sites	Design, cost share and maintenance	BMP workshops, field days, tours	
	4. Establish off stream watering systems	Design, cost share and maintenance	BMP workshops, field days, tours	
	5. Rotational grazing	Design, cost share and maintenance	BMP workshops, field days, tours	

Service Providers, Cont.				
BMP		**Services Needed to Implement BMP**		**Service Provider ****
		Technical Assistance	***Information and Education***	
Streambank	1. Streambank restoration	Design, cost share and maintenance	BMP workshops, field days, tours	KAWS NRCS KFS KSRE CD RC&D
***** See Appendix for service provider directory***				

** 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.*



9.0 Timeframe

The SLT will request an update of monitoring data from KDHE and USACE every year; however, the plan will be reviewed every five years starting in 2015. In 2015, the SLT will request a review of data by KDHE for the Kansas Republican Basin. It is this year that the TMDLs will officially be reviewed for additions or revisions. The timeframe of this document for BMP implementation to meet both sediment and phosphorus TMDLs would be twenty years from the date of publication of this report. Sediment and phosphorus reductions in the water column will not be noticeable by the year 2015 due to a lag time from implementation of BMPs and resulting improvements in water quality. Therefore, the SLT will review sediment and phosphorus concentrations in year 2020. They will examine BMP placement and implementation in 2015 and every subsequent five years after.

Table 36 Review Schedule for Pollutants and BMPs

Review Year	Sediment	Phosphorus	BMP Placement
2015			X
2020	X	X	X
2025	X	X	X
2030	X	X	X

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

- The timeframe for meeting the **sediment goal** will be first year of implementation. If all BMPs are installed, the 30 percent sediment reduction goal in Milford Reservoir will be met. In addition to meeting the sediment goal, the need for implementing new TMDLs for the Republican River at sampling sites #503 and 504 will be reduced. After the sediment goal is met, the BMPs directed at sediment will be considered “protection measures” instead of “restoration measures”. At this point, the SLT may decide to redirect their funding to phosphorus related BMPs.
- The timeframe for meeting the **phosphorus goal** will be seventeen years. If all BMPs are installed, the 30 percent phosphorus reduction goal in Milford Reservoir will be met. In addition to meeting the phosphorus goal, the dissolved oxygen TMDL in Salt Creek, and eutrophication TMDL in Belleville City Lake will be addressed.

10.0 Interim Measureable Milestones

10.1 Adoption Rates

Milestones will be determined by number of acres treated, projects installed, contacts made to residents of the watershed or load reductions at the end of five, ten and twenty years. The SLT will examine the number of acres treated or the load reduction to determine if adequate progress has been made from the current BMP implementations.

Table 37 Short, Medium and Long Term Goals for BMP Cropland Adoption Rate in the Cropland Targeted Area to Address Sediment and Nutrients

Lower Milford Annual Adoption (treated acres), Cropland BMPs						
	Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
Short-Term	1	94	1,883	1,413	659	4,049
	2	94	1,883	1,413	659	4,049
	3	94	1,883	1,413	659	4,049
	4	94	1,883	1,413	659	4,049
	5	94	1,883	1,413	659	4,049
	Total	*471*	*9,417*	*7,063*	*3,296*	*20,247*
Medium-Term	6	94	1,883	1,413	659	4,049
	7	94	1,883	1,413	659	4,049
	8	94	1,883	1,413	659	4,049
	9	94	1,883	1,413	659	4,049
	10	94	1,883	1,413	659	4,049
	Total	*942*	*18,834*	*14,125*	*6,592*	*40,493*
Long-Term	11	94	1,883	1,413	659	4,049
	12	94	1,883	1,413	659	4,049
	13	94	1,883	1,413	659	4,049
	14	94	1,883	1,413	659	4,049
	15	94	1,883	1,413	659	4,049
	Total	*1,413*	*28,251*	*21,188*	*9,888*	*60,740*
	16	94	1,883	1,413	659	4,049
	17	94	1,883	1,413	659	4,049
	18	94	1,883	1,413	659	4,049
	19	94	1,883	1,413	659	4,049
	20	94	1,883	1,413	659	4,049
	Total	***1,883***	***37,668***	***28,251***	***13,184***	***80,986***

Upper Milford Annual Adoption (treated acres), Cropland BMPs				
	Year	Nutrient Management Plan	Vegetative Buffers	Total Adoption
Short-Term	1	149	404	553
	2	149	404	553
	3	149	404	553
	4	149	149	297
	5	149	149	297
	Total	*743*	*1,511*	*2,254*
Medium-Term	6	149	149	297
	7	149	149	297
	8	149	149	297
	9	149	149	297
	10	149	149	297
	Total	*1,487*	*2,254*	*3,740*
Long-Term	11	149	149	297
	12	149	149	297
	13	149	149	297
	14	149	149	297
	15	149	149	297
	Total	*2,230*	*2,997*	*5,227*
	16	149	149	297
	17	149	149	297
	18	149	149	297
	19	149	149	297
	20	149	149	297
	Total	*2,973*	*3,740*	*6,713*

Table 38 Short, Medium and Long Term Goals for BMP Livestock Adoption Rate in the Livestock Targeted Area to Address Nutrients

Livestock BMPs Adopted Each Year						
	Year	Vegetative Filter Strip	Relocate Feedlot	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing
Short-Term	1	1	1		2	
	2	1	2	1	2	1
	3	1	1		2	
	4	1	2	1	2	1
	5	1	1		2	
	Total	*5*	*7*	*2*	*10*	*2*

Livestock BMPs Adopted Each Year, Cont.						
	Year	Vegetative Filter Strip	Relocate Feedlot	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing
Medium-Term	6	1		1	2	1
	7	1	1		2	
	8	1	1	1	2	1
	9	1			2	
	10	1	1	1	2	1
	Total	*10*	*10*	*5*	*20*	*5*
Long-Term	11	1	1		1	
	12	1		1	1	1
	13	1	1		1	
	14	1	1	1	1	1
	15	1			1	
	Total	*15*	*13*	*7*	*25*	*7*
	16	1	1	1	1	1
	17	1	1		1	
	18	1		1	1	1
	19	1	1		1	
	20	1	1	1	1	1
	Total	*20*	*17*	*10*	*30*	*10*

Table 39 Short, Medium and Long Term Goals for BMP Streambank Adoption Rate in the Streambank Targeted Area to Address Sediments and Nutrients

	Year	Streambank Stabilization (feet)
Short-Term	1	500
	2	500
	3	500
	4	500
	5	500
	Total	*2,500*
Medium-Term	6	500
	7	500
	8	500
	9	500
	10	500
	Total	*5,000*

	Streambank Adoption Rates, Cont.	
	Year	Streambank Stabilization (feet)
Long-Term	11	500
	12	500
	13	500
	14	500
	15	500
	Total	*7,500*
	16	500
	17	500
	18	500
	19	500
	20	500
	Total	***10,000***

Table 40 Short, Medium and Long Term Goals for Information and Education Adoption Rates in the Entire Watershed to Address All TMDLs

	Year	Demo Projects	Workshops	Tours and Field Days	Presentations, Informational Meetings	Newsletter Inserts	Technical Assistance One on One Programs	Conference Attendees	Educational Events	Media Campaign	Contacts made by Tech Assistance
Short Term	1	4	5	8	3	1	6	2	5	4	250
	2	4	5	8	3	1	6	2	5	4	250
	3	4	5	8	3	1	6	2	5	4	250
	4	4	5	8	3	1	6	2	5	4	250
	5	4	5	8	3	1	6	2	5	4	250
	Total	***20***	***25***	***40***	***15***	***5***	***30***	***10***	***25***	***20***	***1250***
Medium Term	6	4	5	8	3	1	6	2	5	4	250
	7	4	5	8	3	1	6	2	5	4	250
	8	4	5	8	3	1	6	2	5	4	250
	9	4	5	8	3	1	6	2	5	4	250
	10	4	5	8	3	1	6	2	5	4	250
	Total	***40***	***50***	***80***	***30***	***10***	***60***	***20***	***50***	***40***	***2500***

I&E Adoption Rates, Cont.											
	Year	Demo Projects	Workshops	Tours and Field Days	Presentations, Informational Meetings	Newsletter Inserts	Technical Assistance One on One Programs	Conference Attendees	Educational Events	Media Campaign	Contacts made by Tech Assistance
Long Term	11	4	5	8	3	1	6	2	5	4	250
	12	4	5	8	3	1	6	2	5	4	250
	13	4	5	8	3	1	6	2	5	4	250
	14	4	5	8	3	1	6	2	5	4	250
	15	4	5	8	3	1	6	2	5	4	250
	Total	**60**	**75**	**120**	**45**	**15**	**90**	**30**	**75**	**60**	**3750**
	16	4	5	8	3	1	6	2	5	4	250
	17	4	5	8	3	1	6	2	5	4	250
	18	4	5	8	3	1	6	2	5	4	250
	19	4	5	8	3	1	6	2	5	4	250
	20	4	5	8	3	1	6	2	5	4	250
	Total	***80***	***100***	***160***	***60***	***20***	***120***	***40***	***100***	***80***	***5000***

Over a twenty year time frame, this WRAPS project hopes to improve water quality throughout the watershed and in Milford Reservoir. Measurements taken at Milford Reservoir are important because it is close to the drainage endpoint of the watershed. Any water quality improvements will be observed by conducting tests in Milford Reservoir. Social indicators will also be examined by tracking traffic in Milford Reservoir Parks. 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 benchmark criteria, 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.

Table 41 Benchmarks to Measure Water Quality Progress

Criteria to Measure Water Quality Progress	Information Source
No taste and odor problems in public water supply of City of Milford	KDHE
No algal blooms in main lake basin	USACE
Bathymetric survey conducted every ten years	KBS
Fewer high event stream flow rates entering Milford Reservoir indicating better retention and slower release of storm water in the upper end of the watershed due to an increase in BMPs that slow flow (buffers, riparian areas, no-till, grassed waterways, etc)	USGS
Beach closures at Milford Reservoir	KDHE
No fish kills on Republican River or tributaries	KDWP
Milford Reservoir is not listed for eutrophication or siltation	KDHE
No health advisories against swimming in Republican River	KDHE

Benchmarks, Cont.	
Criteria to Measure Water Quality Progress	**Information Source**
No new listings for DO or E. coli bacteria	KDHE
Biological metrics on Republican River at Clay Center improve	KDHE
Social Indicators to Measure Water Quality Progress	**Information Source**
Visitor traffic to Milford Reservoir	KDWP
Boating traffic in Milford Reservoir	KDWP
Quantity and quality of fishing in Milford Reservoir	KDWP
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

10.2 Phosphorus and Sediment Milestones [36]

At the end of ten years, the SLT will be able to examine water quality data for phosphorus (eutrophication, dissolved oxygen and aquatic plants determination) and TSS (total suspended solids – used as a determination of sediment) 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 related indicators) and sediment reduction in the waterways. KDHE has outlined water quality milestones for total phosphorus and TSS. These milestones are presented below.

1. No DO hits on Salt Creek or Buffalo Creek over 2010-2020
2. No more than one DO hit on unlisted streams over 2010 – 2020
3. Median Total Phosphorus (TP) and TSS declines by 10 – 20 percent over 2010 – 2020
4. Lower Republican River outlet loads entering Milford Reservoir declines by 15 percent by 2020 (284 T TP/yr (-50 T/yr) and 109,151 T TSS/yr (-19,262 T/yr)
5. Bacteria index profiles for Republican River at Rice and Clay Center decline over 2010 – 2020.
6. Note: The Republican River in the vicinity of Concordia is Primary Recreation B, the most stringent of recreation uses; the remainder of the river is Primary C down to Milford Reservoir. The river in northern Republic County is Secondary Recreation b, but there are high bacteria contributions coming from Nebraska that may influence the attainment of water quality standards at Concordia – Rice.
7. Note: Buffalo Creek is designated as Secondary Recreation b and is unlikely to violate water quality standards; Salt Creek is Primary Recreation C and five and seven routine samples taken during April – October since 2003 have been greater than the nominal criterion of 427.

8. Note: No analysis has been done on White Rock Creek since the monitoring station is located above Lovewell Reservoir and water released from Lovewell typically moves through the Kansas-Bostwick Irrigation District system before reaching the Republican River.

Table 42 Phosphorus and Total Suspended Solids 10 Year Milestones

10 year milestones	Current Condition	Improved Condition 2010-2020	Current Condition	Improved Condition 2010-2020
Stream	**TP (median of data collected during indicated period), ppm**		**TSS (median of data collected during indicated period), ppm**	
Buffalo Creek	0.370	0.310	81	65
Wolf Creek	0.365	0.292	35	31
Repub-Concordia/Rice	0.284	0.240	44	40
Salt Creek	0.331	0.265	60	48
Elm Creek	0.260	0.239	32	29
Peats Creek	0.298	0.246	38	34
Mulberry Creek	0.210	0.200	32	29
Five Creek	0.167	0.150	26	23
Repub-Clay Center	0.312	0.256	80	64

If a water quality milestone is not reached by the timeline listed, the SLT will assess the significance of the data to determine if outside factors (i.e. atmospheric loads or weather) contributed to this milestone not being met. If needed, the SLT will assess the effectiveness of the BMPs installed and determine if additional implementation is needed.

If phosphorus and sediment milestones are met by 2030 by implementing SLT recommended BMPs, then...

the Water Quality Standards will be met for Salt Creek, Belleville City Lake and Jamestown Wildlife Management Area, (in addition to improving impairments listed on the 303d list) and...

Salt Creek, Belleville City Lake and Jamestown Wildlife Management Area will meet their full designated uses and Milford Lake will meet its 30% phoshorus reduction and 30% sediment reduction goals.

10.3 BMP Implementation Milestones

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 2030. 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 twenty year period.

Table 43 BMP Implementation Milestones from 2015 to 2030

	Cropland					Livestock					Stream-bank	Information and Education	
Year	Conservation Crop Rotation, acres	Waterways, acres	No-till, acres	Buffers, acres	Nutrient Management Plans, acres	Filter strips, number	Relocate Feedlots, number	Relocate Pasture Feeding Sites, number	Off-stream Watering Systems, number	Rotational Grazing, number	Restoration, feet	Demonstrations/Workshops/ Tours/Field Days. number	I&E and Technical Assistance Contacts/Participants, number
2015	*471*	*9,417*	*7,063*	*4,807*	*20,247*	*5*	*7*	*2*	*10*	*2*	*2,500*	*85*	*1,250*
2020	*942*	*18,834*	*14,125*	*8,846*	*40,493*	*10*	*10*	*5*	*20*	*5*	*5,000*	*170*	*2,500*
2025	*1,413*	*28,251*	*21,188*	*12,885*	*60,740*	*15*	*13*	*7*	*25*	*7*	*7,500*	*255*	*3,750*
2030	*1,883*	*37,668*	*28,251*	*16,157*	*80,986*	*20*	*17*	*10*	*30*	*10*	*10,000*	*340*	*5,000*

11.0 Monitoring Water Quality Progress

The KDHE and USACE sampling data will be reviewed by the SLT every year. Data collected in the Targeted Areas 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.

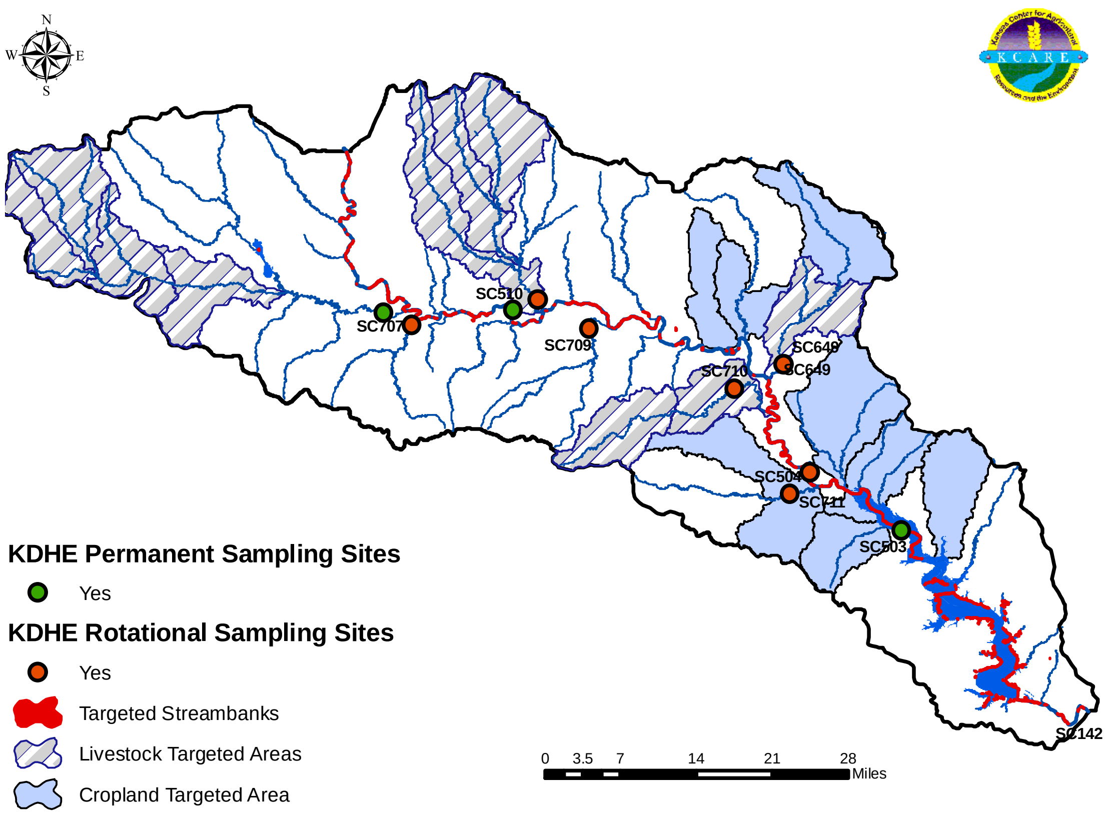


Figure 35 Current Monitoring Sites in the Watershed. [37]

All sampling sites will be continued into the future. Each site is tested for nutrients, metals, ammonia, solid fractions, turbidity, alkalinity, pH, dissolved oxygen, ECB 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, herbicide analysis would not be necessary in the winter months as there are no applications at that time.

The USACE has one sampling site on the Republican River near Clay Center, four sampling sites in Milford Reservoir and one site immediately below the dam. Samples are collected monthly from April to September. Samples taken are analyzed for chlorophyll a, total nitrogen, total phosphorus, Secchi disk depth, atrazine, phytocyanins (blue green algae), iron, manganese, temperature, dissolved oxygen, alkalinity, pH, conductivity, ECB, and caffeine (human impacts resulting from failing septic systems, treatment plants or illicit dumping from boats). [38]

There are three USGS stream flow data stations in the watershed. The flow data derived from the gaging stations will assist the SLT in determining if streambank restoration sites can withstand pressure from high flow events.

Much of the evaluative information can be obtained through the existing networks and sampling plans of KDHE and the USACE, Kansas City District. Public engagement can be obtained through observations of lake clarity, ease of boating and the physical appearance of Milford Reservoir. Some communications with the Kansas Department of Parks and Wildlife will supplement any information on the conditions in the Lower Republican Watershed drainage and on Milford Reservoir.

Monitoring data will be used to direct the SLT in their evaluation of water quality progress. The table below indicates which current monitoring sites data will be used by the SLT in determination of effectiveness of BMP implementation.

Table 44 Monitoring Sites and Tests Needed to Direct SLT in Water Quality Evaluation. Proposed monitoring sites are indicated on map below.

Cropland Targeted Area				
Agency	**Site Number or Name**	**Pollutant Target**	**River, Stream or Lake**	**Sampling Tests Needed**
KDHE	Proposed Site X2	Sediment, Nutrients	Parsons Creek	TSS, TP, DO, ECB
KDHE	711		Five Creek	TSS, TP, DO, ECB
KDHE	649		Peats Creek	TSS, TP, DO, ECB
KDHE	Proposed Site X3		Spring Creek	TSS, TP, DO, ECB
KDHE	Proposed Site X4		Finney Creek	TSS, TP, DO, ECB
KDHE	Proposed Site X5		Lincoln Creek	TSS, TP, DO, ECB
KDHE	Proposed Site X6		Otter Creek	TSS, TP, DO, ECB
KDHE	Proposed Site X7		Mall Creek	TSS, TP, DO, ECB
USACE	24		Republican River	TSS, TP, DO, ECB, Secchi Disk Depth
USACE	5		Milford Reservoir – upper Reservoir	TSS, TP, DO, ECB, Secchi Disk Depth
USACE	3		Milford Reservoir – midReservoir	TSS, TP, DO, ECB, Secchi Disk Depth
USACE	1		Milford Reservoir – Dam Tower	TSS, TP, DO, ECB, Secchi Disk Depth

Monitoring Sites, Cont.				
Livestock Targeted Area				
Agency	**Site Number or Name**	**Pollutant Target**	**River, Stream or Lake**	**Sampling Tests Needed**
KDHE	Proposed Site X1	Nutrients	Buffalo Creek	TP, pH, DO, TN
KDHE	650		Salt Creek	TP, pH, DO, TN
KDHE	710		Mulberry Creek	TP, pH, DO, TN
KDHE	649		Peats Creek	TP, pH, DO, TN, TSS
Streambank Targeted Area				
Agency	**Site Number or Name**	**Pollutant Target**	**River, Stream or Lake**	**Sampling Tests Needed**
KDHE	503	Sediment	Republican River	TSS
KDHE	241		Republican River	TSS
KDHE	504		Republican River	TSS
KDHE	510		Republican River	TSS
KDHE	003		Republican River	TSS
USACE	24		Republican River	TSS, Secchi Disk Depth
USACE	5		Milford Reservoir – upper Reservoir	TSS, Secchi Disk Depth
USACE	3		Milford Reservoir – midReservoir	TSS, Secchi Disk Depth
USACE	1		Milford Reservoir – Dam Tower	TSS, Secchi Disk Depth

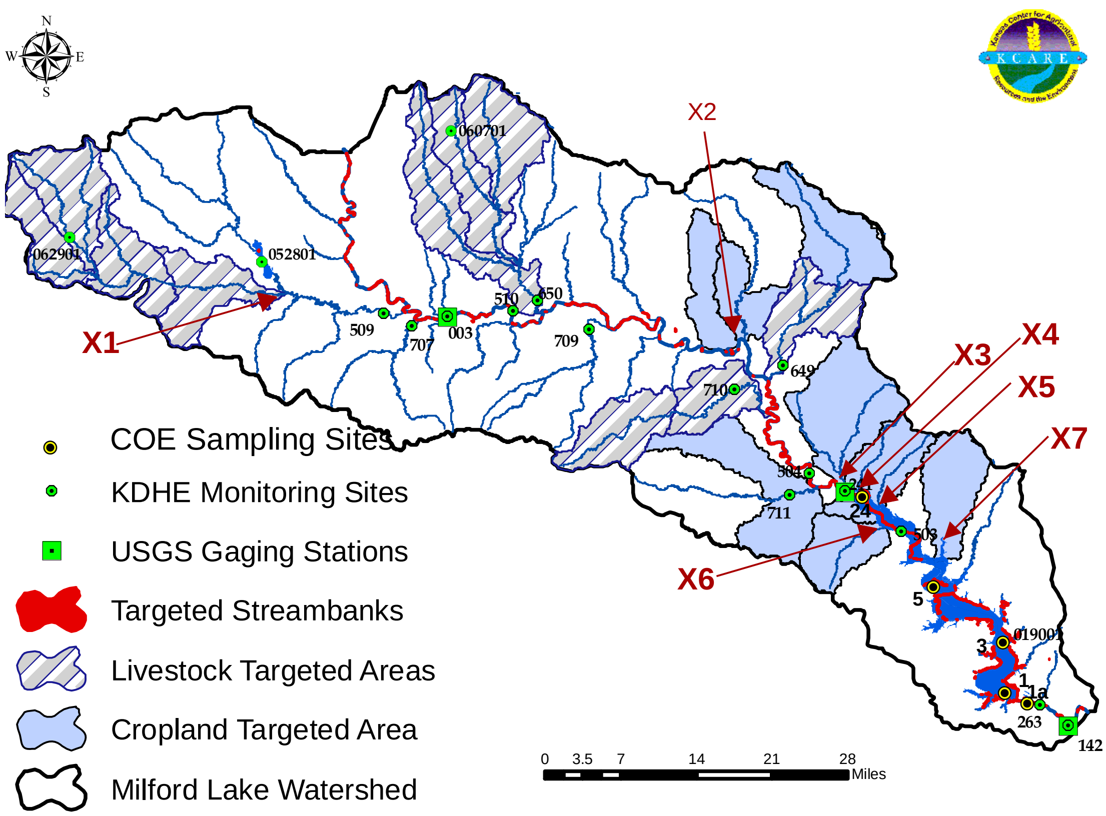


Figure 36 Proposed Monitoring Sites in the Watershed

Monitoring site data that is being generated at this time will be helpful to the SLT. Many of the existing monitoring sites will benefit multiple Targeted Areas. However, additional site placement to support BMP evaluation could be used in the targeted areas:

- The Cropland Targeted Area could benefit with a additional monitoring sites on
  a) Parsons Creek (site X2 on Figure 36),
  b) Spring Creek (site X3 on Figure 36),
  c) Finney Creek (site X4 on Figure 36),
  d) Lincoln Creek (site X5 on Figure 36)
  e) Otter Creek (site X6 on Figure 36) and
  f) Mall Creek (site X7 on Figure 36).
- The Livestock Targeted Area could benefit from a monitoring site at
  a) Buffalo Creek (site X1 on Figure 36).
- The Streambank Targeted Area has monitoring sites along the Republican River and they should be sufficient at this time.

Analysis of the data generated will be used 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 KDHE, USACE and USGS 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.

Monitoring data will be used to direct the SLT in their evaluation of water quality progress. KDHE and USACE 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 Lower Republican Watershed are 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.

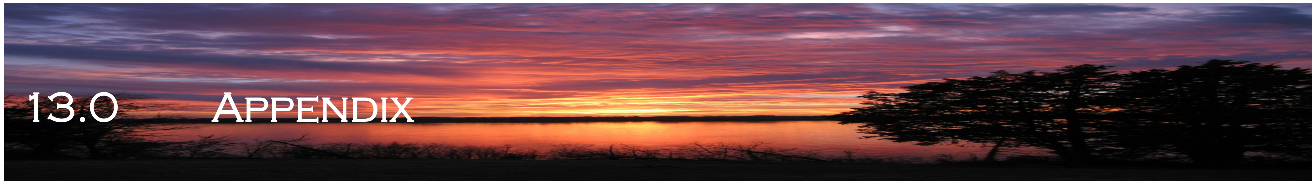
12.0 Review of the Watershed Plan in 2015

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 request a report from KDHE on water quality conditions in the watershed in 2015.
2. The SLT will request a report from KDHE concerning the revisions of the TMDLs from 2015.
3. The SLT will request a report from USACE and Kansas Department of Wildlife and Parks on trends in water quality in Milford Reservoir.
4. The SLT will report on progress towards achieving the adoption rates listed in Section 10.1 of this report.
5. The SLT will report on progress towards achieving the benchmarks listed in Section 10.2 of this report.
6. The SLT will report on progress towards achieving the BMP implementations in Section 10.3 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.
10. The SLT will discuss the possible need for additional assessment data.

In the year 2020, the SLT will request additional information from KDHE:

1. The SLT will ask KDHE for a report on the milestone achievements in **sediment** load reductions according to Section 9.0.
2. The SLT will request from KDHE a report on the milestone achievements in **phosphorus** load reductions according to Section 9.0.



13.1 Service Providers

Table 45 Potential Service Provider Listing

Organization	Programs	Purpose	Technical or Financial Assistance	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	www.epa.gov
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	www.kaws.org
Kansas Dept. of Agriculture	Watershed structures permitting.	Available for watershed districts and multipurpose small lakes development.	Technical and Financial	www.ksda.gov

Organization	Programs	Purpose	Technical or Financial Assistance	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	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	www.kdwp.state.ks.us/

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	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	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	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	http://www.krwa.net

Kansas State Research and Extension	Kansas Center for Agricultural Resources and Environment (KCARE) Watershed Specialists 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 EARTH (Earth Awareness Researchers for Tomorrow's Habitat) Watershed Specialists	*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. Environmental education program designed for Kansas middle schools Provide assistance with WRAPS projects and assistance to farmers and ranchers with implementing BMPs	Technical	www.ksre.ksu.edu

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Website address
Kansas Water Office	Public Information and Education	Provide information and education to the public on Kansas Water Resources	Technical and Financial	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	www.notill.org

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	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	www.accesskansas.org/kscc http://www.kacdnet.org/

Organization	**Programs and Technical Assistance**	**Purpose**	**Technical or Financial Assistance**	**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	www.usace.army.mil
US Geological Survey	National Streamflow Information Program Water Cooperative Program	Provide streamflow data Provide cooperative studies and water-quality information	Technical	http://water.usgs.gov/
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	www.fws.gov

Organization	**Programs and Technical Assistance**	**Purpose**	Technical or Financial Assistance	**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	www.ks.nrcs.usda.gov

13.2 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 percent erosion reduction efficiency, 50 percent phosphorous reduction efficiency.
-Approx. $1,000/acre, 90 percent 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 percent erosion reduction efficiency, 40 percent phosphorous reduction efficiency.
-$800 an acre, 50 percent 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 percent no-till system.
-75 percent erosion reduction efficiency, 40 percent 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 percent 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 percent Erosion Reduction Efficiency, 25 percent 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 percent Erosion Reduction Efficiency, 30 percent phosphorous reduction efficiency
-$1.02 per linear foot, 50 percent cost-share available from NRCS

<u>Nutrient Management Plan</u>
-Managing the amount, source, placement, form and timing of the application of nutrients and soil amendments.
-Intensive soil testing
-25 percent erosion and 25 percent 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 percent cost-share is available from NRCS.

<u>Subsurface Fertilizer Application</u>
-Placing or injecting fertilizer beneath the soil surface.
-Reduces fertilizer runoff.
-0 percent soil and 50 percent 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 percent cost-share is available from NRCS.

Livestock

<u>Vegetative Filter Strip</u>
-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 percent.
-$714 an acre

<u>Relocate Feeding Sites</u>
-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 (e.g. move bale feeders away from stream). Highly variable in price, average of $2,203 per unit.
-Average P reduction: 30-80 percent

<u>Alternative (Off-Stream) Watering System</u>
-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 percent of the time.

-10-25 year lifespan, average P reduction: 30-98 percent 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 percent 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 percent P Reduction.
-Approximately $7,000 with complex systems significantly more expensive.

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

13.3 Appendix Tables

13.3.1 Sediment Load Reductions by Cropland Targeted Sub Watershed

Table 46 Sediment Load Reductions by Sub Watershed

Sub watershed #38 Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total Load Reduction
1	101	3,226	4,537	1,411	9,275
2	202	6,452	9,073	2,823	18,550
3	302	9,678	13,610	4,234	27,825
4	403	12,905	18,147	5,646	37,101
5	504	16,131	22,684	7,057	46,376
6	605	19,357	27,220	8,469	55,651
7	706	22,583	31,757	9,880	64,926
8	807	25,809	36,294	11,291	74,201
9	907	29,035	40,831	12,703	83,476
10	1,008	32,261	45,367	14,114	92,751
11	1,109	35,487	49,904	15,526	102,026
12	1,210	38,714	54,441	16,937	111,302

13	1,311	41,940	58,978	18,349	120,577
14	1,411	45,166	63,514	19,760	129,852
15	1,512	48,392	68,051	21,171	139,127
16	1,613	51,618	72,588	22,583	148,402
17	1,714	54,844	77,125	23,994	157,677
18	1,815	58,070	81,661	25,406	166,952
19	1,916	61,297	86,198	26,817	176,228
20	2,016	64,523	90,735	28,229	185,503

Sub watershed #39 Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total Load Reduction
1	95	3,042	4,278	1,331	8,747
2	190	6,085	8,557	2,662	17,494
3	285	9,127	12,835	3,993	26,241
4	380	12,170	17,114	5,324	34,988
5	475	15,212	21,392	6,655	43,735
6	570	18,254	25,670	7,986	52,482
7	666	21,297	29,949	9,317	61,228
8	761	24,339	34,227	10,648	69,975
9	856	27,382	38,506	11,979	78,722
10	951	30,424	42,784	13,311	87,469
11	1,046	33,467	47,062	14,642	96,216
12	1,141	36,509	51,341	15,973	104,963
13	1,236	39,551	55,619	17,304	113,710
14	1,331	42,594	59,897	18,635	122,457
15	1,426	45,636	64,176	19,966	131,204
16	1,521	48,679	68,454	21,297	139,951
17	1,616	51,721	72,733	22,628	148,698
18	1,711	54,763	77,011	23,959	157,445
19	1,806	57,806	81,289	25,290	166,192
20	1,902	60,848	85,568	26,621	174,939

Sub watershed #41 Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total Load Reduction
1	57	1,826	2,568	799	5,250
2	114	3,653	5,136	1,598	10,501
3	171	5,479	7,705	2,397	15,751
4	228	7,305	10,273	3,196	21,002
5	285	9,131	12,841	3,995	26,252

6	342	10,958	15,409	4,794	31,503
7	399	12,784	17,977	5,593	36,753
8	457	14,610	20,545	6,392	42,004
9	514	16,436	23,114	7,191	47,254
10	571	18,263	25,682	7,990	52,505
11	628	20,089	28,250	8,789	57,755
12	685	21,915	30,818	9,588	63,006
13	742	23,741	33,386	10,387	68,256
14	799	25,568	35,955	11,186	73,507
15	856	27,394	38,523	11,985	78,757
16	913	29,220	41,091	12,784	84,008
17	970	31,046	43,659	13,583	89,258
18	1,027	32,873	46,227	14,382	94,509
19	1,084	34,699	48,795	15,181	99,759
20	1,141	36,525	51,364	15,980	105,010

Sub watershed #42 Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total Load Reduction
1	38	1,231	1,731	539	3,540
2	77	2,462	3,463	1,077	7,079
3	115	3,693	5,194	1,616	10,619
4	154	4,925	6,925	2,155	14,158
5	192	6,156	8,656	2,693	17,698
6	231	7,387	10,388	3,232	21,237
7	269	8,618	12,119	3,770	24,777
8	308	9,849	13,850	4,309	28,316
9	346	11,080	15,582	4,848	31,856
10	385	12,311	17,313	5,386	35,395
11	423	13,543	19,044	5,925	38,935
12	462	14,774	20,776	6,464	42,475
13	500	16,005	22,507	7,002	46,014
14	539	17,236	24,238	7,541	49,554
15	577	18,467	25,969	8,079	53,093
16	616	19,698	27,701	8,618	56,633
17	654	20,929	29,432	9,157	60,172
18	693	22,161	31,163	9,695	63,712
19	731	23,392	32,895	10,234	67,251
20	769	24,623	34,626	10,773	70,791

Sub watershed #11 Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total Load Reduction
1	70	2,252	3,166	985	6,473
2	141	4,503	6,333	1,970	12,947
3	211	6,755	9,499	2,955	19,420
4	281	9,006	12,665	3,940	25,894
5	352	11,258	15,832	4,925	32,367
6	422	13,510	18,998	5,910	38,840
7	493	15,761	22,164	6,896	45,314
8	563	18,013	25,331	7,881	51,787
9	633	20,264	28,497	8,866	58,260
10	704	22,516	31,663	9,851	64,734
11	774	24,768	34,830	10,836	71,207
12	844	27,019	37,996	11,821	77,681
13	915	29,271	41,162	12,806	84,154
14	985	31,523	44,329	13,791	90,627
15	1,055	33,774	47,495	14,776	97,101
16	1,126	36,026	50,661	15,761	103,574
17	1,196	38,277	53,828	16,746	110,047
18	1,267	40,529	56,994	17,731	116,521
19	1,337	42,781	60,160	18,717	122,994
20	1,407	45,032	63,327	19,702	129,468

Sub watershed #24 Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total Load Reduction
1	51	1,623	2,283	710	4,667
2	101	3,247	4,566	1,421	9,335
3	152	4,870	6,849	2,131	14,002
4	203	6,494	9,132	2,841	18,670
5	254	8,117	11,415	3,551	23,337
6	304	9,741	13,698	4,262	28,004
7	355	11,364	15,981	4,972	32,672
8	406	12,988	18,264	5,682	37,339
9	457	14,611	20,547	6,392	42,006
10	507	16,234	22,830	7,103	46,674
11	558	17,858	25,113	7,813	51,341
12	609	19,481	27,396	8,523	56,009
13	660	21,105	29,678	9,233	60,676
14	710	22,728	31,961	9,944	65,343
15	761	24,352	34,244	10,654	70,011
16	812	25,975	36,527	11,364	74,678

17	862	27,598	38,810	12,074	79,346
18	913	29,222	41,093	12,785	84,013
19	964	30,845	43,376	13,495	88,680
20	1,015	32,469	45,659	14,205	93,348

Jamestown Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Nutrient Management Plan	Vegetative Buffers	Total Load Reduction
1	444	887	1,331
2	887	1,775	2,662
3	1,331	2,662	3,993
4	1,775	3,550	5,325
5	2,219	4,437	6,656
6	2,662	5,325	7,987
7	3,106	6,212	9,318
8	3,550	7,100	10,649
9	3,993	7,987	11,980
10	4,437	8,874	13,312
11	4,881	9,762	14,643
12	5,325	10,649	15,974
13	5,768	11,537	17,305
14	6,212	12,424	18,636
15	6,656	13,312	19,967
16	7,100	14,199	21,299
17	7,543	15,086	22,630
18	7,987	15,974	23,961
19	8,431	16,861	25,292
20	8,874	17,749	26,623

Belleville City Lake Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Vegetative Buffers	Total Load Reduction
1	924	924
2	1,848	1,848
3	2,772	2,772

Jewell City Lake Annual Soil Erosion Reduction (tons), Cropland BMPs

Year	Vegetative Buffers	Total Load Reduction
1	610	610
2	1,221	1,221
3	1,831	1,831

13.3.2 Phosphorus Load Reductions by Cropland Targeted Sub Watershed

Table 47 Phosphorus Load Reductions by Sub Watershed

Sub watershed #38 Annual Phosphorous Reduction (lbs), Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total Load Reduction
1	25	788	591	345	1,749
2	49	1,576	1,182	690	3,498
3	74	2,365	1,774	1,035	5,247
4	99	3,153	2,365	1,379	6,995
5	123	3,941	2,956	1,724	8,744
6	148	4,729	3,547	2,069	10,493
7	172	5,518	4,138	2,414	12,242
8	197	6,306	4,729	2,759	13,991
9	222	7,094	5,321	3,104	15,740
10	246	7,882	5,912	3,448	17,489
11	271	8,670	6,503	3,793	19,238
12	296	9,459	7,094	4,138	20,986
13	320	10,247	7,685	4,483	22,735
14	345	11,035	8,276	4,828	24,484
15	369	11,823	8,868	5,173	26,233
16	394	12,612	9,459	5,518	27,982
17	419	13,400	10,050	5,862	29,731
18	443	14,188	10,641	6,207	31,480
19	468	14,976	11,232	6,552	33,229
20	493	15,764	11,823	6,897	34,977

Sub watershed #39 Annual Phosphorous Reduction (lbs), Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total Load Reduction
1	22	717	538	314	1,590
2	45	1,434	1,075	627	3,181
3	67	2,150	1,613	941	4,771
4	90	2,867	2,150	1,254	6,361
5	112	3,584	2,688	1,568	7,951
6	134	4,301	3,225	1,881	9,542
7	157	5,017	3,763	2,195	11,132
8	179	5,734	4,301	2,509	12,722
9	202	6,451	4,838	2,822	14,313
10	224	7,168	5,376	3,136	15,903
11	246	7,884	5,913	3,449	17,493
12	269	8,601	6,451	3,763	19,084
13	291	9,318	6,988	4,077	20,674

14	314	10,035	7,526	4,390	22,264
15	336	10,751	8,063	4,704	23,854
16	358	11,468	8,601	5,017	25,445
17	381	12,185	9,139	5,331	27,035
18	403	12,902	9,676	5,644	28,625
19	426	13,618	10,214	5,958	30,216
20	448	14,335	10,751	6,272	31,806

Sub watershed #41 Annual Phosphorous Reduction (lbs), Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total Load Reduction
1	16	513	385	225	1,139
2	32	1,027	770	449	2,278
3	48	1,540	1,155	674	3,417
4	64	2,053	1,540	898	4,556
5	80	2,567	1,925	1,123	5,695
6	96	3,080	2,310	1,348	6,834
7	112	3,594	2,695	1,572	7,973
8	128	4,107	3,080	1,797	9,112
9	144	4,620	3,465	2,021	10,251
10	160	5,134	3,850	2,246	11,390
11	176	5,647	4,235	2,471	12,529
12	193	6,160	4,620	2,695	13,668
13	209	6,674	5,005	2,920	14,807
14	225	7,187	5,390	3,144	15,946
15	241	7,700	5,775	3,369	17,085
16	257	8,214	6,160	3,594	18,224
17	273	8,727	6,545	3,818	19,363
18	289	9,241	6,930	4,043	20,502
19	305	9,754	7,315	4,267	21,641
20	321	10,267	7,700	4,492	22,780

Sub watershed #42 Annual Phosphorous Reduction (lbs), Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total Load Reduction
1	8	254	191	111	564
2	16	508	381	222	1,127
3	24	762	572	333	1,691
4	32	1,016	762	445	2,254
5	40	1,270	953	556	2,818
6	48	1,524	1,143	667	3,382

7	56	1,778	1,334	778	3,945
8	64	2,032	1,524	889	4,509
9	71	2,286	1,715	1,000	5,073
10	79	2,540	1,905	1,111	5,636
11	87	2,794	2,096	1,222	6,200
12	95	3,048	2,286	1,334	6,763
13	103	3,302	2,477	1,445	7,327
14	111	3,556	2,667	1,556	7,891
15	119	3,810	2,858	1,667	8,454
16	127	4,064	3,048	1,778	9,018
17	135	4,318	3,239	1,889	9,581
18	143	4,572	3,429	2,000	10,145
19	151	4,826	3,620	2,112	10,709
20	159	5,080	3,810	2,223	11,272

Sub watershed #11 Annual Phosphorous Reduction (lbs), Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total Load Reduction
1	19	616	462	270	1,368
2	39	1,233	925	539	2,736
3	58	1,849	1,387	809	4,103
4	77	2,466	1,849	1,079	5,471
5	96	3,082	2,312	1,348	6,839
6	116	3,699	2,774	1,618	8,207
7	135	4,315	3,236	1,888	9,574
8	154	4,932	3,699	2,158	10,942
9	173	5,548	4,161	2,427	12,310
10	193	6,165	4,623	2,697	13,678
11	212	6,781	5,086	2,967	15,045
12	231	7,397	5,548	3,236	16,413
13	250	8,014	6,010	3,506	17,781
14	270	8,630	6,473	3,776	19,149
15	289	9,247	6,935	4,045	20,516
16	308	9,863	7,397	4,315	21,884
17	327	10,480	7,860	4,585	23,252
18	347	11,096	8,322	4,855	24,620
19	366	11,713	8,784	5,124	25,987
20	385	12,329	9,247	5,394	27,355

Sub watershed #24 Annual Phosphorous Reduction (lbs), Cropland BMPs

Year	Conservation	Grassed Waterways	No-Till	Buffers	Total Load

	Rotations				Reduction
1	9	299	224	131	663
2	19	598	449	262	1,327
3	28	897	673	392	1,990
4	37	1,196	897	523	2,654
5	47	1,495	1,121	654	3,317
6	56	1,794	1,346	785	3,981
7	65	2,093	1,570	916	4,644
8	75	2,392	1,794	1,047	5,308
9	84	2,691	2,018	1,177	5,971
10	93	2,990	2,243	1,308	6,635
11	103	3,289	2,467	1,439	7,298
12	112	3,588	2,691	1,570	7,962
13	121	3,887	2,916	1,701	8,625
14	131	4,186	3,140	1,832	9,289
15	140	4,485	3,364	1,962	9,952
16	150	4,785	3,588	2,093	10,616
17	159	5,084	3,813	2,224	11,279
18	168	5,383	4,037	2,355	11,943
19	178	5,682	4,261	2,486	12,606
20	187	5,981	4,485	2,617	13,270

Jamestown Annual Phosphorous Reduction (lbs), Cropland BMPs

Year	Nutrient Management Plan	Vegetative Buffers	Total Load Reduction
1	74	148	222
2	148	296	444
3	222	444	666
4	296	592	887
5	370	740	1,109
6	444	887	1,331
7	518	1,035	1,553
8	592	1,183	1,775
9	666	1,331	1,997
10	740	1,479	2,219
11	813	1,627	2,440
12	887	1,775	2,662
13	961	1,923	2,884
14	1,035	2,071	3,106
15	1,109	2,219	3,328
16	1,183	2,367	3,550
17	1,257	2,514	3,772
18	1,331	2,662	3,993

19	1,405	2,810	4,215
20	1,479	2,958	4,437

Belleville City Lake Annual Phosphorous Reduction (lbs), Cropland BMPs

Year	Vegetative Buffers	Total Load Reduction
1	177	177
2	355	355
3	532	532

Jewell City Lake Annual Phosphorous Reduction (lbs), Cropland BMPs

Year	Vegetative Buffers	Total Load Reduction
1	99	99
2	199	199
3	298	298

13.3.3 Cropland Adoption Rates by Cropland Targeted Sub Watershed

Table 48 Cropland Adoption Rates by Sub Watershed

Sub watershed #38 Annual Adoption (treated acres), Cropland BMPs

	Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
Short-Term	1	24	482	361	169	1,036
	2	24	482	361	169	1,036
	3	24	482	361	169	1,036
	4	24	482	361	169	1,036
	5	24	482	361	169	1,036
	Total	*120*	*2,409*	*1,807*	*843*	*5,179*
Medium-Term	6	24	482	361	169	1,036
	7	24	482	361	169	1,036
	8	24	482	361	169	1,036
	9	24	482	361	169	1,036
	10	24	482	361	169	1,036
	Total	*241*	*4,818*	*3,614*	*1,686*	*10,359*
Long-Term	11	24	482	361	169	1,036
	12	24	482	361	169	1,036
	13	24	482	361	169	1,036
	14	24	482	361	169	1,036
	15	24	482	361	169	1,036
	Total	*361*	*7,227*	*5,420*	*2,529*	*15,538*
	16	24	482	361	169	1,036

	Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
	17	24	482	361	169	1,036
	18	24	482	361	169	1,036
	19	24	482	361	169	1,036
	20	24	482	361	169	1,036
	Total	***482***	***9,636***	***7,227***	***3,373***	***20,717***

Sub watershed #39 Annual Adoption (treated acres), Cropland BMPs

	Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
Short-Term	1	21	422	316	148	906
	2	21	422	316	148	906
	3	21	422	316	148	906
	4	21	422	316	148	906
	5	21	422	316	148	906
	Total	*105*	*2,108*	*1,581*	*738*	*4,532*
Medium-Term	6	21	422	316	148	906
	7	21	422	316	148	906
	8	21	422	316	148	906
	9	21	422	316	148	906
	10	21	422	316	148	906
	Total	*211*	*4,216*	*3,162*	*1,476*	*9,065*
Long-Term	11	21	422	316	148	906
	12	21	422	316	148	906
	13	21	422	316	148	906
	14	21	422	316	148	906
	15	21	422	316	148	906
	Total	*316*	*6,324*	*4,743*	*2,214*	*13,597*
	16	21	422	316	148	906
	17	21	422	316	148	906
	18	21	422	316	148	906
	19	21	422	316	148	906
	20	21	422	316	148	906
	Total	***422***	***8,432***	***6,324***	***2,951***	***18,130***

Sub watershed #41 Annual Adoption (treated acres), Cropland BMPs

	Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
Short-Term	1	14	273	205	96	587
	2	14	273	205	96	587
	3	14	273	205	96	587
	4	14	273	205	96	587
	5	14	273	205	96	587
	Total	*68*	*1,365*	*1,024*	*478*	*2,935*

Medium-Term	6	14	273	205	96	587
	7	14	273	205	96	587
	8	14	273	205	96	587
	9	14	273	205	96	587
	10	14	273	205	96	587
	Total	*137*	*2,731*	*2,048*	*956*	*5,871*
Long-Term	11	14	273	205	96	587
	12	14	273	205	96	587
	13	14	273	205	96	587
	14	14	273	205	96	587
	15	14	273	205	96	587
	Total	*205*	*4,096*	*3,072*	*1,434*	*8,806*
	16	14	273	205	96	587
	17	14	273	205	96	587
	18	14	273	205	96	587
	19	14	273	205	96	587
	20	14	273	205	96	587
	Total	***273***	***5,461***	***4,096***	***1,911***	***11,742***

Sub watershed #42 Annual Adoption (treated acres), Cropland BMPs

	Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
Short-Term	1	9	187	140	66	403
	2	9	187	140	66	403
	3	9	187	140	66	403
	4	9	187	140	66	403
	5	9	187	140	66	403
	Total	*47*	*937*	*702*	*328*	*2,014*
Medium-Term	6	9	187	140	66	403
	7	9	187	140	66	403
	8	9	187	140	66	403
	9	9	187	140	66	403
	10	9	187	140	66	403
	Total	*94*	*1,873*	*1,405*	*656*	*4,028*
Long-Term	11	9	187	140	66	403
	12	9	187	140	66	403
	13	9	187	140	66	403
	14	9	187	140	66	403
	15	9	187	140	66	403
	Total	*140*	*2,810*	*2,107*	*983*	*6,041*
	16	9	187	140	66	403
	17	9	187	140	66	403

	Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
	18	9	187	140	66	403
	19	9	187	140	66	403
	20	9	187	140	66	403
	Total	***187***	***3,747***	***2,810***	***1,311***	***8,055***

Sub watershed #11 Annual Adoption (treated acres), Cropland BMPs

	Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
Short-Term	1	16	311	234	109	669
	2	16	311	234	109	669
	3	16	311	234	109	669
	4	16	311	234	109	669
	5	16	311	234	109	669
	Total	*78*	*1,557*	*1,168*	*545*	*3,347*
Medium-Term	6	16	311	234	109	669
	7	16	311	234	109	669
	8	16	311	234	109	669
	9	16	311	234	109	669
	10	16	311	234	109	669
	Total	*156*	*3,113*	*2,335*	*1,090*	*6,694*
Long-Term	11	16	311	234	109	669
	12	16	311	234	109	669
	13	16	311	234	109	669
	14	16	311	234	109	669
	15	16	311	234	109	669
	Total	*234*	*4,670*	*3,503*	*1,635*	*10,041*
	16	16	311	234	109	669
	17	16	311	234	109	669
	18	16	311	234	109	669
	19	16	311	234	109	669
	20	16	311	234	109	669
	Total	***311***	***6,227***	***4,670***	***2,179***	***13,388***

Sub watershed #24 Annual Adoption (treated acres), Cropland BMPs

	Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
Short-Term	1	10	208	156	73	448
	2	10	208	156	73	448
	3	10	208	156	73	448
	4	10	208	156	73	448
	5	10	208	156	73	448
	Total	*52*	*1,041*	*781*	*364*	*2,239*
Medium-Term	6	10	208	156	73	448

	7	10	208	156	73	448
	8	10	208	156	73	448
	9	10	208	156	73	448
	10	10	208	156	73	448
	Total	*104*	*2,082*	*1,562*	*729*	*4,477*
Long-Term	11	10	208	156	73	448
	12	10	208	156	73	448
	13	10	208	156	73	448
	14	10	208	156	73	448
	15	10	208	156	73	448
	Total	*156*	*3,124*	*2,343*	*1,093*	*6,716*
	16	10	208	156	73	448
	17	10	208	156	73	448
	18	10	208	156	73	448
	19	10	208	156	73	448
	20	10	208	156	73	448
	Total	***208***	***4,165***	***3,124***	***1,458***	***8,954***

Jamestown Wildlife Area Annual Adoption (treated acres), Cropland BMPs

	Year	Nutrient Management Plan	Vegetative Buffers	Total Adoption
Short-Term	1	149	149	297
	2	149	149	297
	3	149	149	297
	4	149	149	297
	5	149	149	297
	Total	*743*	*743*	*1,487*
Medium-Term	6	149	149	297
	7	149	149	297
	8	149	149	297
	9	149	149	297
	10	149	149	297
	Total	*1,487*	*1,487*	*2,973*
Long-Term	11	149	149	297
	12	149	149	297
	13	149	149	297
	14	149	149	297
	15	149	149	297
	Total	*2,230*	*2,230*	*4,460*
	16	149	149	297
	17	149	149	297
	18	149	149	297

19	149	149	297
20	149	149	297
Total	*2,973*	*2,973*	*5,946*

Belleville City Lake Annual Adoption (treated acres), Cropland BMPs

Year	Vegetative Buffers	Total Adoption
1	134	134
2	134	134
3	134	134

Jewell City Lake Annual Adoption (treated acres), Cropland BMPs

Year	Vegetative Buffers	Total Adoption
1	121	121
2	121	121
3	121	121

13.3.4 Cropland Costs Before Cost Share by Cropland Targeted Sub Watershed

Table 49 Cropland Costs Before Cost Share by Sub Watershed

Sub watershed #38 Annual Cost, Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
1	$936	$38,544	$28,073	$11,242	$78,795
2	$964	$39,700	$28,915	$11,579	$81,159
3	$993	$40,891	$29,783	$11,927	$83,594
4	$1,022	$42,118	$30,676	$12,284	$86,101
5	$1,053	$43,382	$31,597	$12,653	$88,684
6	$1,085	$44,683	$32,545	$13,033	$91,345
7	$1,117	$46,024	$33,521	$13,424	$94,085
8	$1,151	$47,404	$34,527	$13,826	$96,908
9	$1,185	$48,826	$35,562	$14,241	$99,815
10	$1,221	$50,291	$36,629	$14,668	$102,810
11	$1,257	$51,800	$37,728	$15,108	$105,894
12	$1,295	$53,354	$38,860	$15,562	$109,071
13	$1,334	$54,955	$40,026	$16,028	$112,343
14	$1,374	$56,603	$41,227	$16,509	$115,713
15	$1,415	$58,301	$42,463	$17,005	$119,184
16	$1,458	$60,050	$43,737	$17,515	$122,760
17	$1,501	$61,852	$45,049	$18,040	$126,443
18	$1,546	$63,707	$46,401	$18,581	$130,236
19	$1,593	$65,619	$47,793	$19,139	$134,143

20	$1,641	$67,587	$49,227	$19,713	$138,167

Sub watershed #39 Annual Cost, Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
1	$819	$33,730	$24,567	$9,838	$68,953
2	$843	$34,741	$25,304	$10,133	$71,022
3	$869	$35,784	$26,063	$10,437	$73,152
4	$895	$36,857	$26,845	$10,750	$75,347
5	$922	$37,963	$27,650	$11,073	$77,607
6	$949	$39,102	$28,480	$11,405	$79,935
7	$978	$40,275	$29,334	$11,747	$82,333
8	$1,007	$41,483	$30,214	$12,099	$84,803
9	$1,037	$42,728	$31,120	$12,462	$87,348
10	$1,068	$44,009	$32,054	$12,836	$89,968
11	$1,100	$45,330	$33,016	$13,221	$92,667
12	$1,133	$46,690	$34,006	$13,618	$95,447
13	$1,167	$48,090	$35,026	$14,026	$98,310
14	$1,202	$49,533	$36,077	$14,447	$101,260
15	$1,238	$51,019	$37,159	$14,881	$104,297
16	$1,276	$52,550	$38,274	$15,327	$107,426
17	$1,314	$54,126	$39,422	$15,787	$110,649
18	$1,353	$55,750	$40,605	$16,260	$113,969
19	$1,394	$57,422	$41,823	$16,748	$117,388
20	$1,436	$59,145	$43,078	$17,251	$120,909

Sub watershed #41 Annual Cost, Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
1	$530	$21,845	$15,911	$6,372	$44,658
2	$546	$22,501	$16,388	$6,563	$45,998
3	$563	$23,176	$16,880	$6,760	$47,378
4	$579	$23,871	$17,386	$6,962	$48,799
5	$597	$24,587	$17,908	$7,171	$50,263
6	$615	$25,325	$18,445	$7,386	$51,771
7	$633	$26,084	$18,998	$7,608	$53,324
8	$652	$26,867	$19,568	$7,836	$54,924
9	$672	$27,673	$20,155	$8,071	$56,571
10	$692	$28,503	$20,760	$8,313	$58,268
11	$713	$29,358	$21,383	$8,563	$60,016
12	$734	$30,239	$22,024	$8,820	$61,817

13	$756	$31,146	$22,685	$9,084	$63,671
14	$779	$32,080	$23,366	$9,357	$65,582
15	$802	$33,043	$24,067	$9,638	$67,549
16	$826	$34,034	$24,789	$9,927	$69,576
17	$851	$35,055	$25,532	$10,224	$71,663
18	$876	$36,107	$26,298	$10,531	$73,813
19	$903	$37,190	$27,087	$10,847	$76,027
20	$930	$38,306	$27,900	$11,173	$78,308

Sub watershed #42 Annual Cost, Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
1	$364	$14,987	$10,915	$4,371	$30,637
2	$375	$15,436	$11,243	$4,502	$31,556
3	$386	$15,899	$11,580	$4,637	$32,503
4	$398	$16,376	$11,928	$4,776	$33,478
5	$409	$16,868	$12,285	$4,920	$34,482
6	$422	$17,374	$12,654	$5,067	$35,516
7	$434	$17,895	$13,034	$5,219	$36,582
8	$447	$18,432	$13,425	$5,376	$37,679
9	$461	$18,985	$13,827	$5,537	$38,810
10	$475	$19,554	$14,242	$5,703	$39,974
11	$489	$20,141	$14,669	$5,874	$41,173
12	$504	$20,745	$15,109	$6,051	$42,409
13	$519	$21,367	$15,563	$6,232	$43,681
14	$534	$22,008	$16,030	$6,419	$44,991
15	$550	$22,669	$16,510	$6,612	$46,341
16	$567	$23,349	$17,006	$6,810	$47,731
17	$584	$24,049	$17,516	$7,014	$49,163
18	$601	$24,771	$18,041	$7,225	$50,638
19	$619	$25,514	$18,583	$7,441	$52,157
20	$638	$26,279	$19,140	$7,665	$53,722

Sub watershed #11 Annual Cost, Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
1	$605	$24,907	$18,141	$7,265	$50,917
2	$623	$25,654	$18,685	$7,483	$52,445
3	$641	$26,424	$19,246	$7,707	$54,018
4	$661	$27,217	$19,823	$7,938	$55,639
5	$681	$28,033	$20,418	$8,176	$57,308

6	$701	$28,874	$21,030	$8,422	$59,027
7	$722	$29,740	$21,661	$8,674	$60,798
8	$744	$30,633	$22,311	$8,935	$62,622
9	$766	$31,552	$22,980	$9,203	$64,501
10	$789	$32,498	$23,670	$9,479	$66,436
11	$813	$33,473	$24,380	$9,763	$68,429
12	$837	$34,477	$25,111	$10,056	$70,482
13	$862	$35,512	$25,865	$10,358	$72,596
14	$888	$36,577	$26,641	$10,668	$74,774
15	$915	$37,674	$27,440	$10,988	$77,017
16	$942	$38,805	$28,263	$11,318	$79,328
17	$970	$39,969	$29,111	$11,658	$81,708
18	$999	$41,168	$29,984	$12,007	$84,159
19	$1,029	$42,403	$30,884	$12,367	$86,684
20	$1,060	$43,675	$31,810	$12,739	$89,284

Sub watershed #24 Annual Cost, Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
1	$404	$16,659	$12,134	$4,859	$34,056
2	$417	$17,159	$12,498	$5,005	$35,078
3	$429	$17,674	$12,873	$5,155	$36,130
4	$442	$18,204	$13,259	$5,309	$37,214
5	$455	$18,750	$13,657	$5,469	$38,331
6	$469	$19,313	$14,066	$5,633	$39,480
7	$483	$19,892	$14,488	$5,802	$40,665
8	$497	$20,489	$14,923	$5,976	$41,885
9	$512	$21,103	$15,371	$6,155	$43,141
10	$528	$21,736	$15,832	$6,340	$44,436
11	$543	$22,389	$16,307	$6,530	$45,769
12	$560	$23,060	$16,796	$6,726	$47,142
13	$577	$23,752	$17,300	$6,928	$48,556
14	$594	$24,465	$17,819	$7,136	$50,013
15	$612	$25,199	$18,353	$7,350	$51,513
16	$630	$25,954	$18,904	$7,570	$53,058
17	$649	$26,733	$19,471	$7,797	$54,650
18	$668	$27,535	$20,055	$8,031	$56,290
19	$688	$28,361	$20,657	$8,272	$57,978
20	$709	$29,212	$21,276	$8,520	$59,718

Jamestown Wildlife Area Annual Cost, Cropland BMPs

Year	Nutrient Management Plan	Vegetative	Total Cost

		Buffers	
1	$8,430	$9,910	$18,340
2	$8,683	$10,207	$18,890
3	$8,943	$10,514	$19,457
4	$9,212	$10,829	$20,041
5	$9,488	$11,154	$20,642
6	$9,773	$11,488	$21,261
7	$10,066	$11,833	$21,899
8	$10,368	$12,188	$22,556
9	$10,679	$12,554	$23,232
10	$10,999	$12,930	$23,929
11	$11,329	$13,318	$24,647
12	$11,669	$13,718	$25,387
13	$12,019	$14,129	$26,148
14	$12,380	$14,553	$26,933
15	$12,751	$14,990	$27,741
16	$13,134	$15,439	$28,573
17	$13,528	$15,903	$29,430
18	$13,933	$16,380	$30,313
19	$14,351	$16,871	$31,223
20	$14,782	$17,377	$32,159

Belleville City Lake Annual Cost, Cropland BMPs

Year	Vegetative Buffers	Total Adoption
1	$8,953	$8,953
2	$9,222	$9,222
3	$9,498	$9,498

Jewell City Lake Annual Cost, Cropland BMPs

Year	Vegetative Buffers	Total Adoption
1	$8,099	$8,099
2	$8,342	$8,342
3	$8,592	$8,592

13.3.5 Cropland Costs After Cost Share by Cropland Targeted Sub Watershed

Table 50 Cropland Costs After Cost Share by Sub Watershed

Sub watershed #38 Annual Cost After Cost-Share, Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total

1	$936	$19,272	$17,125	$1,124	$38,457
2	$964	$19,850	$17,638	$1,158	$39,610
3	$993	$20,446	$18,168	$1,193	$40,799
4	$1,022	$21,059	$18,713	$1,228	$42,023
5	$1,053	$21,691	$19,274	$1,265	$43,283
6	$1,085	$22,342	$19,852	$1,303	$44,582
7	$1,117	$23,012	$20,448	$1,342	$45,919
8	$1,151	$23,702	$21,061	$1,383	$47,297
9	$1,185	$24,413	$21,693	$1,424	$48,716
10	$1,221	$25,146	$22,344	$1,467	$50,177
11	$1,257	$25,900	$23,014	$1,511	$51,682
12	$1,295	$26,677	$23,705	$1,556	$53,233
13	$1,334	$27,477	$24,416	$1,603	$54,830
14	$1,374	$28,302	$25,148	$1,651	$56,475
15	$1,415	$29,151	$25,903	$1,700	$58,169
16	$1,458	$30,025	$26,680	$1,751	$59,914
17	$1,501	$30,926	$27,480	$1,804	$61,711
18	$1,546	$31,854	$28,305	$1,858	$63,563
19	$1,593	$32,809	$29,154	$1,914	$65,470
20	$1,641	$33,794	$30,028	$1,971	$67,434

Sub watershed #39 Annual Cost After Cost-Share, Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
1	$819	$16,865	$14,986	$984	$33,653
2	$843	$17,371	$15,435	$1,013	$34,663
3	$869	$17,892	$15,898	$1,044	$35,703
4	$895	$18,429	$16,375	$1,075	$36,774
5	$922	$18,981	$16,867	$1,107	$37,877
6	$949	$19,551	$17,373	$1,140	$39,013
7	$978	$20,137	$17,894	$1,175	$40,184
8	$1,007	$20,742	$18,431	$1,210	$41,389
9	$1,037	$21,364	$18,983	$1,246	$42,631
10	$1,068	$22,005	$19,553	$1,284	$43,910
11	$1,100	$22,665	$20,140	$1,322	$45,227
12	$1,133	$23,345	$20,744	$1,362	$46,584
13	$1,167	$24,045	$21,366	$1,403	$47,981
14	$1,202	$24,767	$22,007	$1,445	$49,421
15	$1,238	$25,510	$22,667	$1,488	$50,903
16	$1,276	$26,275	$23,347	$1,533	$52,430
17	$1,314	$27,063	$24,048	$1,579	$54,003
18	$1,353	$27,875	$24,769	$1,626	$55,623

19	$1,394	$28,711	$25,512	$1,675	$57,292
20	$1,436	$29,573	$26,278	$1,725	$59,011

Sub watershed #41 Annual Cost After Cost-Share, Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
1	$530	$10,923	$9,706	$637	$21,796
2	$546	$11,250	$9,997	$656	$22,450
3	$563	$11,588	$10,297	$676	$23,123
4	$579	$11,935	$10,606	$696	$23,817
5	$597	$12,293	$10,924	$717	$24,531
6	$615	$12,662	$11,251	$739	$25,267
7	$633	$13,042	$11,589	$761	$26,025
8	$652	$13,433	$11,937	$784	$26,806
9	$672	$13,836	$12,295	$807	$27,610
10	$692	$14,252	$12,664	$831	$28,438
11	$713	$14,679	$13,044	$856	$29,292
12	$734	$15,119	$13,435	$882	$30,170
13	$756	$15,573	$13,838	$908	$31,075
14	$779	$16,040	$14,253	$936	$32,008
15	$802	$16,521	$14,681	$964	$32,968
16	$826	$17,017	$15,121	$993	$33,957
17	$851	$17,528	$15,575	$1,022	$34,976
18	$876	$18,053	$16,042	$1,053	$36,025
19	$903	$18,595	$16,523	$1,085	$37,106
20	$930	$19,153	$17,019	$1,117	$38,219

Sub watershed #42 Annual Cost After Cost-Share, Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
1	$364	$7,493	$6,658	$437	$14,953
2	$375	$7,718	$6,858	$450	$15,401
3	$386	$7,950	$7,064	$464	$15,863
4	$398	$8,188	$7,276	$478	$16,339
5	$409	$8,434	$7,494	$492	$16,829
6	$422	$8,687	$7,719	$507	$17,334
7	$434	$8,947	$7,950	$522	$17,854
8	$447	$9,216	$8,189	$538	$18,390
9	$461	$9,492	$8,435	$554	$18,941
10	$475	$9,777	$8,688	$570	$19,510
11	$489	$10,070	$8,948	$587	$20,095

12	$504	$10,372	$9,217	$605	$20,698
13	$519	$10,684	$9,493	$623	$21,319
14	$534	$11,004	$9,778	$642	$21,958
15	$550	$11,334	$10,071	$661	$22,617
16	$567	$11,674	$10,374	$681	$23,296
17	$584	$12,025	$10,685	$701	$23,994
18	$601	$12,385	$11,005	$722	$24,714
19	$619	$12,757	$11,335	$744	$25,456
20	$638	$13,140	$11,676	$766	$26,219

Sub watershed #11 Annual Cost After Cost-Share, Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
1	$605	$12,454	$11,066	$726	$24,851
2	$623	$12,827	$11,398	$748	$25,596
3	$641	$13,212	$11,740	$771	$26,364
4	$661	$13,608	$12,092	$794	$27,155
5	$681	$14,017	$12,455	$818	$27,970
6	$701	$14,437	$12,829	$842	$28,809
7	$722	$14,870	$13,213	$867	$29,673
8	$744	$15,316	$13,610	$893	$30,563
9	$766	$15,776	$14,018	$920	$31,480
10	$789	$16,249	$14,439	$948	$32,425
11	$813	$16,737	$14,872	$976	$33,397
12	$837	$17,239	$15,318	$1,006	$34,399
13	$862	$17,756	$15,777	$1,036	$35,431
14	$888	$18,289	$16,251	$1,067	$36,494
15	$915	$18,837	$16,738	$1,099	$37,589
16	$942	$19,402	$17,240	$1,132	$38,717
17	$970	$19,984	$17,758	$1,166	$39,878
18	$999	$20,584	$18,290	$1,201	$41,074
19	$1,029	$21,201	$18,839	$1,237	$42,307
20	$1,060	$21,837	$19,404	$1,274	$43,576

Sub watershed #24 Annual Cost After Cost-Share, Cropland BMPs

Year	Conservation Rotations	Grassed Waterways	No-Till	Buffers	Total
1	$404	$8,330	$7,402	$486	$16,621
2	$417	$8,579	$7,624	$500	$17,120
3	$429	$8,837	$7,852	$515	$17,634
4	$442	$9,102	$8,088	$531	$18,163

5	$455	$9,375	$8,330	$547	$18,708
6	$469	$9,656	$8,580	$563	$19,269
7	$483	$9,946	$8,838	$580	$19,847
8	$497	$10,244	$9,103	$598	$20,442
9	$512	$10,552	$9,376	$616	$21,056
10	$528	$10,868	$9,657	$634	$21,687
11	$543	$11,194	$9,947	$653	$22,338
12	$560	$11,530	$10,245	$673	$23,008
13	$577	$11,876	$10,553	$693	$23,698
14	$594	$12,232	$10,869	$714	$24,409
15	$612	$12,599	$11,195	$735	$25,141
16	$630	$12,977	$11,531	$757	$25,896
17	$649	$13,367	$11,877	$780	$26,672
18	$668	$13,768	$12,234	$803	$27,473
19	$688	$14,181	$12,601	$827	$28,297
20	$709	$14,606	$12,979	$852	$29,146

Jamestown Annual Cost After Cost-Share, Cropland BMPs

Year	Nutrient Management Plan	Vegetative Buffers	Total Cost
1	$4,215	$991	$5,206
2	$4,341	$1,021	$5,362
3	$4,472	$1,051	$5,523
4	$4,606	$1,083	$5,689
5	$4,744	$1,115	$5,859
6	$4,886	$1,149	$6,035
7	$5,033	$1,183	$6,216
8	$5,184	$1,219	$6,403
9	$5,339	$1,255	$6,595
10	$5,500	$1,293	$6,793
11	$5,665	$1,332	$6,996
12	$5,835	$1,372	$7,206
13	$6,010	$1,413	$7,422
14	$6,190	$1,455	$7,645
15	$6,376	$1,499	$7,874
16	$6,567	$1,544	$8,111
17	$6,764	$1,590	$8,354
18	$6,967	$1,638	$8,605
19	$7,176	$1,687	$8,863
20	$7,391	$1,738	$9,129

Belleville City Lake Annual Cost After Cost-Share, Cropland BMPs

Year	Vegetative Buffers	Total Adoption
1	$895	$895
2	$922	$922
3	$950	$950

Jewell City Lake Annual Cost After Cost-Share, Cropland BMPs

Year	Vegetative Buffers	Total Adoption
1	$810	$810
2	$834	$834
3	$859	$859

14.0 Bibliography

[1] National Elevation Dataset, East Central Kansas, Kansas Geospatial Community Commons.

[2] Kansas Water Office. Reservoir Fact Sheets.
http://www.kwo.org/reservoirinformation/reservoir%20information.htm

[3] Kansas Unified Watershed Assessment 1999. Kansas Department of Health and Environment and the United States Department of Agriculture Natural Resources Conservation Service.
http://www.kdheks.gov/nps/resources/uwa.pdf

[4] Small River, Big Challenges, Farm Journal, March 2010.
http://kansasfarmer.com/story.aspx/water/officials/meet/to/discuss/republican/river/compact/9/15577
http://snr.unl.edu/szilagyi/JESpaper.pdf
Arbitration information can be found at http://www.ksda.gov/interstate_water_issues/content/142

[5] Kansas Applied Remote Sensing Program, 2005. Kansas Geospatial Community Commons.

[6] Kansas Surface Water Register, 2004. Kansas Department of Health and Environment.
http://www.kdheks.gov/befs/download/2004_WR_ALL_052405.pdf

[7] Kansas Department of Health and Environment. List of exceptional state waters (ESW), special aquatic life use waters (SALU) and outstanding national resource waters (ONRW). 2007.
http://www.kdheks.gov/nps/

[8] Kansas Water Office. March, 2010.

[9] Internet source. http://www.pollutionissues.com/Pl-Re/Point-Source.html

[10] *Permitted Point Source Facilities*: BASINS. Online reference information available at:
http://www.epa.gov/waterscience/basins/index.htm

[11] EPA estimates "10 to 20 % of onsite wastewater systems malfunction each year".
http://cfpub.epa.gov/owm/septic/septic.cfm?page_id=265 Technical team used best professional guess to claim the number of failing septic systems to be 10%.

[12] Kansas Geospatial Community Commons. 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. NPDES Treatment Facilities, Kansas Department of Health and Environment, 1994. http://www.kansasgis.org/catalog/catalog.cfm

[13] Kansas Geospatial Community Commons. http://www.kansasgis.org/catalog/catalog.cfm

[14] Kansas Department of Health and Environment. The Basics of TMDLs.
http://www.kdheks.gov/tmdl/basic.htm#tmdl

[15] Kansas Department of Health and Environment. Kansas TMDL Development Cycle. 2009.
http://www.kdheks.gov/tmdl/download/Kansas_TMDL_Development_Cycle.pdf

[16] Kansas Department of Health and Environment, 2000.
http://www.kdheks.gov/tmdl/klr/BuffaloFCB.pdf
http://www.kdheks.gov/tmdl/klr/BuffaloCl.pdf
http://www.kdheks.gov/tmdl/klr/RepblcnRClyCntr.pdf
http://www.kdheks.gov/tmdl/klr/RepblcnRnrCnrdia.pdf
http://www.kdheks.gov/tmdl/klr/SaltCrDO.pdf
http://www.kdheks.gov/tmdl/klr/SaltCrFCB.pdf
http://www.kdheks.gov/tmdl/klr/bellevilleE.pdf
http://www.kdheks.gov/tmdl/klr/jamestownE.pdf
http://www.kdheks.gov/tmdl/klr/jamestownSILT.pdf
http://www.kdheks.gov/tmdl/klr/jamestownFCB.pdf
http://www.kdheks.gov/tmdl/klr/jewellE.pdf

[17] Kansas Geospatial Community Commons. http://www.kansasgis.org/catalog/catalog.cfm

[18] Kansas Department of Health and Environment, 2010.
http://www.kdheks.gov/tmdl/download/2010_303_d_List_of_All_Imaired_Waters.pdf

[19] Kansas Department of Health and Environment, 2010.
http://www.kdheks.gov/tmdl/download/2010_303_d_List_of_All_Imaired_Waters.pdf

[20] Kansas Department of Heath and Environment, 2010.
http://www.kdheks.gov/tmdl/download/2010_303_d_Delistings.pdf

[21] Kansas Department of Health and Environment, 2010.
http://www.kdheks.gov/tmdl/download/2010_303_d_List_of_All_Imaired_Waters.pdf

[22] Section provided by KDHE, October 23, 2009.

[23] Cropland BMP placement determined by SWAT analysis. Livestock BMP placement determined by SLT. Streambank targeted area determined by Riparian Layer, Kansas Geospatial Community Commons.

[24] SWAT determined land use. National Land Cover Database, 2001.

[25] Kansas Geospatial Commons. US Department of Agriculture Natural Resources Conservation Service. Riparian Inventory. http://www.kansasgis.org/catalog/catalog.cfm

[26] Available at: http://www.oznet.ksu.edu/library/h20ql2/mf2572.pdf

[27] Available at:
http://www.mwps.org/index.cfm?fuseaction=c_Categories.viewCategory&catID=719

[28] MF-2737 Available at: http://www.oznet.ksu.edu/library/h20ql2/mf2737.pdf
MF-2454 Available at: http://www.oznet.ksu.edu/library/ageng2/mf2454.pdf

[29] Williams, J., Smith, C., and Roe, J. Economics of Streambank Stabilization. Presented at the 2009 Dust Bowl to Mud Bowl Conference, Kansas City, MO

[30] Kansas Department of Health and Environment.
http://www.kdheks.gov/tmdl/klr/jamestownSILT.pdf

[31] NRCS T factor. http://www.nrcs.usda.gov/technical/NRI/1997/summary_report/glossary.html and http://www.umbsn.org/watershed_programs/documents/word%20documnets/T-%20featured.htm

[32] K-State GIScience Commons, 2010. http://maps2.gis.ksu.edu/ks-soils/

[33] Rainfall data records. http://countrystudies.us/united-states/weather/kansas/manhattan.htm

[34] CAFO data provided by Kansas Department of Health and Environment, 2003. Grazing density obtained from US Department of Agriculture National Agricultural Statistics Service, 2002. http://nationalatlas.gov/atlasftp.html?openChapters=chpagri#chpagri

[35] USDA/NRCS National Water and Climatic Center.

[36] Kansas Department of Health and Environment. TMDL section. June, 2010.

[37] Kansas Department of Health and Environment. 2009.

[38] Corps of Engineers Annual Water Quality Program Report – Kansas City District 2006. http://www.nwk.usace.army.mil/lakes/WaterQualityReport/06_Milford_Lake.pdf