Waconda Lake WRAPS

9 Element Watershed Protection Plan

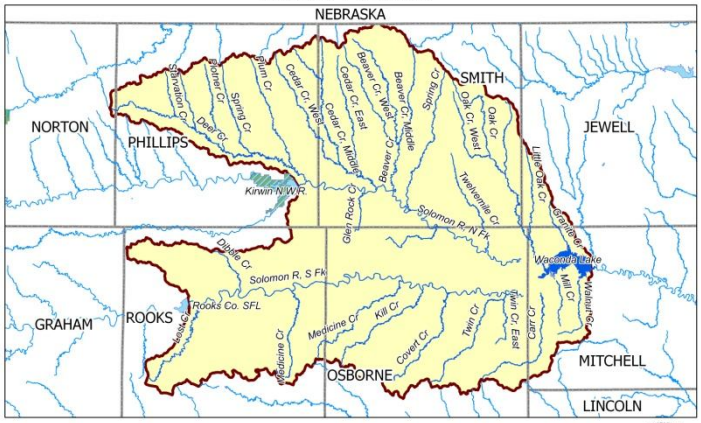
Water Quality Impairments Directly Addressed:

- Waconda Lake Eutrophication TMDL (Medium Priority)
- North Fork Solomon River E. coli TMDL (Medium Priority)
- South Fork Solomon River E. coli TMDL (High Priority)

Other Impairments Which Stand to Benefit from Watershed Plan Implementation:

- South Fork Solomon River Biology TMDL (Low Priority), Total Phosphorus 303(d) listing, and Total Suspended Solids 303(d) listing
- North Fork Solomon River Total Phosphorus 303(d) listing, Total Suspended Solids 303(d) listing, and Biology 303(d) listing
- Twin Creek Dissolved Oxygen TMDL (Medium Priority)
- Oak Creek Dissolved Oxygen 303(d) listing and Total Phosphorus 303(d) listing
- Carr Creek Total Phosphorus 303(d) listing and Total Suspended Solids 303(d) listing
- Beaver Creek Dissolved Oxygen 303(d) listing, Total Phosphorus 303(d) listing, and Total Suspended Solids 303(d) listing
- Deer Creek Dissolved Oxygen 303(d) listing and Total Phosphorus 303(d) listing

Waconda Lake WRAPS
Water Bodies

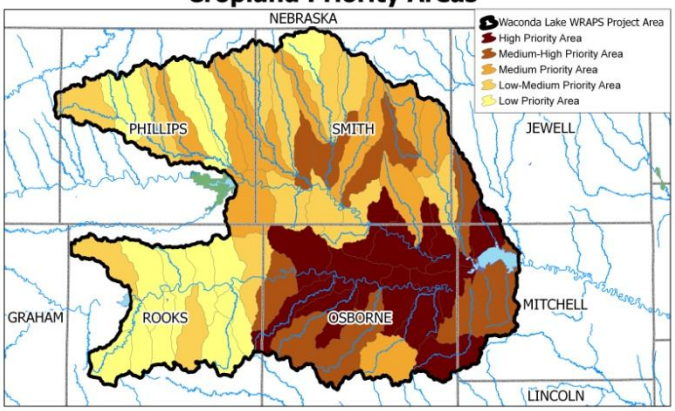


March 2011

Determination of Priority Areas

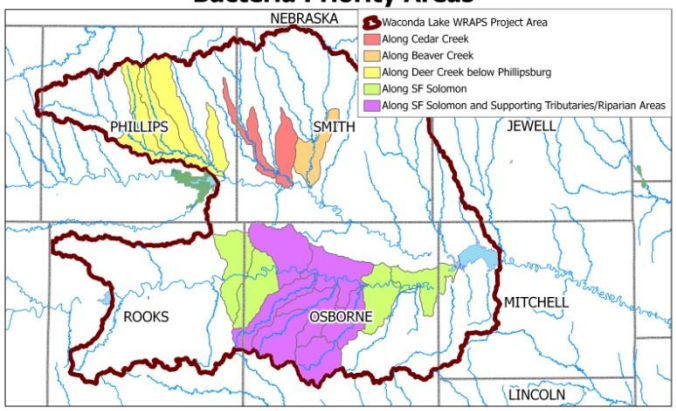
- Spreadsheet Tool for Estimating Pollutant Loads (STEPL) Model to identify HUC 12 watersheds within highest estimated phosphorus loads for cropland targeted areas
- Interpretation of water quality data included within bacteria TMDLs for North and South Fork Solomon Rivers to identify HUC 12 watersheds to focus BMP implementation towards addressing bacteria impairment issues.

Waconda Lake WRAPS
Cropland Priority Areas



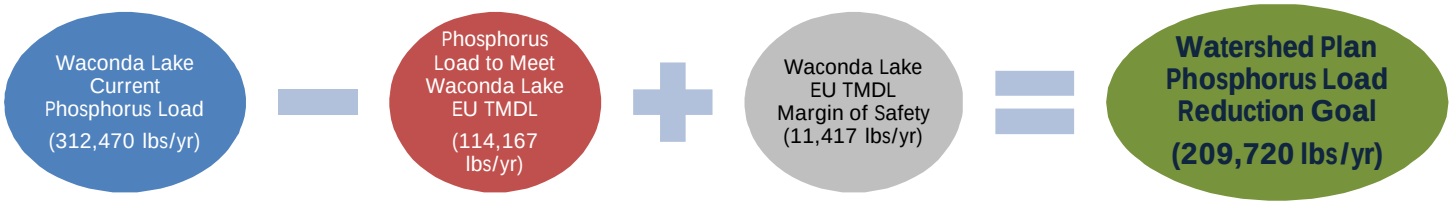
March 2011

Waconda Lake WRAPS
Bacteria Priority Areas



March 2011

Best Management Practice and Load Reduction Goals



Other load reduction goals included within the total watershed plan load reduction goal

- *25,196 lbs/yr phosphorus load reduction from bacteria-reducing BMPs to be implemented in the North Fork Solomon River Bacteria Priority Area*
- *38,252 lbs/yr phosphorus load reduction from bacteria-reducing BMPs to be implemented in the South Fork Solomon River Bacteria Priority Area*

BMPs to be implemented in association with Watershed Plan:

- Cropland-related BMPs
  - Waterways
  - Terraces
  - No-till cropland production
  - Riparian buffers
- Livestock-related BMPs
  - Rotational Grazing
  - Brush Management
  - Alternative watering supply installation
  - Wind breaks
  - Critical Area Planting
  - Fencing/Livestock Exclusion

Load Reduction Goals for Watershed Plan Met within 44 Years if BMPs are Implemented as Scheduled

Waconda Lake WRAPS

Final Plan—October 2011

SOLOMON VALLEY RC&D

Serving Graham, Norton, Osborne, Phillips, Rooks and Smith Counties

Funding for the development of this plan was
provided through an EPA 319 grant 2007-0028 from the Kansas Department of Health and Environment.

Stakeholder Leadership Team

Includes representatives from:
Solomon Valley Resource Conservation and Development (RC&D) Area, Inc.
County Conservation Districts
K-State Research and Extension
Kansas Natural Resource Foundation (KNRF)
North Central Prairie Weed Management Area (NCPWMA)
agriculture producers

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Phillips County: Jean Stapel and Marlene Peters
Rooks County: Kathy Stice
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1.0 Preface

The purpose of this Watershed Restoration and Protection Strategy (WRAPS) report for Waconda Reservoir 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 Kansas 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, timber and industrial 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. The Waconda WRAPS process and the use of this report provides the Stakeholder Leadership Team (SLT) with the capability, capacity and confidence to make decisions that will restore and protect the water quality and watershed conditions of the Waconda Reservoir Watershed.

2.0 Priority Issues and Goals of the Stakeholder Leadership Team

The Waconda WRAPS Stakeholder Leadership Team (SLT) was formed out of concern for the health of the Waconda Reservoir.

The Waconda Reservoir WRAPS began work developing their WRAPS project in June 2006. In December 2006 public meetings were held in Colby, Hill City, Lenora and Osborne to allow the public to voice issues and concerns dealing with water in the watershed. After the meetings, a full list of issues and concerns was compiled and surveys were mailed to those who attended the meetings to rank their top concerns.

Using meeting information and survey results, the SLT met in April 2007 and determined the following top six watershed concerns:

1. Water use efficiency
2. Chemical and fertilizer use.
3. Livestock and pet waste
4. Illegal dumping of trash
5. Household hazardous waste
6. General Education

The #1 concern, water use efficiency, cannot be addressed by 319 funds.

In Jan. 2004, KDHE approved 21 TMDLs within the Solomon Basin that describe the strategies and goals to reduce pollution to achieve water quality standards. **Impairments identified include: sulfate, Selenium, Biology, E. Coli Bacteria, Dissolved Oxygen, and Euthrophication.**

A Rapid Watershed Assessment was conducted by Natural Resources Conservation Service (NRCS), Kansas State Research and Extension, and Kansas Center for Agricultural Resources and the Environment (KCARE) with assistance from the Solomon Valley Resource Conservation and Development (RC&D) Area Inc**. The report for this assessment was released in December 2007.**

In July 2008, the Assessment and Planning Phase of the Waconda WRAPS project began. Because of the large area the Waconda Lake watershed encompasses it was decided to focus Assessment efforts on the area above Waconda Lake and below Kirwin Lake and Webster Lake. A majority of the data included in this plan will focus only on this area.

In November 2009, Kansas Alliance for Wetlands and Streams (KAWS) was hired by the Waconda SLT to conduct an assessment of Streambank Erosion Sites for 2 HUC 12s within the watershed. Areas of concern were identified.

KDHE released revised TMDLs in September 2010, for areas of concern within the Waconda watershed.

At the November 2010 SLT meeting it was determined that there was sufficient enough data to show justification for additional assessment and planning for the watershed above Kirwin Lake. The portion of the Waconda watershed above and including Kirwin Lake has been designated a separate WRAPS project and thus will begin the process of developing a 9 Element plan specific to that area.

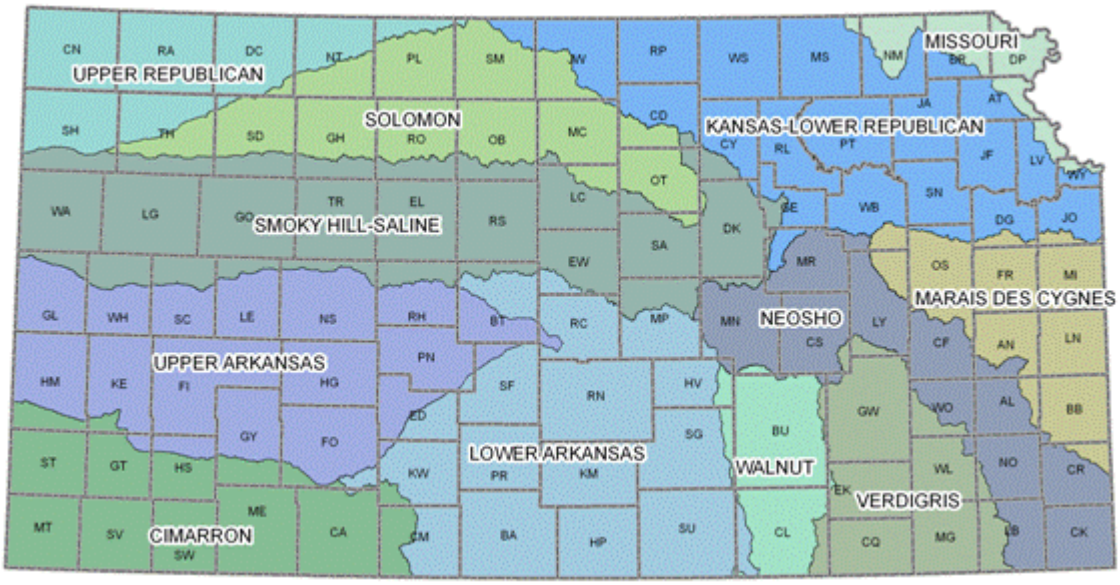
Goals identified by the SLT are:

1. Protection of quality and quantity of public drinking water supplies
2. Protection of quality and quantity water supply for commercial use
3. Protection of groundwater quality and quantity
4. Restoration and protection of water quality in Waconda Reservoir
5. Restoration and protection of water quality in Solomon River and tributary streams
6. Restoration and protection of riparian areas along Solomon River and tributary streams
7. Protection of productivity of agricultural lands
8. Continue (or increase) sustainability of land and wildlife conservation
9. Increase public awareness and education about watershed/water quality issues.

3.0 Watershed Review

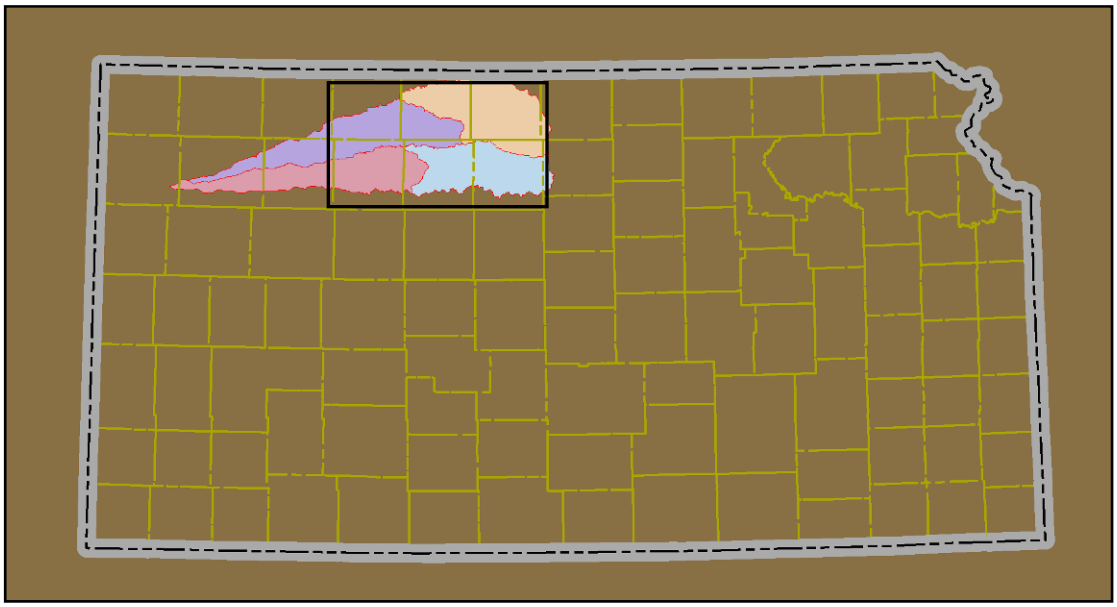
There are twelve river basins located in Kansas. The scope of this WRAPS project is a portion of the Solomon Basin in west central Kansas. The entire basin drains the Solomon River and its tributaries into the Smoky Hill River and eventually empties into the Gulf of Mexico by way of the Mississippi River. The extent of the WRAPS area is the North and South Fork Solomon River and its tributaries upstream of and including Waconda Lake. The Glen Elder Dam at Waconda Lake is the geographical endpoint of this WRAPS project.

Figure 1: Location of Solomon River Basin within the River Basins of Kansas
http://www.kwo.org/BACs/Basin%20Advisory%20Committees.htm



The Waconda Lake watershed is located in north central Kansas and covers portions of Sherman, Thomas, Sheridan, Decatur, Graham, Norton, Rooks, Phillips, Osborne, Smith, Jewell and Mitchell counties for a total of 3,214,150 acres or roughly 5,022 square miles.

Figure 2. Location of the Waconda Lake watershed in relation to the Solomon Valley RC&D and the State of Kansas



The Solomon Valley Resource Conservation and Development (RC&D) Area Inc. is a 501 (c)(3) non-profit organization serving Norton, Phillips, Smith, Graham, Rooks, and Osborne Counties in north central Kansas. The RC&D area is outlined in black. The Solomon Valley RC&D manages and administers the Waconda Lake WRAPS project. The four HUC 8 Units included in the Waconda Lake watershed are in color on the map.

Figure 3. Waconda Lake Watershed with county boundaries, streams/rivers, and lake

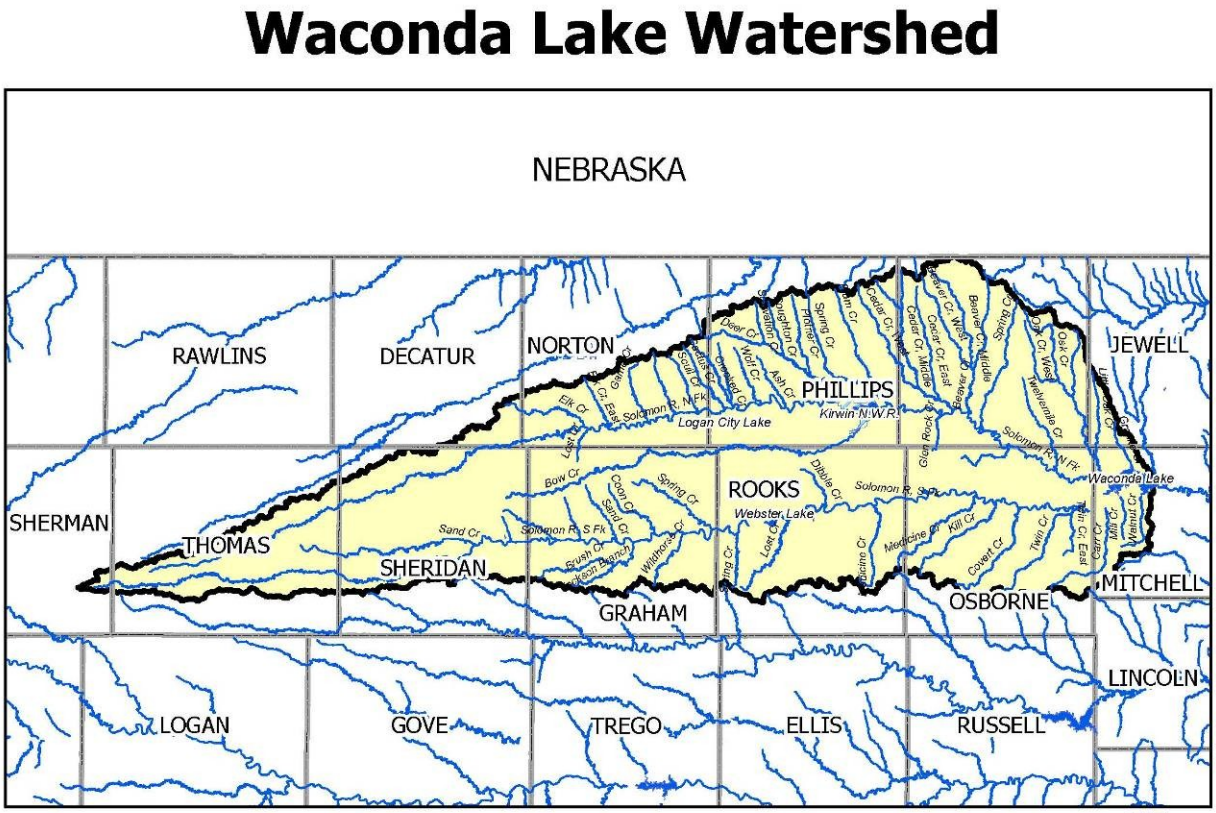
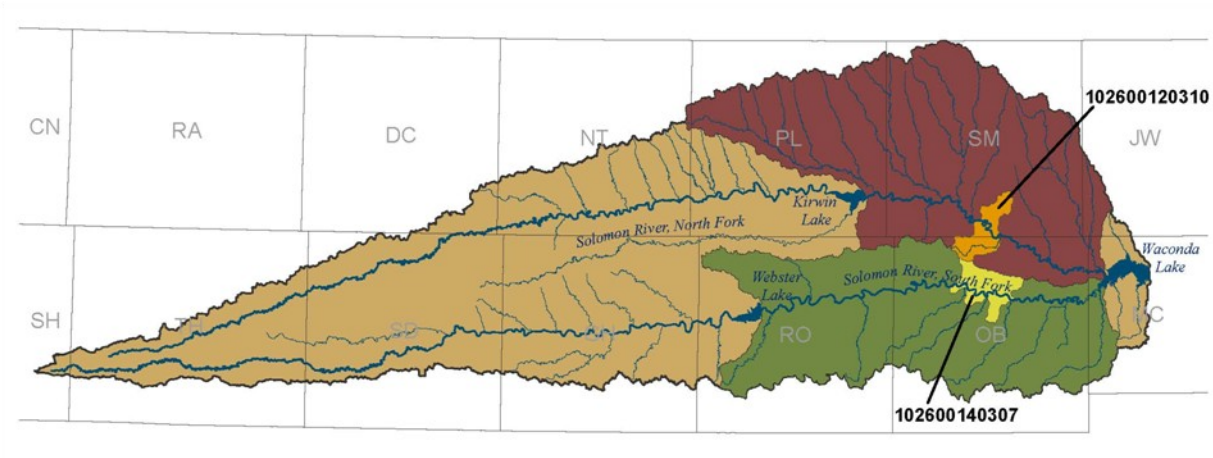


Figure 4. Waconda Lake Watershed KAWS Assessment area, 2010



According to the Kansas Unified Watershed Assessment (KDHE and USDA-NRCS, 1998), the Lower North Fork Solomon River (HUC-8 10260012) and the Lower South Fork Solomon (HUC-8 10260014) were determined to be Category I, or Watersheds in Need of Restoration, based on non-attainment of national clean water action goals. The watersheds were ranked 34th and 45th within the state for watershed restoration priority, respectively. The Solomon River (HUC-8 10260015) created by the confluence of the North and South Fork Solomon River including Waconda Reservoir was also determined to be a "Watershed in Need of Restoration" based on non-attainment of water quality standards and is ranked 23rd for watershed restoration priority within the state.

The Upper North Fork Solomon and the Upper South Fork Solomon, HUC 8 10260011 and 10260013 respectively, are designated as Category IV watersheds. A Category IV watershed has insufficient data to make an assessment of the watershed.

Kansas Alliance for Wetlands and Streams (KAWS) conducted two HUC 12 streambank erosion assessments in the Waconda WRAPS area. The report KAWS produced identified priorities for implementation of BMPs related to streambank erosion on the Lower North Fork and Lower South Fork of the Solomon River, and specifically within HUC-12 102600120310 (North Fork Solomon River) and HUC-12 102600140307 (South Fork Solomon River), the two HUC-12s assessed.

This assessment approach relied heavily on aerial photographic interpretation and analysis of GIS data sources, substantiated by field-based verification involving interested stakeholders and agency professionals where possible. One (1) major and five (5) minor streambank erosion sites were identified for potential rehabilitation or stabilization within the riparian region of the assessment area of the North Fork Solomon River. Streambank erosion sites in this are totaled 2,317.9 linear feet of streambanks. Five (5) livestock operations and a wastewater treatment lagoon were identified in close proximity to Lawrence Creek, and a gully filled up with junk and debris was identified along the main stem of the North Fork Solomon River.

Four (4) minor streambank erosion sites and one major streambank erosion site were identified for potential rehabilitation or stabilization within the riparian region of the South Fork Solomon River. These erosion sites totaled 1,804.3 linear feet of streambanks, and all five site appeared to be in need of riparian buffer rehabilitation. Ten (10) additional riparian buffer rehabilitation projects were identified along the South Fork Solomon River, totaling 3,488 linear feet. Based on the assessment, efforts are probably best focused on implementation of adequate riparian buffers, especially trees, in areas where they are lacking and addressing the impacts of livestock operation in the riparian zone or in close proximity to the river, especially along Lawrence Creek.

This assessment covered a small portion of the Waconda Lake watershed, but gives evidence that BMP implementation within the riparian areas of the watershed is needed. BMPs noted for implementation within the Cropland and Bacteria Targeted Areas that will be mentioned in further detail later on within this plan will help to restore and protection riparian areas within the watershed.stabilization. Information and edu-

cation efforts will also be necessary to increase awareness and understanding of the benefits of a healthy riparian system and BMPs which can be implemented to maintain and restore these areas.

The full KAWS Assessment of Streambank Erosion Sites is provided in Appendix 11.4.

Figure 5. Close-up of KAWS Streambank assessment area

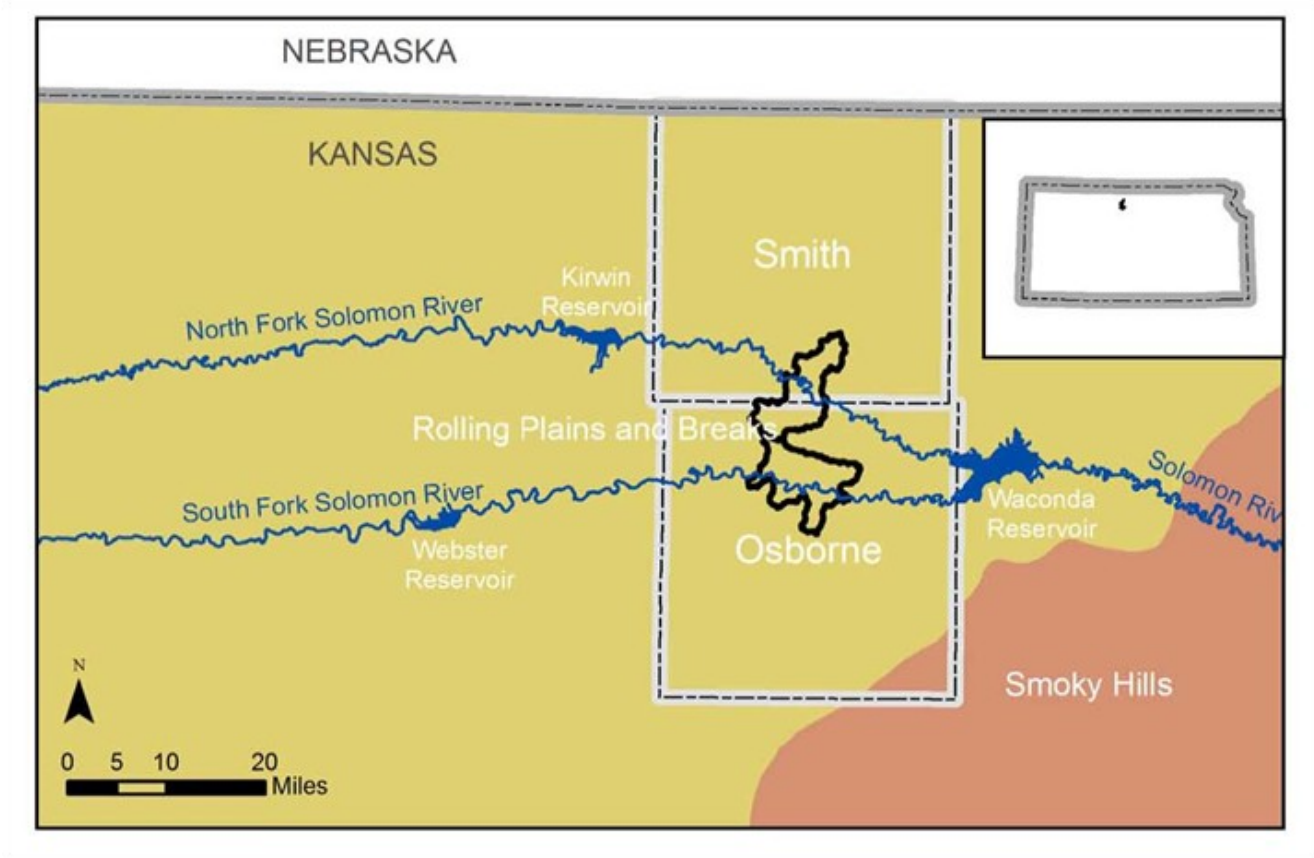
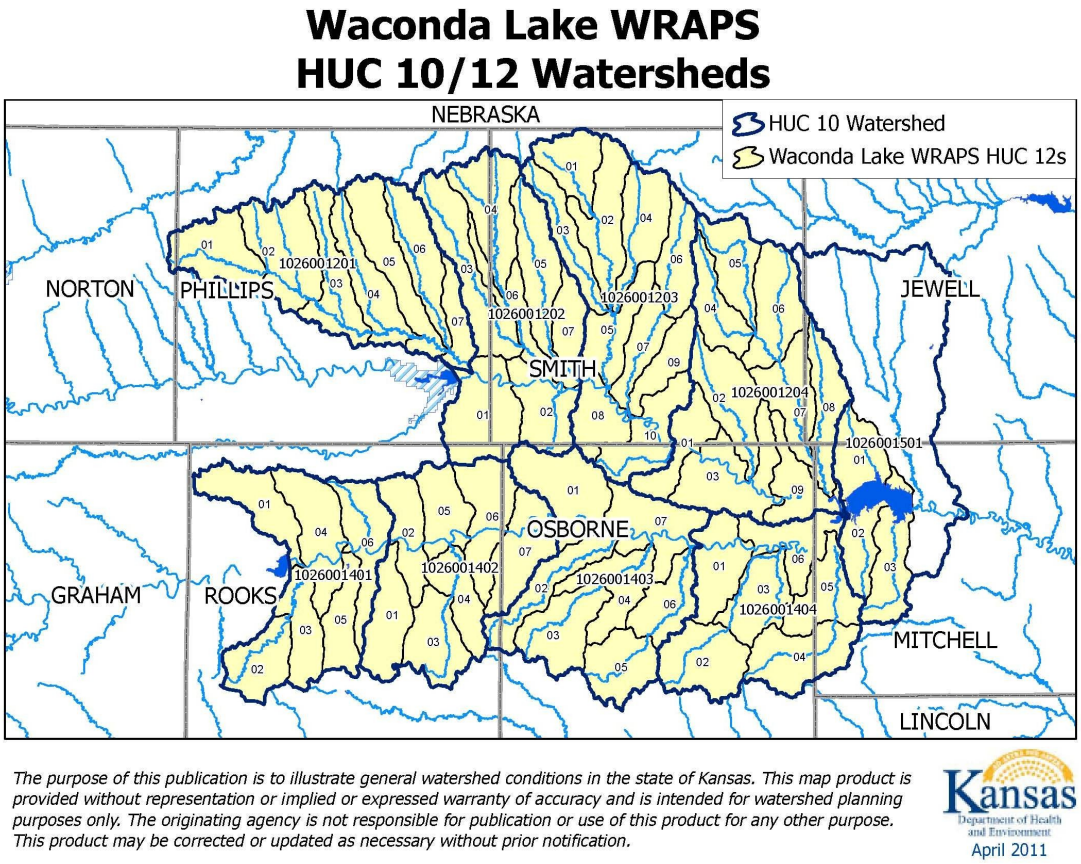


Figure 6. Waconda Lake WRAPS Focus Area with HUC 10/12 watersheds



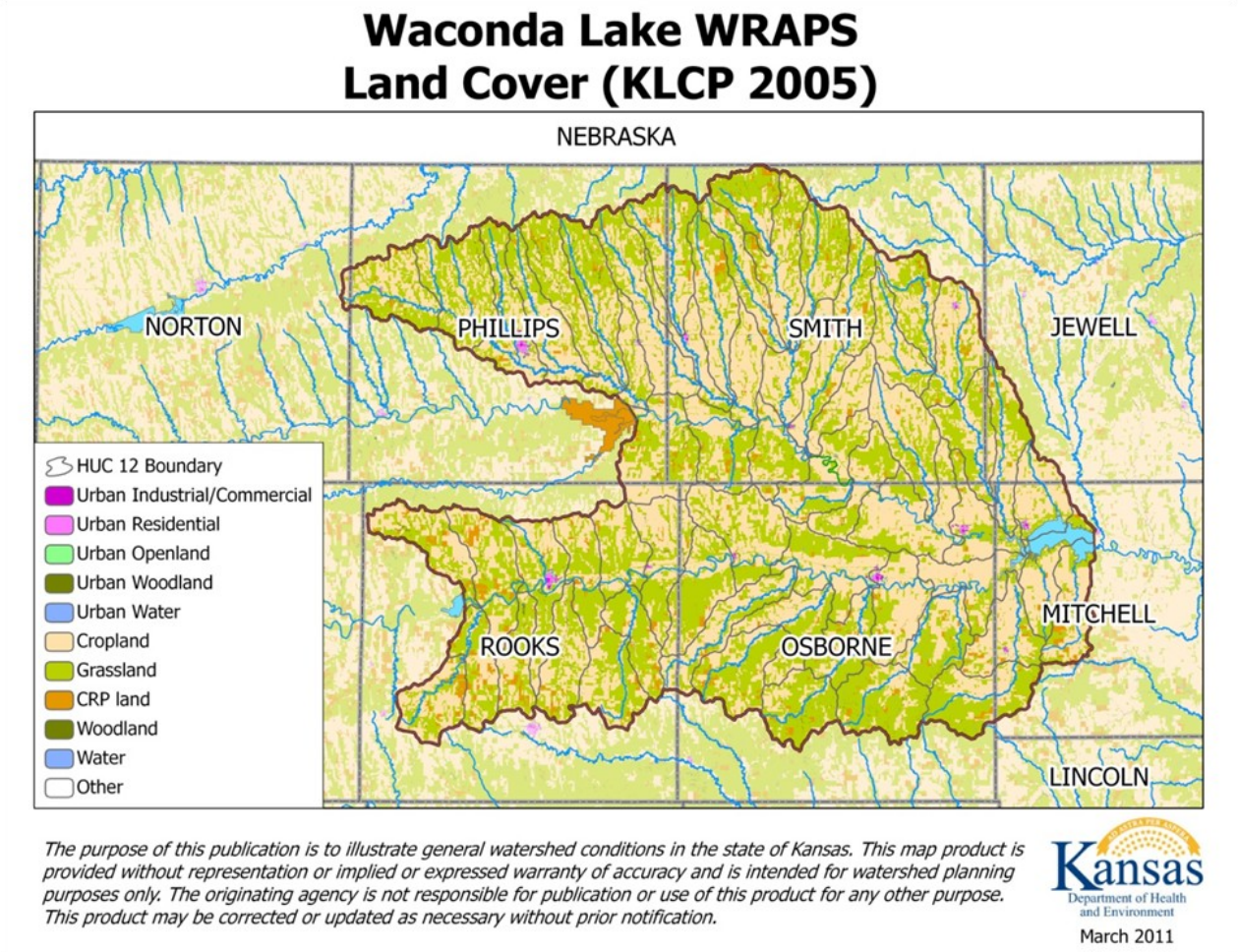
HUC is an acronym for **H**ydrologic **U**nit **C**odes. HUCs are an identification system for watersheds. Each watershed has a unique HUC number in addition to a common name. As watersheds become smaller, the HUC number will become larger. For example, the Solomon Basin is one of twelve basins in the state of Kansas. Within the Solomon Basin are four HUC 8 classifications. HUC 8s can further be split into smaller watersheds that are given HUC 10 numbers and HUC 10 watersheds can be further divided into smaller HUC 12s.

3.1 Land Cover/Land Uses

Wildlife and Habitat* (from Kansas Water Office Volume III Kansas Water Plan)
(http://www.kwo.org/Kansas%20Water%20Plan/SWP/KWP_2008 KWP_Volume_III.htm)
Key wildlife habitat includes cropland, good and excellent rangeland, weedy and brushy fence rows and ungrazed areas, riparian areas, streams, and wetlands. Key wildlife species include ring-necked pheasants, greater prairie chicken, bobwhite quail, and whitetail and mule deer. Three wildlife areas are maintained by state or federal agencies near each of the federal reservoirs. Kirwin National Wildlife Refuge is located

in the rolling hills of the narrow North Fork of the Solomon River valley in southeastern Phillips County. The Kirwin Refuge lies in a transition zone between the tall grass prairies of the east and the short grass plains of the west. As a result, grasses and wildlife common to both areas are found on the Refuge. The water in the Refuge, along with Kirwin Lake is considered an Outstanding National Resource Water and a Special Aquatic Life Use Water. Webster Wildlife Area encompasses 7,622 acres of public hunting surrounding 1,678 surface acres of water. A variety of wildlife habitats are developed and maintained to enhance wildlife. Glen Elder Wildlife Area encompasses almost 13,200 land acres surrounding the 12,500 acre Glen Elder Reservoir. Numerous protected, threatened or endangered species have range within the basin. These include the bald eagle, snowy plover, piping plover, whooping crane, peregrine falcon and Topeka shiner (historic range).

Figure 7. Waconda Lake Focus Area Land Cover and Land Use



Lower North Fork Solomon

Grassland, herbaceous cover, pasture and hay make up approximately 46 percent of the Lower North Fork Solomon. Cropland makes up more than 50 percent of the area with 23.42 percent in small grains and 26.45 percent in row crops. Nearly 3 percent of the cropland is irrigated land.

Table 1. Lower North Fork Solomon Land Cover/Land Use acres

Land Cover/Land Use	Ownership							
	Public		Private		Tribal		Totals	%
	Acres	%	Acres	%	Acres	%		
Open Water	353	*	2,246	0.26	0	---	2,599	0.30
Low Intensity Residential	0	---	1,496	0.17	0	---	1,496	0.17
High Intensity Residential	0	---	110	0.01	0	---	110	0.01
Commercial/Industrial/ Transportation	0	---	2,659	0.31	0	---	2,659	0.31
Bare Rock/Sand/Clay	3	---	549	0.06	0	---	552	0.06
Quarries/Strip Mines/Gravel Pits	0	---	177	0.02	0	---	177	0.02
Transitional	0	---	3	0.00	0	---	3	0.00
Deciduous Forest	16	---	21,845	2.54	0	---	21,861	2.55
Evergreen Forest	0	---	1,636	0.19	0	---	1,636	0.19
Mixed Forest	0	---	0	0.00	0	---	0	0.00
Shrubland	10	---	1,436	0.17	0	---	1,446	0.17
Grasslands/Herbaceous	359	*	318,297	37.08	0	---	318,657	37.12
Pasture/Hay	29	---	75,787	8.83	0	---	75,817	8.83
Row Crops	427	*	226,622	26.40	0	---	227,049	26.45
Small Grains	830	*	200,231	23.33	0	---	201,060	23.42
Fallow	0	---	85	0.01	0	---	85	0.01
Urban/Recreational	0	---	151	0.02	0	---	151	0.02
Woody Wetlands	1	---	1,162	0.14	0	---	1,163	0.14
Emergent Herbaceous Wetlands	23	---	1,844	0.21	0	---	1,867	0.22
HUC Totals[a]	2,051	---	856,337	99.76	0	---	858,388	100.00

*: Less than 1 percent of total acres.

[a]: Totals are approximate due to rounding and small unknown acreages.

Special Considerations for This 8-Digit HUC:

- Small grains and row crops are the predominant commodities grown in rotation on cropland. Wheat is the predominant crop grown. Corn is the predominant crop grown under irrigation.[6]
- Grasslands/Herbaceous and Pasture/Hay makes up approximately 46 percent of the watershed.
- Pasture is included on mostly beef operations, as well as a few small farms and ranches.
- Urban land comprises less than 1 percent of the HUC.

Irrigated Lands	Percent of Cropland	Percent of HUC
	2.9%	1.4%

Lower South Fork Solomon

Grassland, herbaceous cover, pasture and hay make up approximately 62 percent of the Lower South Fork Solomon. Cropland makes up nearly 35 percent of the area with 19.62 percent in small grains and 14.94 percent in row crops. Nearly 3.6 percent of the cropland is irrigated land.

Table 2. Lower South Fork Solomon Land Cover/Land Use acres

Land Cover/Land Use	Ownership							
	Private		Public		Tribal			
	Acres	%	Acres	%	Acres	%	Totals	%
Open Water	3,088	0.46	772	0.11	0	0	3,860	0.57
Low Intensity Residential	291	0.04	0	0.00	0	0	291	0.04
High Intensity Residential	330	0.05	0	0.00	0	0	330	0.05
Commercial/Industrial/Transportation	1,316	0.19	0	0.00	0	0	1,316	0.19
Bare Rock/Sand/Clay	994	0.15	1	0.00	0	0	995	0.15
Quarries/Strip Mines/Gravel Pits	0	0.00	0	0.00	0	0	0	0.00
Transitional	4	0.00	0	0.00	0	0	4	0.00
Deciduous Forest	4,442	0.66	55	0.01	0	0	4,497	0.67
Evergreen Forest	154	0.02	0	0.00	0	0	154	0.02
Mixed Forest	1	0.00	0	0.00	0	0	1	0.00
Shrubland	7,989	1.18	11	0.00	0	0	8,000	1.18
Grasslands/Herbaceous	360,472	53.37	583	0.09	0	0	361,055	53.45
Pasture/Hay	55,323	8.19	127	0.02	0	0	55,450	8.21
Row Crops	99,886	14.79	1,057	0.16	0	0	100,944	14.94
Small Grains	131,436	19.46	1,095	0.16	0	0	132,531	19.62
Fallow	116	0.02	0	0.00	0	0	116	0.02
Urban/Recreational	341	0.05	0	0.00	0	0	341	0.05
Woody Wetlands	81	0.01	8	0.00	0	0	89	0.01
Emergent Herbaceous Wetlands	5,310	0.79	193	0.03	0	0	5,503	0.81
HUC Totals[a]	679,733	99.42	3,950	0.58	0	0	675,479	100.00

[a]: *Totals are approximate due to rounding and small unknown acreages.*

Special Considerations for This 8-Digit HUC:

- Small grains and row crops are the predominant commodities grown in rotation on cropland. Wheat is the predominant crop grown. Corn is the predominant crop grown under irrigation.[6]
- Grasslands/Herbaceous and Pasture/Hay constitute approximately 62 percent of the watershed.
- Pasture is included on mostly beef operations, as well as a few small farms and ranches.
- Urban land comprises less than 1 percent of the HUC.

Irrigated Lands	Percent of Cropland	Percent of HUC
	3.6%	1.3%

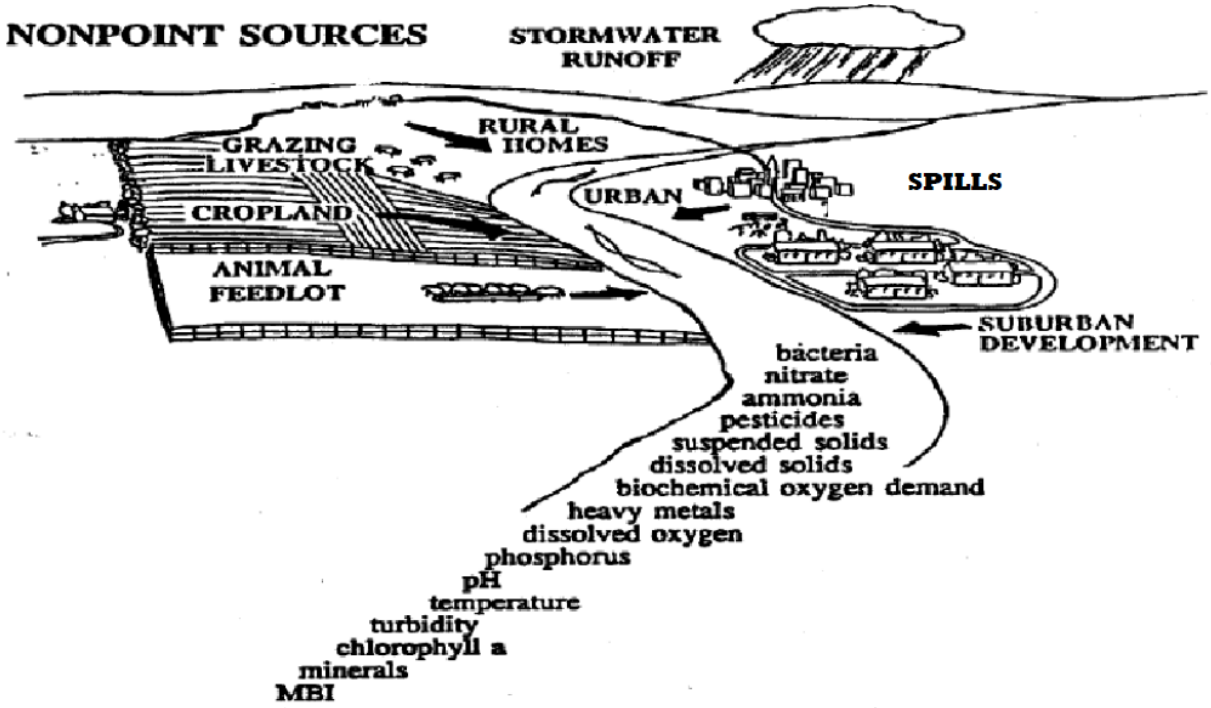
Land Use Potential Contributions to Non Point Source Pollution

Nonpoint source pollution refers to the transport of natural and man-made pollutants by rainfall or snowmelt moving over and through the land surface and entering lakes, rivers, streams, wetlands or ground water. Atmospheric deposition and hydrologic modification are also sources of nonpoint pollution (EPA, 2003). The Kansas Surface Water Quality Standards state:

> "**Nonpoint Source"** *means any activity that is not required to have a national pollutant discharge elimination system permit and that results in the release of pollutants to waters of the state. This release may result from precipitation runoff, aerial drift and deposition from the air, or the release of subsurface brine or other contaminated groundwaters to surface waters of the state." -KAR 28-16-28b(oo)*

The following figure shows a conceptual diagram of common sources of nonpoint pollution and potential contaminants that can be transported to surface and ground waters.

Figure 8. Common Sources of Nonpoint Water Pollution



Source: http://www.kdheks.gov/nps/resources/KSNPSMgmtPlan_04-29-2011_final.pdf

Primary non-point source pollution concerns with cropland include excessive nutrient, pesticide, and organics in groundwater and surface water as well as suspended sediment and turbidity in surface water, streambank erosion, organic matter depletion and inefficient water use on non-irrigated land.

Land with a designated use of grassland, herbaceous cover, pasture or hay will more than likely be used to support livestock production within this watershed. The predominate livestock raised within the Waconda watershed is cattle. Whether raised in confined feeding operations or allowed to roam in fenced grassland areas, livestock animal waste, if not properly managed, can be transported over the surface of agricultural land to nearby lakes and streams. The release of waste from animal feedlots to surface water, groundwater, soil, and air may be associated with a wide range of human health and ecological impacts and contribute to the degradation the N.F and S.F. Solomon River and tributaries as well as Waconda Lake through nutrient and bacteria loading.

Good management practices for small open feedlots and winter feeding areas can minimize the potential for nonpoint source pollution. The key factor in controlling nonpoint pollution is controlling runoff and leaching. Many of the standard practices for erosion and sediment control will reduce losses of animal waste pollutants to surface water systems.

3.2 Designated Uses

Surface waters in this watershed are generally used for aquatic life support (fish), human health purposes, domestic water supply, recreation (fishing, boating, swimming), groundwater recharge, industrial water supply, irrigation and livestock watering. These are commonly referred to as “designated uses” as stated in the Kansas Surface Water Register, 2004, issued by KDHE. BMP implementation work noted within this document will help to restore the designated uses for Waconda Lake as well as the North and South Fork Solomon Rivers and noted tributaries as highlighted within the TMDLs for these respective water bodies.

Table 3. Waconda Lake WRAPS Stream/River/Lake Designated Uses
Waconda Lake WRAPS

Lake/Stream Name	CUSEGA	CLASS	AL	CR	FP	DS	GR	IW	IR	LW
Lower North Fork Solomon (HUC 10260012)										
Cedar Creek, East	1026001217	GP	E	b	O	O	X	O	O	X
Little Oak Creek	102600123	GP	E							
Oak Creek, West	1026001239	GP	E	b	X	O	X	O	O	X
Oak Creek	102600124	GP	E	b	X					
Lawrence Creek	1026001244	GP	E	b	X	O	O	O	O	O
Spring Creek	102600128	GP	E	b	O	O	X	O	X	X
Solomon River, North Fork	102600129	GP	E	b	X	X	X	X	X	X
Solomon River, North Fork	1026001215	GP	E	b	X	X	X	X	X	X
Cedar Creek	1026001216	GP	E	b						
Solomon River, North Fork	1026001222	GP	E	b	X	X	X	X	X	X
Deer Creek	1026001223	GP	E	b	X					
Plotner Creek	1026001230	GP	E	b	X	O	X	O	X	X

Lake/Stream Name	CUSEGA	CLASS	AL	CR	FP	DS	GR	IW	IR	LW
Lower North Fork Solomon (HUC 10260012)										
Beaver Creek, West	1026001214	GP	E	b	X					
Cedar Creek, Middle	1026001219	GP	E	b						
Deer Creek	1026001227	GP	E	b	X					
Deer Creek	1026001231	GP	E	b	X					
Cedar Creek, East	1026001237	GP	E	b						
Solomon River, North Fork	102600125	GP	E	b	X	X	X	X	X	X
Beaver Creek	1026001210	GP	E	b	X					
Starvation Creek	1026001238	GP	E	b						
Cedar Creek, West	1026001220	GP	E	b						
Deer Creek	1026001225	GP	E	b	X					
Deer Creek	1026001229	GP	E	b	X	X	X	X	X	X
Glen Rock Creek	1026001241	GP	E							
Beaver Creek, East Branch	1026001211	GP	E	b	X					
Beaver Creek, Middle	1026001213	GP	E	b						
Cedar Creek	1026001218	GP	E	b						
Oak Creek	102600122	GP	E	b	X	X				
Boughton Creek	1026001234	GP	E	b						
Solomon River, North Fork	1026001221	GP	E	b	X	X	X	X	X	X
Oak Creek, East	1026001240	GP	E	b	X					
Twelvemile Creek	102600126	GP	E	b						
Plum Creek	1026001224	GP	E	b						
Spring Creek	1026001228	GP	E	b	X					
Solomon River, North Fork	102600127	GP	E	C	X	X	X	X	X	X
Francis Wachs Wildlife Area	N/A	GP	E	a	X	O		O	O	O
Lower South Fork Solomon (HUC 10260014)										
Twin Creek, East	1026001429	GP	E	b						
Medicine Creek	1026001416	GP	E	b						
Twin Creek	1026001420	GP	E	b	X					
Solomon River, South Fork	102600147	GP	E	b	X	X	X	X	X	X
Covert Creek	1026001419	GP	E	b	X					
Solomon River, South Fork	102600145	GP	E	b	X	X	X	X	X	X
Solomon River, South Fork	102600141	GP	E	C	X	X	X	X	X	X
Solomon River, South Fork	1026001410	GP	E	B	X	X	X	X	X	X
Medicine Creek	1026001417	GP	E	b						
Carr Creek	1026001421	GP	E	b	X	X				
Solomon River, South Fork	102600143	GP	E	C	X	X	X	X	X	X
Solomon River, South Fork	102600146	GP	E	b	X	X	X	X	X	X
Dibble Creek	10260014363	GP	E	a						
Solomon River, South Fork	102600148	GP	E	b	X	X	X	X	X	X
Lost Creek	1026001413	GP	E	b						
Kill Creek	1026001418	GP	E	b	X					
Solomon River, South Fork	102600144	GP	E	B	X	X	X	X	X	X
Rooks County State Fishing Lake	N/A	GP	E	B	X	O	X	X	X	X

Lake/Stream Name	CUSEGA	CLASS	AL	CR	FP	DS	GR	IW	IR	LW
Solomon River (HUC 10260015)										
Waconda Lake	N/A	GP	E	A	X	X	X	X	X	X
Walnut Creek	1026001526	GP	E	b	X					
Mill Creek	1026001538	GP	E	b						
Granite Creek	1026001524	GP	E	b						

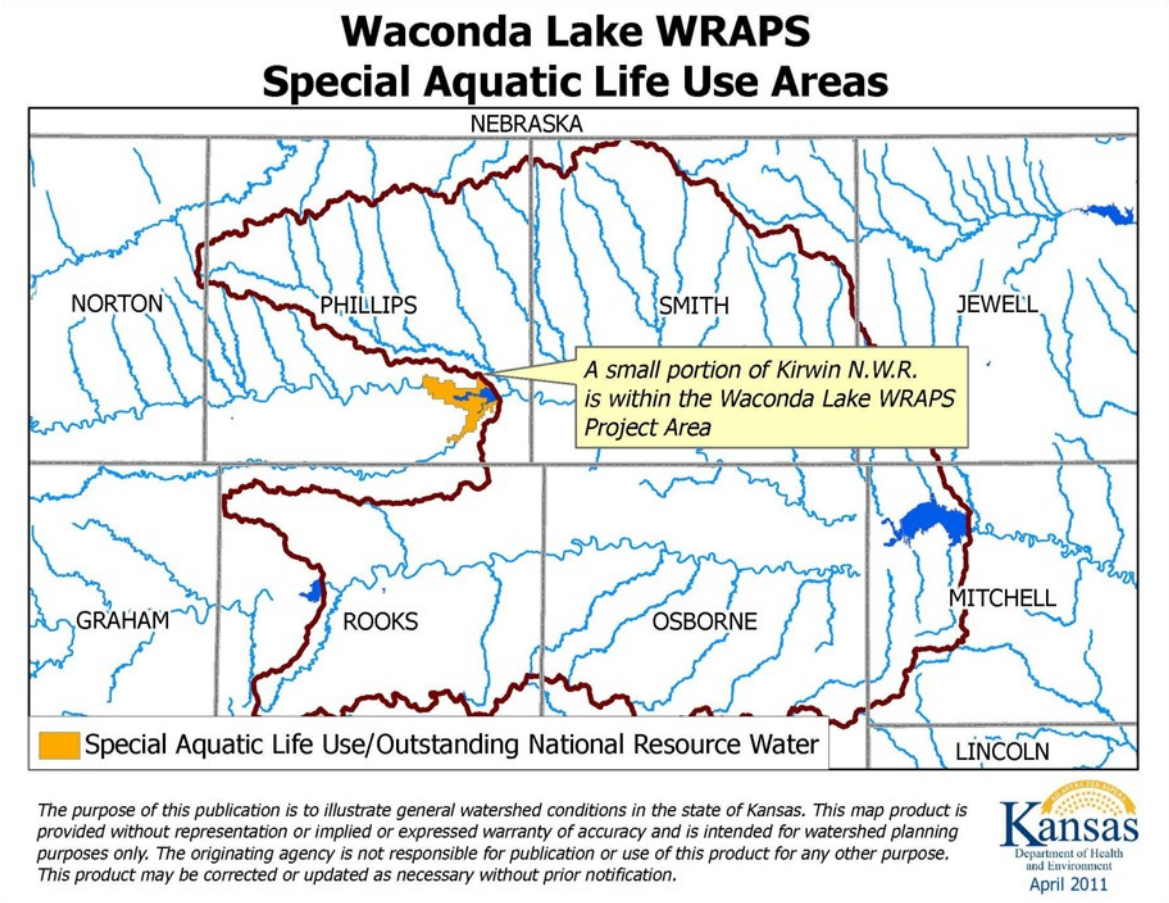
CUSEGA	=	channel unit segment
CLASS	=	antidegradation category
GP	=	general purpose waters
AL	=	designated for aquatic life use
S	=	special aquatic life use water
E	=	expected aquatic life use water
CR	=	designated for contact recreational use
A	=	Primary contact recreation stream segment/lake that is a public swimming area/has a posted public swimming area
B	=	Primary contact recreation stream segment/lake that is by law or written permission of the landowner open to and accessible by the public
C	=	Primary contact recreation stream segment/lake that is not open to and accessible by the public under Kansas law
a	=	Secondary contact recreation stream segment/lake that is by law or written permission of the landowner open to and accessible by the public
b	=	Secondary contact recreation stream segment/lake that is not open to and accessible by the public under Kansas law
FP	=	designated for food procurement use
DS	=	designated for domestic water supply
GR	=	designated for ground water recharge
IW	=	designated for industrial water supply use
IR	=	designated for irrigation use
LW	=	designated for livestock watering use
X	=	referenced stream segment/lake is assigned the indicated designated use
O	=	referenced stream segment/lake does not support the indicated designated use
blank	=	capacity of the referenced stream segment/lake to support the indicated designated use has not been determined by use attainability analysis

3.3 Special Aquatic Life Use 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 Waconda Lake WRAPS Project Area has one water body that is listed as special aquatic life use waters: Kirwin National Wildlife Refuge (NWR).

A small portion of Kirwin NWR is located within the Waconda WRAPS Project Area. This portion of the watershed is predominately cropland and grassland. Predominate sources of pollution that could potentially threaten the health of this feature would include sediment and nutrient runoff from cropland as well as bacteria and nutrient pollutants from grazing activities. Areas in proximity to the Kirwin NWR are included within the Bacteria Priority Area for the North Fork Solomon (draft) Bacteria TMDL, providing the opportunity for livestock-related BMP implementation to be focused close to the refuge.

Figure 9. Waconda Lake Focus Area Special Aquatic Life Use Areas

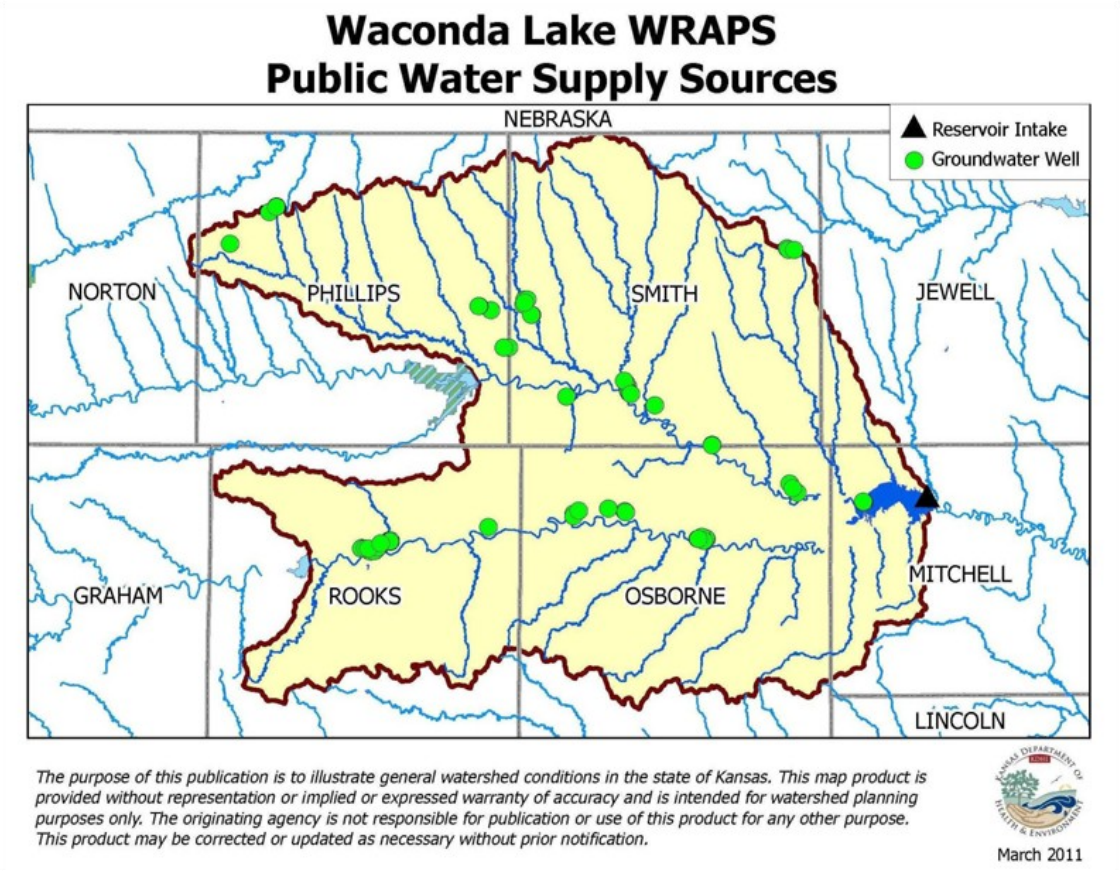


3.4 Public Water Supply (PWS) and National Pollutant Discharge Elimination System (NPDES)

In the state of Kansas, a public water supply system is defined by Kansas Statutes Annotated (K.S.A.) 65-162a and Kansas Administrative Regulations (K.A.R.) 28-15a-2 as a "system for delivery to the public of piped water for human consumption that has at least 10 service connections or regularly serves at least 25 individuals daily at least 60 days out of the year." These systems are regulated by the state to assure the citizenry safe and pathogen-free drinking water and are comprised of water intakes, wells, and water treatment facilities. The KDHE oversees more than 1,080 statewide public water supply systems including municipalities, rural water districts, and privately owned systems. These systems may serve a small community of several families to a city of more than 300,000 persons.

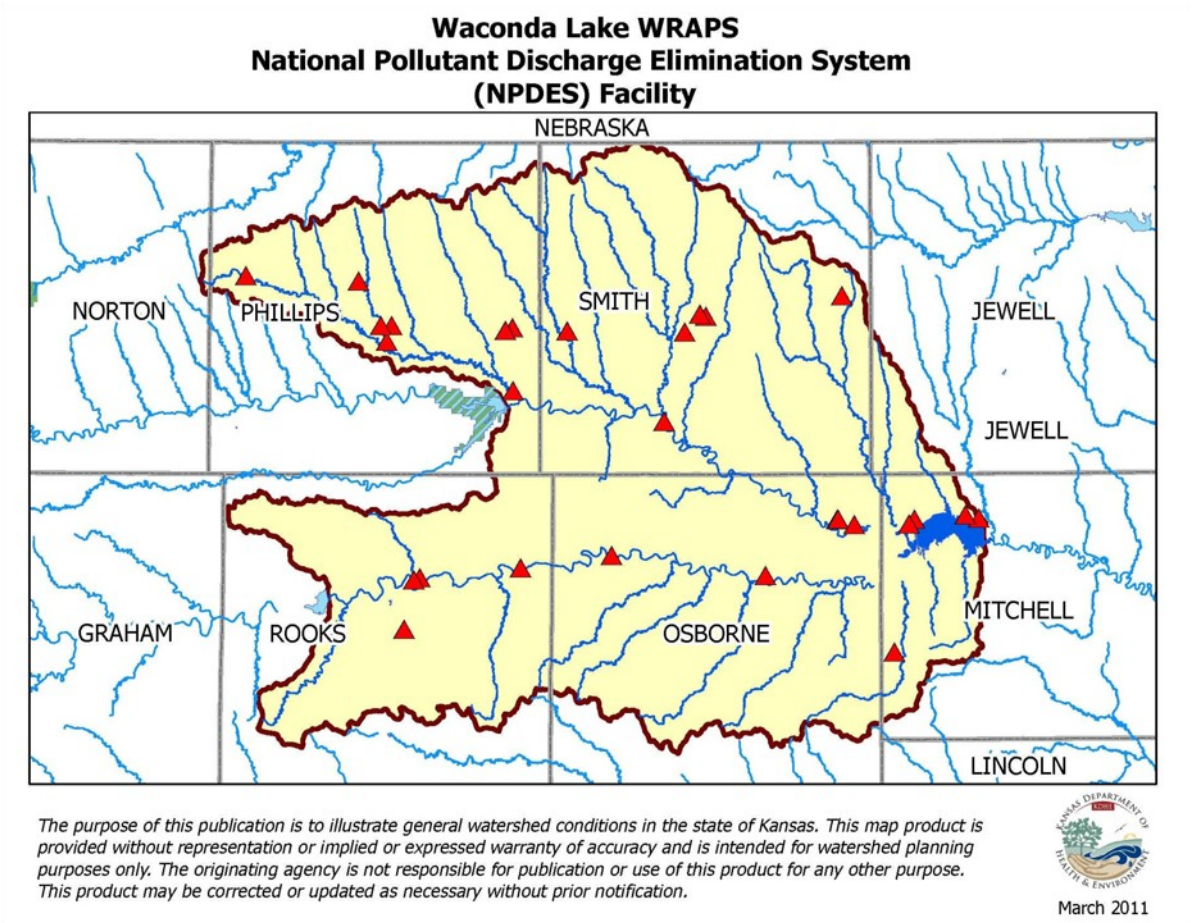
There are approximately 34 active public water supply wells located within the Lower North Fork Solomon watershed. Due to the lack of surface water in this watershed, all of the public water supply is pulled from groundwater. There are approximately 43 active public water supply wells located within the Lower South Fork Solomon watershed. Below the confluence of the North and South Fork Solomon Rivers, there are currently 3 active public water sources. This includes 2 public water supply wells and one surface water intake located on Waconda Lake.

Figure 10. Waconda Lake Focus Area Public Water Supply Sources



Wastewater treatment facilities are permitted and regulated through KDHE. These facilities are considered point sources for pollutants. National Pollutant Discharge Elimination System (NPDES) permits specify the maximum amount of pollutants allowed to be discharged to surface waters. Having these point sources located on streams or rivers could potentially impact water quality within the waterways of the Waconda WRAPS Project Area. Pollutants originating from NPDES facilities within the watershed could include suspended solids, biological pollutants that reduce oxygen in the water column, and inorganic compounds or bacteria. Wastewater is treated to remove solids and organic materials, disinfected to kill bacteria and viruses, and discharged to surface waters. Any pollutant discharge from point sources that is allowed by the state is considered to be Wasteload Allocation and is reflected within TMDLs noted for the WRAPS Project Area.

Figure 11. Waconda Lake Focus Area National Pollutant Discharge Elimination Systems

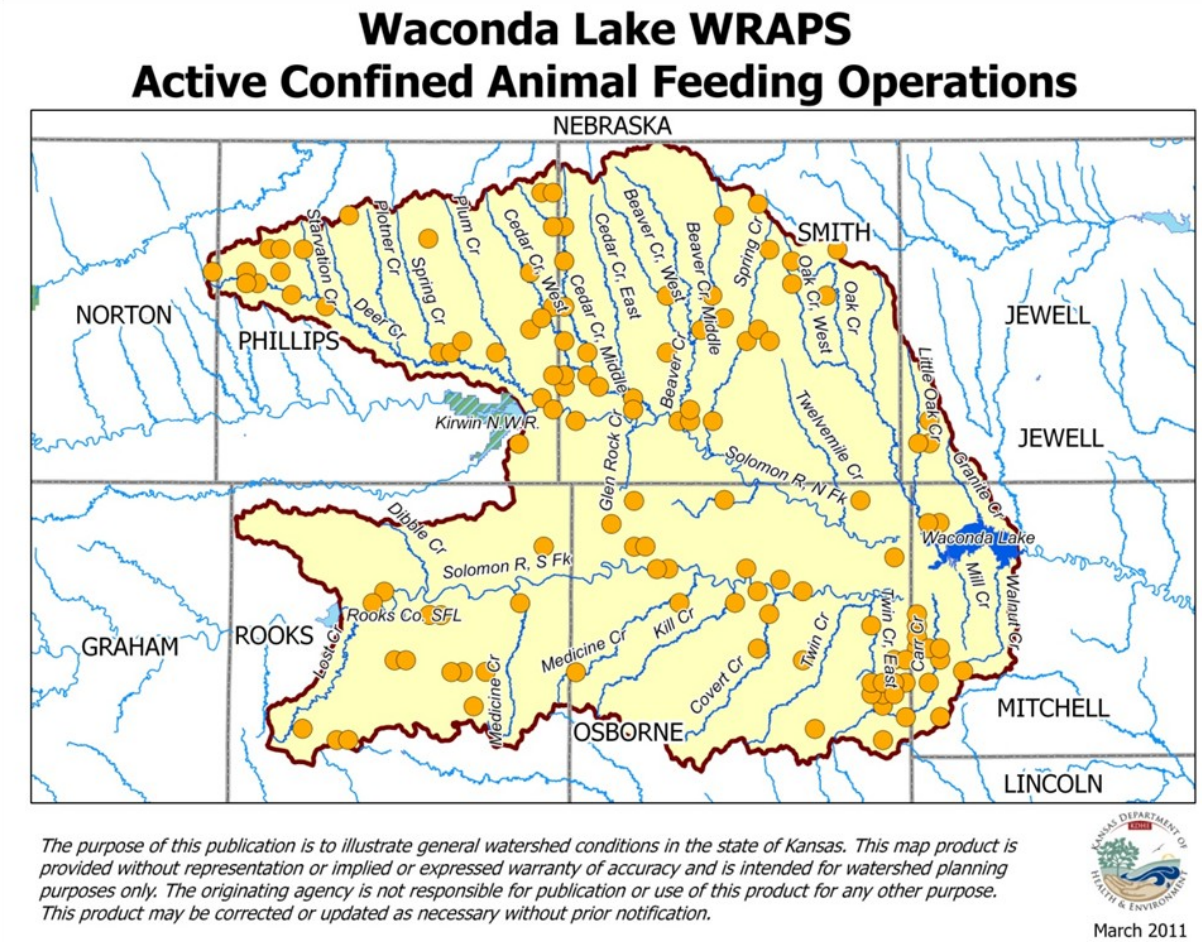


There are also numerous onsite wastewater systems (OWS) present within the watershed. It is unknown at the present time the total number of systems present as well as the number which are currently failing or inadequately constructed. For systems which could be adversely effecting water quality and the surrounding environment as well as all other , counties within the watershed have sanitary codes which provide authority to regulate the operation of OWSs.

3.5 Confined Animal Feeding Operations

Confined Animal Feeding Operations (CAFO), as defined by the Environmental Protection Agency (EPA), are agricultural operations where animals are kept and raised in confined situations. These facilities have animals, feed, manure and urine, dead animals, and production operations consolidated onto small areas of land. Within Kansas, operations within greater than 300 animal units must register with the Kansas Department of Health and Environment (KDHE). Those facilities with greater than 999 animal units are considered point sources of pollution and must be permitted by EPA. Within the Waconda Lake WRAPS Project Area there are numerous CAFOs. Those facilities within the watershed which are not considered potential point sources of pollution could potentially benefit from increased awareness and/or BMPs to be implemented as outlined within this plan. In the event these facilities were to make upgrades to their operations, both phosphorus and bacteria reductions would be realized due to these improvements. Pollutant load reductions resulting from this type of work would help to address both the bacteria water quality impairments noted for the N.F. and S.F. Solomon Rivers as well as the excess nutrients contributing the Waconda Lake EU TMDL.

Figure 12. Waconda Lake Focus Area Active CAFOs



The purpose of this publication is to illustrate general watershed conditions in the state of Kansas. This map product is provided without representation or implied or expressed warranty of accuracy and is intended for watershed planning purposes only. The originating agency is not responsible for publication or use of this product for any other purpose. This product may be corrected or updated as necessary without prior notification.

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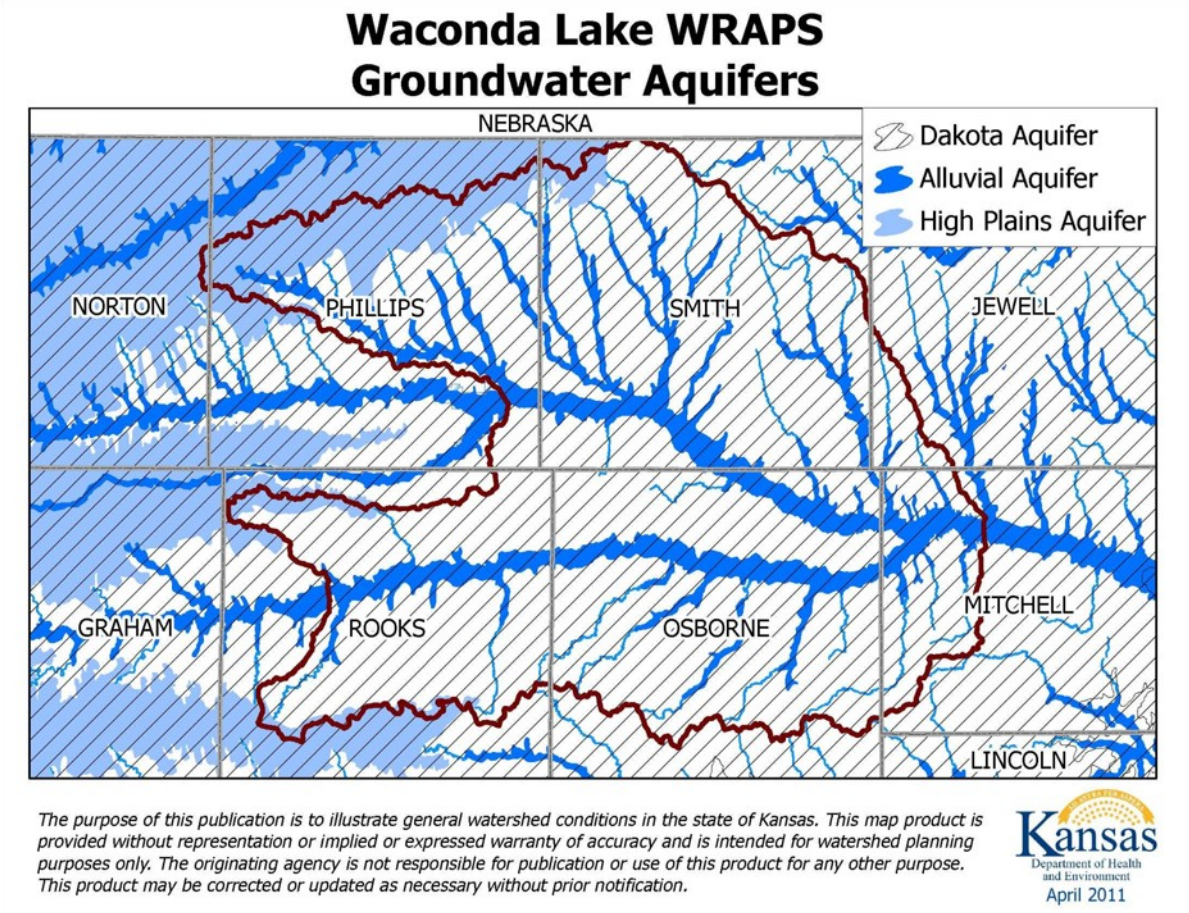
3.6 Aquifers

Major groundwater aquifers underlying this watershed include the Dakota Aquifer and a small portion of the High Plains Aquifer along with alluvial aquifers of the Solomon River and its tributaries.

Figure 13. Waconda Lake Focus Area Groundwater Aquifers



3.7 Water Quality Impairments

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 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. In summary, TMDLs provide a tool to target and reduce point and nonpoint pollution sources. The goal of the WRAPS process is to address high priority TMDLs. KDHE reviews TMDLs assigned in each of the twelve basins of Kansas every five years on a rotational schedule. Table 5 includes the review schedule for the Solomon River Basin. This TMDL review schedule will be taken into consideration when determining dates in which watershed plan review and revisions will take place. Once TMDLs within the Waconda WRAPS project area are reviewed and/or revised by KDHE, the Waconda WRAPS Project will evaluate the new TMDL information and make adjustments to water quality endpoints and watershed plan goal load reductions as needed.

Table 4. TMDL Development Cycle for Solomon River Basin

Year Ending in Sept.	Implementation Period	Possible TMDLs to Revise	TMDLs to Evaluate
2009	2010-2019	2003	N/A
2014	2015-2020	2003, 2004	2003, 2004, 2005
2019	2020-2029	2003, 2004, 2009	2003, 2004, 2006, 2009

The Waconda Lake WRAPS Project Area has numerous new listings on the 2010 "303d list". A 303d list of impaired waters is developed biennially and submitted by KDHE to EPA. To be included on the 303d list, samples taken during the KDHE monitoring program must show that water quality standards are not being met. This in turn means that designated uses are not met. For more information on TMDLs and 303(d) listings within Kansas visit: http://www.kdheks.gov/tmdl/.

NOTE:

Total Maximum Daily Loads (TMDLs) are quantitative objectives and strategies needed to achieve water quality standards. The water quality standards constitute the goals of water quality adequate to fully support designated uses of streams, lakes, and wetlands. The process of developing TMDLs determines:

1. The pollutants causing water quality impairments
2. The degree of deviation away from applicable water quality standards
3. The levels of pollution reduction or pollutant loading needed to attain achievement of water quality standards
4. Corrective actions, including load allocations, to be implemented among point and nonpoint sources in the watershed affecting the water quality limited water body
5. The monitoring and evaluation strategies needed to assess the impact of corrective actions in achieving TMDLs and water quality standards

Provisions for future revision of TMDLs based on those evaluations

The Watershed Conditions Report completed for the Lower North Fork Solomon by KDHE in 2001 indicated 56.8% of the total miles of water in this watershed were not supporting their designated uses. The primary pollutant concern for streams and rivers in HUC 8 10260012 was fecal coliform bacteria (FCB). FCB is a bacteria present in human and animal waste and serves as an indicator of potential disease causing organisms. Additional pollutants in this watershed are sulfate, selenium and ammonia. A Watershed Conditions Report was not completed for the Lower South Fork Solomon River at that time.

The Dec. 2007 Rapid Watershed Assessment (RWA) indicated that 398 of the 700 miles (57%) of stream in the Lower North Fork Solomon did not meet their designated use. In the Lower South Fork Solomon 158 of the 473 miles (33%) of stream did not meet their designated use.

Table 5. Waconda Lake Watershed Impaired Waters

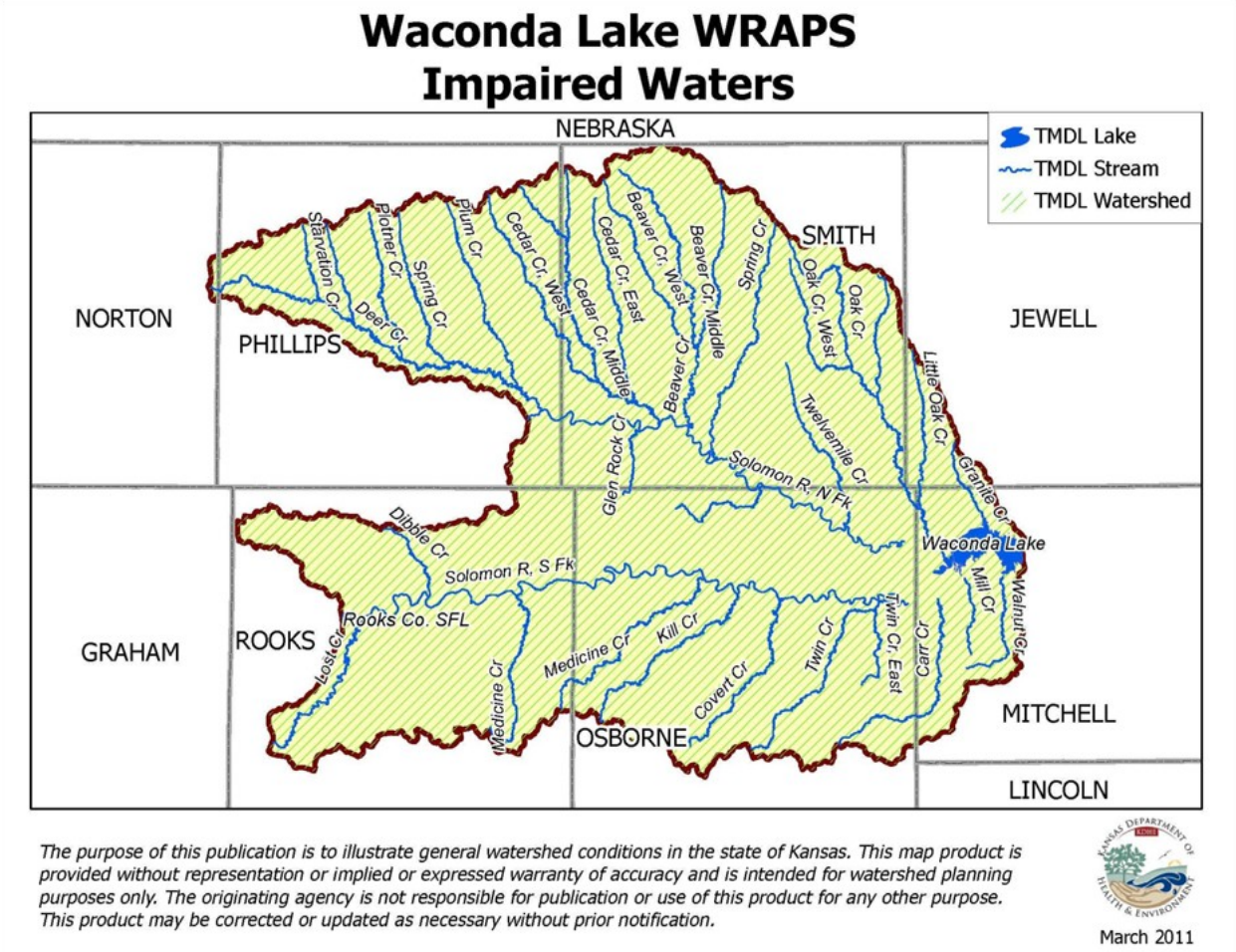
Waconda Lake Watershed Impaired Waters			
Impaired Waters with EPA Approved TMDLs			
Water Body	Impairment	Priority	KDHE Monitoring Station(s)
Waconda Lake	Eutrophication	Medium	LM018001
Waconda Lake	Sulfate	Low	LM018001
Lower South Fork Solomon	Biology	Low	SB543
Lower North Fork Solomon	Sulfate	Low	SC014
Lower North Fork Solomon	Selenium	Low	SC014
Lower South Fork Solomon	Sulfate	Low	SC542, SC543
Lower South Fork Solomon	Selenium	Low	SC542, SC543
North Fork Solomon River at Portis	E. Coli Bacteria	Medium	SC014
South Fork Solomon River	E. Coli Bacteria	High	SC543
Oak Creek	Sulfate	Low	SC544
Oak Creek	Selenium	Low	SC544
Kill Creek	Sulfate	Low	SC665
Kill Creek	Selenium	Low	SC665
Covert Creek	Sulfate	Low	SC666
Covert Creek	Selenium	Low	SC666
Twin Creek	Low Dissolved Oxygen	Medium	SC668
Carr Creek	Sulfate	Low	SC669
Beaver Creek	Sulfate	Low	SC670
Beaver Creek	Selenium	Low	SC670
Deer Creek	Sulfate	Low	SC721
Deer Creek	Selenium	Low	SC721

Impaired Waters with Draft TMDLs (October 2011)			
Water Body	Impairment	Priority	KDHE Monitoring Sta-
Deer Creek (Revision)	Sulfate and Selenium	High	SC721
Non-TMDL Impaired Waters (303d List)			
Water Body	Impairment	Priority	KDHE Monitoring Sta-
North Fork Solomon River At Portis	Arsenic	Low	SC014
North Fork Solomon River At Portis	Biology	Low	SC014
North Fork Solomon River At Portis	Total Phosphorus	Low	SC014
North Fork Solomon River At Portis	Total Suspended Solids	Low	SC014
South Fork Solomon River	Total Phosphorus	Low	SC543
South Fork Solomon River	Total Suspended Solids	Low	SC543
Oak Creek Near Cawker	Low Dissolved Oxygen	Low	SC544
Oak Creek Near Cawker	Total Phosphorus	Low	SC544
Carr Creek Near Cawker	Total Phosphorus	Low	SC669
Carr Creek Near Cawker	Total Suspended Solids	Low	SC669
Beaver Creek Near Gay-	Arsenic	Low	SC670
Beaver Creek Near Gay-	Low Dissolved Oxygen	Low	SC670
Beaver Creek Near Gay-	Total Phosphorus	Low	SC670
Beaver Creek Near Gay-	Total Suspended Solids	Low	SC670
Twelve Mile Creek Near	Total Phosphorus	Low	SC674
Twelve Mile Creek Near	Total Suspended Solids	Low	SC674
Deer Creek Near Kirwin	Arsenic	Low	SC721
Deer Creek Near Kirwin	Low Dissolved Oxygen	Low	SC721
Deer Creek Near Kirwin	Total Phosphorus	Low	SC721
South Fork Solomon River Near Woodston	Low Dissolved Oxygen	Low	SC737

Water quality impairments which are directly addressed from BMPs noted for implementation within watershed

Water quality impairments which stand to benefit from BMPs noted for implementation within watershed plan

Figure 14. Waconda Lake Focus Area Impaired Waters



3.8 TMDL Load Allocations

As previously stated within this watershed plan, the Waconda Lake WRAPS SLT has identified restoration and protection of water quality in Waconda Lake as well as within the Solomon River and tributary systems as a goal. With both drainage areas of the N.F. and S.F. Solomon Rivers contributing to nutrient and sediment loading entering Waconda Lake, all BMP work taking place within the Waconda Lake WRAPS Project Area would contribute to phosphorus reductions needed to meet the Waconda Lake Eutrophication TMDL. The overall load reduction goal of the Waconda Lake WRAPS watershed plan is to reduce phosphorus entering Waconda Lake by 209,720 lbs/yr, thus helping to address the Medium Priority Eutrophication TMDL.

Waconda Lake Current Phosphorus Load
312,470 lbs/yr

-

Phosphorus Load to Meet Waconda Lake EU TMDL
114,167 lbs/yr

+

Waconda Lake TMDL Margin of Safety
11,417 lbs/yr

=

Watershed Plan Phosphorus Load Reduction Goal
209,720 lbs/yr

Reductions in bacteria concentrations observed within the North and South Fork Solomon Rivers are also anticipated as a result of BMP implementation noted within this watershed plan. It is the goal of this watershed plan to reduce E. coli bacteria index profiles for the North and South Fork Solomon Rivers to 1.0 for at least 90% of the samples collected from April thru October. Bacteria index profiles for both the North and South Fork Solomon Rivers are shown in the figures below. Load reductions from livestock-related BMPs will also produce nutrient load reductions to help address Total Phosphorus and Eutrophication water quality impairments within the WRAPS project area.

With these goals in mind, best management practice (BMP) implementation schedules have been developed in consultation with the SLT and other technical advisors serving within the watershed to directly address the following approved and draft water quality impairments:

- Waconda Lake Eutrophication (EU) Medium Priority TMDL
  - ◊ *Overall Watershed Plan Phosphorus Load Reduction Goal = 209,720 lbs/yr*
- North Fork Solomon River Bacteria Medium Priority TMDL
  - ◊ *Phosphorus load reductions taking place in watershed will count towards Waconda Lake EU TMDL—phosphorus load reduction goal of 25,196 lbs/yr.*
- South Fork Solomon River Bacteria High Priority TMDL
  - ◊ *Phosphorus load reductions taking place in watershed will count towards Waconda Lake EU TMDL—phosphorus load reduction goal of 38,252 lbs/yr*

These BMP implementation schedules have been developed to address nutrient runoff originating from cropland as well as bacteria and nutrient pollutants originating from livestock-related sources within the watershed. BMPs noted within the Cropland Targeted Areas will produce nutrient load reductions to help address the necessary non-point source reduction needed to meet the Waconda Lake EU TMDL, while those practices noted for implementation within the Bacteria Targeted Areas will produce pollutant reductions to help address both the North and South Fork Solomon River Bacteria TMDLs. Work within the Bacteria Targeted Areas will also produce pollutant load re-

ductions which will produce nutrient load reductions to help address the Waconda Lake EU TMDL.

BMP implementation noted within the Cropland and Bacteria Targeted Areas will also positively benefit other TMDLs and 303(d) listed waters within the Waconda Lake WRAPS Project Area. These impaired waters are listed as follows:

- Lower South Fork Solomon River (SC543, SB543)
  - ◊ Low Priority Biology TMDL
  - ◊ Low Priority Total Phosphorus 303(d) listing
  - ◊ Low Priority Total Suspended Solids 303(d) listing
- Lower North Fork Solomon River (SC014)
  - ◊ Low Priority Total Phosphorus 303(d) listing
  - ◊ Low Priority Total Suspended Solids 303(d) listing
  - ◊ Low Priority Biology 303(d) listing
- Twin Creek (SC668)
  - ◊ Medium Priority Dissolved Oxygen TMDL
- Oak Creek (SC544)
  - ◊ Low Priority Dissolved Oxygen 303(d) listing
  - ◊ Low Priority Total Phosphorus 303(d) listing
- Carr Creek (SC669)
  - ◊ Low Priority Total Phosphorus 303(d) listing
  - ◊ Low Priority Total Suspended Solids 303(d) listing
- Beaver Creek (SC670)
  - ◊ Low Priority Total Phosphorus 303(d) listing
  - ◊ Low Priority Total Suspended Solids 303(d) listing
  - ◊ Low Priority Dissolved Oxygen 303(d) listing
- Deer Creek (SC721)
  - ◊ Low Priority Total Phosphorus 303(d) listing
  - ◊ Low Priority Dissolved Oxygen 303(d) listing

BMP implementation will also take place within areas of the watershed not included within the Cropland and Bacteria Targeted Areas identified within this watershed plan. Within these areas, landowners could potentially utilize other existing cost-share programs to assist with BMP implementation. Water quality impairments which could also benefit from BMP implementation not specifically identified within this watershed plan include:

- Twelve Mile Creek (SC674)
  - ◊ Low Priority Total Phosphorus 303(d) listing
  - ◊ Low Priority Total Suspended Solids 303(d) listing
- South Fork Solomon River Near Woodston (SC737)
  - ◊ Low Priority Dissolved Oxygen 303(d) listing

Figure 15. Waconda Lake Focus Area TMDL Monitoring Sites

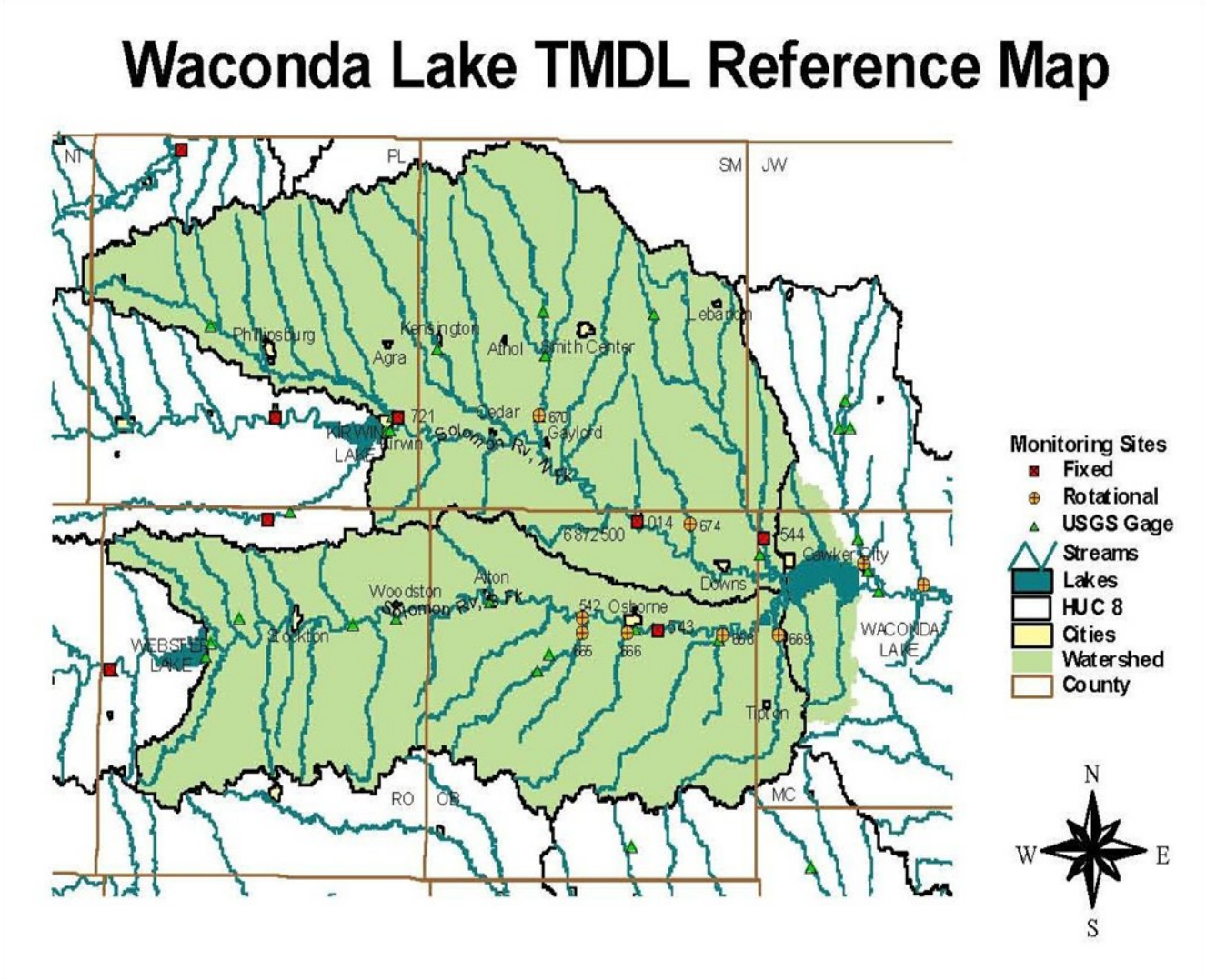


Figure 16. North Fork Solomon River Bacteria TMDL Contributing Area

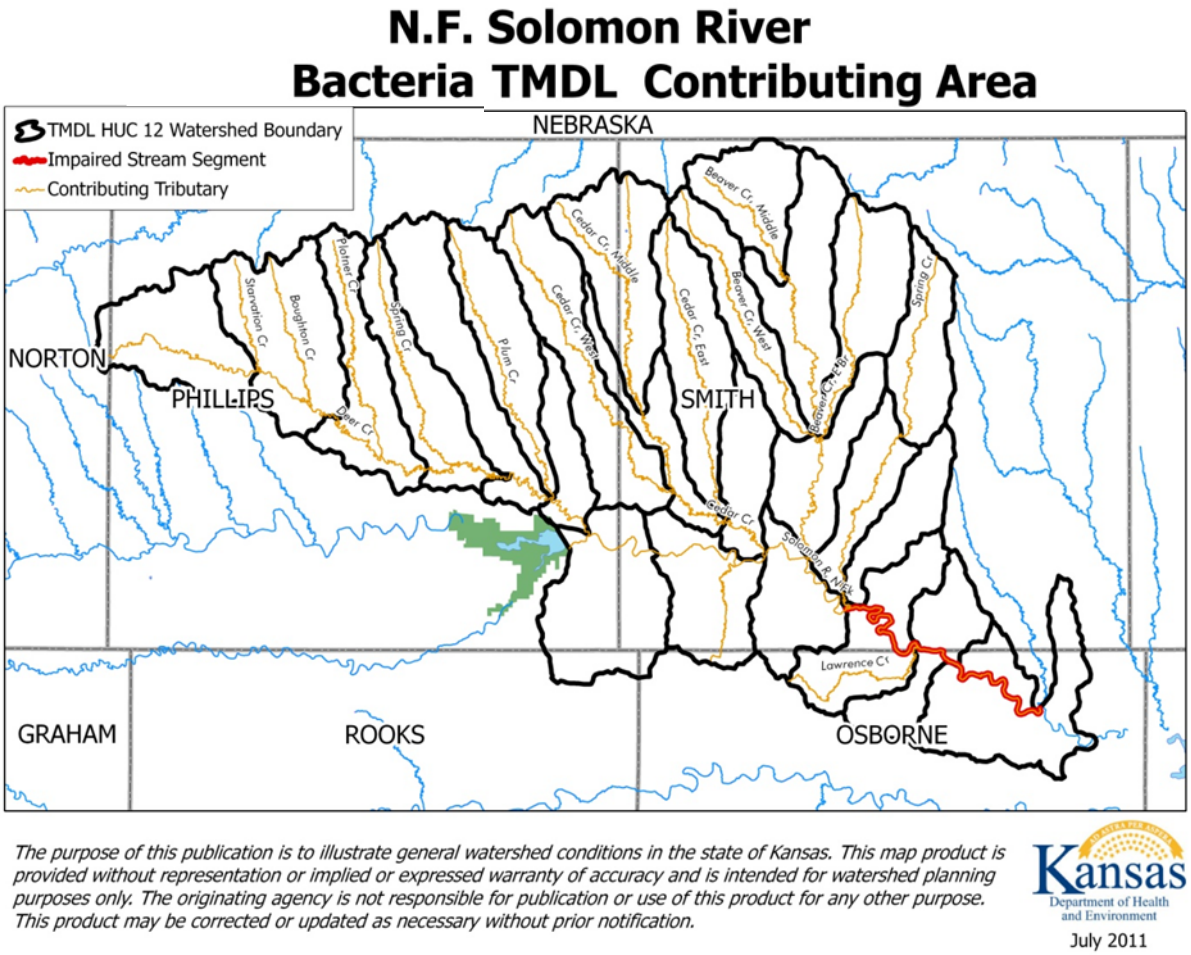
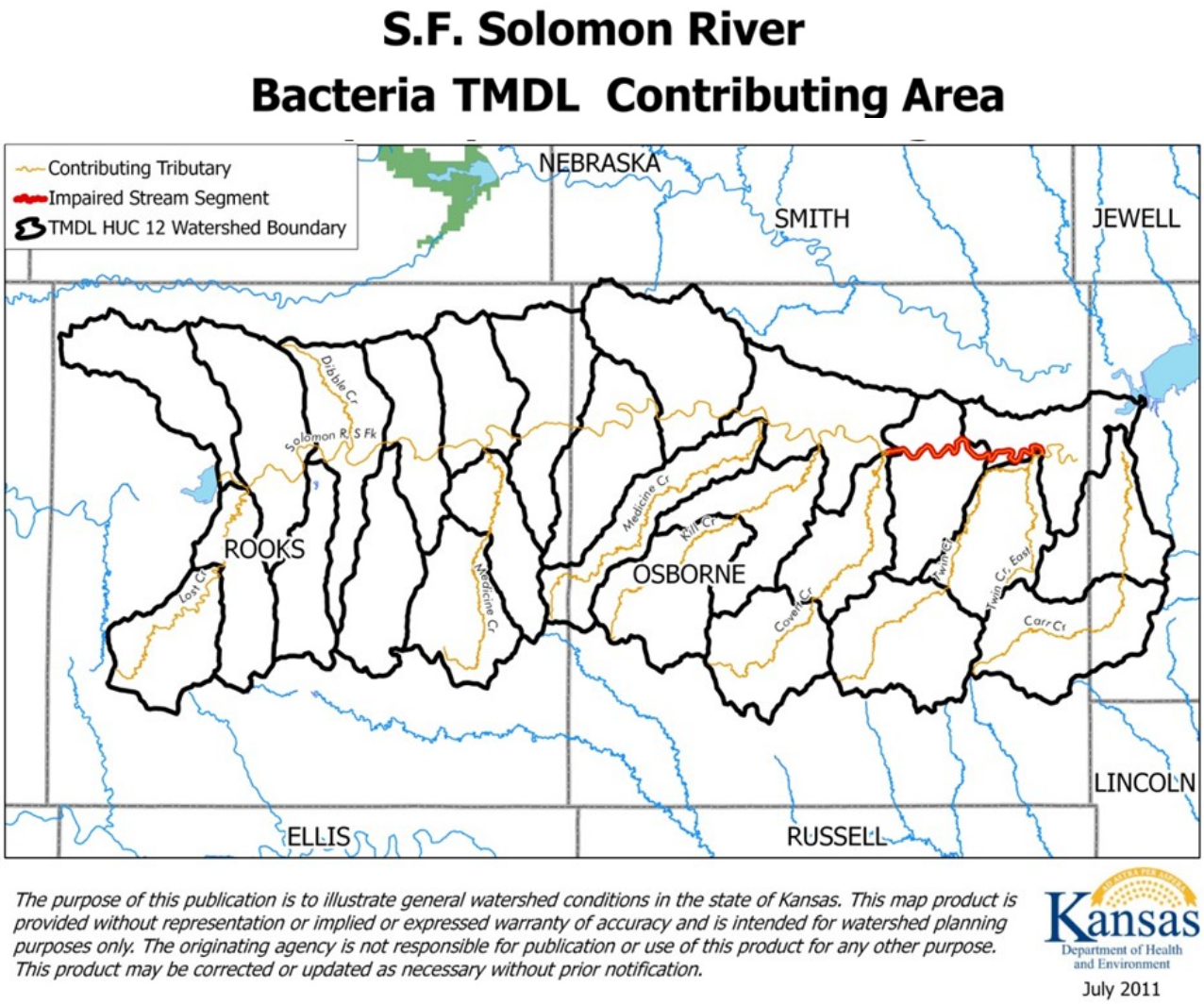


Figure 17. South Fork Solomon River Bacteria TMDL Contributing Area



4.0 Determination of Critical Targeted Areas and BMP Needs

A component of an effective watershed plan is identification of priority areas in which to focus BMP implementation. Targeting implementation of BMPs within focused areas of a watershed helps to maximize water quality improvements noted for the receiving water bodies. For the Waconda Lake WRAPS watershed plan, targeted BMP implementation is necessary to efficiently reduce the phosphorus loading of Waconda Lake through inflow of the North and South Fork Solomon Rivers and tributaries which contribute to the eutrophication impairment for Waconda Lake. The primary non-point source contributors to phosphorus loading of Waconda Lake are likely runoff from cropland and livestock grazing/feeding operations. With these two sources of nutrients estimated to be contributing the majority of the phosphorus load entering Waconda Lake, BMP implementation will be focused on addressing cropland sources as well as those sources which introduce bacteria and associated nutrients to surface waters within the Waconda Lake WRAPS project area.

4.1 Cropland Targeting

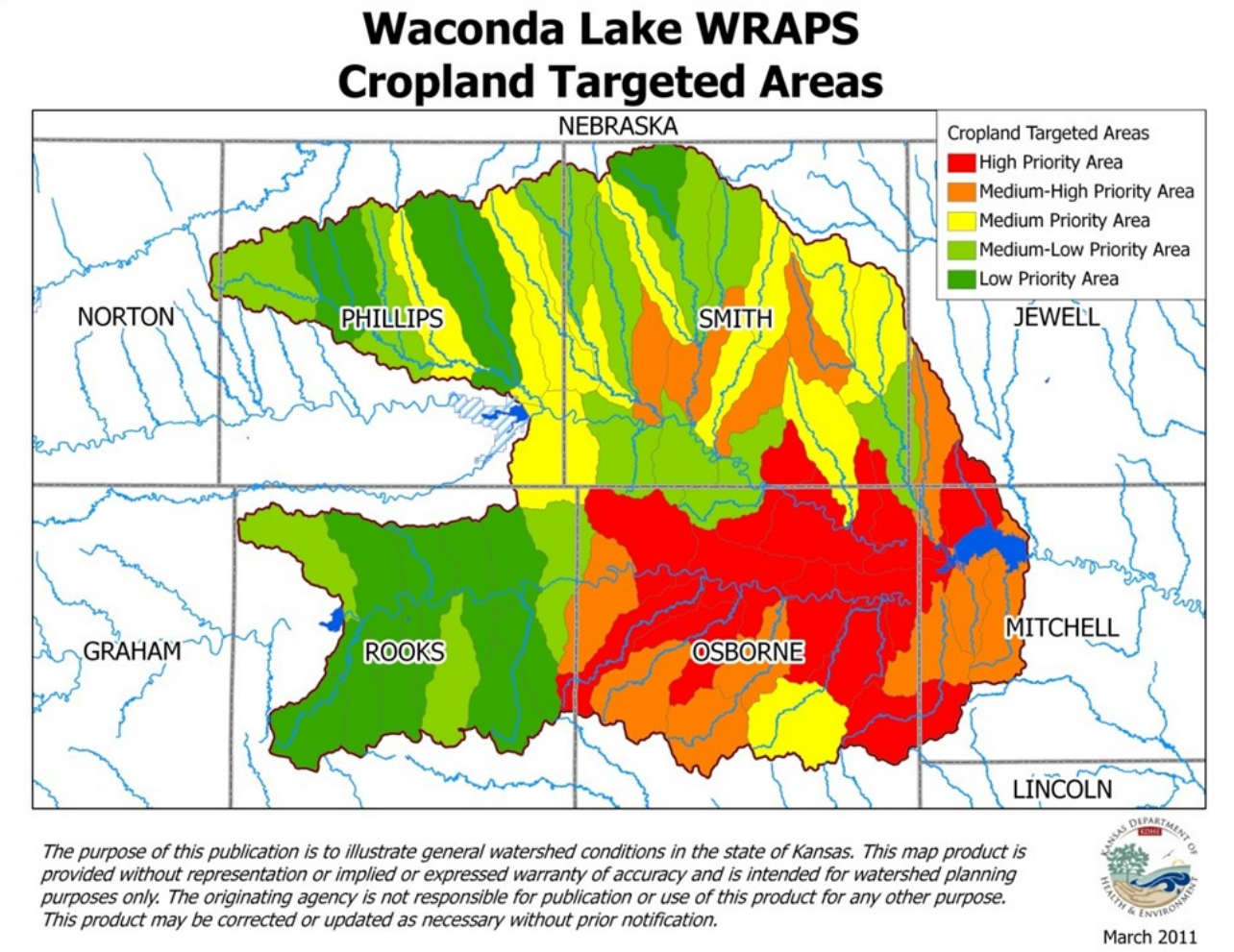
Excess nutrients from cropland runoff within the Waconda Lake watershed are thought to be a primary contributing source of phosphorus which is contributing to the Waconda Lake eutrophication TMDL. A variety of tools can be utilized to characterize nutrient loading from cropland-related sources. For the Waconda Lake WRAPS project area KDHE has developed a STEPL model to characterize nutrient loading originating from HUC 12 watersheds. STEPL, or Spreadsheet Tool for Estimating Pollutant Loads, is a Microsoft Excel based model which utilizes algorithms to calculate estimated nutrient and sediment loads resulting from differing land uses for selected watersheds. This tool can also be utilized to evaluate estimated load reductions resulting from BMP implementation within modeled watersheds.

Results of the STEPL model were displayed using ArcMap to show graphically the estimated phosphorus loads for the Waconda Lake WRAPS project area. These estimated loads were divided into 5 different classification types using quantile classification. This classification technique provides roughly the same number of HUC 12 watersheds in each classification range. These five data ranges were then divided into the following Priority Area classification based off of their quantile values:

- High (HUC 12s with quantiles values in 80-100 percentile range)
- Medium-High (60-80 percentile range)
- Medium (40-60 percentile range)
- Medium Low (20-40 percentile range)
- Low (0-20 percentile range)

The Waconda WRAPS project will evaluate noted load reductions for each of the Cropland Targeted Areas to determine the extent to which cropland BMP implementation will take place towards meeting the TMDL phosphorus reduction goal for the Waconda Lake eutrophication TMDL. This process will start first with evaluation of load reductions noted in the High Priority Area. If noted load reductions in the High Priority Area do not meet the eutrophication TMDL reduction goal, then focus will shift next to reductions in the Medium-High Priority Area. When evaluated with noted load reductions from BMP implementation within the bacteria focus area, the Waconda WRAPS project will be able to determine the spatial extent in which BMP implementation needs to be focused to meet watershed plan load reduction goals.

Figure 18. Waconda Lake WRAPS Cropland Priority Areas



High Priority Cropland Targeted Area HUC 12 Watersheds

102600120401
102600140302
102600140307
102600140403
102600120403
102600120409
102600140406
102600140304
102600140301
102600140404
102600140401
102600150101

Medium-High Priority Cropland Targeted Area HUC 12 Watersheds

102600140405
102600120404
102600150102
102600140303
102600120309
102600120408
102600140207
102600140305
102600120305
102600140306
102600120207
102600150103

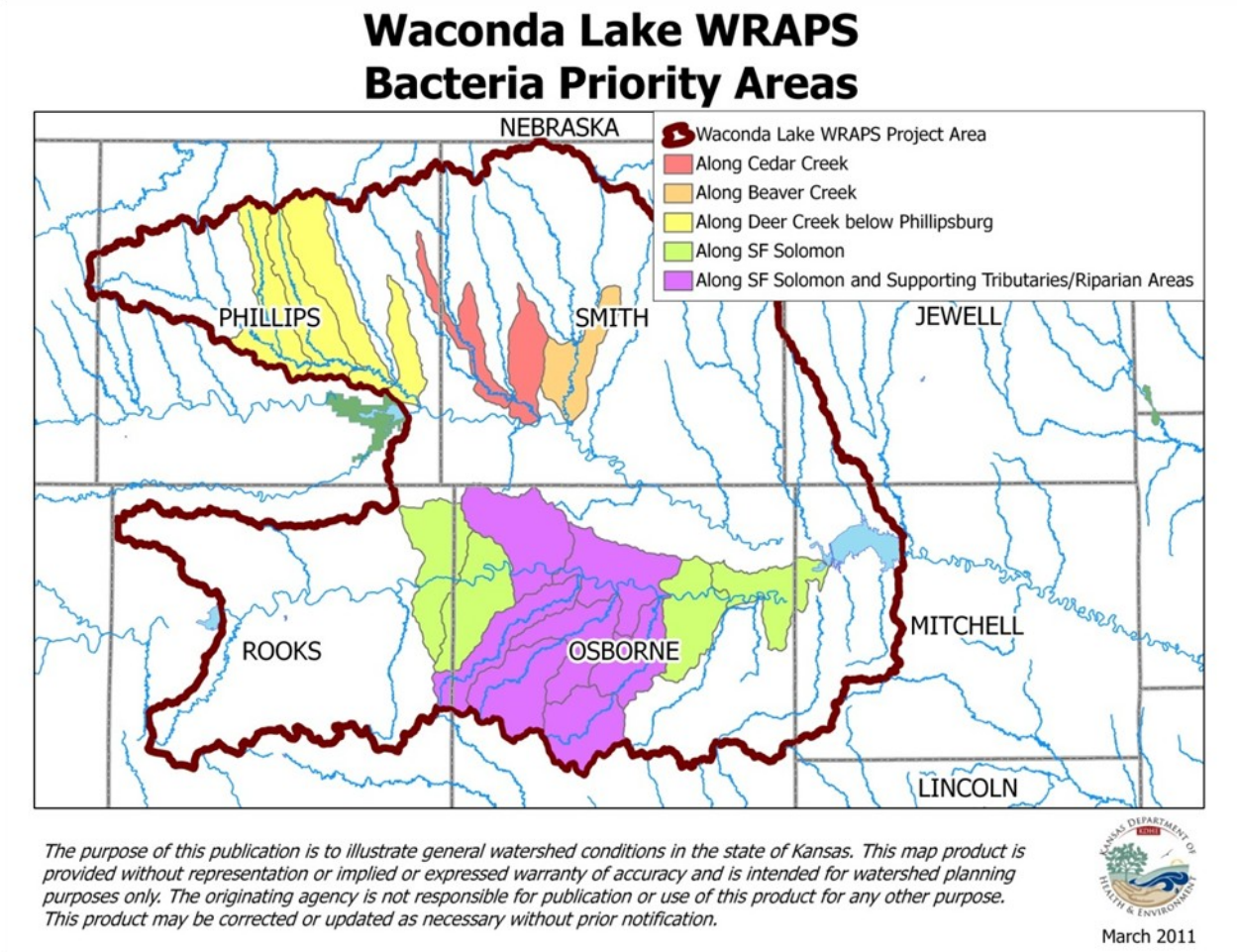
4.2 Bacteria Targeting

In 2010, the KDHE-Watershed Planning Section, which evaluates and develops TMDLs within Kansas, conducted data analysis on water quality conditions within the Solomon River Basin. Among the water bodies that were assessed were the North and South Fork Solomon Rivers. Analysis of water quality data for these waters revealed bacteria levels which are above acceptable levels for contact recreation. Because of the degree of impairment noted for bacteria in these water bodies, both the North and South Fork Solomon Rivers are now included on the Kansas 303(d) list of impaired waters for e. coli bacteria. These impairments also warranted development of bacteria TMDLs for the North and South Fork Solomon Rivers, which are currently in draft status and being reviewed by EPA. The draft bacteria TMDL for the North Fork Solomon River is noted as a Medium Priority for implementation while the South Fork Solomon river draft TMDL is noted as a High Priority for implementation. Listed below are links for these draft TMDLs:

- Lower North Fork Solomon River to Twelvemile Creek draft TMDL
  - ◊ http://www.kdheks.gov/tmdl/2010/NF_Sol_ECB.pdf
- Lower South Fork Solomon River draft TMDL
  - ◊ http://www.kdheks.gov/tmdl/2010/SF_Sol_ECB.pdf

Within these draft TMDLs there are noted priority areas for implementation. These priority areas are identified by taking into consideration water quality data from KDHE monitoring sites within the watershed as well as the designated use particular water bodies. From this information the KDHE TMDL staff provides areas to focus BMP implementation within to help impaired water bodies meet designated uses. These areas as noted within the TMDL will be classified as priority areas for implementing bacteria-reducing BMPs.

Figure 19. Waconda Lake WRAPS Bacteria Priority Areas



N.F. Solomon River Bacteria Priority HUC 12 Watersheds

102600120103
102600120104
102600120105
102600120107
102600120206
102600120207
102600120305

S.F. Solomon River Bacteria Priority HUC 12 Watersheds

102600140206
102600140207
102600140301
102600140302
102600140303
102600140304
102600140305
102600140306
102600140307
102600140401
102600140406

4.3 Cropland BMP Needs

One of the primary mechanisms the Waconda Lake Watershed Plan will utilize to generate nutrient load reductions necessary to meet the Waconda Lake EU TMDL is implementation of cropland BMPs. Types and quantities of BMPs to implement within the Waconda Lake WRAPS Project Area were determined through consultation with agency representatives from County Conservation Districts as well as NRCS staff who serve on the SLT. This feedback resulted in determination of annual rates of BMP implementation for specified practices which took into consideration local adoption rates of the identified practices. These adoption rates for cropland BMPs were then extrapolated forward until approximately 50 percent of the cropland within the High Priority Cropland Target Area was treated.

The amount of cropland needing treatment within the Project Area was obtained from NRCS Rapid Watershed Assessments for both the Lower North Fork and Lower South Fork Solomon River HUC 8 Watersheds. These documents indicate that approximately 50 percent of the cropland within these two HUC 8 Watersheds is in need of treatment through implementation of BMPs. By having a 50 percent cropland treatment target and analyzing the resulting load reductions from this BMP work, it was determined that additional implementation needed to take place within the Project Area to approach and/or meet phosphorus load reduction goals outside of focused implementation within the High Priority Cropland Targeted Area. With this in mind, a 50 percent cropland treatment need was taken into consideration to determine rates of implementation for BMPs to be implemented within the Medium-High Cropland Targeted Area.

The result of the above mentioned needs characterization led to the determination that it would take 44 years of BMP implementation with the practices identified by the SLT to treat approximately 50 percent of cropland within the High and Medium-High Priority HUC 12 watersheds. With this in mind, separate cropland BMP implementation schedules were developed for each of these two Cropland Targeted Areas. These cropland BMP implementation schedules are included within *Section 5.1*.

4.4 Livestock/Grazingland BMP Needs

To address the North and South Fork Solomon River Bacteria (draft) TMDL, the Waconda Lake Watershed Plan will implement livestock BMPs to address sources of bacteria within these two impaired watersheds. These livestock/grazingland-related practices will help to address what has been indicated as a predominate source of bacteria pollution within the watershed as well as produce phosphorus load reductions towards meeting the Waconda Lake EU TMDL. Types and quantities of BMPs to implement within the Waconda Lake WRAPS Project Area were determined through consultation with agency representatives from County Conservation Districts as well as NRCS staff who serve on the SLT. The relocation of livestock feeding sites has been identified as a need within the Waconda watershed. The BMPs of Off-Stream Watering Systems and Fencing – Livestock Exclusion will be used to address this concern. This feedback resulted in determination of annual rates of BMP implementation for specified practices which took into consideration local adoption rates of the identified practices. These

adoption rates for livestock BMPs were then utilized to determine appropriate types and quantities of BMPs to implement within the riparian areas and grazed range located within the Bacteria Priority Area.
The result of the above mentioned needs characterization led to the determination that it would take 30 years of BMP implementation with the practices identified by the SLT to produce load reductions to reach the 46,276 lb/yr phosphorus load reduction which is to be achieved by BMP implementation within the Bacteria Priority Areas. This 30 year implementation period produces phosphorus load reductions of 38,252 lb/yr within the S.F. Solomon River Bacteria Priority Area as well as a reduction in the N.F. Solomon River Bacteria Priority Area of 25,196 lb/yr. These separate BMP implementation schedules will result in implementation of BMPs to address the Bacteria (draft) TMDLs for each of these waters as well as result in load reductions necessary to meet the Waconda Lake EU TMDL. These riparian and grazed range BMP implementation schedules are included within Section 5.2.

5.0 Load Reduction Estimate Methodology

Pollutant load reductions for BMPs included within this plan were calculated utilizing EPA's Region 5 Model. The Region 5 Model is an Excel-based workbook which KDHE utilizes to evaluate load reductions resulting from BMPs in which WRAPS projects across Kansas have helped to implement within their respective watersheds. This model can be utilized to evaluate load reductions from BMPs such as gully stabilization, streambank stabilization, agricultural-cropland practices, feedlot-livestock activities, as well as urban runoff. The primary load reductions that are obtained from the Region 5 Model are nitrogen, phosphorus, and sediment. KDHE utilizes county-level USLE factors for input information as well as applicable load reduction efficiency information from Kansas State University Extension publications as well as other information sources to calculate these pollutant load reductions. More information about the Region 5 Model can be found at http://it.tetratech-ffx.com/stepl/.

5.1 Cropland BMPs and Pollutant Load Reductions to Address Waconda Lake EU TMDL

The following BMPs have been identified as appropriate cropland BMPs for implementation within the Waconda Lake WRAPS Project Area by the SLT. BMP needs and adoption rates were taken into consideration to determine the types and quantities of BMPs needed for implementation within the High and Medium-High Priority Cropland Targeted Areas. These BMPs generate approximately 152,000 lbs/yr of the phosphorus reduction necessary to meet the Waconda Lake EU TMDL.

Table 6. Cropland high priority area BMP Implementation Schedule

Cropland High Priority Area Priority HUC 12s				
BMP Implementation Schedule				
BMP quantities reflect acres of cropland treated by practice				
Year	Waterways	Terraces	No-Till	Riparian Buffers
2011	646.9	646.9	646.9	194.1
2012	646.9	646.9	646.9	194.1
2013	646.9	646.9	646.9	194.1
2014	646.9	646.9	646.9	194.1
2015	646.9	646.9	646.9	194.1
2016	646.9	646.9	646.9	194.1
2017	646.9	646.9	646.9	194.1
2018	646.9	646.9	646.9	194.1
2019	646.9	646.9	646.9	194.1
2020	646.9	646.9	646.9	194.1
2021	646.9	646.9	646.9	194.1
2022	646.9	646.9	646.9	194.1
2023	646.9	646.9	646.9	194.1
2024	646.9	646.9	646.9	194.1
2025	646.9	646.9	646.9	194.1
2026	646.9	646.9	646.9	194.1
2027	646.9	646.9	646.9	194.1
2028	646.9	646.9	646.9	194.1
2029	646.9	646.9	646.9	194.1
2030	646.9	646.9	646.9	194.1
2031	646.9	646.9	646.9	194.1
2032	646.9	646.9	646.9	194.1
2033	646.9	646.9	646.9	194.1
2034	646.9	646.9	646.9	194.1
2035	646.9	646.9	646.9	194.1
2036	646.9	646.9	646.9	194.1
2037	646.9	646.9	646.9	194.1
2038	646.9	646.9	646.9	194.1
2039	646.9	646.9	646.9	194.1
2040	646.9	646.9	646.9	194.1
2041	646.9	646.9	646.9	194.1
2042	646.9	646.9	646.9	194.1
2043	646.9	646.9	646.9	194.1
2044	646.9	646.9	646.9	194.1
2045	646.9	646.9	646.9	194.1
2046	646.9	646.9	646.9	194.1
2047	646.9	646.9	646.9	194.1
2048	646.9	646.9	646.9	194.1
2049	646.9	646.9	646.9	194.1
2050	646.9	646.9	646.9	194.1
2051	646.9	646.9	646.9	194.1
2052	646.9	646.9	646.9	194.1
2053	646.9	646.9	646.9	194.1
2054	646.9	646.9	646.9	194.1
Total	*28,462*	*28,462*	*28,462*	*8,539*

Table 7. Cropland medium-high priority area BMP Implementation Schedule

Cropland Medium-High Priority Area Priority HUC 12s				
BMP Implementation Schedule				
BMP quantities reflect acres of cropland treated by practice				
Year	Waterways	Terraces	No-Till	Riparian Buffers
2011	505.3	505.3	505.3	151.6
2012	505.3	505.3	505.3	151.6
2013	505.3	505.3	505.3	151.6
2014	505.3	505.3	505.3	151.6
2015	505.3	505.3	505.3	151.6
2016	505.3	505.3	505.3	151.6
2017	505.3	505.3	505.3	151.6
2018	505.3	505.3	505.3	151.6
2019	505.3	505.3	505.3	151.6
2020	505.3	505.3	505.3	151.6
2021	505.3	505.3	505.3	151.6
2022	505.3	505.3	505.3	151.6
2023	505.3	505.3	505.3	151.6
2024	505.3	505.3	505.3	151.6
2025	505.3	505.3	505.3	151.6
2026	505.3	505.3	505.3	151.6
2027	505.3	505.3	505.3	151.6
2028	505.3	505.3	505.3	151.6
2029	505.3	505.3	505.3	151.6
2030	505.3	505.3	505.3	151.6
2031	505.3	505.3	505.3	151.6
2032	505.3	505.3	505.3	151.6
2033	505.3	505.3	505.3	151.6
2034	505.3	505.3	505.3	151.6
2035	505.3	505.3	505.3	151.6
2036	505.3	505.3	505.3	151.6
2037	505.3	505.3	505.3	151.6
2038	505.3	505.3	505.3	151.6
2039	505.3	505.3	505.3	151.6
2040	505.3	505.3	505.3	151.6
2041	505.3	505.3	505.3	151.6
2042	505.3	505.3	505.3	151.6
2043	505.3	505.3	505.3	151.6
2044	505.3	505.3	505.3	151.6
2045	505.3	505.3	505.3	151.6
2046	505.3	505.3	505.3	151.6
2047	505.3	505.3	505.3	151.6
2048	505.3	505.3	505.3	151.6
2049	505.3	505.3	505.3	151.6
2050	505.3	505.3	505.3	151.6
2051	505.3	505.3	505.3	151.6
2052	505.3	505.3	505.3	151.6
2053	505.3	505.3	505.3	151.6
2054	505.3	505.3	505.3	151.6
Total	22232	22232	22232	6670

Table 8. Cropland high priority area BMP est. phosphorus load reductions

Cropland High Priority Area Priority HUC 12s					
BMP Estimated Phosphorus Load Reductions					
Quantities reflect lbs of reduction estimated by practice					
Year	Waterways	Terraces	No-Till	Riparian Buffers	Annual Reduction
2011	712	427	569	241	1,948
2012	712	427	569	241	1,948
2013	712	427	569	241	1,948
2014	712	427	569	241	1,948
2015	712	427	569	241	1,948
2016	712	427	569	241	1,948
2017	712	427	569	241	1,948
2018	712	427	569	241	1,948
2019	712	427	569	241	1,948
2020	712	427	569	241	1,948
2021	712	427	569	241	1,948
2022	712	427	569	241	1,948
2023	712	427	569	241	1,948
2024	712	427	569	241	1,948
2025	712	427	569	241	1,948
2026	712	427	569	241	1,948
2027	712	427	569	241	1,948
2028	712	427	569	241	1,948
2029	712	427	569	241	1,948
2030	712	427	569	241	1,948
2031	712	427	569	241	1,948
2032	712	427	569	241	1,948
2033	712	427	569	241	1,948
2034	712	427	569	241	1,948
2035	712	427	569	241	1,948
2036	712	427	569	241	1,948
2037	712	427	569	241	1,948
2038	712	427	569	241	1,948
2039	712	427	569	241	1,948
2040	712	427	569	241	1,948
2041	712	427	569	241	1,948
2042	712	427	569	241	1,948
2043	712	427	569	241	1,948
2044	712	427	569	241	1,948
2045	712	427	569	241	1,948
2046	712	427	569	241	1,948
2047	712	427	569	241	1,948
2048	712	427	569	241	1,948
2049	712	427	569	241	1,948
2050	712	427	569	241	1,948
2051	712	427	569	241	1,948
2052	712	427	569	241	1,948
2053	712	427	569	241	1,948
2054	712	427	569	241	1,948
Total	*31,308*	*18,785*	*25,047*	*10,588*	*85,728*

Table 9. Cropland medium-high priority area BMP est. phosphorus load reductions

Cropland Medium-High Priority Area Priority HUC 12s					
BMP Estimated Phosphorus Load Reductions					
Quantities reflect lbs. of reduction estimated by practice					
Year	Waterways	Terraces	No-Till	Riparian Buffers	Annual Reduction
2011	556	333	445	188	1,522
2012	556	333	445	188	1,522
2013	556	333	445	188	1,522
2014	556	333	445	188	1,522
2015	556	333	445	188	1,522
2016	556	333	445	188	1,522
2017	556	333	445	188	1,522
2018	556	333	445	188	1,522
2019	556	333	445	188	1,522
2020	556	333	445	188	1,522
2021	556	333	445	188	1,522
2022	556	333	445	188	1,522
2023	556	333	445	188	1,522
2024	556	333	445	188	1,522
2025	556	333	445	188	1,522
2026	556	333	445	188	1,522
2027	556	333	445	188	1,522
2028	556	333	445	188	1,522
2029	556	333	445	188	1,522
2030	556	333	445	188	1,522
2031	556	333	445	188	1,522
2032	556	333	445	188	1,522
2033	556	333	445	188	1,522
2034	556	333	445	188	1,522
2035	556	333	445	188	1,522
2036	556	333	445	188	1,522
2037	556	333	445	188	1,522
2038	556	333	445	188	1,522
2039	556	333	445	188	1,522
2040	556	333	445	188	1,522
2041	556	333	445	188	1,522
2042	556	333	445	188	1,522
2043	556	333	445	188	1,522
2044	556	333	445	188	1,522
2045	556	333	445	188	1,522
2046	556	333	445	188	1,522
2047	556	333	445	188	1,522
2048	556	333	445	188	1,522
2049	556	333	445	188	1,522
2050	556	333	445	188	1,522
2051	556	333	445	188	1,522
2052	556	333	445	188	1,522
2053	556	333	445	188	1,522
2054	556	333	445	188	1,522
Total	24,456	14,673	19,564	8,270	66,964

5.2 Livestock/Grazingland BMPs to Address N.F./S.F. Solomon River and Waconda Lake EU TMDLs

The following BMPs have been identified as appropriate livestock/grazingland BMPs for implementation within the Waconda Lake WRAPS Project Area by the SLT. BMP needs and adoption rates were taken into consideration to determine the types and quantities of BMPs needed for implementation within the Bacteria Priority Areas. These BMPs generate approximately 46,000 lbs/yr of the phosphorus reduction necessary to meet the Waconda Lake EU TMDL. These BMPs will also result in reductions in bacteria loading originating from the Bacteria Priority Areas previously discussed within this plan. Although no quantitative bacteria pollutant load reductions can be calculated for these BMPs, it is the expectation of the SLT that implementation of these practices will help to directly address the bacteria water quality impairments which are present on both the North Fork and South Fork Solomon Rivers.

Table 10. Bacteria South Fork priority area BMP implementation schedule

Bacteria Priority Area - S.F. Solomon River Bacteria TMDL BMP Implementation Schedule *BMP quantities reflect acres of cropland treated by practice*						
Year	Rotational Grazing (acres)	Brush Mgmt. (acres)	Alternative Water Supply (#systems)	Wind break (#wb)	Critical Area Planting (acres)	Fencing-Livestock Exclusion (ln. ft.)
2011	293	394	3	0	33	0
2012	293	394	4	0	33	0
2013	293	394	4	0	33	0
2014	293	394	4	0	33	0
2015	293	394	3	1	33	1,300
2016	293	394	4	0	33	0
2017	293	394	4	0	33	0
2018	293	394	4	0	33	0
2019	293	394	3	0	33	0
2020	293	394	4	1	33	0
2021	293	394	4	0	33	0
2022	293	394	4	0	33	0
2023	293	394	3	0	33	0
2024	293	394	4	0	33	0
2025	293	394	4	0	33	0
2026	293	394	4	1	33	0
2027	293	394	4	0	33	0
2028	293	394	4	0	33	0
2029	293	394	4	0	33	0
2030	293	394	4	1	33	0

2031	293	394	4	0	33	1,300
2032	293	394	4	0	33	0
2033	293	394	4	0	33	0
2034	293	394	4	0	33	0
2035	293	394	4	1	33	0
2036	293	394	4	0	33	0
2037	293	394	4	0	33	0
2038	293	394	4	0	33	0
2039	293	394	4	0	33	0
2,040	293	394	4	1	33	0
Total	8,790	11,820	116	6	999	2,600

Table 11. Bacteria South Fork priority area BMP est. phosphorus load reductions

Bacteria Priority Area - S.F. Solomon River Bacteria TMDL							
BMP Estimated Phosphorus Load Reductions							
Quantities reflect lbs. of reduction estimated by practice							
Year	Rotational Grazing	Brush Mgmt.	Alternative Water Sup-ply	Wind break	Critical Area Planting	Fencing-Livestock Exclusion	Total An-nual Reduc-tion
2011	58	0	438	0	581	0	1,077
2012	58	0	584	0	581	0	1,223
2013	58	0	584	0	581	0	1,223
2014	58	0	584	0	581	0	1,223
2015	58	0	438	146	581	635	1,858
2016	58	0	584	0	581	0	1,223
2017	58	0	584	0	581	0	1,223
2018	58	0	584	0	581	0	1,223
2019	58	0	438	0	581	0	1,077
2020	58	0	584	146	581	0	1,369
2021	58	0	584	0	581	0	1,223
2022	58	0	584	0	581	0	1,223
2023	58	0	438	0	581	0	1,077
2024	58	0	584	0	581	0	1,223
2025	58	0	584	0	581	0	1,223
2026	58	0	584	146	581	0	1,369
2027	58	0	584	0	581	0	1,223
2028	58	0	584	0	581	0	1,223
2029	58	0	584	0	581	0	1,223
2030	58	0	584	146	581	0	1,369
2031	58	0	584	0	581	635	1,858
2032	58	0	584	0	581	0	1,223
2033	58	0	584	0	581	0	1,223

2034	58	0	584	0	581	0	1,223
2035	58	0	584	146	581	0	1,369
2036	58	0	584	0	581	0	1,223
2037	58	0	584	0	581	0	1,223
2038	58	0	584	0	581	0	1,223
2039	58	0	584	0	581	0	1,223
2040	58	0	584	146	581	0	1369
Total	*1,740*	*0*	*16,936*	*876*	*17,430*	*1,270*	*38,252*

Table 12. Bacteria North Fork priority area BMP implementation schedule

Bacteria Priority Area - N.F. Solomon River Bacteria TMDL BMP Implementation Schedule *BMP quantities reflect acres of cropland treated by practice*					
Year	Rotational Grazing (acres)	Brush Mgmt. (acres)	Alternative Water Supply (#systems)	Critical Area Planting (acres)	Fencing-Livestock Exclusion (ln. ft.)
2011	435	133	2	22	0
2012	435	133	2	22	0
2013	435	133	2	22	0
2014	435	133	2	22	0
2015	435	133	3	22	1,500
2016	435	133	2	22	0
2017	435	133	2	22	0
2018	435	133	2	22	0
2019	435	133	2	22	0
2020	435	133	3	22	0
2021	435	133	2	22	0
2022	435	133	2	22	0
2023	435	133	2	22	0
2024	435	133	2	22	0
2025	435	133	2	22	0
2026	435	133	3	22	0
2027	435	133	2	22	0
2028	435	133	2	22	0
2029	435	133	2	22	0
2030	435	133	2	22	1,500
2031	435	133	2	22	0
2032	435	133	3	22	0
2033	435	133	2	22	0
2034	435	133	2	22	0
2035	435	133	2	22	0
2036	435	133	2	22	0

2037	435	133	2	22	0
2038	435	133	3	22	0
2039	435	133	2	22	0
2040	435	133	2	22	0
Total	13050	3,990	65	672	3,000

Table 13. Bacteria North Fork priority area BMP est. phosphorus load reductions

Bacteria Priority Area - N.F. Solomon River Bacteria TMDL						
BMP Estimated Phosphorus Load Reductions						
Quantities reflect lbs. of reduction estimated by practice						
Year	Rotational Grazing	Brush Mgmt.	Alternative Water Supply	Critical Area Planting	Fencing-Livestock Exclusion	Total Annual Reduction (lbs)
2011	83	0	292	404	0	779
2012	83	0	292	404	0	779
2013	83	0	292	404	0	779
2014	83	0	292	404	0	779
2015	83	0	438	404	548	1,473
2016	83	0	292	404	0	779
2017	83	0	292	404	0	779
2018	83	0	292	404	0	779
2019	83	0	292	404	0	779
2020	83	0	438	404	0	925
2021	83	0	292	404	0	779
2022	83	0	292	404	0	779
2023	83	0	292	404	0	779
2024	83	0	292	404	0	779
2025	83	0	292	404	0	779
2026	83	0	438	404	0	925
2027	83	0	292	404	0	779
2028	83	0	292	404	0	779
2029	83	0	292	404	0	779
2030	83	0	292	404	548	1,327
2031	83	0	292	404	0	779
2032	83	0	438	404	0	925
2033	83	0	292	404	0	779
2034	83	0	292	404	0	779
2035	83	0	292	404	0	779
2036	83	0	292	404	0	779
2037	83	0	292	404	0	779
2038	83	0	438	404	0	925
2039	83	0	292	404	0	779
2,040	83	0	292	404	0	779
Total	*2490*	*0*	*9,490*	*12,120*	*1,096*	*25,196*

6.0 BMP Implementation Milestones

Development of BMP implementation milestones provides for the opportunity to evaluate watershed plan implementation progress at given intervals over the duration of the plan. Once developed, these milestones give WRAPS projects and their respective SLTs a framework to evaluate progress of BMP implementation for the practices identified with the plan as well as insight as to whether or not BMP implementation schedules need to be adjusted to meet the overall implementation goals of the plan.

For the Waconda Lake WRAPS Watershed Plan, BMP implementation milestones have been developed for work to be conducted within the Cropland High and Medium-High Priority Areas as well as the Bacteria Targeted Areas for the N.F. and S.F. Solomon River (draft) Bacteria TDML Watersheds. Short, mid, and long term BMP implementation milestones have been developed for these areas in which BMP implementation will be focused as a tool to evaluate implementation progress being made towards directly addressing the priority water quality impairments within the Project Area.

Table 14. Cropland high priority area BMP implementation milestones

Cropland High Priority Area Priority HUC 12s				
BMP Implementation Milestones				
BMP quantities reflect acres of cropland treated by practice				
Year	Waterways	Terraces	No-Till	Riparian Buffers
2011	646.9	646.9	646.9	194.1
2012	646.9	646.9	646.9	194.1
2013	646.9	646.9	646.9	194.1
2014	646.9	646.9	646.9	194.1
2015	646.9	646.9	646.9	194.1
2016	646.9	646.9	646.9	194.1
2017	646.9	646.9	646.9	194.1
2018	646.9	646.9	646.9	194.1
2019	646.9	646.9	646.9	194.1
2020	646.9	646.9	646.9	194.1
Short Term Milestone	***6,469***	***6,469***	***6,469***	***1,941***
2021	646.9	646.9	646.9	194.1
2022	646.9	646.9	646.9	194.1
2023	646.9	646.9	646.9	194.1
2024	646.9	646.9	646.9	194.1
2025	646.9	646.9	646.9	194.1
2026	646.9	646.9	646.9	194.1
2027	646.9	646.9	646.9	194.1
2028	646.9	646.9	646.9	194.1
2029	646.9	646.9	646.9	194.1
2030	646.9	646.9	646.9	194.1
Mid Term Milestone	***12,937***	***12,937***	***12,937***	***3,881***

2031	646.9	646.9	646.9	194.1
2032	646.9	646.9	646.9	194.1
2033	646.9	646.9	646.9	194.1
2034	646.9	646.9	646.9	194.1
2035	646.9	646.9	646.9	194.1
2036	646.9	646.9	646.9	194.1
2037	646.9	646.9	646.9	194.1
2038	646.9	646.9	646.9	194.1
2039	646.9	646.9	646.9	194.1
2040	646.9	646.9	646.9	194.1
2041	646.9	646.9	646.9	194.1
2042	646.9	646.9	646.9	194.1
2043	646.9	646.9	646.9	194.1
2044	646.9	646.9	646.9	194.1
2045	646.9	646.9	646.9	194.1
2046	646.9	646.9	646.9	194.1
2047	646.9	646.9	646.9	194.1
2048	646.9	646.9	646.9	194.1
2049	646.9	646.9	646.9	194.1
2050	646.9	646.9	646.9	194.1
2051	646.9	646.9	646.9	194.1
2052	646.9	646.9	646.9	194.1
2053	646.9	646.9	646.9	194.1
2054	646.9	646.9	646.9	194.1
Long Term Milestone	***28,462***	***28,462***	***28,462***	***8,539***
Total	*28,462*	*28,462*	*28,462*	*8,539*

Table 15. Cropland medium-high priority area BMP implementation milestones

Cropland Medium-High Priority Area Priority HUC 12s				
BMP Implementation Milestones				
BMP quantities reflect acres of cropland treated by practice				
Year	Waterways	Terraces	No-Till	Riparian Buffers
2011	505.3	505.3	505.3	151.6
2012	505.3	505.3	505.3	151.6
2013	505.3	505.3	505.3	151.6
2014	505.3	505.3	505.3	151.6
2015	505.3	505.3	505.3	151.6
2016	505.3	505.3	505.3	151.6
2017	505.3	505.3	505.3	151.6
2018	505.3	505.3	505.3	151.6
2019	505.3	505.3	505.3	151.6
2020	505.3	505.3	505.3	151.6
Short Term Milestone	***5,053***	***5,053***	***5,053***	***1,516***
2021	505.3	505.3	505.3	151.6
2022	505.3	505.3	505.3	151.6
2023	505.3	505.3	505.3	151.6
2024	505.3	505.3	505.3	151.6
2025	505.3	505.3	505.3	151.6
2026	505.3	505.3	505.3	151.6
2027	505.3	505.3	505.3	151.6

2028	505.3	505.3	505.3	151.6
2029	505.3	505.3	505.3	151.6
2030	505.3	505.3	505.3	151.6
Mid Term Milestone	***10,106***	***10,106***	***10,106***	***3,032***
2031	505.3	505.3	505.3	151.6
2032	505.3	505.3	505.3	151.6
2033	505.3	505.3	505.3	151.6
2034	505.3	505.3	505.3	151.6
2035	505.3	505.3	505.3	151.6
2036	505.3	505.3	505.3	151.6
2037	505.3	505.3	505.3	151.6
2038	505.3	505.3	505.3	151.6
2039	505.3	505.3	505.3	151.6
2040	505.3	505.3	505.3	151.6
2041	505.3	505.3	505.3	151.6
2042	505.3	505.3	505.3	151.6
2043	505.3	505.3	505.3	151.6
2044	505.3	505.3	505.3	151.6
2045	505.3	505.3	505.3	151.6
2046	505.3	505.3	505.3	151.6
2047	505.3	505.3	505.3	151.6
2048	505.3	505.3	505.3	151.6
2049	505.3	505.3	505.3	151.6
2050	505.3	505.3	505.3	151.6
2051	505.3	505.3	505.3	151.6
2052	505.3	505.3	505.3	151.6
2053	505.3	505.3	505.3	151.6
2054	505.3	505.3	505.3	151.6
Long Term Milestone	**22,232**	**22,232**	**22,232**	**6,670**
Total	22,232	22,232	22,232	6,670

Table 16. Bacteria S.F. priority area BMP implementation milestones

Bacteria Priority Area - S.F. Solomon River Bacteria TMDL BMP Implementation Milestones *BMP quantities reflect acres of cropland treated by practice*						
Year	Rotational Grazing (acres)	Brush Mgmt. (acres)	Alternative Water Sup-ply (#systems)	Wind break (#wb)	Critical Area Planting (acres)	Fencing-Livestock Exclusion (ln. ft.)
2011	293	394	3	0	33	0
2012	293	394	4	0	33	0
2013	293	394	4	0	33	0
2014	293	394	4	0	33	0
2015	293	394	3	1	33	1,300
Short Term Milestone	*1,465*	*1,970*	*18*	*1*	*167*	*1,300*

2016	293	394	4	0	33	0
2017	293	394	4	0	33	0
2018	293	394	4	0	33	0
2019	293	394	3	0	33	0
2020	293	394	4	1	33	0
2021	293	394	4	0	33	0
2022	293	394	4	0	33	0
2023	293	394	3	0	33	0
2024	293	394	4	0	33	0
2025	293	394	4	0	33	0
Mid Term Milestone	*4,395*	*5,910*	*56*	*2*	*500*	*1,300*
2026	293	394	4	1	33	0
2027	293	394	4	0	33	0
2028	293	394	4	0	33	0
2029	293	394	4	0	33	0
2030	293	394	4	1	33	0
2031	293	394	4	0	33	1,300
2032	293	394	4	0	33	0
2033	293	394	4	0	33	0
2034	293	394	4	0	33	0
2035	293	394	4	1	33	0
2036	293	394	4	0	33	0
2037	293	394	4	0	33	0
2038	293	394	4	0	33	0
2039	293	394	4	0	33	0
2,040	293	394	4	1	33	0
Long Term Milestone	*8,790*	*11,820*	*116*	*6*	*999*	*2,600*

Table 17. Bacteria N.F. priority area BMP implementation milestones

Bacteria Priority Area - N.F. Solomon River Bacteria TMDL BMP Implementation Milestones *BMP quantities reflect acres of cropland treated by practice*					
Year	Rotational Grazing (acres)	Brush Mgmt. (acres)	Alternative Water Sup-ply (#systems)	Critical Area Planting (acres)	Fencing-Livestock Exclusion (ln. ft.)
2011	435	133	2	22	0
2012	435	133	2	22	0
2013	435	133	2	22	0
2014	435	133	2	22	0
2015	435	133	3	22	1,500
Short Term Mile-stone	*2,175*	*665*	*11*	*112*	*1,500*

2016	435	133	2	22	0
2017	435	133	2	22	0
2018	435	133	2	22	0
2019	435	133	2	22	0
2020	435	133	3	22	0
2021	435	133	2	22	0
2022	435	133	2	22	0
2023	435	133	2	22	0
2024	435	133	2	22	0
2025	435	133	2	22	0
Mid Term Milestone	*6,525*	*1,995*	*32*	*336*	*1,500*
2026	435	133	3	22	0
2027	435	133	2	22	0
2028	435	133	2	22	0
2029	435	133	2	22	0
2030	435	133	2	22	1,500
2031	435	133	2	22	0
2032	435	133	3	22	0
2033	435	133	2	22	0
2034	435	133	2	22	0
2035	435	133	2	22	0
2036	435	133	2	22	0
2037	435	133	2	22	0
2038	435	133	3	22	0
2039	435	133	2	22	0
2040	435	133	2	22	0
Long Term Mile-stone	*13050*	*3990*	*65*	*672*	*3000*

7.0 Information/Education and Technical Assistance Plan

7.1 Information/Education and technical assistance schedule with cost estimates

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. Additional watershed issues identified by the Waconda WRAPS SLT will be address through information/education activities included in this plan. Listed below are the activities and events along with their costs and possible sponsoring agencies. All activities will be focused in the WRAPS high priority project areas.

Table 18. Information/Education and technical assistance schedule with cost estimates

BMP	Target Audience	Activity/Event	Time Frame	Estimated Costs	Sponsor/
Livestock BMP Implementation					
Relocate Pasture Feeding Sites/Pens	Livestock Producers/ Landowners	Tour/Field Day	Annual-Summer	$5,000	Kansas Rural Center K-State Research and Extension Conservation Districts Solomon Valley RC&D
	Livestock Producers/ Landowners	Demonstration Project	Annual-Summer	$5,000	Kansas Rural Center K-State Research and Extension Conservation Districts Solomon Valley RC&D
	Livestock Producers/ Landowners	Scholarships to Grazing Schools and Workshops	Annual-Ongoing	5 per year, $100 per scholarship: $500 total	Kansas Rural Center K-State Research and Extension KS Grazing Lands Coalition
	Livestock Producers/ Landowners	One-on-one technical assistance for producers to implement live-stock BMPs in targeted areas	Annual – Ongoing	Watershed Specialist $20,000	K-State Research and Extension Conservation Districts
	Livestock Producers/ Landowners	One-on-one technical assistance to remove livestock from riparian areas	Annual – Ongoing	$5,000	Kansas Forest Service Conservation Districts
Off-stream/ Alternative Watering Systems	Livestock Producers/ Landowners	Tour/Field Day	Annual-Summer	Included above	Kansas Rural Center K-State Research and Extension Conservation Districts NRCS Solomon Valley RC&D
	Livestock Producers/ Landowners	Demonstration Project	Annual-Summer	$5,000	Kansas Rural Center K-State Research and Extension Conservation Districts NRCS Solomon Valley RC&D

Livestock BMP Implementation					
Off-stream/ Alternative Watering Systems	Livestock Producers/ Landowners	Scholarships to Grazing Schools and Workshops	Annual-Ongoing	Included above	Kansas Rural Center K-State Research and Extension KS Grazing Lands Coalition
	Livestock Producers/ Landowners	One-on-one technical assistance for producers to implement livestock BMPs in targeted areas	Annual, Ongoing	Included above	K-State Research and Extension Conservation Districts
Rotational Grazing	Livestock Producers/ Landowners	Tour/Field Day/Workshop	Annual-Summer	$5,000	Kansas Rural Center K-State Research and Extension NRCS
	Livestock Producers/ Landowners	One-on-one technical assistance for producers to implement livestock BMPs in targeted areas	Annual, Ongoing	Included above	K-State Research and Extension NRCS Conservation Districts
Grazing Management Plans (critical area planting & brush management)	Livestock Producers/ Landowners	Tour/Field Day/Workshop	Annual-Summer	$5,000	Kansas Rural Center K-State Research and Extension Conservation Districts NRCS Solomon Valley RC&D North Central Prairie Weed Management Assoc
	Livestock Producers/ Landowners	One-on-one technical assistance for producers to implement livestock BMPs in targeted areas	Annual, Ongoing	Included above	K-State Research and Extension Conservation districts NRCS
		Sub-Total if fully implemented	Annual	$50,500	

Cropland BMP Implementation					
Permanent Vegetation	Farmers/Landowners	Workshop/Field Day/Tour	Annual, Spring	$5,000	K-State Research and Extension Conservation districts NRCS Solomon Valley RC&D
	Farmers/Landowners	Forestry Field Day	Annual	$5,000	Kansas Forest Service Solomon Valley RC&D North Central Prairie Weed Management Area
Grassed Waterways	Farmers/Landowners	One-on-one technical assistance for farmers/ landowners to implement water-ways in targeted areas	Annual	No Cost	Conservation Districts NRCS
No-Till	Farmers/Landowners	Scholarships for farmers/ landowners to attend No-Till on the Plains Annual Conference	Annual, Winter	5 per year, $150 per scholarship: $750	No-Till on the Plains Conservation Districts
	Farmers/Landowners	Workshop/Field Day/Tour	Annual, Spring	$5,000	No-Till on the Plains Conservation Districts K-State Research and Extension Solomon Valley RC&D
	Farmers/Landowners	One-on-one technical assistance for farmers/ landowners to implement no-till in targeted areas	Annual-Ongoing	$20,000	No-Till on the Plains K-State Research and Extension Conservation Districts NRCS
Nutrient Manage-ment Plans	Farmers/Landowners	Workshop/Field Day	Annual, Spring	$5,000	Conservation Districts K-State Research and Extension NRCS Solomon Valley RC&D
	Farmers/Landowners	One-on-one technical assistance for farmers to implement NMPs in targeted areas	Annual	Included above	Conservation Districts K-State Research and Extension NRCS Conservation Districts
Terraces	Farmers/Landowners	Workshop/Field Day/Tour	Annual, Spring	$5,000	K-State Research and Extension Conservation districts NRCS Solomon Valley RC&D
		Sub-Total if fully implemented	Annual	$45,750	

General / Watershed Wide Information and Education					
Educational Activities Targeting Youth	Educators, K-12 Students	Envirothon	Annual	$1,000	Conservation Districts NRCS Solomon Valley RC&D
		Eco-Meet	Annual	$1,000	Conservation Districts NRCS Solomon Valley RC&D
		Range Youth Camp	Annual	5 Scholarships @$220/ea. $1,100	Conservation Districts NRCS Producer Organizations
		WACKY Day	Annual	$500	Conservation Districts Kansas Natural Resource Foundation Solomon Valley RC&D Local FFA Chapters
		Poster, essay, and speech contests	Annual	No Cost	Conservation Districts Solomon Valley RC&D
		Water Festival	Annual	$5,000	Kansas Natural Resource Foundation Solomon Valley RC&D
		EARTH	Annual	$5,000	E.A.R.T.H. program
Educational Activities Targeting Adults	Watershed residents	BMP Auction Technical Assistance (To be conducted in targeted watersheds only)	Annual	$9,000	K-State Research and Extension Conservation Districts
		River Friendly Farms (To be conducted in targeted watersheds only)	Annual	$20,000	Kansas Rural Center
		Newsletters, press releases, advertisements, and producer mailings Web Sites	As needed	$1,000	K-State Research and Extension Conservation Districts KAWS Kansas Rural Center Solomon Valley RC&D
		Presentation at Annual meetings	Annual – Winter	No Charge	Conservation District Solomon Valley RC&D
		Displays at community events and county fairs	Annual	$500	Conservation District K-State Research and Extension Solomon Valley RC&D North Central Prairie Weed Management Area
		Sub-Total if fully implemented	Annual	$44,100	

Watershed Issues Information and Education					
Groundwater	Watershed residents	Newsletters, press releases, advertisements, and producer mailings Web Sites	As needed	Included above	K-State Research and Extension Conservation Districts KAWS Kansas Rural Center Solomon Valley RC&D
		Presentation at Annual meetings	Annual – Winter	No Charge	Conservation District Solomon Valley RC&D
		Displays at community events and county fairs	Annual	$500	Conservation District K-State Research and Extension Solomon Valley RC&D North Central Prairie Weed Management Area
		Water well decommissioning demonstration	Annual	$5,000	Conservation District K-State Research and Extension Solomon Valley RC&D North Central Prairie Weed Management Area
		One-on-one technical assistance for farmers/ Landowners in targeted areas to test water wells, record data, and educate on protecting water quality	On-going	$10,000	Conservation District K-State Research and Extension Solomon Valley RC&D North Central Prairie Weed Management Area
		Ground water quality and protection demonstrations using an Envision Groundwater model and providing written information	On-going – in conjunction with other demonstrations and meetings	$5,000	Conservation District K-State Research and Extension NRCS Solomon Valley RC&D North Central Prairie Weed Management Area Producer membership Organizations
Degraded Streams and Rivers	Watershed residents	Publicize and promote streambank BMPs	Annual	$500	Conservation Districts KAWS Kansas Forest Service Solomon Valley RC&D

Urban Areas	Watershed residents	Publicize and promote Water Quality BMPs for urban areas	Annual	$500	Conservation Districts Solomon Valley RC&D
Flooding	City/County, Watershed Landowners	Onsite visits	As needed	$250	Conservation Districts
Biological Items of Concern	Watershed residents	Publicize and promote management practices that protect native and endangered species	Annual	$500	KDWP US Fish & Wildlife
Water Quantity	Watershed residents	Publicize and promote drought management practices	As needed	$500	Conservation Districts Solomon Valley RC&D
		Sub-Total if fully implemented	Annual	$22,750	

Project Coordination & Grant Management				
Project management	WRAPS Coordinator 0.50 FTE	Annual	$30,000	Solomon Valley RC&D
Grant management	RC&D Executive Director	Annual	$12,000	Solomon Valley RC&D
	Sub-total if fully implemented	Annual	$42,000	
	Total if fully implemented	**Annual**	**$205,100**	

7.2 Evaluation of Information and Education Activities

All service providers conducting Information and Education (I&E) activities funded through the Waconda 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

8.1 Costs of Implementing Cropland BMPs

Table 19. Cropland High Priority Area BMP Implementation Costs Before Cost Share

Cropland High Priority Area Priority HUC 12s					
BMP Estimated Annual Costs Before Cost-Share					
Costs reflect 3% Annual Inflation					
Year	Water-ways	Ter-races	No-Till	Riparian Buff-ers	Annual Cost
2011	$97,030	$64,687	$50,255	$12,937	$224,909
2012	$99,941	$66,627	$51,763	$13,325	$231,656
2013	$102,939	$68,626	$53,316	$13,725	$238,606
2014	$106,027	$70,685	$54,915	$14,137	$245,764
2015	$109,208	$72,805	$56,562	$14,561	$253,137
2016	$112,484	$74,989	$58,259	$14,998	$260,731
2017	$115,859	$77,239	$60,007	$15,448	$268,553
2018	$119,334	$79,556	$61,807	$15,911	$276,609
2019	$122,914	$81,943	$63,662	$16,389	$284,908
2020	$126,602	$84,401	$65,571	$16,880	$293,455
2021	$130,400	$86,933	$67,538	$17,387	$302,258
2022	$134,312	$89,541	$69,565	$17,908	$311,326
2023	$138,341	$92,228	$71,652	$18,446	$320,666
2024	$142,492	$94,994	$73,801	$18,999	$330,286
2025	$146,766	$97,844	$76,015	$19,569	$340,195
2026	$151,169	$100,780	$78,296	$20,156	$350,400
2027	$155,704	$103,803	$80,645	$20,761	$360,912
2028	$160,376	$106,917	$83,064	$21,383	$371,740
2029	$165,187	$110,125	$85,556	$22,025	$382,892
2030	$170,142	$113,428	$88,122	$22,686	$394,379
2031	$175,247	$116,831	$90,766	$23,366	$406,210
2032	$180,504	$120,336	$93,489	$24,067	$418,396
2033	$185,919	$123,946	$96,294	$24,789	$430,948
2034	$191,497	$127,665	$99,183	$25,533	$443,877
2035	$197,242	$131,494	$102,158	$26,299	$457,193
2036	$203,159	$135,439	$105,223	$27,088	$470,909
2037	$209,254	$139,502	$108,379	$27,900	$485,036
2038	$215,531	$143,688	$111,631	$28,738	$499,587
2039	$221,997	$147,998	$114,980	$29,600	$514,575
2040	$228,657	$152,438	$118,429	$30,488	$530,012
2041	$235,517	$157,011	$121,982	$31,402	$545,912
2042	$242,582	$161,722	$125,642	$32,344	$562,290
2043	$249,860	$166,573	$129,411	$33,315	$579,158
2044	$257,356	$171,570	$133,293	$34,314	$596,533
2045	$265,076	$176,718	$137,292	$35,344	$614,429

2046	$273,029	$182,019	$141,411	$36,404	$632,862
2047	$281,219	$187,480	$145,653	$37,496	$651,848
2048	$289,656	$193,104	$150,023	$38,621	$671,403
2049	$298,346	$198,897	$154,523	$39,779	$691,546
2050	$307,296	$204,864	$159,159	$40,973	$712,292
2051	$316,515	$211,010	$163,934	$42,202	$733,661
2052	$326,010	$217,340	$168,852	$43,468	$755,670
2053	$335,791	$223,861	$173,917	$44,772	$778,341
2054	$345,864	$230,576	$179,135	$46,115	$801,691

Table 20. Cropland High Priority Area BMP Implementation Costs After Cost Share

Cropland High Priority Area Priority HUC 12s					
BMP Estimated Annual Costs After Cost-Share					
Costs reflect 3% Annual Inflation					
Year	Water-ways	Ter-races	No-Till	Riparian Buff-ers	Annual Cost
2011	$48,515	$32,343	$30,656	$1,294	$112,807
2012	$49,970	$33,314	$31,575	$1,333	$116,192
2013	$51,469	$34,313	$32,522	$1,373	$119,677
2014	$53,014	$35,342	$33,498	$1,414	$123,268
2015	$54,604	$36,403	$34,503	$1,456	$126,966
2016	$56,242	$37,495	$35,538	$1,500	$130,775
2017	$57,929	$38,620	$36,604	$1,545	$134,698
2018	$59,667	$39,778	$37,702	$1,591	$138,739
2019	$61,457	$40,971	$38,834	$1,639	$142,901
2020	$63,301	$42,201	$39,999	$1,688	$147,188
2021	$65,200	$43,467	$41,198	$1,739	$151,604
2022	$67,156	$44,771	$42,434	$1,791	$156,152
2023	$69,171	$46,114	$43,707	$1,845	$160,836
2024	$71,246	$47,497	$45,019	$1,900	$165,662
2025	$73,383	$48,922	$46,369	$1,957	$170,631
2026	$75,585	$50,390	$47,760	$2,016	$175,750
2027	$77,852	$51,901	$49,193	$2,076	$181,023
2028	$80,188	$53,459	$50,669	$2,138	$186,454
2029	$82,593	$55,062	$52,189	$2,202	$192,047
2030	$85,071	$56,714	$53,755	$2,269	$197,809
2031	$87,623	$58,416	$55,367	$2,337	$203,743
2032	$90,252	$60,168	$57,028	$2,407	$209,855
2033	$92,960	$61,973	$58,739	$2,479	$216,151
2034	$95,748	$63,832	$60,501	$2,553	$222,635
2035	$98,621	$65,747	$62,316	$2,630	$229,314
2036	$101,579	$67,720	$64,186	$2,709	$236,194
2037	$104,627	$69,751	$66,111	$2,790	$243,280
2038	$107,766	$71,844	$68,095	$2,874	$250,578
2039	$110,999	$73,999	$70,138	$2,960	$258,095
2040	$114,329	$76,219	$72,242	$3,049	$265,838
2041	$117,758	$78,506	$74,409	$3,140	$273,813
2042	$121,291	$80,861	$76,641	$3,234	$282,028
2043	$124,930	$83,287	$78,941	$3,331	$290,489
2044	$128,678	$85,785	$81,309	$3,431	$299,203
2045	$132,538	$88,359	$83,748	$3,534	$308,179

2046	$136,514	$91,010	$86,260	$3,640	$317,425
2047	$140,610	$93,740	$88,848	$3,750	$326,947
2048	$144,828	$96,552	$91,514	$3,862	$336,756
2049	$149,173	$99,449	$94,259	$3,978	$346,859
2050	$153,648	$102,432	$97,087	$4,097	$357,264
2051	$158,257	$105,505	$100,000	$4,220	$367,982
2052	$163,005	$108,670	$103,000	$4,347	$379,022
2053	$167,895	$111,930	$106,090	$4,477	$390,392
2054	$172,932	$115,288	$109,272	$4,612	$402,104

Table 21. Cropland Med-High Priority Area BMP Implementation Costs Before Cost Share

Cropland Medium-High Priority Area Priority HUC 12s					
BMP Estimated Annual Costs Before Cost-Share					
Costs reflect 3% Annual Inflation					
Year	Water-ways	Terraces	No-Till	Riparian Buff-ers	Annual Cost
2011	$75,792	$50,528	$39,255	$10,106	$175,680
2012	$78,066	$52,044	$40,433	$10,409	$180,951
2013	$80,408	$53,605	$41,646	$10,721	$186,379
2014	$82,820	$55,213	$42,895	$11,043	$191,971
2015	$85,304	$56,870	$44,182	$11,374	$197,730
2016	$87,864	$58,576	$45,507	$11,715	$203,662
2017	$90,499	$60,333	$46,873	$12,067	$209,772
2018	$93,214	$62,143	$48,279	$12,429	$216,065
2019	$96,011	$64,007	$49,727	$12,801	$222,547
2020	$98,891	$65,927	$51,219	$13,185	$229,223
2021	$101,858	$67,905	$52,756	$13,581	$236,100
2022	$104,914	$69,942	$54,338	$13,988	$243,183
2023	$108,061	$72,041	$55,968	$14,408	$250,478
2024	$111,303	$74,202	$57,647	$14,840	$257,993
2025	$114,642	$76,428	$59,377	$15,286	$265,732
2026	$118,081	$78,721	$61,158	$15,744	$273,704
2027	$121,624	$81,082	$62,993	$16,216	$281,916
2028	$125,272	$83,515	$64,883	$16,703	$290,373
2029	$129,031	$86,020	$66,829	$17,204	$299,084
2030	$132,901	$88,601	$68,834	$17,720	$308,057
2031	$136,888	$91,259	$70,899	$18,252	$317,298
2032	$140,995	$93,997	$73,026	$18,799	$326,817
2033	$145,225	$96,817	$75,217	$19,363	$336,622
2034	$149,582	$99,721	$77,473	$19,944	$346,721
2035	$154,069	$102,713	$79,798	$20,543	$357,122
2036	$158,691	$105,794	$82,192	$21,159	$367,836
2037	$163,452	$108,968	$84,657	$21,794	$378,871
2038	$168,356	$112,237	$87,197	$22,447	$390,237
2039	$173,406	$115,604	$89,813	$23,121	$401,944
2040	$178,608	$119,072	$92,507	$23,814	$414,002
2041	$183,967	$122,644	$95,282	$24,529	$426,423
2042	$189,486	$126,324	$98,141	$25,265	$439,215

2043	$195,170	$130,114	$101,085	$26,023	$452,392
2044	$201,025	$134,017	$104,118	$26,803	$465,963
2045	$207,056	$138,037	$107,241	$27,607	$479,942
2046	$213,268	$142,179	$110,459	$28,436	$494,341
2047	$219,666	$146,444	$113,772	$29,289	$509,171
2048	$226,256	$150,837	$117,185	$30,167	$524,446
2049	$233,043	$155,362	$120,701	$31,072	$540,179
2050	$240,035	$160,023	$124,322	$32,005	$556,385
2051	$247,236	$164,824	$128,052	$32,965	$573,076
2052	$254,653	$169,769	$131,893	$33,954	$590,268
2053	$262,293	$174,862	$135,850	$34,972	$607,977
2054	$270,161	$180,108	$139,926	$36,022	$626,216

Table 22. Cropland Med-High Priority Area BMP Implementation Costs After Cost Share

Cropland Medium-High Priority Area Priority HUC 12s					
BMP Estimated Annual Costs After Cost-Share					
Costs reflect 3% Annual Inflation					
Year	Water-ways	Terraces	No-Till	Riparian Buff-ers	Annual Cost
2011	$37,896	$25,264	$23,946	$1,011	$88,116
2012	$39,033	$26,022	$24,664	$1,041	$90,760
2013	$40,204	$26,803	$25,404	$1,072	$93,482
2014	$41,410	$27,607	$26,166	$1,104	$96,287
2015	$42,652	$28,435	$26,951	$1,137	$99,175
2016	$43,932	$29,288	$27,760	$1,172	$102,151
2017	$45,250	$30,166	$28,592	$1,207	$105,215
2018	$46,607	$31,071	$29,450	$1,243	$108,372
2019	$48,005	$32,004	$30,334	$1,280	$111,623
2020	$49,446	$32,964	$31,244	$1,319	$114,971
2021	$50,929	$33,953	$32,181	$1,358	$118,421
2022	$52,457	$34,971	$33,146	$1,399	$121,973
2023	$54,031	$36,020	$34,141	$1,441	$125,632
2024	$55,651	$37,101	$35,165	$1,484	$129,401
2025	$57,321	$38,214	$36,220	$1,529	$133,283
2026	$59,041	$39,360	$37,307	$1,574	$137,282
2027	$60,812	$40,541	$38,426	$1,622	$141,400
2028	$62,636	$41,757	$39,578	$1,670	$145,642
2029	$64,515	$43,010	$40,766	$1,720	$150,012
2030	$66,451	$44,300	$41,989	$1,772	$154,512
2031	$68,444	$45,629	$43,248	$1,825	$159,147
2032	$70,498	$46,998	$44,546	$1,880	$163,922
2033	$72,613	$48,408	$45,882	$1,936	$168,839
2034	$74,791	$49,861	$47,259	$1,994	$173,905
2035	$77,035	$51,356	$48,677	$2,054	$179,122
2036	$79,346	$52,897	$50,137	$2,116	$184,495
2037	$81,726	$54,484	$51,641	$2,179	$190,030
2038	$84,178	$56,119	$53,190	$2,245	$195,731
2039	$86,703	$57,802	$54,786	$2,312	$201,603

2040	$89,304	$59,536	$56,429	$2,381	$207,651
2041	$91,983	$61,322	$58,122	$2,453	$213,881
2042	$94,743	$63,162	$59,866	$2,526	$220,297
2043	$97,585	$65,057	$61,662	$2,602	$226,906
2044	$100,513	$67,008	$63,512	$2,680	$233,713
2045	$103,528	$69,019	$65,417	$2,761	$240,725
2046	$106,634	$71,089	$67,380	$2,844	$247,946
2047	$109,833	$73,222	$69,401	$2,929	$255,385
2048	$113,128	$75,419	$71,483	$3,017	$263,046
2049	$116,522	$77,681	$73,628	$3,107	$270,938
2050	$120,017	$80,012	$75,836	$3,200	$279,066
2051	$123,618	$82,412	$78,112	$3,296	$287,438
2052	$127,326	$84,884	$80,455	$3,395	$296,061
2053	$131,146	$87,431	$82,869	$3,497	$304,943
2054	$135,081	$90,054	$85,355	$3,602	$314,091

8.2 Costs of Implementing Bacteria BMPs

Table 23. S.F. Solomon Bacteria Priority Area BMP Implementation Costs Before Cost Share

Bacteria Priority Area - S.F. Solomon River Bacteria TMDL							
BMP Cost Before Cost-Share							
Costs Reflect 3% Annual Inflation							
Year	Rotational Grazing (acres)	Brush Mgmt. (acres)	Alternative Water Supply (#systems)	Wind break (#wb)	Critical Area Planting (acres)	Fencing-Livestock Exclusion (ln. ft.)	Total Cost
2011	$7,000	$394,000	$11,385	$0	$4,496	$0	$416,881
2012	$7,210	$405,820	$15,635	$0	$4,630	$0	$433,296
2013	$7,426	$417,995	$16,104	$0	$4,769	$0	$446,295
2014	$7,649	$430,534	$16,588	$0	$4,912	$0	$459,683
2015	$7,879	$443,450	$12,814	$5,628	$5,060	$2,268	$477,098
2016	$8,115	$456,754	$17,598	$0	$5,212	$0	$487,678
2017	$8,358	$470,457	$18,126	$0	$5,368	$0	$502,309
2018	$8,609	$484,570	$18,669	$0	$5,529	$0	$517,378
2019	$8,867	$499,107	$14,422	$0	$5,695	$0	$528,092
2020	$9,133	$514,081	$19,806	$6,524	$5,866	$0	$555,410
2021	$9,407	$529,503	$20,401	$0	$6,042	$0	$565,353
2022	$9,690	$545,388	$21,013	$0	$6,223	$0	$582,313
2023	$9,980	$561,750	$16,232	$0	$6,410	$0	$594,372
2024	$10,280	$578,602	$22,292	$0	$6,602	$0	$617,776
2025	$10,588	$595,960	$22,961	$0	$6,800	$0	$636,309
2026	$10,906	$613,839	$23,650	$7,790	$7,004	$0	$663,189
2027	$11,233	$632,254	$24,359	$0	$7,214	$0	$675,061

2028	$11,570	$651,222	$25,090	$0	$7,430	$0	$695,313
2029	$11,917	$670,759	$25,843	$0	$7,653	$0	$716,172
2030	$12,275	$690,881	$26,618	$8,768	$7,883	$0	$746,425
2031	$12,643	$711,608	$27,417	$0	$8,119	$3,639	$763,426
2032	$13,022	$732,956	$28,239	$0	$8,363	$0	$782,580
2033	$13,413	$754,945	$29,086	$0	$8,614	$0	$806,058
2034	$13,815	$777,593	$29,959	$0	$8,872	$0	$830,239
2035	$14,230	$800,921	$30,858	$10,164	$9,138	$0	$865,311
2036	$14,656	$824,949	$31,784	$0	$9,413	$0	$880,801
2037	$15,096	$849,697	$32,737	$0	$9,695	$0	$907,225
2038	$15,549	$875,188	$33,719	$0	$9,986	$0	$934,442
2039	$16,015	$901,444	$34,731	$0	$10,285	$0	$962,475
2040	$16,496	$928,487	$35,773	$11,783	$10,594	$0	$1,003,132

Table 24. S.F. Solomon Bacteria Priority Area BMP Implementation Costs After Cost Share

Bacteria Priority Area - S.F. Solomon River Bacteria TMDL							
BMP Cost After Cost-Share							
Costs Reflect 3% Annual Inflation							
Year	Rota-tional Grazing (acres)	Brush Mgmt. (acres)	Alternative Water Supply (#systems)	Wind break (#wb)	Critical Area Planting (acres)	Fencing-Livestock Exclu-sion (ln. ft.)	Total Cost
2011	$3,500	$197,000	$5,693	$0	$2,248	$0	$208,440
2012	$3,605	$202,910	$7,818	$0	$2,315	$0	$216,648
2013	$3,713	$208,997	$8,052	$0	$2,385	$0	$223,147
2014	$3,825	$215,267	$8,294	$0	$2,456	$0	$229,842
2015	$3,939	$221,725	$6,407	$2,814	$2,530	$1,134	$238,549
2016	$4,057	$228,377	$8,799	$0	$2,606	$0	$243,839
2017	$4,179	$235,228	$9,063	$0	$2,684	$0	$251,154
2018	$4,305	$242,285	$9,335	$0	$2,764	$0	$258,689
2019	$4,434	$249,554	$7,211	$0	$2,847	$0	$264,046
2020	$4,567	$257,040	$9,903	$3,262	$2,933	$0	$277,705
2021	$4,704	$264,752	$10,200	$0	$3,021	$0	$282,676
2022	$4,845	$272,694	$10,506	$0	$3,111	$0	$291,157
2023	$4,990	$280,875	$8,116	$0	$3,205	$0	$297,186
2024	$5,140	$289,301	$11,146	$0	$3,301	$0	$308,888
2025	$5,294	$297,980	$11,481	$0	$3,400	$0	$318,155
2026	$5,453	$306,920	$11,825	$3,895	$3,502	$0	$331,594
2027	$5,616	$316,127	$12,180	$0	$3,607	$0	$337,530
2028	$5,785	$325,611	$12,545	$0	$3,715	$0	$347,656
2029	$5,959	$335,379	$12,921	$0	$3,827	$0	$358,086
2030	$6,137	$345,441	$13,309	$4,384	$3,941	$0	$373,212

2031	$6,321	$355,804	$13,708	$0	$4,060	$1,820	$381,713
2032	$6,511	$366,478	$14,120	$0	$4,181	$0	$391,290
2033	$6,706	$377,472	$14,543	$0	$4,307	$0	$403,029
2034	$6,908	$388,797	$14,980	$0	$4,436	$0	$415,120
2035	$7,115	$400,460	$15,429	$5,082	$4,569	$0	$432,655
2036	$7,328	$412,474	$15,892	$0	$4,706	$0	$440,401
2037	$7,548	$424,848	$16,369	$0	$4,847	$0	$453,613
2038	$7,775	$437,594	$16,860	$0	$4,993	$0	$467,221
2039	$8,008	$450,722	$17,365	$0	$5,143	$0	$481,238
2040	$8,248	$464,243	$17,886	$5,891	$5,297	$0	$501,566

Table 25. N.F. Solomon Bacteria Priority Area BMP Implementation Costs Before Cost Share

Bacteria Priority Area - N.F. Solomon River Bacteria TMDL							
BMP Cost Before Cost-Share							
Costs Reflect 3% Annual Inflation							
Year	Rotational Grazing (acres)	Brush Mgmt. (acres)	Alternative Water Supply (#systems)	Wind break (#wb)	Critical Area Planting (acres)	Fencing-Livestock Exclusion (ln. ft.)	Total Cost
2011	$7,000	$133,000	$7,590	$112,000	$0	$0	$259,590
2012	$7,210	$136,990	$7,818	$115,360	$0	$0	$267,378
2013	$7,426	$141,100	$8,052	$118,821	$0	$0	$275,399
2014	$7,649	$145,333	$8,294	$122,385	$0	$0	$283,661
2015	$7,879	$149,693	$12,814	$126,057	$227,916	$0	$524,358
2016	$8,115	$154,183	$8,799	$129,839	$0	$0	$300,936
2017	$8,358	$158,809	$9,063	$133,734	$0	$0	$309,964
2018	$8,609	$163,573	$9,335	$137,746	$0	$0	$319,263
2019	$8,867	$168,480	$9,615	$141,878	$0	$0	$328,841
2020	$9,133	$173,535	$14,855	$146,135	$0	$0	$343,658
2021	$9,407	$178,741	$10,200	$150,519	$0	$0	$348,867
2022	$9,690	$184,103	$10,506	$155,034	$0	$0	$359,333
2023	$9,980	$189,626	$10,822	$159,685	$0	$0	$370,113
2024	$10,280	$195,315	$11,146	$164,476	$0	$0	$381,217
2025	$10,588	$201,174	$11,481	$169,410	$0	$0	$392,653
2026	$10,906	$207,210	$17,737	$174,492	$0	$0	$410,345
2027	$11,233	$213,426	$12,180	$179,727	$0	$0	$416,566
2028	$11,570	$219,829	$12,545	$185,119	$0	$0	$429,063
2029	$11,917	$226,424	$12,921	$190,673	$0	$0	$441,935
2030	$12,275	$233,216	$13,309	$196,393	$355,085	$0	$810,278
2031	$12,643	$240,213	$13,708	$202,284	$0	$0	$468,848
2032	$13,022	$247,419	$21,179	$208,353	$0	$0	$489,974
2033	$13,413	$254,842	$14,543	$214,604	$0	$0	$497,401

2034	$13,815	$262,487	$14,980	$221,042	$0	$0	$512,323
2035	$14,230	$270,362	$15,429	$227,673	$0	$0	$527,693
2036	$14,656	$278,472	$15,892	$234,503	$0	$0	$543,524
2037	$15,096	$286,827	$16,369	$241,538	$0	$0	$559,830
2038	$15,549	$295,431	$25,289	$248,784	$0	$0	$585,054
2039	$16,015	$304,294	$17,365	$256,248	$0	$0	$593,923
2040	$16,496	$313,423	$17,886	$263,935	$0	$0	$611,741

Table 26. N.F. Solomon Bacteria Priority Area BMP Implementation Costs After Cost Share

Bacteria Priority Area - N.F. Solomon River Bacteria TMDL							
BMP Cost After Cost-Share							
Costs Reflect 3% Annual Inflation							
Year	Rotational Grazing (acres)	Brush Mgmt. (acres)	Alternative Water Supply (#systems)	Wind break (#wb)	Critical Area Planting (acres)	Fencing-Livestock Exclusion (ln. ft.)	Total Cost
2011	$3,500	$66,500	$3,795	$56,000	$0	$0	$129,795
2012	$3,605	$68,495	$3,909	$57,680	$0	$0	$133,689
2013	$3,713	$70,550	$4,026	$59,410	$0	$0	$137,700
2014	$3,825	$72,666	$4,147	$61,193	$0	$0	$141,831
2015	$3,939	$74,846	$6,407	$63,028	$113,958	$0	$262,179
2016	$4,057	$77,092	$4,399	$64,919	$0	$0	$150,468
2017	$4,179	$79,404	$4,531	$66,867	$0	$0	$154,982
2018	$4,305	$81,787	$4,667	$68,873	$0	$0	$159,631
2019	$4,434	$84,240	$4,807	$70,939	$0	$0	$164,420
2020	$4,567	$86,767	$7,427	$73,067	$0	$0	$171,829
2021	$4,704	$89,370	$5,100	$75,259	$0	$0	$174,434
2022	$4,845	$92,052	$5,253	$77,517	$0	$0	$179,667
2023	$4,990	$94,813	$5,411	$79,843	$0	$0	$185,057
2024	$5,140	$97,657	$5,573	$82,238	$0	$0	$190,608
2025	$5,294	$100,587	$5,740	$84,705	$0	$0	$196,327
2026	$5,453	$103,605	$8,869	$87,246	$0	$0	$205,173
2027	$5,616	$106,713	$6,090	$89,864	$0	$0	$208,283
2028	$5,785	$109,914	$6,273	$92,559	$0	$0	$214,531
2029	$5,959	$113,212	$6,461	$95,336	$0	$0	$220,967
2030	$6,137	$116,608	$6,655	$98,196	$177,542	$0	$405,139
2031	$6,321	$120,106	$6,854	$101,142	$0	$0	$234,424
2032	$6,511	$123,710	$10,590	$104,176	$0	$0	$244,987
2033	$6,706	$127,421	$7,272	$107,302	$0	$0	$248,701
2034	$6,908	$131,244	$7,490	$110,521	$0	$0	$256,162
2035	$7,115	$135,181	$7,714	$113,836	$0	$0	$263,847

2036	$7,328	$139,236	$7,946	$117,252	$0	$0	$271,762
2037	$7,548	$143,413	$8,184	$120,769	$0	$0	$279,915
2038	$7,775	$147,716	$12,645	$124,392	$0	$0	$292,527
2039	$8,008	$152,147	$8,683	$128,124	$0	$0	$296,962
2040	$8,248	$156,712	$8,943	$131,968	$0	$0	$305,870

8.3 Total BMP Cost Estimates

Table 27. Annual and total cost estimates for Waconda WRAPS Implementation

Total Annual Costs of Implementing Cropland, Livestock, Information and Education and Technical Assistance					
	BMPs Implemented		I&E and Technical Assistance		
Year	Cropland	Livestock	I&E	Technical Assistance	Total Cost
2011	$400,589	$676,471	$74,100	$131,000	$1,282,160
2012	$412,607	$700,674	$76,323	$134,930	$1,324,534
2013	$424,985	$721,694	$78,613	$138,978	$1,364,270
2014	$437,735	$743,344	$80,971	$143,147	$1,405,197
2015	$450,867	$1,001,456	$83,400	$147,442	$1,683,165
2016	$464,393	$788,614	$85,902	$151,865	$1,490,774
2017	$478,324	$812,273	$88,479	$156,421	$1,535,497
2018	$492,674	$836,641	$91,134	$161,113	$1,581,562
2019	$507,454	$856,933	$93,868	$165,947	$1,624,202
2020	$522,678	$899,068	$96,683	$170,925	$1,689,354
2021	$538,358	$914,220	$99,584	$176,053	$1,728,215
2022	$554,509	$941,646	$102,572	$181,335	$1,780,062
2023	$571,144	$964,485	$105,649	$186,775	$1,828,053
2024	$588,279	$998,993	$108,818	$192,378	$1,888,468
2025	$605,927	$1,028,962	$112,083	$198,149	$1,945,121
2026	$624,105	$1,073,534	$115,445	$204,094	$2,017,178
2027	$642,828	$1,091,627	$118,909	$210,216	$2,063,580
2028	$662,113	$1,124,376	$122,476	$216,523	$2,125,488
2029	$681,976	$1,158,107	$126,150	$223,019	$2,189,252
2030	$702,435	$1,556,703	$129,935	$229,709	$2,618,782
2031	$723,509	$1,232,274	$133,833	$236,600	$2,326,216
2032	$745,214	$1,272,554	$137,848	$243,698	$2,399,314
2033	$767,570	$1,303,459	$141,983	$251,009	$2,464,021
2034	$790,597	$1,342,562	$146,243	$258,540	$2,537,942
2035	$814,315	$1,393,004	$150,630	$266,296	$2,624,245
2036	$838,745	$1,424,325	$155,149	$274,285	$2,692,504
2037	$863,907	$1,467,055	$159,803	$282,513	$2,773,278
2038	$889,824	$1,519,496	$164,598	$290,989	$2,864,907

2039	$916,519	$1,556,398	$169,535	$299,718	$2,942,170
2040	$944,015	$1,614,873	$174,622	$308,710	$3,042,220
2041	$972,335	$0	$179,860	$317,971	$1,470,166
2042	$1,001,505	$0	$185,256	$327,510	$1,514,271
2043	$1,031,550	$0	$190,814	$337,336	$1,559,700
2044	$1,062,497	$0	$196,538	$347,456	$1,606,491
2045	$1,094,372	$0	$202,434	$357,879	$1,654,685
2046	$1,127,203	$0	$208,507	$368,616	$1,704,326
2047	$1,161,019	$0	$214,762	$379,674	$1,755,455
2048	$1,195,849	$0	$221,205	$391,064	$1,808,118
2049	$1,231,725	$0	$227,842	$402,796	$1,862,363
2050	$1,268,677	$0	$234,677	$414,880	$1,918,234
2051	$1,306,737	$0	$241,717	$427,327	$1,975,781
2052	$1,345,939	$0	$248,969	$440,146	$2,035,054
2053	$1,386,317	$0	$256,438	$453,351	$2,096,106
2054	$1,427,907	$0	$264,131	$466,952	$2,158,990
Total	$35,671,824	$33,015,821	$6,598,488	$11,665,335	$86,951,468

8.4 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) Cooperative Conservation Partnership Initiative (CCPI) State Acres for Wildlife Enhancement (SAFE) Grassland Reserve Program (GRP) Farmable Wetlands Programs (FWP)
EPA/KDHE	319 Funding Grants KDHE WRAPS Funding Clean Water Neighbor Grants
KS Dept. of Wildlife and Parks	Partnering for Wildlife
Kansas Alliance for Wetlands & Streams	
State Conservation Commission	
KDA – Division of Conservation	
No-till on the Plains	
Conservation District	
Kansas Rural Center	River Friendly Farms Program
Kansas Forest Service	Forest Legacy Program (US Forest Service & Kansas Forest Service)
US Fish and Wildlife	

9.0 Water Quality Milestones to Determine Improvements

The primary goal that is focused on within the Waconda Lake WRAPS Watershed Plan is restoration of water quality of Waconda Lake for designated uses supportive of aquatic life, domestic water supply, recreation, and other designated uses for the Waconda Lake watershed. The plan specifically addresses several TMDLs and 303(d) listings for Waconda Lake, North Fork Solomon River, and South Fork Solomon River. The following is a list of the impairments being directly addressed by the plan:

Waconda Lake (KDHE Station (LM018001)
Medium Priority Eutrophication TMDL

North Fork Solomon River At Portis (KDHE Station SC014)
Low Priority Bacteria (ECB) 303(d) listing
Medium Priority draft TMDL pending (8/3/2011)

South Fork Solomon River Near Osborne (KDHE Station SC542, SC 543)
Low Priority Bacteria (ECB) 303(d) listing
High Priority draft TMDL pending (8/3/2011)

In order to reach the load reduction goals associated with the Waconda Lake WRAPS Project Area impairments, an implementation schedule for BMP implementation spanning 44 years has been developed.

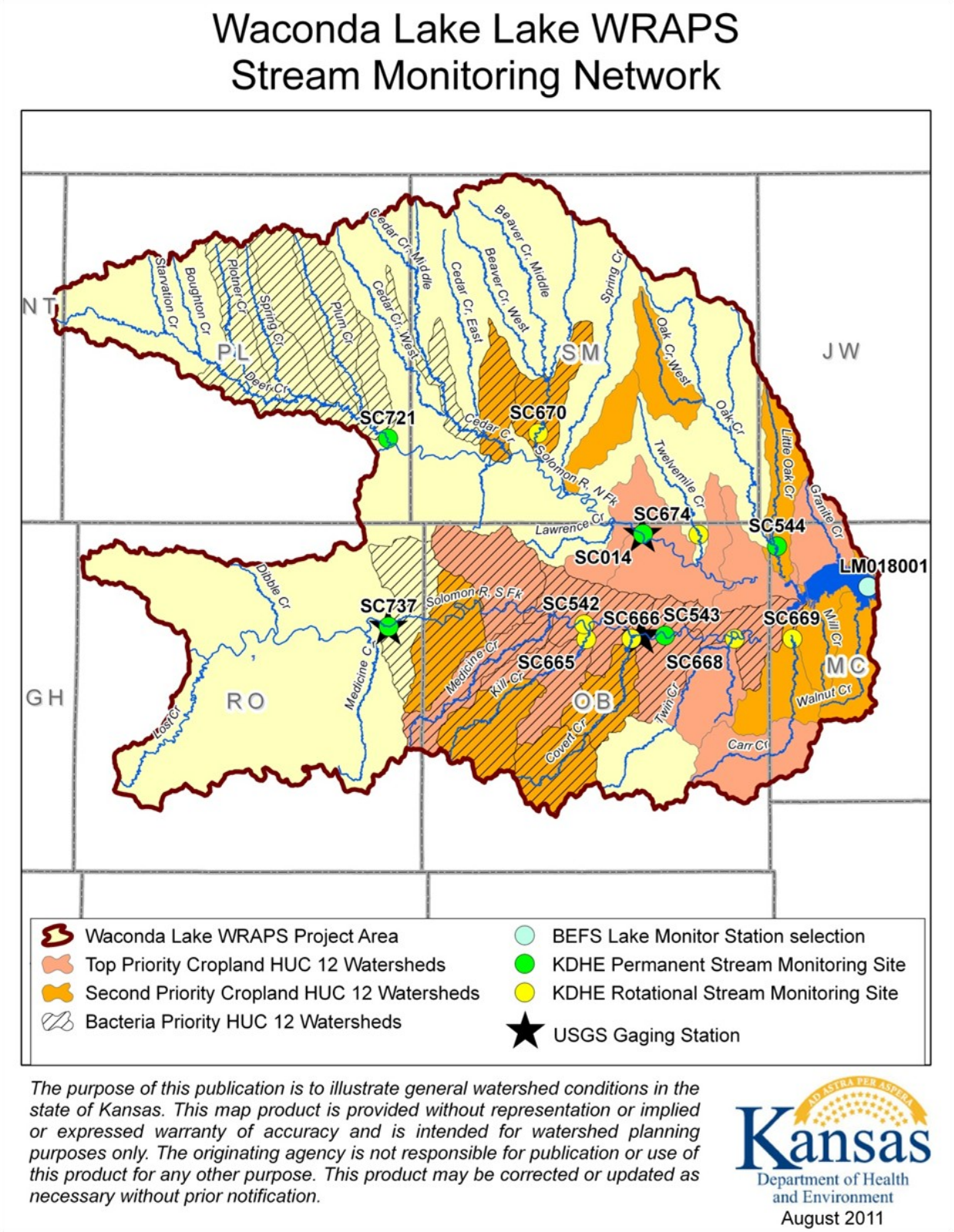
The selected practices included in the plan will be implemented throughout the targeted areas within the Waconda Lake watershed below Kirwin Lake and Webster Lake. Water quality milestones have been developed for Waconda Lake, North Fork Solomon River, and South Fork Solomon River along with additional indicators of water quality. The purpose of the milestones and indicators is to measure water quality improvements associated with the implementation schedule contained in this plan.

9.1 Monitoring Sites in the Waconda Lake WRAPS Project Area

Water quality milestones contained in this section are tied to the sampling stations that KDHE continues to monitor for water quality in each of the water bodies that will be positively affected by the BMP implementation schedule included in this plan. KDHE has several monitoring stations located with the Waconda Lake WRAPS Project Area. The stations listed below will be utilized to measure water quality improvements throughout the implementation of the plan.

Station ID	Water Body	Type of Station
SC542	S.F. Solomon River Near Osborne	Rotational
SC670	Beaver Creek Near Gaylord	Rotational
SC014	N.F. Solomon River At Portis	Permanent
SC543	S.F. Solomon River Near Osborne	Permanent
SC721	Deer Creek Near Kirwin	Permanent
LM018001	Waconda Lake	Lake

Figure 20. Waconda Lake WRAPS Stream Monitoring Network



The purpose of this publication is to illustrate general watershed conditions in the state of Kansas. This map product is provided without representation or implied or expressed warranty of accuracy and is intended for watershed planning purposes only. The originating agency is not responsible for publication or use of this product for any other purpose. This product may be corrected or updated as necessary without prior notification.

Kansas
Department of Health and Environment
August 2011

The previous map shows both the permanent and rotational KDHE stream monitoring stations as well as monitored lakes located within the Waconda Lake WRAPS Project Area as well as the targeted areas for implementation that have been identified and discussed in previous sections of this plan. The permanent monitoring sites are continuously sampled, while the rotational sites are typically sampled every four years. The stream monitoring sites are sampled for nutrients, *E. Coli* bacteria, chemicals, turbidity, alkalinity, dissolved oxygen, pH, ammonia and metals. The KDHE lake monitoring sites are typically sampled once every 3 years between April and October. Lake monitoring sites are sampled for chlorophyll a, total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), turbidity, dissolved oxygen, and secchi disk depth. The pollutant indicators tested for at each site may vary depending on the season at collection time and other factors.

In addition to the KDHE monitoring stations, the Waconda Lake Watershed has several USGS gauging stations located within the watershed that provide real-time flow information. Streamflow information for these sites as well as other gauging stations within Kansas can be found at http://ks.water.usgs.gov/.

9.2 Water Quality Milestones for Waconda Lake WRAPS Project Area

As previously stated, this plan estimates that it will take 44 years to implement the planned BMPs necessary to meet the load reduction goals for the impairments being addressed in the Waconda Lake WRAPS Project Area. Several water quality milestones and indicators have been developed, as included herein. The table below includes short term, mid-term, and long term water quality goals for various parameters monitored in the watershed.

Table 28. Water Quality Milestones for Waconda Lake

Water Quality Milestones for Waconda Lake								
		Mid Term Goal		**Long Term Goal**			**Mid Term Goal**	**Long Term Goal**
	Current Condition (1990 - 2010) Average TP	**Improved Condition (2011 - 2021) Average TP**	**Total Reduction Needed***	**Improved Condition (2011 - 2041) Average TP**	**Total Reduction Needed***	**Current Condition (1990 - 2010) Secchi (Avg)**	**Improved Condition (2011 - 2021) Secchi (Avg)**	**Improved Condition (2011 - 2041) Secchi (Avg)**
Sampling Site	**Total Phosphorus (average of data collected during indicated period), ppb**					**Secchi (average of data collected during indicated period), m**		
Waconda Lake LM018001	63	57	**10**	35	**44**	1.71	**Secchi depth > 1.75**	**Maintain Secchi depth > 1.88**

	Current Condition (1990 - 2010) Chlorophyll a	Mid Term Goal		Long Term Goal				
		Improved Condition (2011 - 2021) Chlorophyll a	Total Reduc-tion Needed*	Improved Condition (2011 - 2041) Chloro-phyll a	Total Reduc-tion Needed*			
Sampling Site	**Chlorophyll a (average of data collected during indicated period), ppb**							
Waconda Lake LM018001	19.2	17.1	**11**	10	**48**			

Table 29. Water Quality Milestones for N.F./S.F. Solomon River and Tributaries

	Current Condition (2010 303d List) Median TP	10-Year Goal		Long Term Goal	
		Improved Condition (2011 - 2021) Median TP	Total Reduction Needed	Improved Condition Median TP	Total Reduction Needed
Sampling	**Total Phosphorus (median of data collected during indicated period), µg/**				
Beaver Creek Near Gaylord SC670	332	302	9.0%	201	39.5%
Deer Creek Near Kirwin SC721	551	430	22.0%	201	63.5%
Oak Creek Near Cawker City SC554	213	210	1.4%	201	5.6%
North Fork Solomon River At Portis SC014	261	247	5.4%	201	23.0%
Carr Creek Near Cawker City SC669	234	226	3.4%	201	14.1%
South Fork Solomon River Near Osborne SC543	204	203	0.5%	201	1.5%

9.3 Water Quality Milestones for Bacteria

The water quality goal associated with the bacteria impairments in the Waconda Lake WRAPS Project Area can be tied to the *E. Coli* Bacteria (ECB) Index values. ECB index values for individual samples are computed as the ratio of the sample count to the contact recreation criterion. The calculated index is the natural logarithm of each sample value taken during the primary recreation season (April through October), divided by the natural logarithm of the bacteria criteria. Plotting the ECB ratio against the percentile rank for each individual sample within the data set for each sampling location illustrates the frequency and magnitude of the bacteria impairment for the sampling location. Higher bacteria frequencies are evident when the ECB ratio is over 1 for a large percentage of samples.

The water quality milestones associated with bacteria are based on the contact recreation designation of the impaired water body, as well as the proximity and designation of the downstream water body. Contact recreation is designated as either primary or secondary. Primary contact recreation designation is assigned to water bodies that have a high likelihood of ingestion based on public access, while secondary contact recreation designation is assigned to waters that are not as likely to be ingested due to restricted public access.

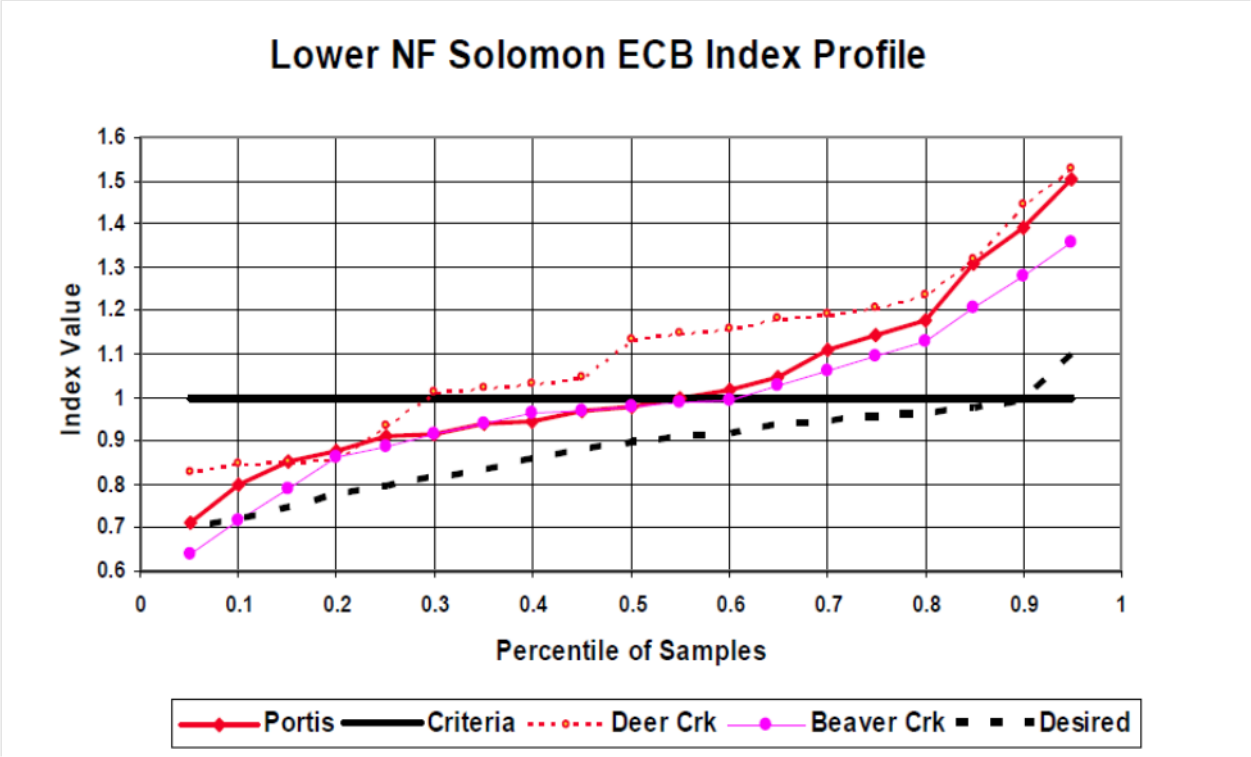
Bacteria load reductions should result in less frequent exceedance of the nominal ECB criterion. For the North Fork Solomon River at Portis(SC014), Deer Creek near Kirwin (SC721), and Beaver Creek near Gaylord (SC670) sampling stations SC246 and SC282, the bacteria index is based on the criteria of 427 Colony Forming Units (CFUs)/100ml, Primary Recreation Class C. These bacteria index values represent the natural logarithm of each sample value taken during the April-October Primary Recreation season, divided by the natural logarithm of the bacteria criteria for Primary Recreation Class C [ln(427)].

$$\textbf{Index} = \ln(\textbf{ECB Count}) / \ln(427)$$

The indicator will be the Upper Decile of those index values, with the target being that the index is below 1.0 at the upper decile (90^{th} percentile).

Sampling station SC014 on the North Fork Solomon River at Portis was sampled in accordance with the Water Quality Standard in April and June of 2006. The geometric mean for the five samples collected over a 30-day period was 782 CFUs/100ml for the April sampling and 502 for the June sampling. Both of these intensive sampling geometric mean results for this station are well above the Water Quality Standard, thus justifying the listing of this stream for impairment by bacteria.

Figure 21. Lower N.F. Solomon ECB Index Profile



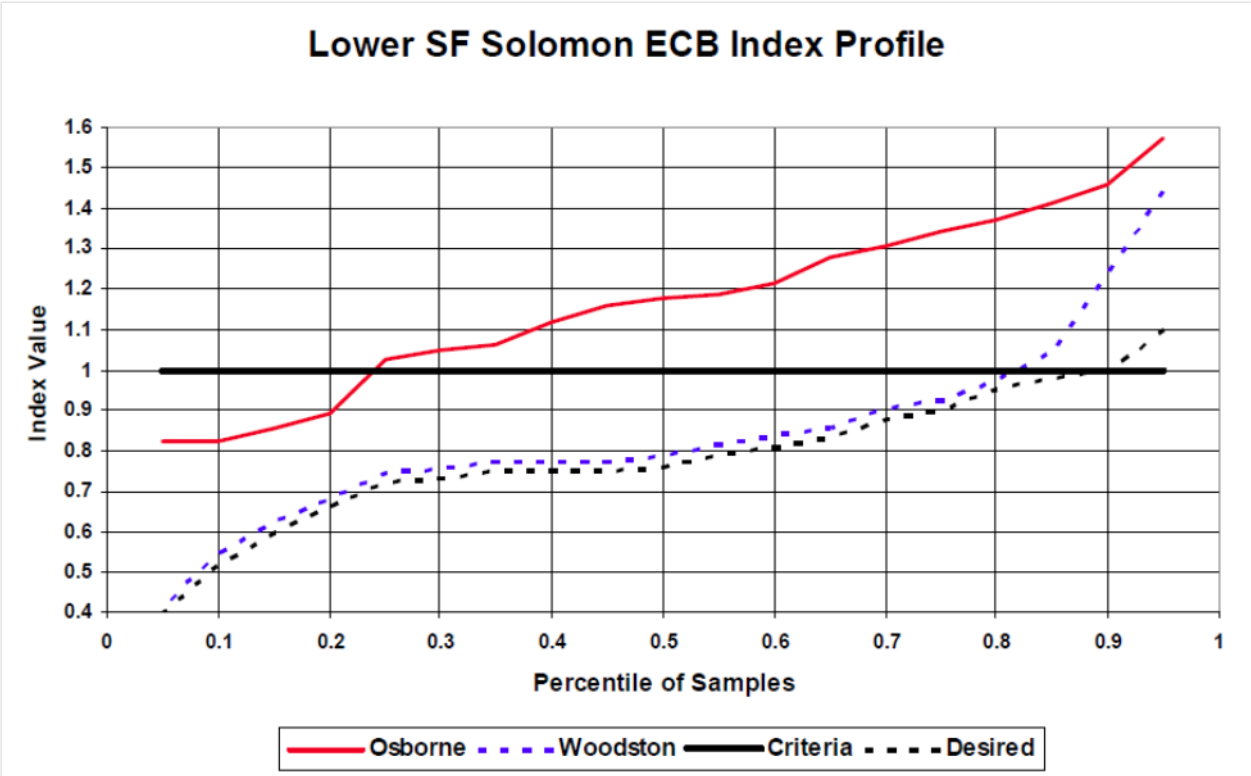
Bacteria load reductions also should result in less frequent exceedance of the nominal ECB criterion for the South Fork Solomon River near Woodston (SC737) and at Osborne (SC543). For these two sampling stations the bacteria index is based on the criteria of 262 Colony Forming Units (CFUs)/100ml, Primary Recreation Class B. These bacteria index values represent the natural logarithm of each sample value taken during the April-October Primary Recreation season, divided by the natural logarithm of the bacteria criteria for Primary Recreation Class C [ln(262)].

Index = ln(ECB Count) / ln(262)

The indicator will be the Upper Decile of those index values, with the target being that the index is below 1.0 at the upper decile (90^{th} percentile).

Sampling station SC543 on the South Fork Solomon River at Osborne was sampled in accordance with the Water Quality Standard in April and June of 2006. The geometric mean for the five samples collected over a 30-day period was 528 CFUs/100ml for the April sampling and 1123 for the June sampling. Both of these intensive sampling geometric mean results for this station are well above the Water Quality Standard, thus justifying the listing of this stream for impairment by bacteria.

Figure 22. Lower S.F. Solomon ECB Index Profile



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.

9.4 Additional Water Quality Indicators

In addition to the monitoring data, other water quality indicators can be utilized by KDHE and the SLT. Such indicators may include anecdotal information from the SLT and other citizen groups within the watershed (skin rash outbreaks, fish kills, nuisance odors), which can be used to assess short-term deviations from water quality standards. These additional indicators can act as trigger-points that might initiate further revisions or modifications to the WRAPS plan by KDHE and the SLT.

Taste and odor issues from public water supplies utilizing water from Waconda Lake
Occurrence of algal blooms in Waconda Lake
Visitor traffic to Waconda Lake
Boating traffic in Waconda Lake
Trends of quantity and quality of fishing in Waconda Lake
Beach closings

9.5 Evaluation of Monitoring Data

Monitoring data in the Waconda Lake watershed will be used to determine water quality progress, track water quality milestones, and to determine the effectiveness of the implementation of conservation practices outlined in the plan. The schedule of review for the monitoring data will be tied to the water quality milestones that have been developed, as well as the frequency of the sampling data.

The implementation schedule and water quality milestones for the Waconda Lake watershed extend through a 44-year period from 2011 to 2054. Throughout that period, KDHE will continue to analyze and evaluate the monitoring data collected. After the first ten years of monitoring and implementation of conservation practices, KDHE will evaluate the available water quality data to determine whether the water quality milestones have been achieved. If milestones are not achieved, KDHE will assist the Waconda Lake WRAPS group to analyze and understand the context for non-achievement, as well as the need to review and/or revise the water quality milestones included in the plan. KDHE and the SLT can address any necessary modifications or revisions to the plan based on the data analysis. In 2054, at the end of the plan, a final determination can be made as to whether the water quality standards have been attained for Waconda Lake as well as the North and South Fork Solomon Rivers.

In addition to the planned review of the monitoring data and water quality milestones, KDHE and the SLT may revisit the plan in shorter increments. This would allow the group to evaluate newer available information, incorporate any revisions to applicable TMDLs, or address any potential water quality indicators that might trigger an immediate review.

10.0 Review of the Watershed Plan

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.
2. The SLT will request a report from KDHE concerning the 2014 TMDL revisions.
3. The SLT will request reports from US Army Corps of Engineers (USACE) and Kansas Department of Wildlife and Parks concerning water quality and quantity, wildlife, and any other concerns or observations at Waconda Lake.
4 The SLT will request reports from NRCS and the Conservation Districts concerning BMP adoption rates and any other water quality and quantity issues.
5. The SLT will use all data and assistance available to determine progress toward achieving implementation milestones in Section 6.0 of this report and progress toward achieving the water quality milestones listed in Section 9.0 of this report.
6. The SLT will discuss impairments on the 303d list and the possibility of addressing these impairments prior to them being listed as TMDLs.
7. The SLT will discuss the possible need for additional assessment data.
8. The SLT will discuss the possible need for revision of the pollution load reduction goals and BMP implementation schedule.
9. The SLT will discuss necessary adjustments and revisions needed to this plan to reach pollution load reduction goals.

11.0 Appendix

11.1 Glossary of Terms

Impairment definitions: (Dec. 2007 RWA)

Arsenic: A highly poisonous metallic element having three allotropic forms, yellow, black, and gray, of which the brittle, crystalline gray is the most common. Arsenic and its compounds are used in insecticides, weed killers, solid-state doping agents, and various alloys.

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.

Biology: Excess nutrients and organic enrichment in stream water can have a negative influence on aquatic populations. Nitrogen and phosphorus can originate from agricultural fertilizers, urban fertilizers, failing septic systems and livestock or wildlife manure in the stream

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

Dissolved Oxygen (DO): Amount of oxygen dissolved in water. Oxygen available to aquatic life with the water column. State water quality standards require a stream or lake to have at least 5mg/L of dissolved oxygen.

E. coli bacteria: Bacteria indicators (either fecal coliform or *E. coli*) are found in the digestive systems of warm-blooded animals. Some strains cause diarrheal diseases. In surface waters, E. coli bacteria are an indicator of potential disease causing organisms. Potential sources of bacteria contamination in surface waters include municipal wastewater, livestock, septic systems, pets, and wildlife.

Eutrophication (E): Excess of mineral and organic nutrients that promote a proliferation of plant life in lakes and ponds. The enrichment of bodies of fresh water due to increases in inorganic plant nutrient loading (e.g. nitrate, phosphate) and low in oxygen content. It may occur naturally but can also be the result of human activity (cultural eutrophication from fertilizer runoff and sewage discharge) and is particularly evident in slow-moving rivers and shallow lakes.

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.

NPDES (National Pollutant Discharge Elimination System) 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. Originates from 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): One of the primary nutrients required for the growth of plants. Element in water that, in excess, can lead to increased biological activity in water. TP or total phosphorus is a chemical measurement of all phosphorus forms in a water sample.
Riparian Zone: Margin of vegetation within approximately 100 feet of waterway.
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.
Sedimentation: Deposition of slit, clay or sand in slow moving waters.
Selenium: A naturally occurring metal in marine shale that serves as a micronutrient. Excessive amounts impair aquatic life and bioaccumulation up the food chain occurs causing toxicity to birds, mammals, and humans. Kansas water quality standards are an average of 5ppb and a maximum of 20ppb.
Stakeholder Leadership Team (SLT): Organization of watershed residents, landowners, farmers, ranchers, agency personnel and all persons with an interest in water quality.
Sulfate: Sulfate is a naturally occurring mineral that can cause taste and odor problems in drinking water. Sulfates are dissolved into groundwater as the water moves through gypsum rock formations. The water quality standard for sulfate in Kansas is 250ug/L.
Suspended Solids: Solids which are not in true solution and which can be removed by filtration. Such suspended solids usually contribute directly to turbidity. Defined in waste management, these are small particles of solid pollutants that resist separation by conventional methods. Suspended solids (along with Biochemical Oxygen Demand - BOD) is a measurement of water quality and an indicator of treatment plant efficiency.
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.

11.2 BMP Definitions:

(Some information from Kansas NRCS Field Office Technical Guide)

Cropland

Grassed Waterway

DEFINITION
A natural or constructed channel that is shaped or graded to required dimensions and established with suitable vegetation.
PURPOSES
This practice may be applied as part of a conservation management system to support one or more of the following purposes:
• To convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding

- To reduce gully erosion
- To protect/improve water quality

CONDITIONS WHERE PRACTICE APPLIES

In areas where added water conveyance capacity and vegetative protection are needed to control erosion resulting from concentrated runoff and where such control can be achieved by using this practice alone or combined with other conservation practices.

Terraces

DEFINITION

An earth embankment or a combination ridge and channel constructed across the field slope.

PURPOSE

This practice may be applied as part of a resource management system to support one or both of the following:

- Reduce soil erosion
- Retain runoff for moisture conservation

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Soil erosion by water is a problem.
- There is a need to conserve water.
- The soils and topography are such that terraces can be constructed and farmed with reasonable effort.
- A suitable outlet can be provided.
- Excess runoff is a problem.
- There is a need to improve overall water quality.

No-Till

DEFINITION

Managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round, while limiting soil-disturbing activities to only those necessary to place nutrients, condition residue, and plant crops.

PURPOSE

- Reduce sheet and rill erosion
- Reduce wind erosion
- Improve soil organic matter content
- Reduce CO_2 losses from the soil
- Reduce soil particulate emissions
- Increase plant-available moisture
- Provide food and escape cover for wildlife

CONDITIONS WHERE PRACTICE APPLIES

- This practice applies to all cropland and other land where crops are planted.
- This practice includes planting methods commonly referred to as no-till, strip till, di-

rect seed, zero till, slot till, or zone till. Approved implements are: No-till and strip-till planters, certain drills and air seeders, strip-type fertilizer and manure injectors and applicators, in-row chisels, and similar implements that only disturb strips and slots. All others are considered to be full-width or capable of full disturbance and therefore not compatible.

Riparian Buffer

DEFINITION
Grasses, grass-like plants, and forbs that are tolerant of intermittent flooding or saturated soils and that are established or managed in the transitional zone between terrestrial and aquatic habitats.
PURPOSE
To provide the following functions:
- Provision of food, shelter, shading substrate, access to adjacent habitats, nursery habitat, and pathways for movement by resident and nonresident aquatic, semi-aquatic, and terrestrial organisms.
- Improve and protect water quality by reducing the amount of sediment and other pollutants such as pesticides, organic materials, and nutrients in surface runoff as well as nutrients and chemicals in shallow ground-water flow.
- Help stabilize streambank and shorelines.
- Increase net carbon storage in the biomass and soil.

CONDITIONS WHERE PRACTICE APPLIES
- Areas adjacent to perennial and intermittent watercourses or water bodies where the natural plant community is dominated by herbaceous vegetation that is tolerant of periodic flooding or saturated soils. For seasonal or ephemeral watercourses and waterbodies, this zone extends to the center of the channel or basin.
- Where the riparian area has been altered and the potential natural plant community has changed or converted to cropland, pastureland, rangeland, or other commercial/agricultural uses.
- Where channel and streambank stability is adequate to support this practice.

Livestock

Rotational Grazing

DEFINITION
Managing the controlled harvest of vegetation with grazing animals by rotating livestock within a pasture to spread manure more uniformly and allow the forage to regenerate. May involve significant cross fencing and additional watering sites.
PURPOSE
- Improve or maintain the health and vigor of plant communities
- Improve or maintain quantity and quality of forage for livestock health and productivity
- Improve or maintain water quality and quantity

• Reduce accelerated soil erosion, and maintain or improve soil condition
• Improve or maintain the quantity and quality of food and/or cover available for wildlife
• Promote economic stability through grazing land sustainability

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where grazing animals are managed.

Brush Management

DEFINITION

Removal, reduction, or manipulation of non-herbaceous plants

PURPOSES

This practice may be applied to accomplish one or more of the following purposes:
•Restore natural plant community balance
•Create the desired plant community
•Reduce competition for space, moisture, and sunlight between desired and unwanted plants
•Manage noxious woody plants
•Restore desired vegetative cover to protect soils, control erosion, reduce sediment, improve water quality, and enhance stream flow
•Maintain or enhance wildlife habitat including that associated with threatened and endangered species
•Improve forage accessibility, quality, and quantity for livestock
•Protect life and property from wildfire hazards
•Improve visibility and access for handling livestock

CONDITIONS WHERE THIS PRACTICE APPLIES

•On rangeland, native or naturalized pasture, and pasture and haylands where removal or reduction of excessive woody (non-herbaceous) plants is desired
•Where adjustments in grazing management, prescribed burning, and other conservation practices will not restore the kind of plant cover needed to attain conservation objectives within a reasonable time frame
•Where brush management will improve areas for wildlife, recreation, or natural beauty
•Where control of woody species is necessary to conserve moisture
•Where a reduction of brush is necessary for the safety of life and property in areas of high wildfire hazard.

Alternative (Off-Stream) Watering System (which may include any or all of the following components)

Watering Facility

DEFINITION

A permanent or portable device to provide an adequate amount and quality of drinking water for livestock and/or wildlife.

PURPOSE
To provide access to drinking water for livestock and/or wildlife in order to:
• Meet daily water requirements
• Improve animal distribution
CONDITIONS WHERE PRACTICE APPLIES
This practice applies to all land uses where there is a need for new or improved watering facilities for livestock and/or wildlife.

Pumping Plant

DEFINITION
A pumping facility installed to transfer water for a conservation need.
PURPOSE
Provide a dependable water source or disposal facility for water management.
CONDITIONS WHERE PRACTICE APPLIES
Wherever water must be pumped to accomplish a conservation objective, which may include (but is not limited to) one of the following:
• To provide a water supply for such purposes as irrigation, recreation, livestock, or wildlife
• To maintain critical water levels in swamps, marshes, open water, or newly constructed wetlands and ponds
• To transfer wastewater for utilization as part of a waste management system
• To provide drainage by the removal of surface runoff water or groundwater

Pipeline

DEFINITION
Pipeline having an inside diameter of 8 inches or less.
PURPOSE
To convey water from a source of supply to points of use for livestock, wildlife, or recreation areas.
CONDITIONS WHERE PRACTICE APPLIES
Where it is desirable or necessary to convey water in a closed conduit from one point to another.
Water quality and quantity shall be adequate for the pipeline to facilitate the conservation use of forage resources by livestock.
Water for distribution can be from wells, springs, flowing streams, ponds, or rural water districts.

Critical Area Planting

DEFINITION
Establishment of adapted perennial vegetation such as grasses, forbs, legumes, shrubs, and trees.
PURPOSES
This practice may be applied as part of a conservation management system to accom-

plish one or more of the following purposes:

- Restore a plant community similar to its historic climax or the desired plant community.
- Provide or improve forages for livestock.
- Provide or improve forage, browse, or cover for wildlife.
- Reduce erosion by wind and/or water.
- Improve water quality and quantity.
- Increase carbon sequestration.

CONDITIONS WHERE PRACTICE APPLIES

On rangeland, native or naturalized pasture, grazed forest, or other suitable location where the principal method of vegetation management will be with herbivores. This practice shall be applied where desirable vegetation is below the acceptable level for natural reseeding to occur, or where the potential for enhancement of the vegetation by grazing management is unsatisfactory.

Stream Fencing – Livestock Exclusion

DEFINITION

A constructed barrier to prevent livestock from entering streams and ponds

PURPOSES

- To improve water quality by reducing sediment, nutrient, organic, and inorganic loading of the stream.
- To reduce streambank and streambed erosion.
- To facilitate the accomplishment of conservation objectives by providing a means to control movement of animals.

CONDITIONS WHERE PRACTICE APPLIES

This practice may be applied on any area where management of animal movement is needed. Fences are not needed where natural barriers will serve the purpose.

Stream Crossing – Livestock Exclusion

DEFINITION

A stabilized area or structure constructed across a stream to provide a travel-way for people, livestock, equipment, or vehicles.

PURPOSES

- To improve water quality by reducing sediment, nutrient, organic, and inorganic loading of the stream.
- To reduce streambank and streambed erosion.
- To provide crossing for access to another land unit.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all land uses where an intermittent or perennial watercourse exists and a ford, bridge, or culvert type crossing is desired for livestock, people, and / or equipment.

Relocate Feeding Sites

DEFINITION

- Feedlot- Move feedlot or pens away from a stream, waterway, or body of water to increase filtration and waste removal of manure.
- 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).

PURPOSE

To improve water quality by reducing loading of nutrients, organics, pathogens, and other contaminants associated with livestock, poultry, and other agricultural operations.

CONDITIONS WHERE PRACTICE APPLIES

This practice can be applied where the location of livestock in conjunction with a stream, waterway, or body of water can contribute to loading of nutrients, organics, pathogens, and other contaminants.

11.3 Service Providers*

** 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.*

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.accesskansas.org/kda
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.kdheks.gov
Kansas Natural Resource Foundation	Natural resource development and protection.	Plan and implement projects and programs that improve environmental quality of life.	Technical	

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Website address
Kansas Department of Wildlife and Parks **US Fish and Wildlife**	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 all nongame species. 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/ www.fws.gov/
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	www.kansasruralcenter.org

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Website address
Kansas State Research and Extension	Water Quality Programs, Waste Management Programs	Provide programs, expertise and educational materials that relate to minimizing the impact of rural and urban activities on water quality.		
	Kansas Center for Agricultural Resources and Environment (KCARE)	Educational program to develop leadership for improved water quality.		www.kcare.ksu.edu
	Kansas Environmental Leadership Program (KELP)	Provide guidance to local governments on water protection programs.		www.ksu.edu/kelp
	Kansas Local Government Water Quality Planning and Management	Reduce non-point source pollution emanating from Kansas grasslands.	Technical	www.ksu.edu/olg
	Rangeland and Natural Area Services (RNAS)	Service-learning projects available to college and university faculty and community watersheds in Kansas.		
	WaterLINK	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.		www.k-state.edu/waterlink/
	Kansas Pride: Healthy Ecosystems/ Healthy Communities			www.kansasprideprogram.ksu.edu/healthyecosystems/
	Citizen Science	Education combined with volunteer soil and water testing for enhanced natural resource stewardship.		www.ksu.edu/kswater/
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
Solomon Valley RC&D	Natural resource development and protection.	Plan and implement projects and programs that improve environmental quality of life.	Technical	www.solomonvalleyrcd.org

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Website address
State Conservation Commission and Conservation Districts	Water Resources Cost Share	Provide cost share assistance to landowners for establishment of water conservation practices.	Technical and Financial	www.accesskansas.org/kscc
	Nonpoint Source Pollution Control Fund	Provides financial assistance for nonpoint pollution control projects which help restore water quality.		www.kacdnet.org
	Riparian and Wetland Protection Program	Funds to assist with wetland and riparian development and enhancement.		
	Stream Rehabilitation Program	Assist with streams that have been adversely altered by channel modifications.		
	Kansas Water Quality Buffer Initiative	Compliments Conservation Reserve Program by offering additional financial incentives for grass filters and riparian forest buffers.		
	Watershed district and multipurpose lakes	Programs are available for watershed district and multipurpose small lakes.		
US Army Corps of Engineers	Planning Assistance to States	Assistance in development of plans for development, utilization and conservation of water and related land resources of drainage	Technical	www.usace.army.mil
	Environmental Restoration	Funding assistance for aquatic ecosystem restoration.		
US Fish and Wildlife Service	Fish and Wildlife Enhancement Program	Supports field operations which include technical assistance on wetland design.	Technical	www.fws.gov
	Private Lands Program	Contracts to restore, enhance, or create wetlands.		
US Geological Survey	National Streamflow Information Program	Provide streamflow data	Technical	ks.water.usgs.gov
	Water Cooperative Program	Provide cooperative studies and water-quality information		Nrtwq.usgs.gov

Organization	Programs and Technical Assistance	Purpose	Technical or Financial Assistance	Website address
USDA- **Natural Resources Conservation Service and Farm Service Agency**	Conservation Compliance	Primarily for the technical assistance to develop conservation plans on cropland.	Technical and Financial	www.ks.nrcs.usda.gov
	Conservation Operations	To provide technical assistance on private land for development and application of Resource Management Plans.		
	Watershed Planning and Operations	Primarily focused on high priority areas where agricultural improvements will meet water quality objectives.		
	Wetland Reserve Program	Cost share and easements to restore wetlands.		
	Wildlife Habitat Incentives Program	Cost share to establish wildlife habitat which includes wetlands and riparian areas.		
	Grassland Reserve Program, EQIP, and Conservation Reserve Program	Improve and protect rangeland resources with cost-sharing practices, rental agreements, and easement purchases.		
North Central Prairie Weed Management Area	Natural resource development and protection.	Plan and implement projects and programs that improve environmental quality of life.	Technical	
KS Grazing Lands Coalition	Regenerating Kansas grazing lands	Regenerate Kansas grazing land resources through cooperative management, economics, ecology, production, education, and technical assistance programs.	Technical	www.kglc.org
Local FFA Chapters	Youth Education Programs	Make a positive difference in the lives of students. . .through ag education	Technical	

11.4 KAWS Streambank Assessment

Assessment of Streambank Erosion Sites on North and South Fork of the Solomon River: HUC-14 10260012030100 HUC-14 10260014030070

November 2009

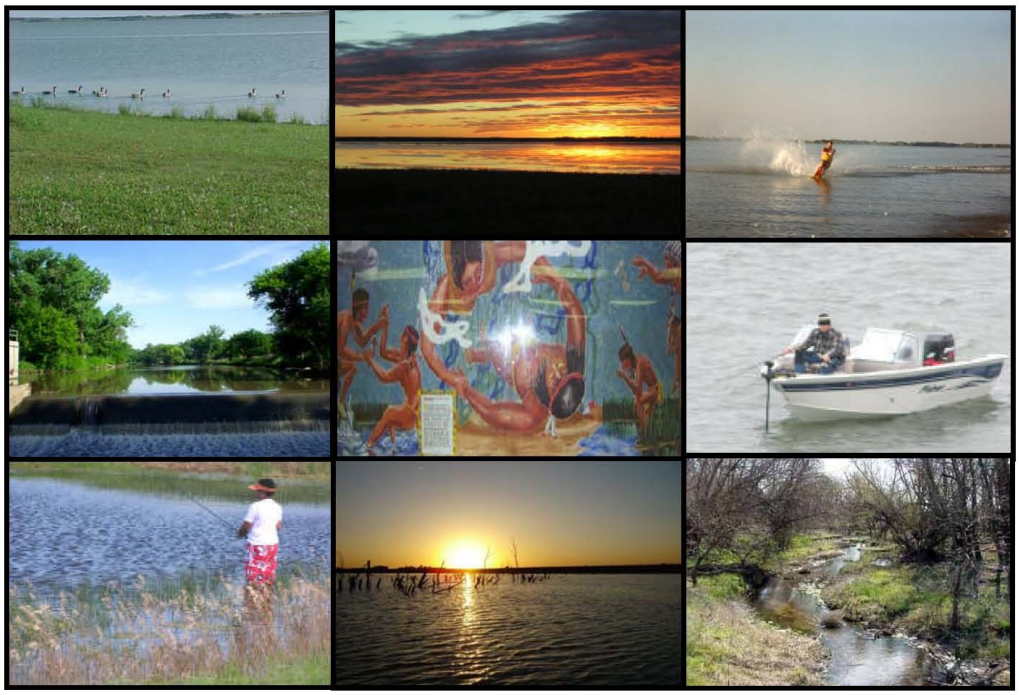


Photo sources: www.glenelder.com, www.tamuk.edu/music/gregsanders/Kansas and anonymous

Assessment and report completed by the Kansas Alliance for Wetlands and Streams (KAWS) and Blue Earth for the Waconda Lake Watershed Restoration and Planning Strategy (WRAPS).

The Kansas Department of Health and Environment has provided financial assistance to this project through EPA Section 319 Non Point Source Pollution Control Grant and Kansas Water Plan Funds.

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Executive Summary

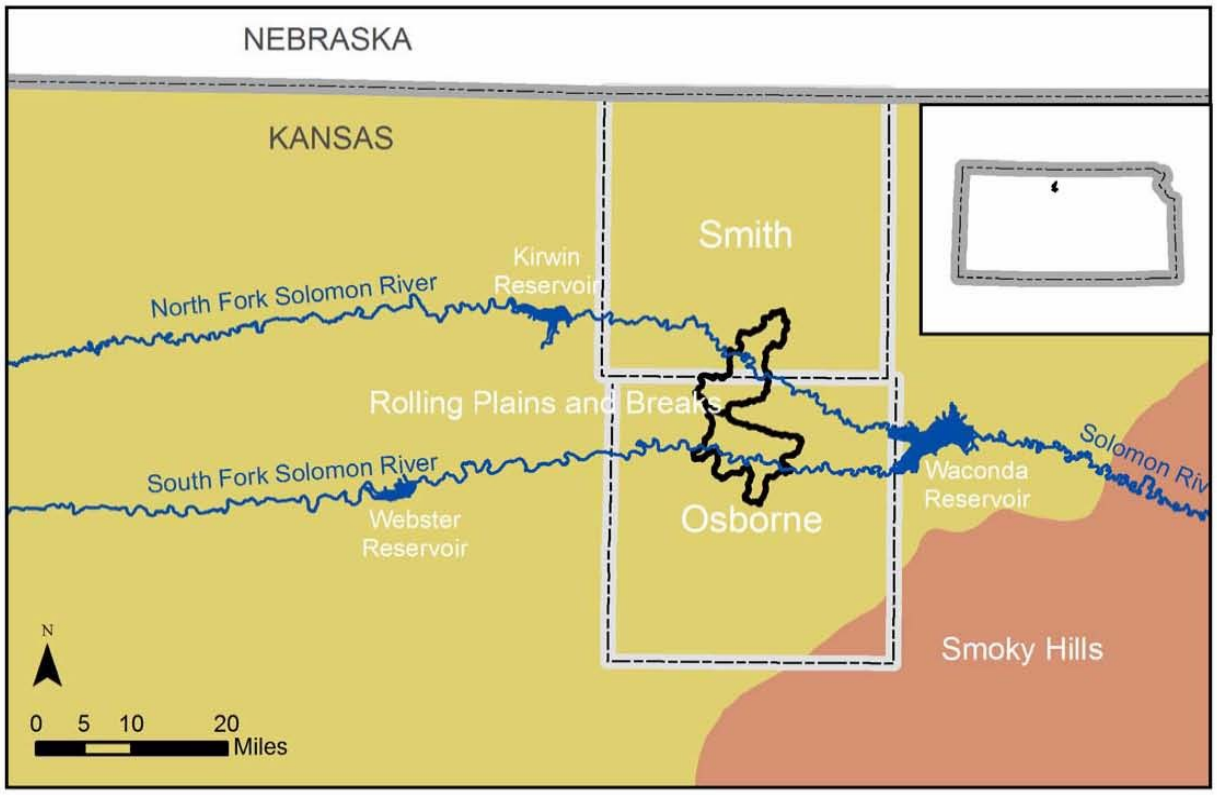
According to the Kansas Unified Watershed Assessment, the Lower North Fork Solomon River and the Lower South Fork Solomon River were determined to be Category I, or Watersheds in Need of Restoration, based on non-attainment of national clean water action goals. The watersheds were ranked 34th and 45th within the state for watershed restoration priority, respectively. Total Maximum Daily Loads (TMDLs) and general water quality concerns in streams, rivers, and lakes in the watersheds and for Waconda Reservoir include selenium, sulfate, biological impairment, eutrophication, dissolved oxygen, fecal coliform bacteria and water quantity.

The Waconda Watershed Restoration and Protection Strategy (WRAPS) is in the assessment and planning stages. The WRAPS Stakeholder Leadership Team (SLT) is currently developing their plan, objectives, and goals, and identifying specific actions necessary to reach desired endpoints, especially as related to medium and high priority TMDLs in the basin above Waconda Reservoir. These efforts will eventually culminate in an action plan for the watershed including identification of specific best management practices (BMPs) to be implemented which will improve water quality. Concerns by the SLT regarding streambank erosion and sedimentation processes in the watershed were the motivation for undertaking an assessment of streambank erosion sites for two HUC-14s located in the watershed above Waconda Reservoir—one on the Lower North Fork Solomon River and one on the Lower South Fork Solomon River. The goal of the WRAPS SLT and this assessment was to identify priorities for implementation of BMPs related to streambank erosion on the Lower North Fork and Lower South Fork of the Solomon River, and specifically within the two HUC-14s being assessed.

The assessment approach relied heavily on aerial photographic interpretation and analysis of GIS data sources, substantiated by field-based verification involving interested stakeholders and agency professionals where possible. The scope of this assessment focused on identifying streambank erosion sites on rivers and streams in two HUC-14s of the Solomon River system above Waconda Reservoir. In general, the North Fork and South Fork Solomon Rivers and their tributaries had no high priority streambank erosion sites requiring major stabilization projects located within the boundaries of the HUC-14s. Five (5) minor streambank erosion sites and one (1) major streambank erosion site were identified for potential rehabilitation or stabilization within the riparian region of the North Fork Solomon River and its tributaries, but none were considered high priority. Streambank erosion sites totaled 2317.9 linear feet of streambanks. Three (3) riparian buffer rehabilitation projects (two associated with livestock activity) totaled 1021.5 feet along the riparian region of the North Fork Solomon River. Five (5) livestock operations and a wastewater treatment lagoon were identified in close proximity to Lawrence Creek, and a gully filled up with junk and debris was identified along the main stem of the North Fork Solomon River. Four (4) minor streambank erosion sites and one major streambank erosion site were identified for potential rehabilitation or stabilization within the riparian region of the South Fork Solomon River and its tributaries, but none were considered high priority. Streambank erosion sites totaled 1804.3 linear feet of streambanks, and all five of the streambank erosion sites appeared to be in need of riparian buffer rehabilitation. Ten (10) additional riparian buffer rehabilitation projects were identified along the South Fork Solomon River, totaling 3488.1 linear feet. Based on the assessment, efforts are probably best focused on implementation of adequate riparian buffers, especially trees, in areas where they are lacking and addressing the impacts of livestock operations in the riparian zone or in close proximity to the river, especially along Lawrence Creek.

Areas of Interest: HUC-14 10260012030100 on the North Fork Solomon River and HUC-14 10260014030070 on South Fork Solomon River, Kansas (Figure 1)

Figure 1. Location of HUC-14 10260012030100 (North Fork Solomon River) and HUC-14 10260014030070 (South Fork Solomon River) including Waconda Reservoir. The assessment area is for streams and rivers in the HUC-14 watersheds and the riparian areas (defined as 100 feet on either side of streams and rivers). HUC-14 10260012030100 is located in south central Smith County and north central Osborne County, Kansas. HUC-14 10260014030070 is located in north central Osborne County, Kansas. The North Fork of the Solomon River and the South Fork of the Solomon River join downstream at Waconda Reservoir to form the Solomon River. Both HUC-14s are situated in the Rolling Plains and Breaks Ecoregion of the Central Great Plains.



Summary of Major Water Quality Issues for Assessment

According to the Kansas Unified Watershed Assessment (KDHE and USDA-NRCS, 1998), the Lower North Fork Solomon River (HUC-8 10260012) and the Lower South Fork Solomon (HUC-8 10260014) were determined to be Category I, or Watersheds in Need of Restoration, based on non-attainment of national clean water action goals. The watersheds were ranked 34th and 45th within the state for watershed restoration priority, respectively. The Solomon River (HUC-8 10260015) created by the confluence of the North and South Fork Solomon River including Waconda Reservoir was also determined to be a "Watershed in Need of Restoration" based on non-attainment of water quality standards and is ranked 23rd for watershed restoration priority within the state.

The Watershed Conditions Report completed for the Lower North Fork Solomon by KDHE in 2001 indicated

56.8% of the total miles of water in this watershed were not supporting their designated uses. The primary pollutant concern for streams and rivers in HUC 8 10260012 was fecal coliform bacteria (FCB). FCB is a bacteria present in human and animal waste and serves as an indicator of potential disease causing organisms. Additional pollutants in this watershed are sulfate, selenium and ammonia. A Watershed Conditions Report was not completed for the Lower South Fork Solomon River.

The Watershed Conditions Report completed for the Solomon River by KDHE in 2001 indicated that 79 percent of the total miles of water in this watershed did not meet their designated uses. The primary pollutant concern of streams and rivers in HUC 8 10260015 was fecal coliform bacteria (FCB). Other pollutant concerns were dissolved oxygen, sulfate, selenium, chloride, and ammonia. Potential sources of FCB contamination include feedlots, wastewater treatment facilities, septic systems, and wildlife. Within HUC 10260015, there is one large lake (Waconda Lake), two state fishing lakes, and several smaller city and county lakes. The primary pollutant concerns for lakes within the watershed were eutrophication, excess biomass, and dissolved oxygen. Eutrophication is a natural process which creates conditions favorable for algae blooms and excess plant growth. This process is often accelerated by excess nutrient loading from the watershed.

Active TMDLs for the Lower North Fork and Lower South Fork Solomon River HUC-8 watersheds are sulfate, selenium, dissolved oxygen, and biological impairment. Fecal coliform bacteria (FCB) was an identified TMDL, but it was delisted in 2004; recent monitoring has indicated that FCB concentrations may be in excess of the water quality standard and a TMDL may be reconsidered. Lake TMDLs in the HUC-8 watersheds include dissolved oxygen, eutrophication and sulfate. Stream and lake monitoring sites used by KDHE are identified in Figure 2.

The Solomon River–Waconda Reservoir WRAPS ((Waconda WRAPS) is in the assessment and planning stages of the WRAPS process. The WRAPS Stakeholder Leadership Team (SLT) is currently developing their WRAPS plan, objectives, and goals, and identifying specific actions necessary to reach desired endpoints. These efforts will eventually culminate in an action plan for the watershed including identification of specific best management practices (BMPs) to be implemented which will improve water quality.

A main concern of the Waconda WRAPS SLT which has been acknowledged during previous meetings was the need for stream bank stabilization within the watershed. Team members have experienced and observed many sites throughout the watershed that may require stabilization. Additionally, Waconda Lake has experienced over 9.3% loss of its storage capacity from 1967 to 2001 (U.S. Department of the Interior, 2001) including the associated water quality problems associated with delivery of nutrient– and contaminant-enriched sediments to surface water bodies. Concerns by the SLT regarding streambank erosion and sedimentation processes in the watershed were the motivation for undertaking an assessment of streambank erosion sites for two HUC-14s located in the watershed above Waconda Reservoir—one on the Lower North Fork Solomon River and one on the Lower South Fork Solomon River.

Focus of the Assessment

Results of the assessment effort to identify streambank erosion sites for BMP implementation throughout HUC-14 10260012030100 (North Fork of the Solomon River) and HUC-14 10260014030070 (South Fork of the Solomon River) are described herein. Much of this work is based on analysis and interpretation of aerial photographs and geographical information system (GIS) data at medium resolution (i.e., 30 m x 30 m pixel size) in an attempt to identify potential streambank erosion sites contributing to sediment delivery downstream. Field verification of sites identified in the assessment was completed by the assessor in cooperation with interested members of the SLT and agency professionals and in communication with the WRAPS coordinator. Although subjectivity is inherent in the assessment approach, verification of sites on the ground was used to validate results and identify potential problems or misidentifications wherever possible.

Scope of Level 1 Watershed Assessment

Assessment Area

The **assessment areas** identified in the scope of work are HUC-14 10260012030100 on the North Fork of the Solomon River and HUC-14 10260014030070 on the South Fork of the Solomon River.

- The **riparian regions** of the North Fork of the Solomon River and its tributaries in HUC-14 10260012030100 were the main focus. HUC-14 10260012030100 is located in south central Smith County and north central Osborne County. Gaylord, KS, is situated about 3 miles west to northwest of the western watershed boundary, and Portis, KS, is about 2.5 miles east of the eastern watershed boundary. Lawrence Creek is the major named tributary in the watershed. The North Fork of the Solomon River joins the South Fork of the Solomon River approximately 16 miles downstream of the eastern watershed boundary at the upper end of Waconda Reservoir.

- The **riparian regions** of the South Fork of the Solomon River and its tributaries in HUC-14 10260014030070 were the focus. HUC-14 10260014030070 is located in north central Osborne County. Osborne, KS, is situated on the eastern watershed boundary, and Alton, KS, is about 4 miles west of the western watershed boundary. The South Fork of the Solomon River joins the North Fork of the Solomon River approximately 14 miles downstream of the eastern watershed boundary at the upper end of Waconda Reservoir.

Assessment Activities

- The **riparian region** was used to identify eroding streambanks for rehabilitation and stabilization along streams and rivers in both HUC-14s using aerial photography and GIS data sources, including estimates of linear extent in feet and applicable maps.

- Obvious noteworthy points occurring within the **riparian regions** of the two HUC-14s, such as livestock feeding areas or riparian buffer rehabilitation sites, were also identified as a courtesy using aerial photography, including applicable maps. However, this was not the focus of the assessment.

- **Field verification** of observations obtained from aerial photography and GIS data analysis was conducted with interested members of Waconda WRAPS SLT.

- **Presentation of assessment results** to Waconda WRAPS SLT.

Methods

Summary of Assessment Methodologies

- **Identification of potential eroding streambanks for rehabilitation and stabilization, including estimates of linear extent in feet and applicable maps (Figures 3-9; Tables 1-2).**

Visual inspection of 2008 U.S. Department of Agriculture (USDA) Farm Service Agency (FSA) National Agriculture Imagery Program (NAIP) color composite was used to identify major sites of streambank erosion occurring within the riparian region of HUC-14 10260012030100 on the North Fork of the Solomon River and HUC-14 10260014030070 on the South Fork of the Solomon River. Aerial photography was examined scene

by scene, or a quarter section at a time, within the riparian region to identify indicators of potential or apparent bank erosion or instability. Indicators of bank erosion or instability included: minimal or no deep rooted vegetation, especially trees, to protect banks; bank steepness; outside meander bend locations; and near-bank stress points evident from stream flow angle directed into streambanks. Stream channelization and its history, while important to streambank erosion processes and channel stability, was not included in the scope of this assessment, but should also be considered as part of a holistic stream rehabilitation strategy. Streambank erosion sites with a linear extent equal to or greater than 500 feet were the primary focus of this assessment. However, sites less than 500 feet in linear extent (minor sites) were also reported where observable. Figures 3-9 present maps indicating locations of observed streambank erosion. Tables 1-2 summarize the total linear extent of streambank erosion sites.

- **Identification of obvious noteworthy points occurring within the riparian regions of the two HUC-14s, such as livestock feeding areas or riparian buffer rehabilitation sites, were also identified as a courtesy using aerial photography, including applicable maps (Figures 3-9; Tables 1-2);**

Visual inspection of 2008 USDA-FSA NAIP color composite aerial photography to identify major sites of streambank erosion yielded occasional sightings of potential stream or river impairments beyond the scope of the assessment. These occurrences were noted and identified as a courtesy to the Waconda WRAPS for further consideration of BMP implementation and/or assessment. All of these sites consisted of either livestock feeding operations in close proximity to streams and rivers (i.e., potential sources of FCB, nutrients, and riparian buffer disturbance) or minimal or no riparian vegetation buffer to adequately stabilize streambanks. Aerial photography was examined scene by scene, or a quarter section at a time, and obvious indicators of livestock operations or animal feeding activity in the riparian region were recorded. Indicators of livestock operations or animal feeding activity included: denuded vegetation; fence lines, grain storage buildings, hay stacks, outbuildings, lagoons, ponds, enclosures, paddocks, manure piles, and watering/feeding sites. Aerial photography was examined to identify sites where only minimal riparian vegetation buffers existed, or instances where cultivated land persisted up to the edge of the streambank. Figures 3-9 present locations where obvious livestock activity was observed within the riparian region or minimal riparian buffers were noted within the two HUC-14s.

- **Field verification with interested members of the Waconda WRAPS SLT.**

Assessment results were field verified on September 22, 2009. Field verification was completed with the assistance of the Lujeana Howell (KAWS) and Darla Juhl (Coordinator of Solomon Valley RC&D) on September 22, 2009. This approach allowed development of consensus on the results, an opportunity to improve the results and a better understanding of the watershed conditions and limitations of the assessment methodologies to accurately reflect actual watershed conditions.

The majority of the assessment area which was accessible by vehicle was field verified. Observations made by the field verification team were used to revise remotely assessed data as appropriate. A range of subjective conditions existed at some sites. In these instances, group consensus was used to judge the identification of the site as correct or in need of revision.

- **Presentation of results to Waconda WRAPS SLT.**

Assessment results were presented to the Waconda WRAPS SLT on December 30, 2009.

Results

Setting

The Lower North Fork and Lower South Fork of the Solomon River are situated in the Rolling Plains and Breaks ecoregion of the Central Great Plains of north central Kansas (Chapman et. al, 2001). HUC-14 10260012030100 occupies an area of nearly 43.2 square miles (27,630.3 acres), and HUC-14 10260014030070 occupies an area of nearly 49.3 sq. miles (31,560.8 acres) in the ecoregion.

The Rolling Plains and Breaks ecoregion is characterized by dissected plains with broad undulating to rolling ridge tops and hilly to steep valley sides. Loess is common on hill tops and alluvium on floodplains and stream terraces. The area was historically mixed-grass prairie, with areas of riparian forest along major stream corridors. Prevalent prairie grass species were big bluestem, little bluestem, blue grama, needle-and-thread, side-oats grama, and western wheatgrass. Today, due to significant land use conversion, the ecoregion is generally a mosaic of predominantly cropland and rangeland. Winter wheat, grain sorghum and soybeans are the major crops, with irrigated areas along the major rivers planted to corn, alfalfa, and small grains. Rangeland is common on the breaks (Chapman et. al, 2001).

HUC-14 10260012030100 (North Fork Solomon River)

Five (5) minor streambank erosion sites (< 500 feet length) and one (1) major streambank erosion site (> 500 feet length) were identified for potential rehabilitation or stabilization within the riparian region of the North Fork Solomon River and its tributaries. All of these sites were identified by aerial photography, but road and property access did not allow on-the-ground verification of many of these sites. Streambank erosion sites totaled 2317.9 linear feet of streambanks. The average length of the sites was 386.3 ± 57.5 feet. The longest site was 661.7 feet. All of the streambank erosion sites appeared to be in need of riparian buffer rehabilitation since only a minimal band of riparian vegetation appeared to be present. Three (3) additional riparian buffer rehabilitation projects totaling 1021.5 feet were identified; two of these were also sites of livestock operations along the river.

Additional noteworthy points of interest observed during the assessment and field verification of results was five (5) livestock operations and a wastewater treatment lagoon in close proximity to Lawrence Creek, and a gully filled up with junk and debris on the main stem of the North Fork Solomon River.

Table 1. Eroding streambank sites, riparian buffer sites, livestock sites, and points of interest identified in HUC-14 10260012030100 along the North Fork Solomon River and its tributaries.

Site ID	Site Type	Length (ft)	Verification Comments
NF-1	buffer	379.0	unable to verify, but in aerial photos appears to be narrow riparian buffer
NF-2	buffer/ minor erosion	349.0	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field; potential minor bank erosion
NF-3	buffer/ major erosion	661.7	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field; potential major bank erosion
NF-4	buffer/ minor erosion	256.7	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field; potential minor bank erosion
NF-5	buffer/ minor erosion	377.6	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field; potential minor bank erosion
NF-6	buffer/ minor erosion	334.0	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field; potential minor bank erosion
NF-7	buffer/ livestock	339.0	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field; potential minor bank erosion
NF-8	buffer/ livestock	303.5	verified livestock operation on river with inadequate riparian buffer; difficult to verify buffer from road
NF-P1	junk-filled gully	NA	gully filled with junk and debris
NF-P2	livestock activity	NA	livestock feeding operation near river; narrow riparian buffer
NF-P3	waste treatment lagoon	NA	livestock waste treatment lagoon near river
NF-P4	livestock activity	NA	livestock feeding operation near river; narrow riparian buffer
NF-P5	livestock activity	NA	livestock feeding operation near river
NF-P6	livestock activity	NA	livestock feeding operation near river
NF-P7	livestock activity	NA	livestock feeding operation near river; narrow riparian buffer

HUC-14 10260014030070 (South Fork Solomon River)

Four (4) minor streambank erosion sites (< 500 feet length) and one (1) major streambank erosion site (> 500 feet) were identified for potential rehabilitation or stabilization within the riparian region of the South Fork Solomon River and its tributaries. All of these sites were identified by aerial photography, and road and property access did not allow on-the-ground verification of two of these sites. Streambank erosion sites totaled 1804.3 linear feet of streambanks. The average length of the sites was 360.9 ± 62.7 feet. The longest site was 628.5 feet. All four of the streambank erosion sites appeared to be in need of riparian buffer rehabilitation since only a minimal band of riparian vegetation appeared to be present. Ten (10) additional riparian buffer rehabilitation projects were identified totaling 3488.1 linear feet.

Table 2. Eroding streambank sites, riparian buffer sites, livestock sites, and points of interest identified in HUC-14 10260014030070 along the South Fork Solomon River and its tributaries.

Site ID	Site Type	Length (ft)	Verification Comments
SF-1	buffer	450.0	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field
SF-2	buffer/ minor erosion	356.4	minimal riparian vegetation on south side of bridge; minor bank erosion
SF-3	buffer	475.9	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field
SF-4	buffer	445.9	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field
SF-5	buffer	348.2	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field
SF-6	buffer	347.2	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field
SF-7	buffer/ minor erosion	321.6	new bridge site in need of riparian vegetation planting; rock debris used to "treat" minor bank erosion site
SF-8	buffer	376.9	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field
SF-9	buffer/ major erosion	628.5	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field
SF-10	buffer	292.2	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field
SF-11	buffer/ minor erosion	258.8	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field; minor bank erosion
SF-12	buffer	272.9	unable to verify, but in aerial photos appears to be narrow riparian buffer
SF-13	buffer/ minor erosion	239.0	unable to verify, but in aerial photos appears to be narrow riparian buffer near ag field; minor bank erosion
SF-14	buffer	294.1	minimal riparian vegetation at bridge site
SF-15	buffer	184.8	minimal riparian vegetation at bridge site

Discussion

The scope of this assessment focused on identifying streambank erosion sites on rivers and streams in two HUC-14s of the Solomon River system above Waconda Reservoir. In general, the North Fork and South Fork Solomon Rivers and their tributaries had no high priority streambank erosion sites requiring major stabilization projects located within the boundaries of the HUC-14s. While a geomorphologic survey of the streams and rivers in the system was beyond the scope of this assessment, general observations made during field verification activities were compared to previous survey work completed by the State Conservation Commission at U.S. Geological Survey gaging stations in or near the HUC-14s being assessed.

General observations suggested that reaches of the North Fork Solomon River evaluated during this assessment were probably in a state of transition involving down-cutting, widening and establishment of a new floodplain at a lower elevation. Evidence of a discontinuous floodplain at a lower elevation was observed in several locations during field verification. Tributaries of the North Fork, especially Lawrence Creek since it was visited in several areas to verify results, generally appeared to be narrow and deep and as a result of continued down-cutting— an indication of instability. Previous survey work indicated that the channel type for the North Fork Solomon River at Portis, Kansas, was an F5, which suggests observations made during field verification are supported by previous survey work. Five streambank erosion sites were identified on the

North Fork Solomon River in HUC-14 10260012030100; one of these sites was considered major due to its linear extent exceeding 500 feet. All streambank erosion sites should be considered for riparian rehabilitation and visited to evaluate conditions, but are likely only a low to moderate priority for streambank stabilization. Based on the assessment, efforts are probably best focused on implementation of adequate riparian buffers, especially trees, in areas where they are lacking and addressing the impacts of livestock operations in the riparian zone or in close proximity to the river, especially in Lawrence Creek.

Conditions on the South Fork Solomon River in HUC-14 10260014030070 appeared better than for the North Fork with respect to streambank condition, but several observations were made during this assessment regarding an inadequate riparian buffer. Four minor streambank erosion sites were noted, but two of these were at bridge sites. Two observations of inadequate riparian vegetation were made at bridge sites as well. A previous geomorphological survey of the South Fork Solomon River at Osborne, Kansas, indicated that the channel was an E5— an indication of a more stable channel type in which the channel is connected to its floodplain. No livestock operations were noted in the riparian area of this HUC-14 during this assessment, but it should be stressed that this was not the focus of the assessment (i.e., they may exist but were not identified), nor was an assessment of the riparian area.

Summary

- The Lower North Fork and Lower South Fork of the Solomon River are situated in the Rolling Plains and Breaks ecoregion of the Central Great Plains of north central Kansas.

- The ecoregion was historically mixed-grass prairie, with areas of riparian forest along major stream corridors. Today, due to significant land use conversion, the ecoregion is generally a mosaic of predominantly cropland and rangeland.

- Five (5) minor streambank erosion sites and one (1) major streambank erosion site were identified for potential rehabilitation or stabilization within the riparian region of the North Fork Solomon River and its tributaries. Streambank erosion sites totaled 2317.9 linear feet of streambanks.

- Three (3) riparian buffer rehabilitation projects (two associated with livestock activity) totaled 1021.5 feet along the riparian region of the North Fork Solomon River.

- Five (5) livestock operations and a wastewater treatment lagoon were identified in close proximity to Lawrence Creek, and a gully filled up with junk and debris was identified along the main stem of the North Fork Solomon River.

- Four (4) minor streambank erosion sites and one major streambank erosion site were identified for potential rehabilitation or stabilization within the riparian region of the South Fork Solomon River and its tributaries. Streambank erosion sites totaled 1804.3 linear feet of streambanks, and all five of the streambank erosion sites appeared to be in need of riparian buffer rehabilitation.

- Ten (10) additional riparian buffer rehabilitation projects were identified along the South Fork Solomon River, totaling 3488.1 linear feet.

- Based on the assessment, efforts are probably best focused on implementation of adequate riparian buffers, especially trees, in areas where they are lacking and addressing the impacts of livestock operations in the riparian zone or in close proximity to the river, especially along Lawrence Creek.

References

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Metadata

2008 U.S. Department of Agriculture (USDA) Farm Service Agency (FSA) National Agriculture Imagery Program (NAIP) Color-composite Imagery: http://www.kansasgis.org/catalog/catalog.cfm

Figure 2. Locations of Kansas Department of Health and Environment (KDHE) stream and lake monitoring sites in relation to HUC-14 watersheds assessed. The assessment watersheds are indicated in black and the HUC-8 watershed boundaries are indicated in turquoise.