Upper Portion of the Lower Smoky Hill River Watershed

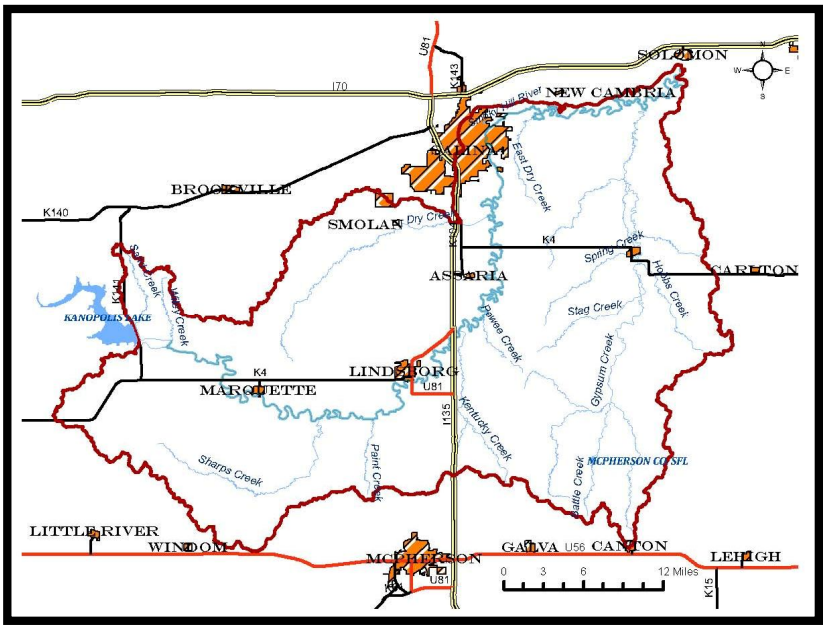
Watershed Restoration and Protection Strategy

Water Quality Impairments Directly Addressed:

- Smoky Hill River near Mentor E. coli Bacteria TMDL (High Priority)
- Smoky Hill River near Mentor Total Suspended Solids TMDL (High Priority)
- Smoky Hill River near Salina Total Suspended Solids TMDL (High Priority)
- Smoky Hill River near Salina Total Phosphorus 303(d) listing

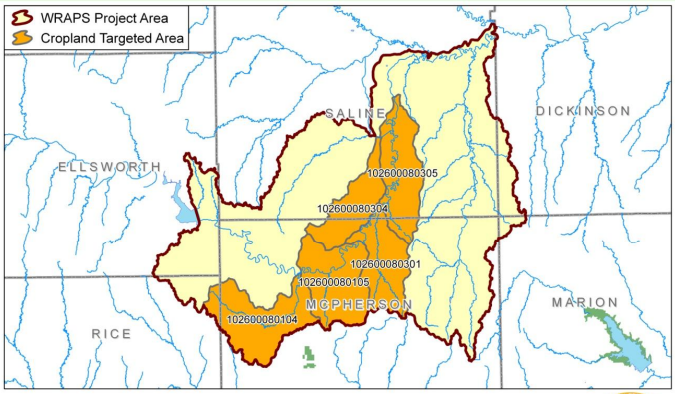
Other Impairments Which Stand to Benefit from Watershed Plan Implementation:

- Smoky Hill River near Salina Biology TMDL (Medium Priority)
- Smoky Hill River near Salina Nitrate 303(d) listing



Determination of Priority Areas

- The Watershed Institute (TWI) conducted a streambank stability assessment along the main stem of the Smoky Hill River within the WRAPS project area. Individual streambank sites were prioritized base off of metrics identified by TWI
- Cropland targeted areas were identified through analysis of KDHE stream monitoring data within the watershed as well as consultation with SLT members. Areas upstream of Salina and downstream of the Smoky Hill River/Sharps Creek confluence were identified as the primary area of focus for cropland BMP work adjacent to the Smoky Hill River.
- Livestock targeted areas were identified through livestock assessment work which included: (1) evaluation of current permitted and certified livestock facilities, (2) local firsthand knowledge of livestock producers within the watershed, (3) windshield survey of the watershed, and (4) evaluation of current water quality monitoring data.



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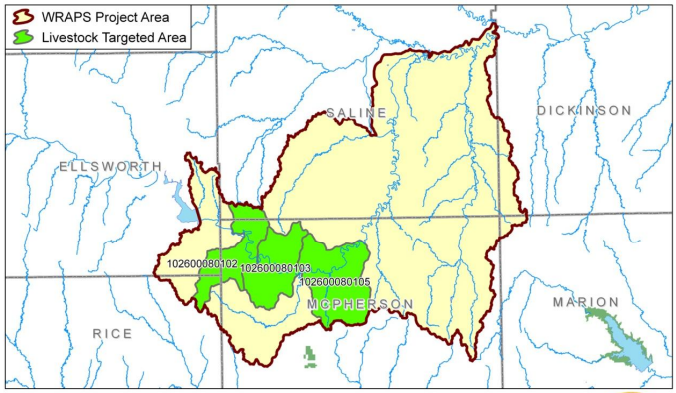
Kansas Department of Health and Environment
October 2011



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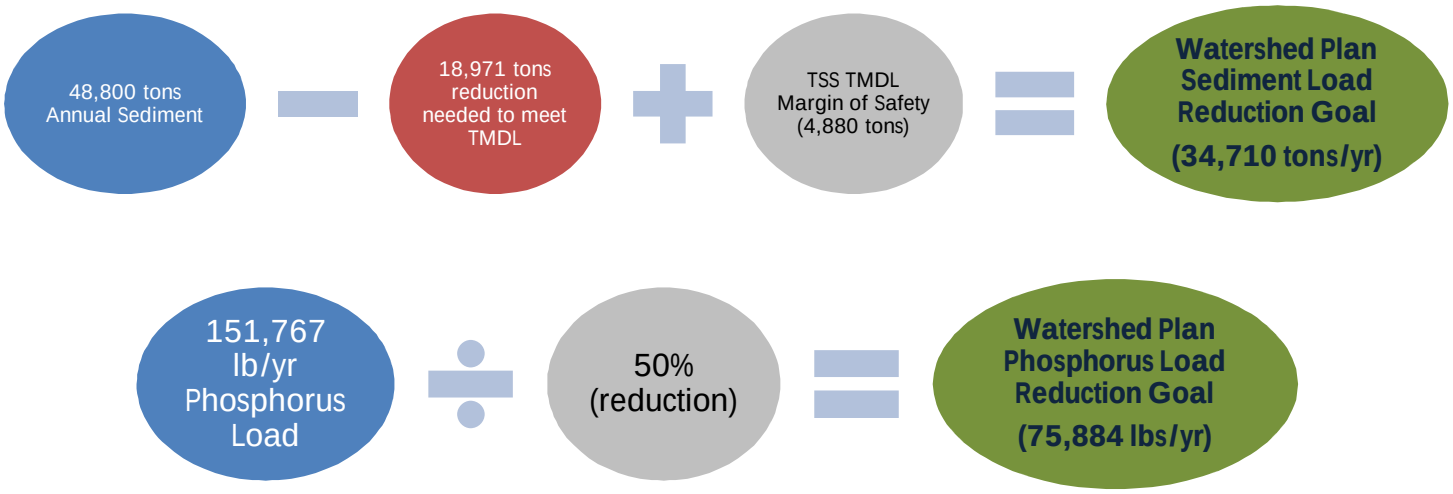
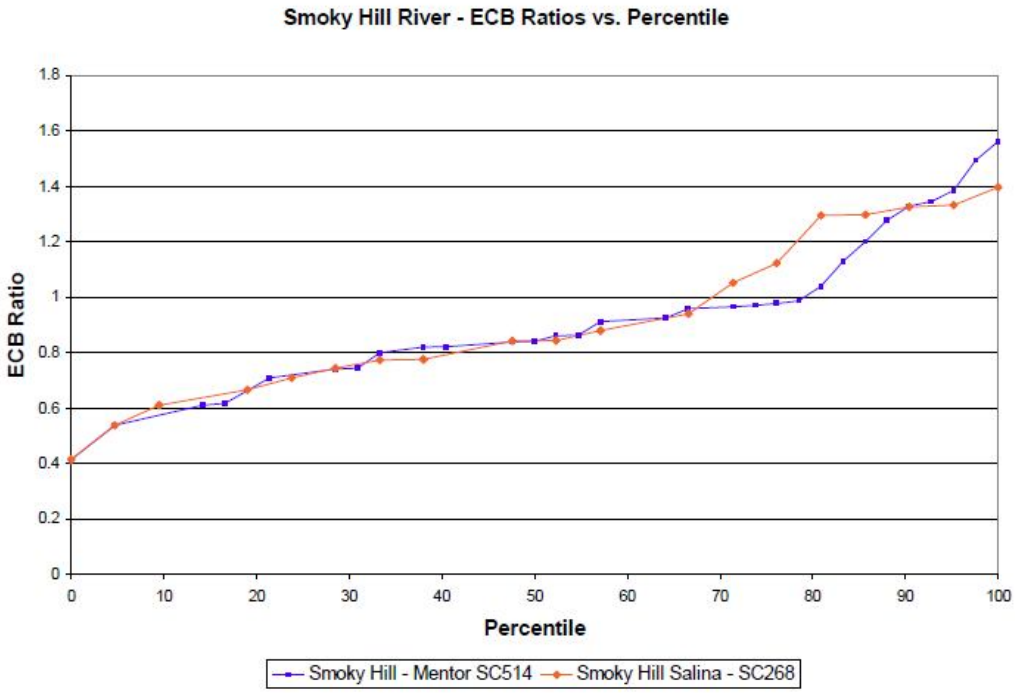
Kansas Department of Health and Environment
October 2011

Best Management Practice and Load Reduction Goals



Bacteria Load Reduction Goal

The indicator will be the Upper Decile of those index values; with the target being that the index improves over time with the upper decile (90th percentile) value approaching or falling below 1.



BMPs to be implemented in association with Watershed Plan:

- Cropland-related BMPs
    - No-Till Agriculture
    - Conservation Tillage
    - Grassed Waterways
    - Buffers
    - Nutrient Management Plans
    - Terraces
    - Incorporation of Manure
    - Water Retention
- Livestock-related BMPs
    - Vegetative Filter Strip
    - Relocate Feeding Pens
    - Relocate Pasture Feeding Sites
    - Off Stream Watering System
- Other BMPs
    - Streambank Stabilization

Load Reduction Goals for Watershed Plan Met within 16 Years if BMPs are Implemented as Scheduled

Upper Portion of the
Lower Smoky Hill River Watershed

Watershed Restoration and Protection Strategy

Final Draft Plan June 2012

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

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Glossary of Terms

Best Management Practices (BMP): Environmental protection practices used to control pollutants, such as sediment or nutrients, from common agricultural or urban land use activities.
Biological Oxygen Demand (BOD): Measure of the amount of oxygen removed from aquatic environments by aerobic microorganisms for their metabolic requirements.
Biota: Plant and animal life of a particular region.
Chlorophyll a: Common pigment found in algae and other aquatic plants that is used in photosynthesis
Dissolved Oxygen (DO): Amount of oxygen dissolved in water.
E. coli bacteria: Bacteria normally found in gastrointestinal tracts of animals. Some strains cause diarrheal diseases.
Eutrophication (E): Excess of mineral and organic nutrients that promote a proliferation of plant life in lakes and ponds.
Fecal coliform bacteria (FCB): Bacteria that originate in the intestines of all warm-blooded animals.
Municipal Water System: Water system that serves at least 25 people or has more than 15 service connections.
NPDES Permit: Required by Federal law for all point source discharges into waters.
Nitrates: Final product of ammonia's biochemical oxidation. Primary source of nitrogen for plants. Contained in manure and fertilizers.
Nitrogen(N or TN): Element that is essential for plants and animals. TN or total nitrogen is a chemical measurement of all nitrogen forms in a water sample.
Nutrients: Nitrogen and phosphorus in water source.
Phosphorus (P or TP): Element in water that, in excess, can lead to increased biological activity.
Riparian Zone: Margin of vegetation within approximately 100 feet of waterway.
Sedimentation: Deposition of slit, clay or sand in slow moving waters.
Secchi Disk: Circular plate 10-12" in diameter with alternating black and white quarters used to measure water clarity by measuring the depth at which it can be seen.
Stakeholder Leadership Team (SLT): Organization of watershed residents, landowners, farmers, ranchers, agency personnel and all persons with an interest in water quality.
Total Suspended Solids (TSS): Measure of the suspended organic and inorganic solids in water. Used as an indicator of sediment or silt.

Watershed Restoration and Protection Strategy for the Upper Portion of the Lower Smoky Hill (1026008) Watershed

1.0 Preface

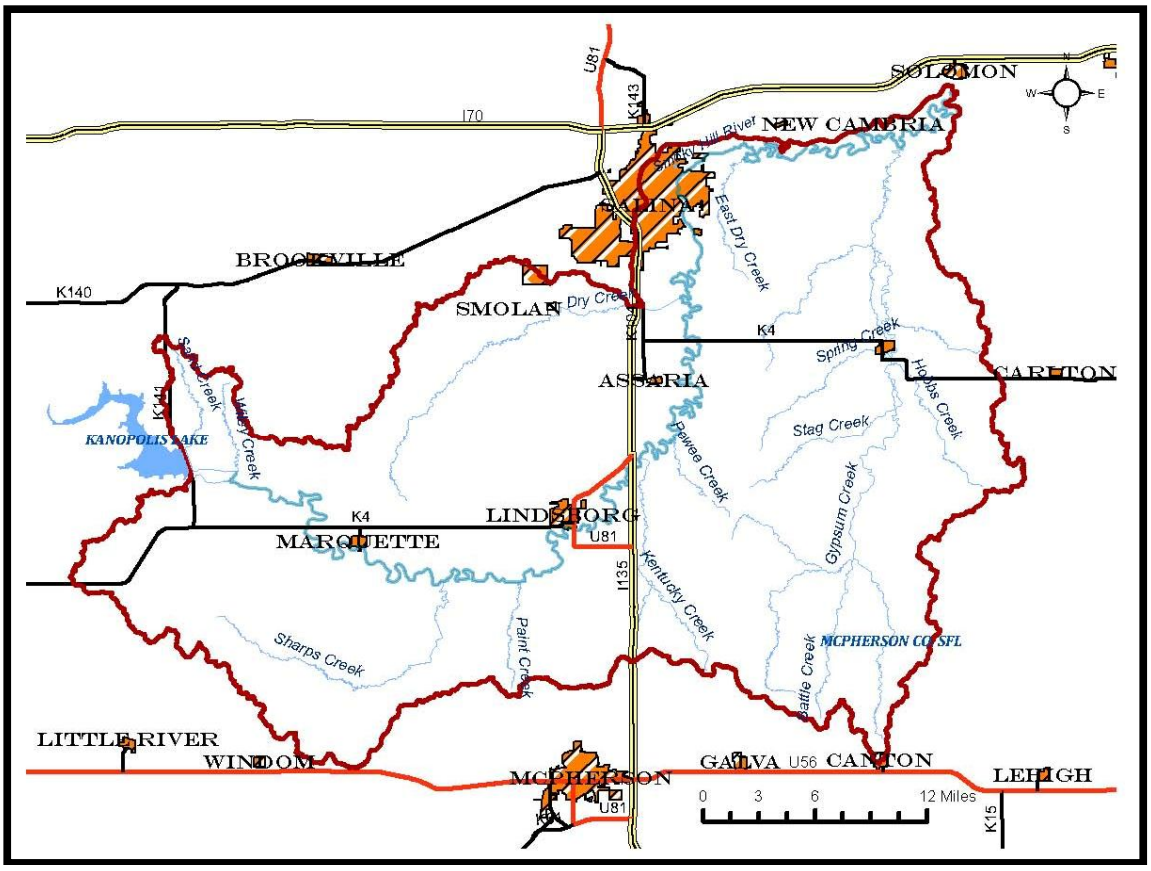
The purpose of this Watershed Restoration and Protection Strategy (WRAPS) report for the upper portions of the Lower Smoky Hill watershed is to outline a plan of restoration and protection goals and actions for the surface waters of the watershed. Watershed goals are characterized as “restoration” or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

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

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

Figure 1. Map of Watershed[1]

Upper Portion of the Lower Smoky Hill River Watershed



2.0 Development of the Stakeholder Leadership Team

In 2003, a group of concerned citizens established a proactive, voluntary grass roots Stakeholder Leadership Team (SLT). This volunteer task force consisted of landowners, producers, residents, agency representatives and other stakeholders in the Project Area that were interested in exploring water quality issues and nonpoint source pollution. The SLT was dedicated to developing a WRAPS plan for the preservation and protection of the Project Area and the consensus of the SLT was that stream bank stabilization would be the main watershed objective.

The main area of concern for the SLT is sedimentation in the Smoky Hill River. Sedimentation is not only a concern due to land physiological changes, but also because Salina draws sixty to eighty percent of its drinking water from the river. The main treatment issue for the river water prior to consumption is turbidity caused by excess soil particles in the water column. Sedimentation can originate from stream bank degradation, overland erosion and resuspension of silt from the river channel. Raising and lowering of stream levels caused by reservoir releases causes streambank degradation. Log jams from falling trees create changes in stream flow, increased flooding and erosion. In the Project Area, many farmers use river water to irrigate their crops. Sedimentation and stream bank degradation create a hardship for these irrigators. Loss of river depth reduces adequate irrigation water and steep riverbanks inhibit access to the river for irrigation equipment. Degradation of the riverbanks and overland erosion from cropland are areas that will be analyzed during the WRAPS process to determine the extent and location of needed restoration projects.

Kanopolis Lake, although not included in this watershed, is an important component of the Smoky Hill/Saline Basin's public water supply and drought management program. The purpose of the program is to allow for coordinated operation of state-owned or controlled water storage space in federal reservoirs in the basin to satisfy downstream municipal and industrial water rights during drought conditions. Water right holders are therefore allowed to receive enhanced stream flow during times of drought while the state operates the reservoirs in the basin as a system for increased efficiency in water delivery.

Salina Water Treatment Plant Tour

WRAPS Stakeholder Leadership

3.0 Watershed Goals

The Stakeholder Leadership Team (SLT) has identified specific goals needed to achieve watershed improvement. Implementation of best management practices (BMPs), as well as financial incentives and cost share programs will, over time, lead to decreases in impairments in surface water resources. Responsibility for restoration and protection of the watershed rests primarily in the hands of local stakeholders. For this reason, federal and state agencies provide technical and financial assistance for education activities and implementation of best management practices.

The SLT has been meeting since 2003 and they have set the following **watershed restoration and protection goals**:

1. Conserve and Preserve Water Quantity to ensure adequate water for future drinking water supplies, industry, farming enterprises, recreation needs and other urban needs.
2. Promote wildlife habitat and rural aesthetics while providing for the farming economy and increased population growth.
3. Protect groundwater quality and quantity.
4. Continue sustainability of land conservation.
5. Increase public awareness and education about watershed/water quality issues.
6. Evaluate and maintain water quality to meet or exceed KDHE standards.
    a. Reduce sediment and nutrients entering the extent of the Smoky Hill River from Lake Kanopolis downstream to Solomon.
    b. Reduce E. coli bacteria entering the Smoky Hill River.

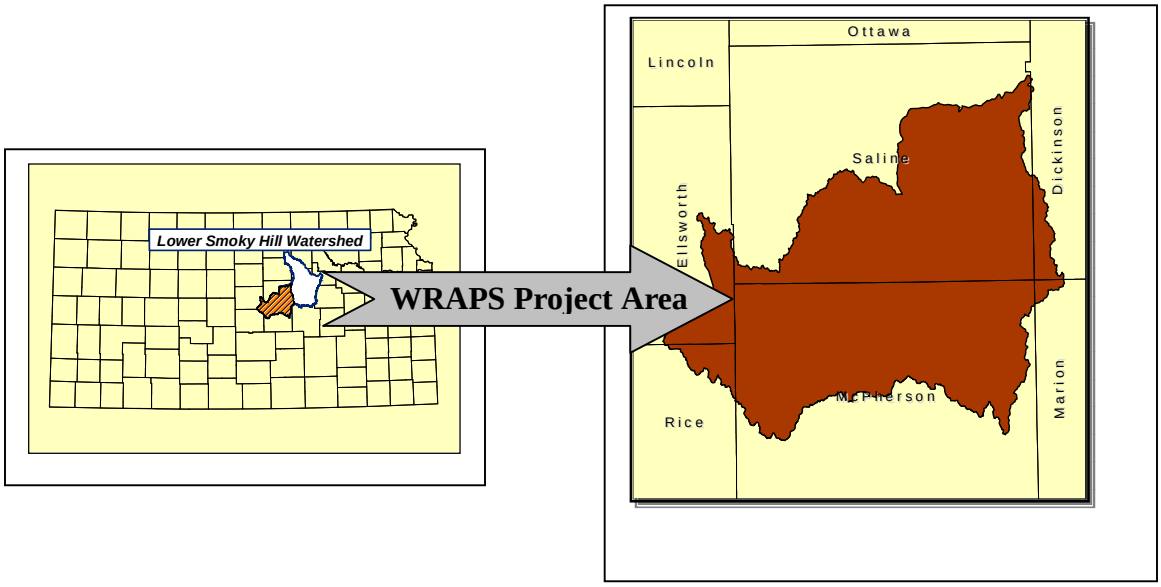
Within the context of this WRAPS Plan, Goals 5 and 6 are the goals that will be directly addressed.

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

4.0 Watershed Review

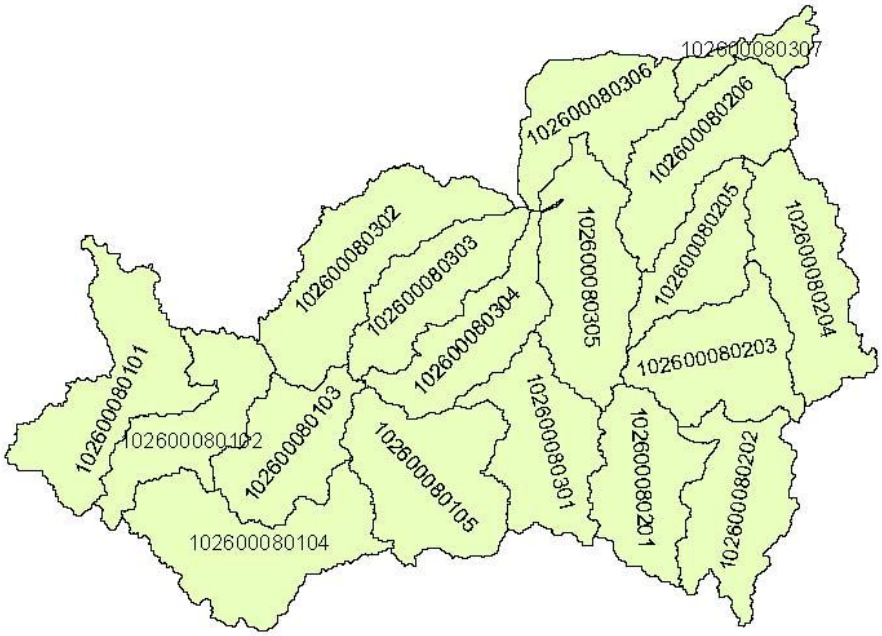
NOTE: For this WRAPS Report, the Upper Portion of the Lower Smoky Hill Watershed will be referred to as the "Project Area". The Project Area is contained within the larger Lower Smoky Hill Watershed.

The Project Area of this Watershed Restoration and Protection Strategy (WRAPS) is the upper portion of the Lower Smoky Hill Watershed. This watershed begins at the impoundment dam of Kanopolis Lake and contains the Smoky Hill River, along with its tributaries, as it meanders eastward to the town of Solomon - the ending point for the Project Area WRAPS process.



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

HUC is an acronym for **H**ydrologic **U**nit **C**odes. HUCs are an identification system for watersheds. Each watershed has a HUC number in addition to a common name. As watersheds become smaller, the HUC number will become larger. The Lower Smoky Hill River Watershed is classified as a HUC 8, meaning it has an 8 digit identifying code. HUC 8s can further be split into smaller watersheds that are given HUC 10 numbers and HUC 10 watersheds can be further divided even smaller HUC 12s. The Project Area is the upstream area above Solomon in the Lower Smoky Hill Watershed and contains 18 HUC 12 delineations.

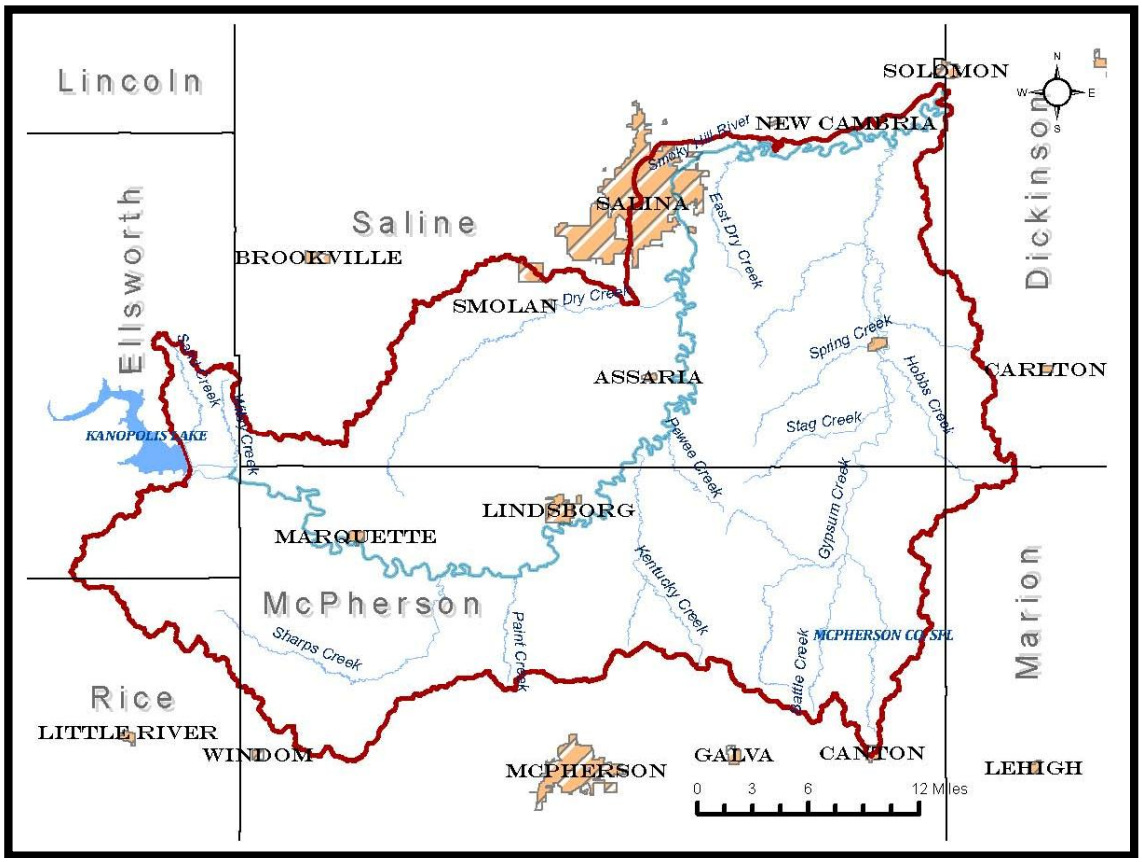


The Lower Smoky Hill River Watershed is designated as a Category I watershed indicating it is in need of restoration as defined by the *Kansas Unified Watershed Assessment 1999* submitted by the Kansas Department of Health and Environment (KDHE) and the United States Department of Agriculture (USDA)[2] in 1999. A Category I watershed does not meet state water quality standards or fails to achieve aquatic system goals related to habitat and ecosystem health. Category I watersheds are also assigned a priority for restoration. The Lower Smoky Hill Watershed is ranked 35th in priority out of 92 watersheds in the state. As a part of the Lower Smoky Hill River Watershed, the Project Area of this WRAPS process is also in need for protection and restoration.

4.1 Description

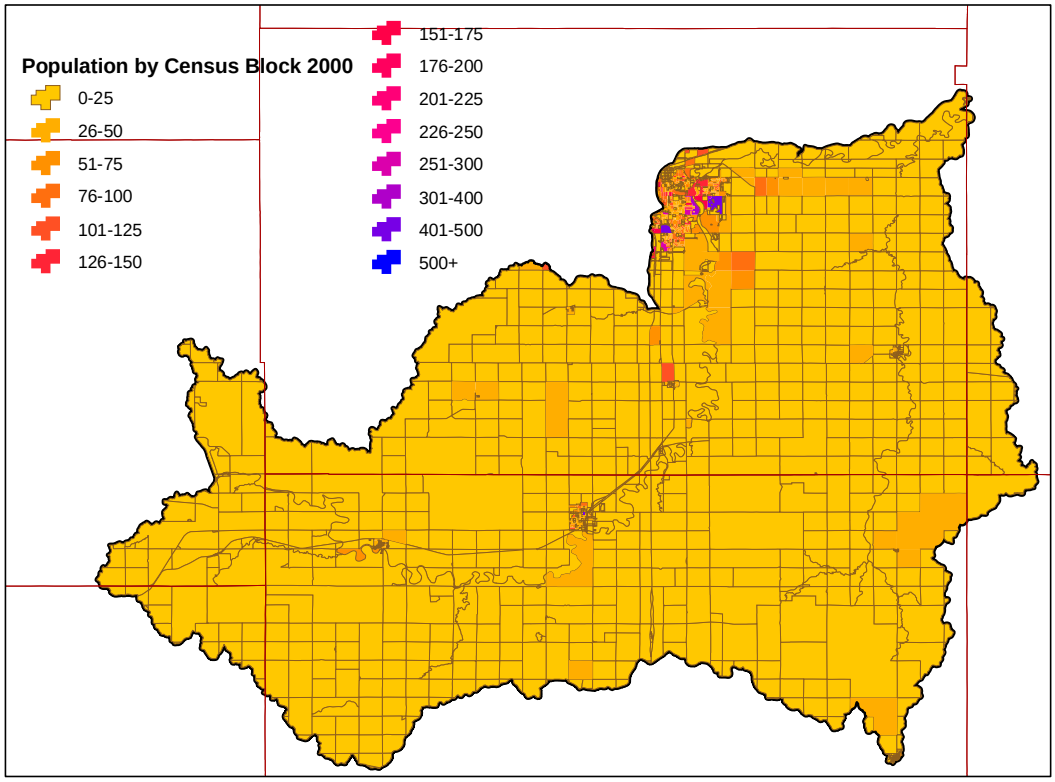
The Project Area is comprised of over 500,000 acres that is primarily contained in Saline and McPherson Counties with small coverage in Ellsworth, Rice, Dickinson and Marion counties in central Kansas.

Figure 2. Overview of Project Area



The major city in the watershed is Salina (pop. 45,833). Four smaller municipalities in the watershed are Marquette (pop. 542), Lindsborg (pop. 3,321), Assaria (pop. 438) and Solomon (pop. 1,072) according to the 2000 US Census Bureau. Approximately 132,259 people live in the six counties that cover the watershed; however this number includes several large cities within the counties that are not contained within the Project Area. According to the US Census Bureau, the average population density (in the six counties covering the Project Area) is slightly below the Kansas state average. Population decreased in the Project Area counties of the watershed by an average of 1.9 percent from 2000 to 2006 (US Census Bureau).

Figure 3. Population Distribution Map



4.2 Public Water Supply and NPDES

Most of the Public Water Supply (PWS) diversion points in this watershed are from groundwater wells. Only the town of Salina (Population 48,766) has a surface water diversion point on the Smoky Hill River. Excess sediment in the river can affect this surface water diversion point by:

- The need to remove excess sediment buildup at the water intake, or
- The need to perform additional treatment procedures for sediment removal prior to consumption.
- E. coli bacteria will also affect surface water supplies causing an extra cost in water treatment prior to public consumption.

Salina is the only PWS in the Project Area to be affected by these surface water related problems since all other PWS are groundwater in origin and groundwater does not tend to be affected by sediment or E. coli bacteria.

The table below lists the public water supplies in the Upper Lower Smoky Hill River Watershed. *(Table provided by KDHE 2010)*

Upper Lower Smoky Hill River WRAPS Public Water Supply Information				
Public Water Supplier	Water Type	Water Source	Surface Water Body Source	Population Served (2010 Est.)
Assaria	Groundwater	Well	N/A	469
Gypsum	Groundwater	Well	N/A	412
Kanop O Lanes Trailer Court	Groundwater	Well	N/A	N/A
Lakeside Recreational Park	Groundwater	Well	N/A	N/A
Lindsborg	Groundwater	Well	N/A	3,937
Marquette	Groundwater	Well	N/A	584
Salina	Groundwater and Surface Water	Well and River	Smoky Hill River	48,766
Saline Co. RWD 1	Groundwater	Well	N/A	156
Saline Co. RWD 2	Groundwater	Well	N/A	376
Saline Co. RWD 8	Groundwater	Well	N/A	249
Southeast Saline Schools	Groundwater	Well	N/A	N/A
Total Population				54,949

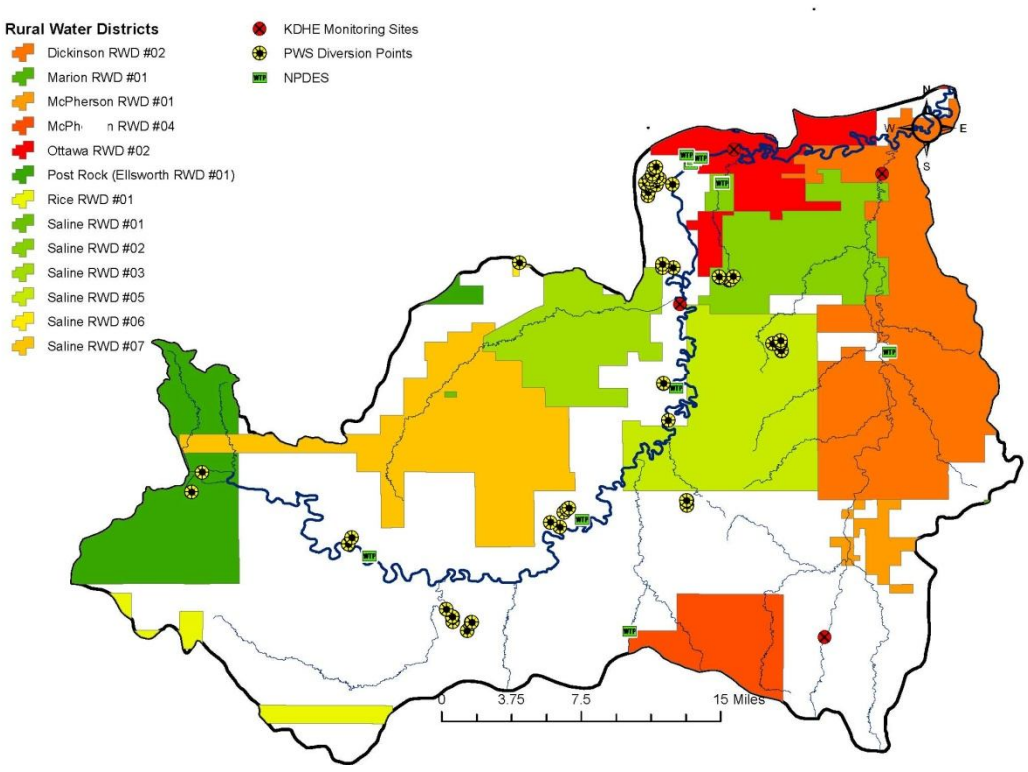
Wastewater treatment facilities are permitted and regulated through KDHE. They are considered point sources of pollutants. National Pollutant Discharge Elimination System (NPDES) permits specify the maximum amount of pollutants allowed to be discharged to surface waters. Having theses point sources located on streams or rivers may impact water quality in the waterways. For example, municipal waste water can contain suspended solids, biological pollutants that reduce oxygen in the water column, inorganic compounds or bacteria. Waste water will be treated to remove solids and organic materials, disinfected to kill bacteria and viruses, and discharged to surface water. Treatment of municipal waste water is similar across the country.[3] A wasteload allocation is the load of pollutant a discharger is allowed to release, which is typically set in the TMDL; otherwise it is considered a permitted discharge. The watershed has ten NPDES facilities.

Table 1. NPDES Facilities[4]

ID	Town Location	Waterway	Type of System
41	Salina	Smoky Hill River	Trickle Filter Multi Stage
42	Salina	Smoky Hill River	Trickle Filter Multi Stage
43	Salina	Smoky Hill River	Trickle Filter Multi Stage
244	Salina	Smoky Hill River	Trickle Filter Multi Stage
695	None	Unnamed Creek	Waste Stabilization Pond; Overflowing
827	Asyria	Smoky Hill River	Waste Stabilization Pond; Overflowing
833	Lindsborg	Smoky Hill River	Oxidation Ditch
834	Marquette	Smoky Hill River	Waste Stabilization Pond; Overflowing
921	None	West Dry Creek	Waste Stabilization Pond; Overflowing
1020	Gypsum	Gypsum Creek	Waste Stabilization Pond; Overflowing

The municipal and industrial wastewater treatment facilities in the Project Area are located in Figure 4. Thousands of onsite wastewater systems exist in the basin. The functional condition of these systems is generally unknown. All counties in the watershed have sanitary codes.

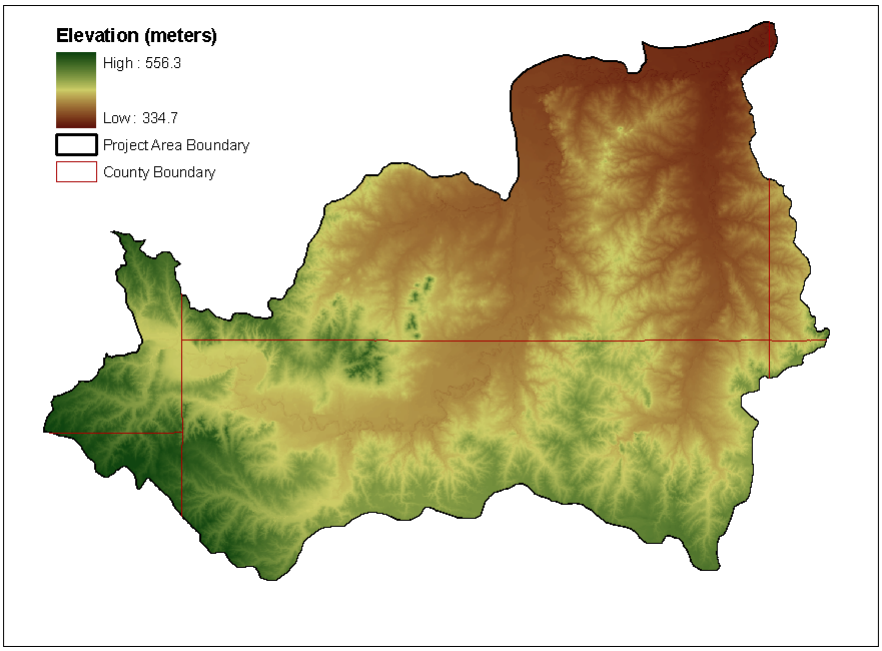
Figure 4. Rural Water Districts in the Project Area



4.3 Water Resources and Uses

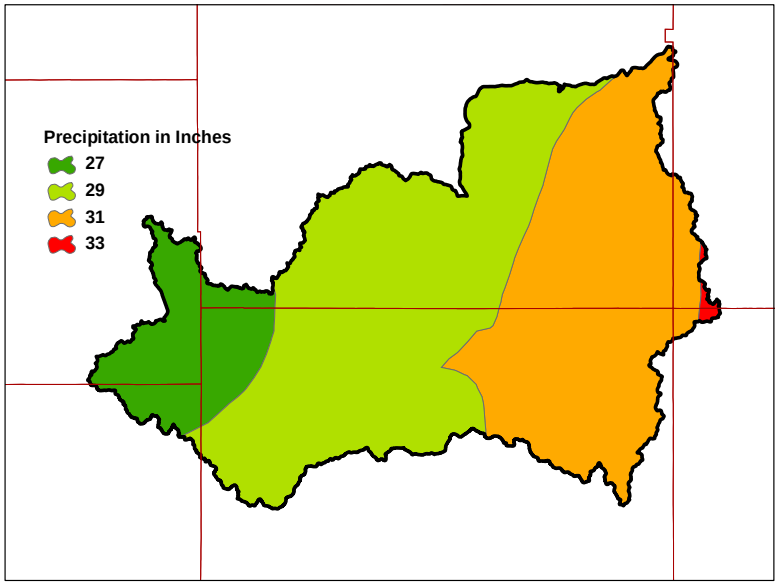
The major river in the Project Area is the Smoky Hill River. Gypsum, Battle, Dry, Sharps and Sand Creeks are a few of the tributaries of the Smoky Hill River. The elevation of the watershed is distinct. The lower, flatter plains lie along the river and stream corridors with the edges of the watershed flanked by hills.

Figure 5. Relief Map



Annual rainfall averages range from 27 to 33 inches. Precipitation in the watershed averages 30 inches per year.

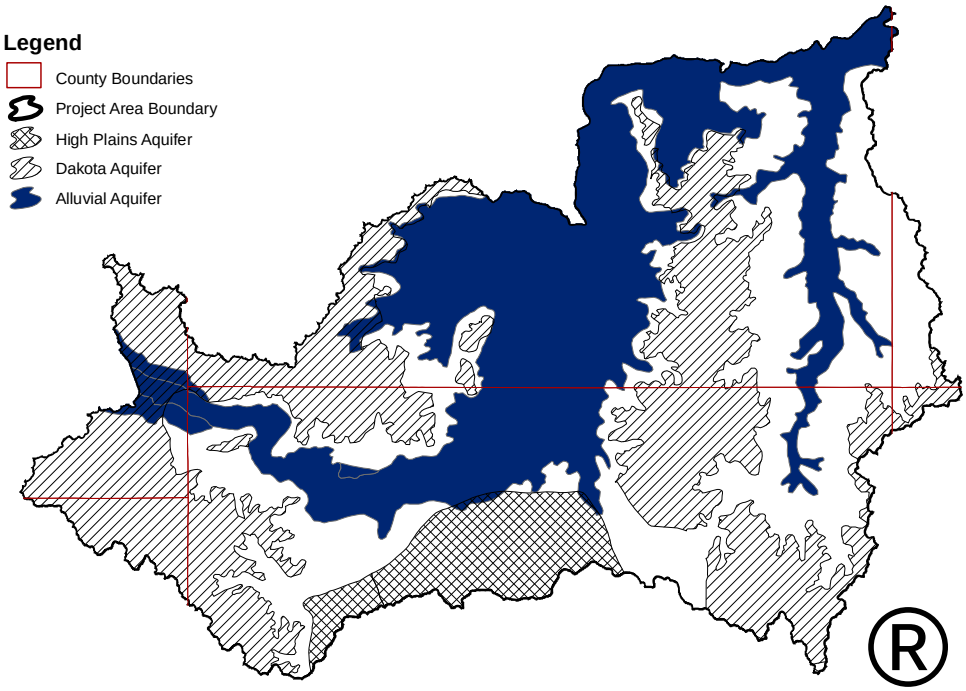
Figure 6. Precipitation Map



The Project Area lies above portions of the Alluvial Aquifer, the Dakota Aquifer and High Plains Aquifers.

- Alluvial Aquifer - The alluvial aquifer is a part of and connected to a river system and consists of sediments deposited by rivers in the stream valleys. The Alluvial Aquifers follow the path of the Smoky Hill River and its tributaries and are interconnected to the surface water in the river.
- Dakota Aquifer - The Dakota aquifer extends from southwestern Kansas to the Arctic Circle. In recent years, the Dakota aquifer has been used for irrigation purposes in southwest and in north-central Kansas (Cloud, Republic and Washington counties) and continues to present time. The Dakota aquifer also provides water for municipal, industrial, and stock water supplies. A one-mile distance between wells is the current stipulation for drilling in the Dakota.
- High Plains Aquifer – The High Plains Aquifer is a primary source of groundwater in western Kansas. Drawdown or depletion of the aquifer has greatly surpassed the rate of natural recharge. Responses of future aquifer withdrawals are predicted to cause continued aquifer declines, a reduction in the number of functional wells, and an increase of saline water intrusion into the aquifer.

Figure 7. Aquifers



There are approximately 3,305 registered groundwater wells in the entire Lower Smoky Hill River Watershed. Water from these wells is used for domestic use, monitoring, irrigation, livestock watering, lawn and gardening, and public water supply.

The surface waters in the Upper Portion of the Lower Smoky Hill River Watershed are generally used for aquatic life support, food procurement, domestic water supply, recreational use, groundwater recharge, industrial water supply, irrigation and livestock watering. Surface waters are given certain "designated uses" based on what the waters will be used for as stated in the Kansas Surface Water Register, 2009, issued by KDHE. For example, waters that will come into contact with human skin should be of higher quality than waters used for watering livestock. Therefore, each "designated use" category has a different water quality standard associated with it. When water does not meet its "designated use" water quality standard then the water is considered "impaired."

Table 2. Designated Water Uses

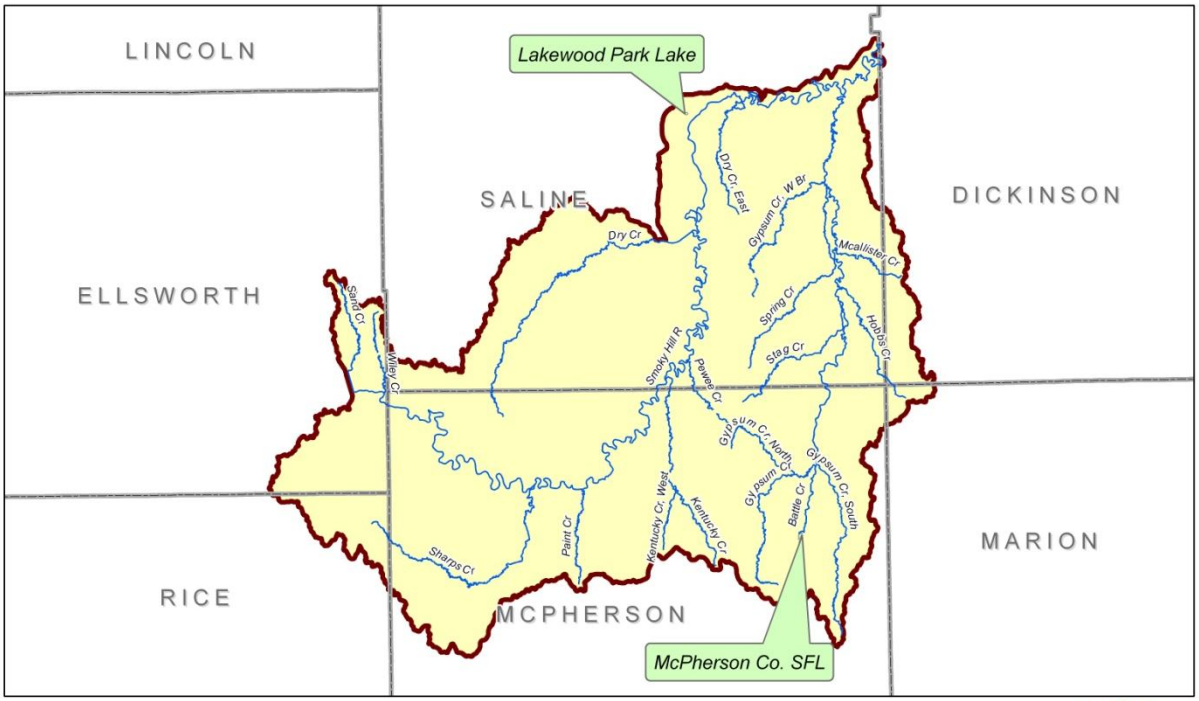
Lake/Stream Name	CUSEGA	CLASS	AL	CR	FP	DS	GR	IW	IR	LW
Battle Creek	1026000823	GP	E	b	O	X	X	X	X	X
Dry Creek	1026000836	GP	E	b	O	O	X	X	X	X
Dry Creek, East	1026000843	GP	E	b	O	O	X	O	X	X
Gypsum Creek	1026000818	GP	E	C	X	X	X	X	X	X
Gypsum Creek	1026000820	GP	E	C	X	X	X	X	X	X
Gypsum Creek	1026000822	GP	E	b	O	X	X	X	X	X
Gypsum Creek, North	1026000857	GP	E	b	O	X	X	X	X	X
Gypsum Creek, South	1026000824	GP	E	b	O	X	X	X	X	X
Gypsum Creek, West Branch	1026000844	GP	E	b	O	X	X	X	X	X
Hobbs Creek	1026000848	GP	E	b	O	O	X	O	X	X
Kentucky Creek	1026000817	GP	E	b	O	X	X	X	X	X
Kentucky Cr, West	1026000854	GP	E	b	X	X	X	X	X	X
Mcallister Creek	1026000849	GP	E	b	O	O	X	O	X	X
Paint Creek	1026000852	GP	E	b	X	X	X	X	X	X
Pewee Creek	1026000856	GP	E	b	O	X	X	X	X	X
Sand Creek	1026000846	GP	E	b	O	O	X	O	X	X
Sharps Creek	1026000816	GP	E	b	O	X	X	X	X	X
Smoky Hill River	1026000811	GP	E	C	X	X	X	X	X	X
Smoky Hill River	1026000812	GP	E	C	X	X	X	X	X	X
Smoky Hill River	1026000813	GP	E	B	X	X	X	X	X	X
Smoky Hill River	1026000814	GP	E	B	X	X	X	X	X	X
Smoky Hill River	1026000815	GP	E	B	X	X	X	X	X	X
Spring Creek	1026000845	GP	E	b	O	O	X	O	X	X
Stag Creek	1026000819	GP	E	b	O	O	X	O	X	X
Wiley Creek	1026000847	GP	E	b	O	O	X	O	X	X
Lakewood Park Lake	N/A	GP	E	B	X	X	X	X	X	X
McPherson County State Fishing Lake	N/A	GP	E	B	X	X	X	X	X	X

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

E = Expected Aquatic Life Use Water
X = Referenced stream segment is assigned the indicated designated use
C = Primary contact recreation stream segment is not open to and accessible by the public under Kansas law
b = Secondary contact recreation stream segment is not open to and accessible by the public under Kansas law

Below is a map of all KDHE Classified waters, including lakes, in the Upper Lower Smoky Hill River WRAPS Project Area.

Figure 8. Upper Lower Smoky WRAPS KDHE Classified Waters



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KDHE maintains three stream **monitoring sites** in the Project Area. Two are located on the Smoky Hill River with the final site on Gypsum Creek. A lake monitoring site is located in McPherson County State Fishing Lake.

4.4 Land Cover/Uses

Land use activities have a significant impact on the types and quantity of nonpoint source pollutants in the watershed. Urban sprawl or the conversion of agricultural land to suburban homes and small acreages farms can have an impact on water quality. In addition, agricultural activities and lack of maintenance of agricultural structures can have cumulative effects on land transformation.

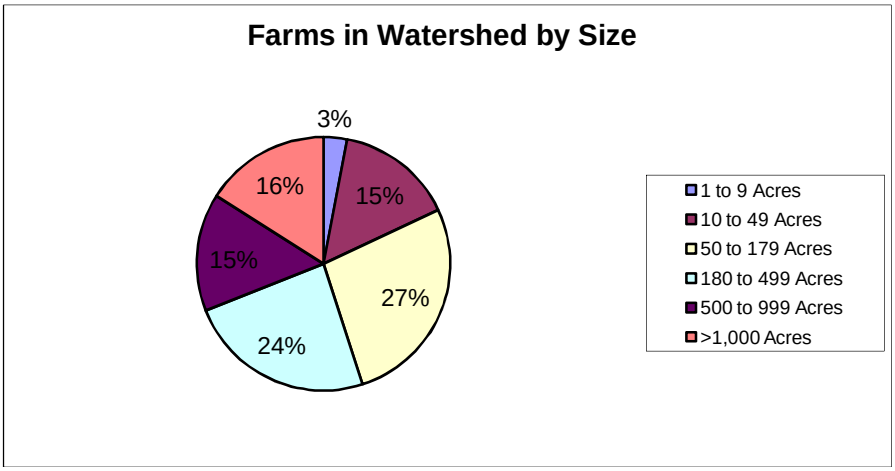
The major land use in the watershed is **grassland** covering 47**%** of the watershed. Grassland can be a major contributor of sediment, nutrients and E. coli bacteria pollution. Gullies in rangeland are a major source of erosion and sedimentation. E. coli and nutrients can originate from grasslands through overgrazing and allowing livestock access to streams and creeks.

Sources of sediment and nutrients originating from **cropland** (40**%** of the watersheds land use) can originate from overland flow across conventional tilled crop fields and ephemeral gullies that are plowed through each year. Cropland bacteria can originate from application of manure prior to a rainfall event or on frozen ground.

The remaining land uses in the watershed is **woodlands** (~4%)**,** and **urban and recreational water uses** (6%).

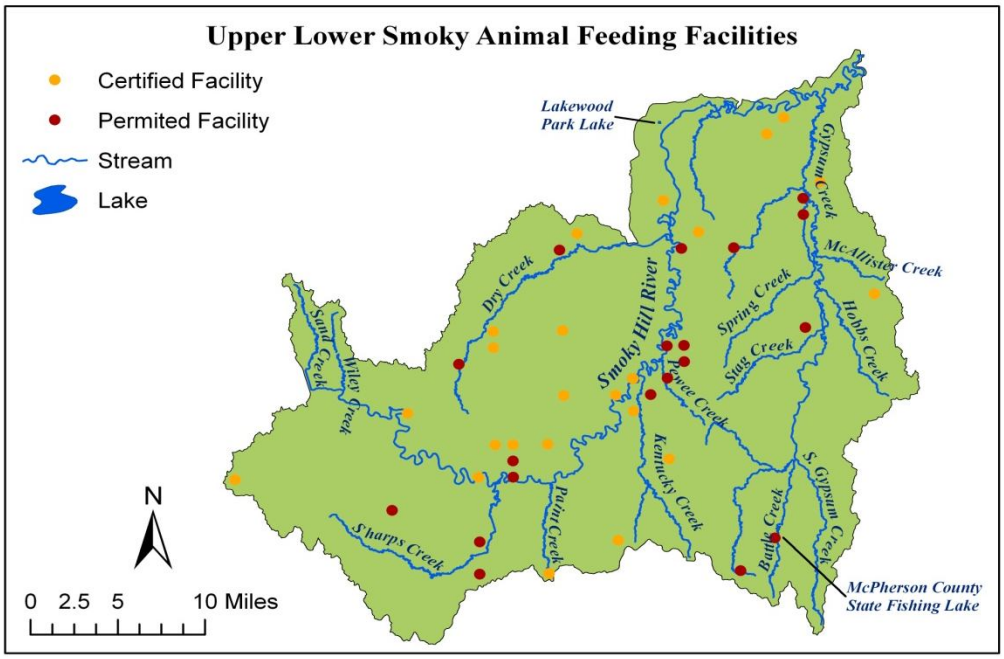
Note: Additional contribution of E. coli bacteria can be from humans through failing or inadequately constructed septic systems. Also, failing and sloughing streambanks with undercuts will also contribute to sediment.

According to the National Agricultural Statistics Service (2002), there are a total of 926 farms in the Project Area. The average size of a farm is 653 acres. Crops grown are primarily wheat, grain sorghum, corn and soybeans.



In Kansas, animal feeding operations (AFOs) with greater than 300 animal units must register with KDHE. Confined animal feeding operations (CAFOs), those with more than 999 animal units, must be permitted with EPA. An animal unit or AU is an equal standard for all animals based on size and manure production. For example: 1 AU=one animal weighing 1,000 pounds.

Figure 9. Animal Feeding Facilities in the Project Area (provided by KDHE)



PERMIT TYPE

1. Permitted Facility - A CAFO that requires on site animal waste management system based upon its pollution potential. A state permit is issued for facilities between 300 and 999 animal units (A.U.); in addition, a federal permit is issued to facilities in excess of 1000 A.U. based upon federal (EPA) animal count procedures.

2. Certified Facility - A facility that does not pose a significant pollution potential as determined by KDHE investigation. Certified facilities can be up to 999 animal units and cannot have pollution control structures in place.

Kansas Animal Unit Multipliers

An Animal Unit (AU) is a unit of measurement intended to make comparable the waste generated by different species. As determined by Kansas's law (KSA 65-171d):
The number of beef cattle weighing more than 700 pounds multiplied by 1.0
The number of cattle weighing less than 700 pounds multiplied by 0.5
The number of mature dairy cattle multiplied by 1.4
The number of swine weighing more than 55 pounds multiplied by 0.4
The number of swine weighing 55 pounds or less multiplied by 0.1
The number of sheep or lambs multiplied by 0.1
The number of horses multiplied by 2.0
The number of turkeys multiplied by 0.018
The number of laying hens or broilers, if the facility has continuous overflow watering, multiplied by 0.01
The number of laying hens or broilers, if the facility has a liquid manure system, multiplied by 0.033
The number of ducks multiplied by 0.2

Figure 10. Landcover (National Land Cover Database, 2001)

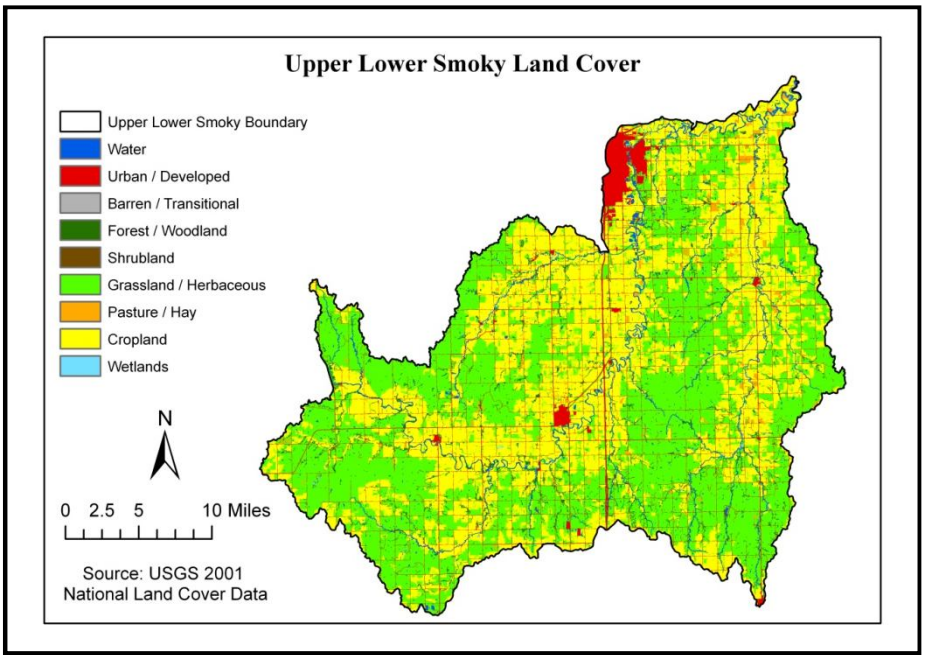


Table 3. Land Use Distribution (National Land Cover Database, 2001)

Land Cover/Land Use in the Lower Smoky Hill Watershed	**Acres**	**%**
Grassland/Herbaceous	240,868	47.3
Cropland	203,290	39.9
Urban/Developed	31,362	6.2
Forest/Woodland	18,445	3.6
Water	6,442	1.3
Pasture/Hay	4,494	0.9
Wetlands	3,934	0.8
Barren/Transitional	28	0.0
Shrubland	10	0.0
Total Acres	508,872	100

Table 4. Land Cover/Land Use Definitions

Land Cover/Land Use	Definition
Water	All areas of open water, generally with less than 25% cover of vegetation or soil.
Urban/Developed	Includes developed open spaces with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses such as large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes. Also included are lands of low, medium, and high intensity with a mixture of constructed materials and vegetation, such as single-family housing units, multifamily housing units, and areas of retail, commercial, and industrial uses.
Barren/Transitional	Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
Forest/Woodland	Areas dominated by trees generally taller than 5 meters, and greater than 20% of total vegetation cover. Includes deciduous forest, evergreen forest, and mixed forest.
Shrubland	Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
Grassland/Herbaceous	Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
Pasture/Hay	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.
Cropland	Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.
Wetlands	Areas where forest or shrubland vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water. This class also includes areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
Source: http://www.mrlc.gov/nlcd_definitions.php and http://www.mrlc.gov/changeproduct_definitions.php	

4.5 Special Aquatic Life Use Waters

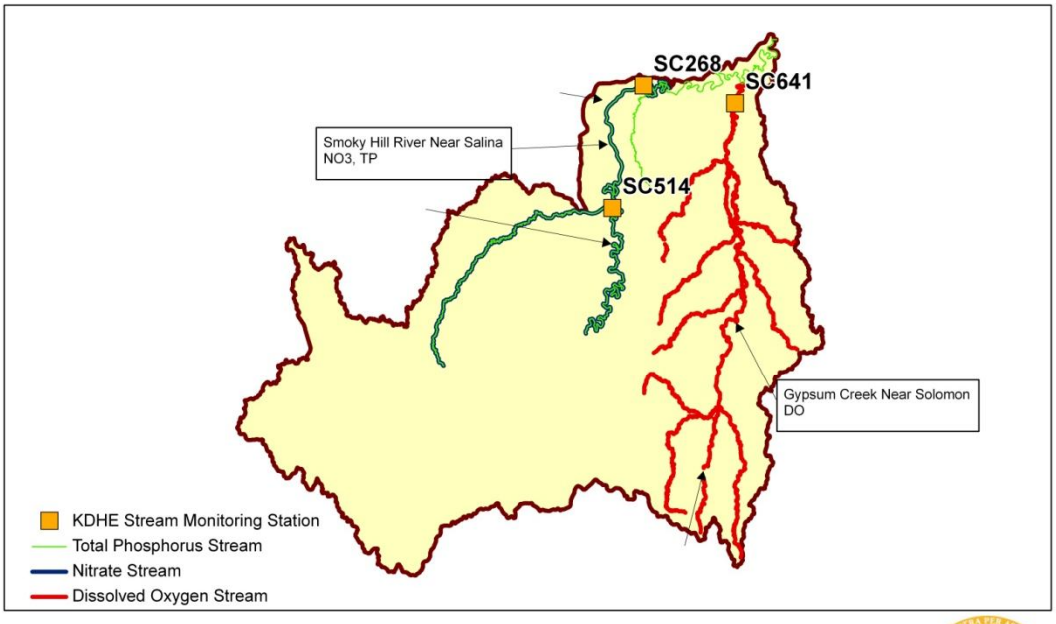
Special aquatic life use waters are defined as “surface waters that contain combinations of habitat types and indigenous biota not found commonly in the state, or surface waters that contain representative populations of threatened or endangered species.” The Upper Portion of the Lower Smoky Hill River Watershed has NO special aquatic life use waters.

5.0 Overview of Water Quality

5.1 303d Listings in Watershed

As part of the federal *Clean Water Action Plan* completed by KDHE and Natural Resource Conservation Service (NRCS), the Smoky Hill River Watershed was classified as a "Category I – Watershed in Need of Restoration" for water quality and natural resource degradation. It is ranked 35th out of ninety-two watersheds in Kansas in need of restoration. 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. After being included on the 303d list, a water body will then be assigned a TMDL for that impairment. A TMDL designation sets the maximum amount of pollutant that a specific body of water can receive without violating the surface water quality standards, resulting in failure to support their designated uses. TMDLs provide a tool to target in order to reduce point and nonpoint pollution sources. The goal of the WRAPS process is to address high priority TMDLs. Based on the watershed approach, 100% of the stream miles in the Lower Smoky Hill River Watershed are impaired. Sulfate (S), biology (Bio), chloride (Cl), aquatic plants (AP), dissolved oxygen (DO), eutrophication (E) and pH are impairments of the streams and lakes in the watersheds in the Project Area.

Figure 11. 303(d) List Impaired Waters



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5.2 TMDLs in the Watershed

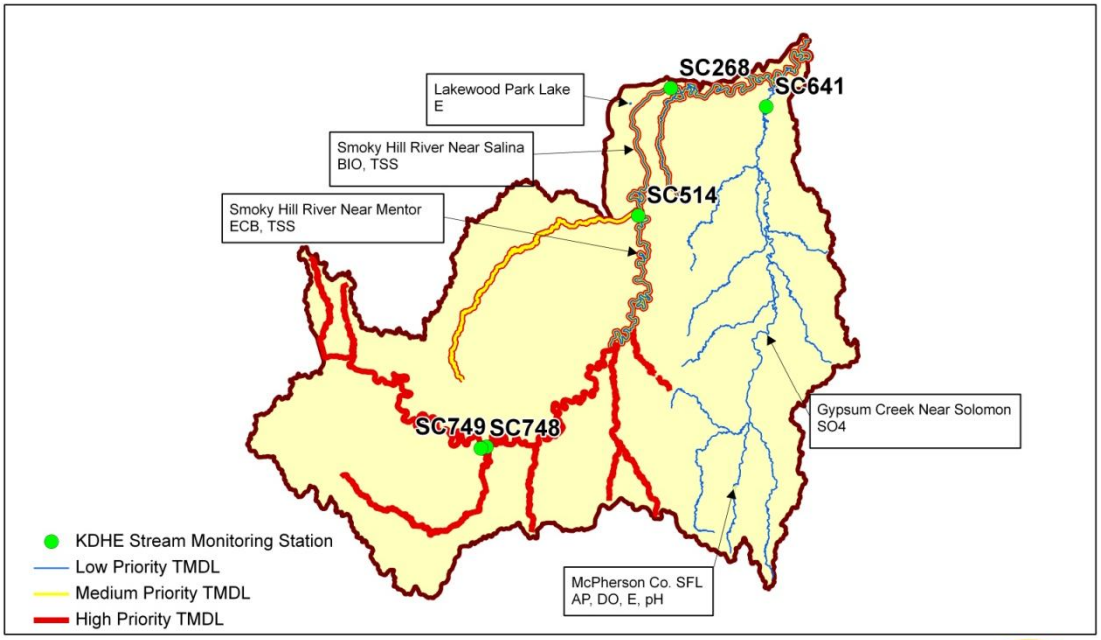
A TMDL designation sets the maximum amount of pollutant that a specific body of water can receive without violating the surface water-quality standards, resulting in failure to support their designated uses. TMDLs provide a tool to target and reduce point and nonpoint pollution sources. TMDLs established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

KDHE reviews TMDLs assigned in each of the twelve basins of Kansas every five years on a rotational schedule. The table below includes the review schedule for the Smoky Hill-Saline Basin.

Table 5. TMDLs Review Schedule for the Smoky Hill-Saline Basin[5]

Year Ending in September	Implementation Period	Possible TMDLs to Revise	TMDLs to Evaluate
2009	2010-2019	2003	N/A
2014	2015-2024	2003, 2004	2003, 2004, 2006
2019	2020-2029	2003, 2004, 2009	2003, 2004, 2006, 2009

Figure 12. TMDL Impaired Waters



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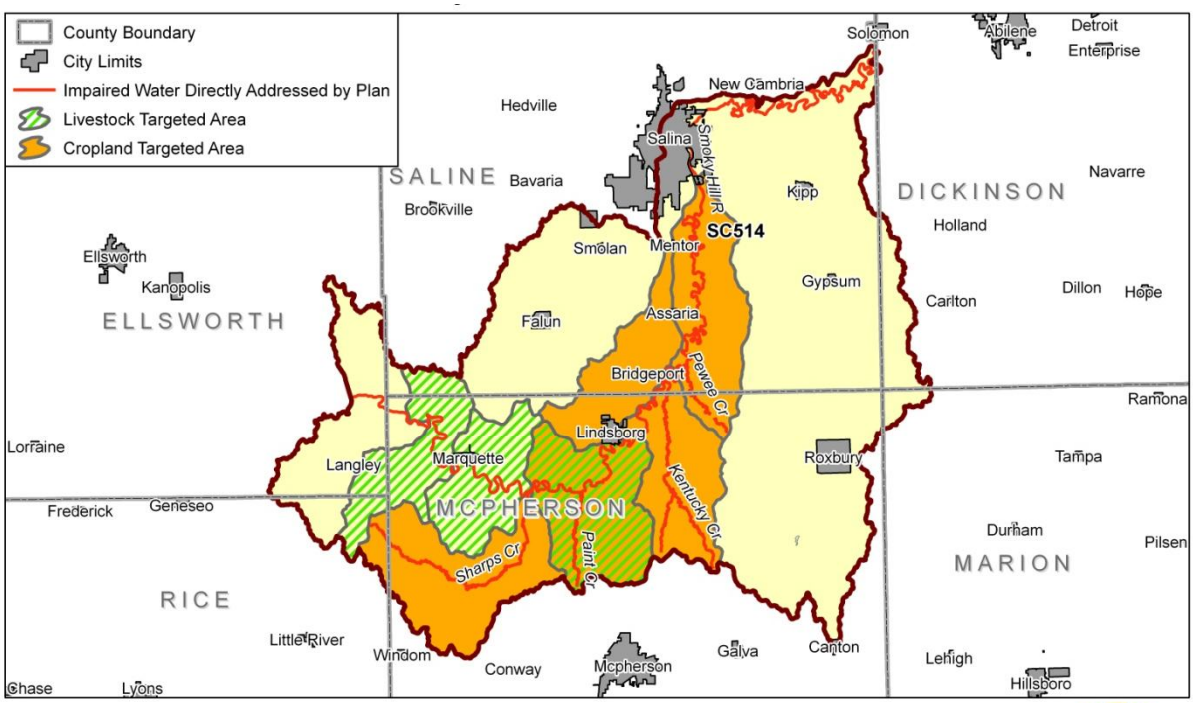
Water Quality Impairments and TMDL(s) in the Upper Portion of the Lower Smoky Hill River Watershed are listed in the table below.

Table 6. Water Quality Impairments in the Project Area[6]

Water Quality Impairments and TMDL(s) in the Upper Portion of the Lower Smoky Hill River Watershed are listed in the table below. Category 4a and 5, impaired water segments high-lighted in yellow are those in which the SLT has chosen to target in this WRAPS Plan. Each high-lighted segment bares the impairment listed to the left. Areas high-lighted in green are not directly targeted by this WRAPS Plan but will subsequently be addressed as implementation takes place.			
Category 4a – TMDL has been developed for water			
Impairment	**Water Segment**	**Priority**	**Sampling Station**
Biology (BIO)	Smoky Hill River near Salina	Medium	SC268
E. coli Bacteria	Smoky Hill River near Mentor	High	SC514
Total Suspended Solids (TSS)	Smoky Hill River near Mentor	High	SC514
	Smoky Hill River near Salina	High	SC268
Category 5 – 303(d) Listed Waters that are Impaired by Pollutants and in need of TMDLs.			
Impairment	**Water Segment**	**Priority**	**Sampling Station**
Nitrate (NO3)	Smoky Hill River near Salina	Low	SC268
Total Phosphorus (TP)	Smoky Hill River near Salina	Low	SC268

The map below indicates the impaired waters that will be directly addressed by this WRAPS Plan.

Figure 13. TMDL and 303(d) Impaired Waters Directly Addressed by WRAPS Plan



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5.3 Impairments Assigned to the Lower Smoky Watershed

5.3.1 Impairments NOT targeted by this WRAPS Plan

Aquatic Plants (AP) is listed as a medium priority TMDL for the McPherson County State Fishing Lake (SFL) at Sampling Station LM013501. Though they may be a nuisance, aquatic plants create less of an impact to the designated uses than do algal blooms. The aquatic plant community provides shoreline protection and habitat for fishes and other aquatic life. Lakes are considered impaired for recreation only if aquatic plants cover greater than 70% of the lake surface. The growth of aquatic plants can be reduced to acceptable levels (30 to 40% cover) if the nutrient level is reduced. Generally, total phosphorus levels less than 50 ppb tended to maintain healthy plant communities where macrophyte restoration was the goal. Greater total phosphorus levels tended to allow nuisance species to re-invade, or plants to succumb to algal blooms shading them out.

Dissolved Oxygen (DO) is a medium priority TMDL at McPherson County SFL, Sampling Station LM013501. Dissolved oxygen problems arise within the water column of lakes through the decomposition of organic matter. Excessive algal growth in the

water creates dissolved oxygen problems in three ways. First, the obvious crash of the algal bloom places dead and decomposing organic matter within the water column, exerting an oxygen demand as the decomposition process ensues. The second, more subtle impact on oxygen is the shading effect the near-surface plankton has on algae at lower depths. Effectively blocking sunlight from reaching those lower depths shifts the biological process of the deeper algae from oxygen production to oxygen uptake through respiration. Finally, the growth stemming from primary productivity is driven during daylight hours by the presence of sunlight, but the resulting biomass reverts to oxygen demanding respiration during the night. Reductions in nutrients, particularly phosphorus, should result in diminished algal growth and primary productivity, thereby lowering the amount of organic matter which the lake water must assimilate through the decomposition process, using its oxygen reserves dissolved within the water column.

Eutrophication (E) is a TMDL that is listed for water bodies in the Upper Portion of the Lower Smoky Hill River Watershed. E is listed as a low priority TMDL for Lakewood Park Lake and is listed as a medium priority TMDL for McPherson County SFL.

pH is a medium priority TMDL for McPherson County SFL, Sampling Station LM013501. Levels of pH typically rise above 8.5 under vigorous photosynthesis. Photosynthesis drives the biological system by converting carbon dioxide and water through sunlight into sugar and oxygen. An additional end-product from the photosynthesis process is hydroxyl ions, stripped of hydrogen atoms in the production of glucose. Therefore, not only is carbon dioxide taken up from the water column, where it tends to form carbonic acid with disassociated hydrogen ions, but the addition of the hydroxyl ions in combination with bicarbonate ions in the water column raises pH levels. Explosive primary productivity driven by photosynthesis and results in pH rises above the desired 8.5 level. Therefore, more moderate productivity, in terms of rate and biomass volume, induced by lower available nutrients should yield more temperate rises of pH and maintain conditions within the 6.5-8.5 level expressed as water quality standards.

As mentioned above, McPherson County SFL has TMDLs for E, DO, AP and pH. These water quality impairments are interconnected in the lake's ecosystem. **E** is a natural process that occurs when a water body receives excess nutrients. These excess nutrients, primarily nitrogen and phosphorus, create optimum conditions that are favorable for algal blooms and plant growth. Some species of blue-green algae produce toxins that are harmful to both animals and humans. These algal blooms have been linked to health problems ranging from skin irritation to liver damage to death, depending on type and duration of exposure. The livelihood of many fish, shellfish, and livestock has also been endangered through contact with this toxin. Proliferation of algae and subsequent decomposition can also deplete available dissolved oxygen in the water profile. As discussed under TSS, this lack of dissolved oxygen is devastating for aquatic species and can lead to fish kills. These excess nutrients can originate from failing septic systems and manure and fertilizer runoff in rural and urban areas. Desirable criteria for a healthy water profile includes **DO** rates greater than 5 milligrams per liter and biological oxygen demand (BOD) less than 3.5 milligrams per liter. BOD is

a measure of the amount of oxygen removed in water from biodegradable organic matter. It can be used to indicate organic pollution levels. McPherson County SFL is limited by light penetration as indicated by a Secchi disc depth of fifteen inches (the depth at which a lowered disc is no longer visible indicating transparency of the water column). This is due to clay turbidity in the lake. The chlorophyll a average of the lake is 52.7ug/liter. Chlorophyll a concentration greater than 30 mg/liter is considered to be hypertrophic. The dissolved oxygen concentration levels are compromised at increasing depth due to **AP** life. At three meters, the dissolved oxygen concentration is 4.5 mg/L, which is below the 5 mg/L cutoff for adequate oxygen for fish. Similarly, **pH** averages 8.0, which exceeds the criteria for healthy ecosystem. The pH of water determines the solubility and biological availability of chemical constituents such as nutrients and heavy metals.

In the McPherson County SFL, with impairments cited for eutrophication, dissolved oxygen, pH, and aquatic plants, the impairments are bundled together because all of these impairments are linked to elevated nutrient levels. The TMDLs are developed based on the belief that nutrient level decreases would induce lower algal productivity with corresponding reductions in incidents of depleted dissolved oxygen and elevated ph. Reduced nutrient availability also limits uptake by aquatic plants and tempers their growth. In all these bundled TMDLs, the desired endpoint is to reduce the average summer chlorophyll a concentrations so that the designated uses are achieved. The implementation measures would work toward reducing the limiting nutrient(s).

Sulfate (SO4) is listed as a low priority TMDL for Gypsum Creek near Solomon at Sampling StationSC641. SO4 is a naturally occurring mineral in gypsum beds, outcrops and enriched soils. As the water in the river flows across these sulfur containing rock formations, it interacts and subsequently absorbs sulfate in the water column. The TMDL criterion for sulfate is set at less than 250 milligrams per liter of water. Sulfate concentration in the river is inversely proportional to flow rate. When the flow in the river is high, sulfate concentration is low and, conversely, when river flow rate is low, sulfate concentration is dramatically high. Therefore, there is a seasonal inconsistency in sulfate concentration in the river. There is some evidence that oil brine scar sites or excessive irrigation withdrawals could cause high sulfate concentrations, however, the majority of the sulfate intrusion is a natural occurrence. Because there can be minimal control on natural contributions, the TMDL is set as a low priority. High sulfate concentrations in water can cause digestive problems in humans and livestock in addition to taste and odor problems in drinking water.

5.3.2 Impairments Targeted by this WRAPS Plan

Biology (BIO) is listed as a medium priority TMDL for support of aquatic life in the Smoky Hill River near Salina, Sampling Station SC268. This WRAPS plan will **positively impact** this TMDL by BMP implementation. In 1994, the City of Salina started diverting wastewater flow to a new Wastewater Treatment Plant. The biological community responded positively to the resulting water quality changes. Prior to the upgrade, the average Macroinvertebrate Biotic Index (MBI) value was 4.95 indicating

that the aquatic community was partially impaired. High MBI numbers indicate greater pollutant load. The Smoky Hill River now averages a MBI of 4.00. Organic material from agricultural and urban nonpoint sources may contribute to the biological impairment downstream. These sources tend to become dominant under higher flow conditions. Additional biological measures are necessary to assure indications of good aquatic community health.

E. coli Bacteria has been added to the 303(d) list as a high priority for Smoky Hill River near Mentor at Sampling Station SC514. This area will be **directly targeted** by this WRAPS Plan. E. coli can originate in both rural and urban areas. In the past, KDHE has measured fecal coliform bacteria in determination of issuance of a TMDL. Currently, KDHE is transitioning from measuring FCB to measuring levels of E. coli bacteria due to E. coli being more specific for indicating potential for human disease. Presence of E. coli in waterways can originate from failing septic systems, runoff from livestock production areas, close proximity of any mammals to water sources, and manure application to agricultural fields.

EPA required the adoption of the E. Coli standard in 2003 since E. Coli correlates better between illness and concentrations than FCB. Kansas House Bill 2219 established the E. Coli criteria which is based on a geometric mean for 5-samples collected in a 30-day period with numeric standards based on the designated recreational use of the stream.

The bacteria endpoints tied to water quality standards will be maintaining geometric means of bacteria samples collected within 30-day periods during April-October below 262 cfus/100ml on these streams. Reductions in frequency and magnitude of high bacteria will serve as the necessary allocations to reduce “loading” and achieve the water quality standard.

Throughout the remainder of this WRAPS Plan, the term “Bacteria” will be used and will indicate both FCB and E. Coli Bacteria as required by the 2003 Water Quality Standard for E. Coli Bacteria, House Bill 2219.

Nitrate (NO3) has been 303 (d) listed as a low priority for the Smoky Hill River near Salina at Sampling Station SC268. Water naturally contains less than 1 milligram of nitrate-nitrogen per liter and is not a major source of exposure. Higher levels indicate that the water has been contaminated. Common sources of nitrate contamination include fertilizers, animal wastes, septic tanks, municipal sewage treatment systems, and decaying plant debris. High nitrate concentrations can cause health problems. For example, infants who are fed water or formula made with water that is high in nitrate can develop a condition that doctors call methemoglobinemia, also called "blue baby syndrome" because the skin appears blue-gray or lavender in color. This color change is caused by a lack of oxygen in the blood. While not directly targeted by this WRAPS Plan, upstream BMP implementation targeted towards the TP and TSS impairments will **positively impact** the NO3 impairment on the Smoky Hill River near Salina.

Total Phosphorus (TP) is 303(d) listed as a low priority for Smoky Hill River near Salina. A TP impairment is a common impairment and can be caused by excessive application to crop fields. When a runoff event occurs, excess P is delivered to nearby water bodies. Livestock near small creeks and other waters bodies can also increase P input into those water segments. As mentioned above, excessive P inputs into water bodies can contribute to E, DO, AP and BIO impairments. Therefore, TP will be **directly targeted** on cropland and livestock areas in the Smoky Hill River near Salina segment, Sampling Station SC268.

Total Suspended Solids (TSS) is listed as a high priority TMDL for Smoky Hill River near Mentor and Salina (Sampling Stations SC514 and SC268, respectively). These segments will both be **directly targeted** by this WRAPS Plan. TSS is made up of particles such as soil, algae, and finely divided plant material suspended in water. These pollutants may attach to sediment particles on the land and be carried into water bodies with storm water. In the water, the pollutants may be released from the sediment or travel farther downstream. These particles can come from cropland, stream banks, construction sites, as well as municipal and industrial wastewater. High TSS can block light from reaching submerged vegetation, slowing down photosynthesis. High TSS can also cause an increase in surface water temperature as the suspended particles absorb heat from sunlight, also harming aquatic life. Suspended sediment can clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development. When suspended solids settle to the bottom of a water body, they can smother the eggs of fish and aquatic insects, as well as suffocate newly hatched insect larvae. Settled sediments can fill in spaces between rocks which could have been used by aquatic organisms for homes. High TSS can also cause problems for industrial use as solids may clog or scour pipes and machinery.

5.4 TMDL Load Allocations[7]

TMDL loading is based on several factors. A total load is derived from the TMDL. Part of this total load is wasteload allocation. This portion comes from point sources in the watershed: NPDES facilities, CAFOs or other regulated sites. Some TMDLs will have a natural or background load allocation, which might be atmospheric deposition or natural mineral content in the waters. After removing all the point source and natural contributions, the amount of load left is the TMDL Load Allocation. This is the amount that originates from nonpoint sources (pollutants originating from diffuse areas, such as agricultural or urban areas that have no specific point of discharge) and is the amount that this WRAPS project is directed to address. All Best Management Practices (BMPs) derived by the SLT will be directed at this Load Allocation by nonpoint sources.

5.4.1 Total Suspended Solids / Sediment

Sedimentation comes predominantly from nonpoint sources. Based on the soil characteristics of the watershed, overland runoff can easily carry sediment to stream segments. Total Suspended Solids (TSS) which are particles such as soil, algae, and finely divided plant material suspended in water. Sources of TSS are soil erosion from

cropland, stream banks, or construction sites, and municipal and industrial waste. The sediment currently entering the Lower Smoky Hill River annually varies on flow rate.

Using the table below, KDHE has provided numbers for high, medium and low flow rates for the amount of sediment delivered into the Smoky Hill River under those conditions. **Based on these numbers, there is a need to reduce the amount of sediment entering the river by 34,710 tons/year to meet TMDL standards.** BMPs implemented on targeted areas in the watershed will accomplish this goal.

Table 7. TSS Load Reduction Needs

TSS Load Reductions at Salina for Smoky Hill River							
Current condition Salina							
					Nonpoint Needing		
% Flow	**Flow**	**TSS Load**	**TMDL**	**MOS**	**Ton/day**	**% Reduction**	**Ton/year to be reduced**
60	97	14.98	13.1	1.5	3.38	12.55006676	1233.7
50	125	22.55	16.9	2.26	7.91	25.05543237	2887.15
40	168	35.79	22.7	3.58	16.67	36.57446214	6084.55
30	249	66.9	33.6	6.69	39.99	49.77578475	14596.35
20	428	158.4	57.8	15.84	116.44	63.51010101	42500.6
10	1010	618.2	136.4	61.82	543.62	77.93594306	198421.3
6	1740	1466.2	235	146.62	1377.82	83.97217296	502904.3
AVG Flow	**385**	**133.7**	**51.975**	**13.37**	**95.095**	**61.12565445**	**34709.675**

5.4.1 Nutrients

Nutrient concentrations in the Upper Portion of the Lower Smoky Hill River Watershed are derived primarily of nitrogen and phosphorus from in-field runoff. Nitrogen will not be a focus of this WRAPS Plan; however BMPs addressing sediment and phosphorus will provide N load reductions.

Using the table below, KDHE has provided numbers for high, medium and low flow rates for the amount of phosphorus delivered into the Smoky Hill River under those conditions. **Based on these numbers, there is a need to reduce the amount of Phosphorus entering the river by 75,884 lbs/year to meet TMDL standards.** BMPs implemented on targeted areas in the watershed will accomplish this goal.

Table 8. TP Load Reduction Needs

TP Load Reductions at Salina for Smoky Hill River						
		NP Current	Desired			
% Flow	Flow	TP 0.2	TP 0.1	% Reduction	lbs/day to be reduced	lbs/yr to be reduced
60	97	104.76	52.38	50	52.38	19118.7
50	125	135	67.5	50	67.5	24637.5
40	168	181.44	90.72	50	90.72	33112.8
30	249	268.92	134.46	50	134.46	49077.9
20	428	462.24	231.12	50	231.12	84358.8
10	1010	1090.8	545.4	50	545.4	199071
6	1740	1879.2	939.6	50	939.6	342954
AVG Flow						
		151,767	**75884**	**50**	**207.9**	**75,884**

5.4.3 E. Coli Bacteria in the Smoky Hill River near Mentor[8]

The E. Coli Standard for the Smoky Hill River is based on the Primary Contact Recreation Class B standard, which is a geometric mean of 262 Colony Forming Units (CFUs)/100ml for 5-samples in a 30 day period during the recreation season of April 1-October 31; and a geometric mean of 2,358 CFUs/100ml for 5-samples in a 30 day period during the non-recreation season (November 1 – March 31).

Bacteria Load Reductions should result in less frequent exceedances of the nominal ECB criterion (262 CFUs/100ml) along with a lowered magnitude of those exceedances.

E. Coli Index values for individual samples are computed as the ratio of the sample count to the contact recreation criteria. An index value of one or below indicates the sample was below the criterion. The calculated index is the natural logarithm of each sample value taken during the April-October primary recreation season, divided by the natural logarithm of the bacteria criteria (262 cfus/100ml). Plotting the ECB ratio against the percentile for each individual sample within the respective data set illustrates the frequency distribution and magnitude of the bacteria impairment for the sampling location. Higher bacteria frequencies are evident when the ECB index values (or ratios) are over one for an extended percentage of the data set. The E. Coli index values for the Smoky Hill River at Mentor and Salina indicates the frequency of E.Coli concentrations over the criteria are similar between the sampling locations at Salina and Mentor along the Smoky Hill River. The magnitude is assessed by noting how high the ratios are for the samples with ratios greater than one within the data set. Currently, about 80% of the ECB index values along the Smoky Hill River at Mentor are below one.

The bacteria endpoints tied to water quality standards will be maintaining geometric means of bacteria samples collected within 30-day periods during April-October below 262 cfus/100ml on these streams. Reductions in frequency and magnitude of high bacteria will serve as the necessary allocations to reduce "loading" and achieve the water quality standard. The ECB index values will shift downward over an extended period of time and the percentage of samples below the index value of one will increase. The target is to achieve an index below 1.0 at the upper decile (90^{th} percentile of samples) for samples collected during the recreational season.

6.0 Critical Targeted Areas

In the Upper Portion of the Lower Smoky Hill River Watershed, “Critical Areas” have been identified as areas that need to be protected or restored, such as areas that have TMDLs, emerging pollutant threats on the 303d list or contain a public water supply. Critical areas are defined by EPA as geographic areas that are critical to implement management practices in order to achieve load reductions.[9] Two areas have been identified as Critical Areas in this WRAPS:

1. Sub watersheds with streambanks identified by The Water Institute’s 2009 Assessment
2. Sub watersheds with priority TMDLs or 303d listed water segments

Based on the information available, the Sub watersheds that are considered “Critical Areas” are as follows:

- Smoky Hill River near Salina for Biology, Total Phosphorus (TP) and Total Suspended Solids (TSS)
- Smoky Hill River near Mentor for Bacteria and TSS

This WRAPS Plan will target specific land within these critical areas and in doing so will meet TMDL and 303d needs in all areas mentioned above. While targeting within these critical areas and meeting the previously mentioned TMDLs, this Plan will subsequently have a positive impact on 303d listed Smoky Hill River near Salina for Nitrates (NO3).

In every watershed, there are specific locations that contribute a greater pollutant load due to soil type, proximity to a stream and land use practices. By focusing Best Management Practices (BMPs) in these areas; pollutants can be reduced at a more efficient rate. These areas are called targeted areas. “Targeted Areas” are those specific areas within the Critical Areas that require BMP placement in order to meet load reductions.

Therefore, the SLT has targeted areas within the sub watersheds listed above to focus BMP placement for TSS, Nutrients (primarily Phosphorus) and Bacteria. Areas and impairments targeted for these sub watersheds:

- Streambanks and Riparian areas for Sediment.
- Cropland will be targeted for Sediment and Nutrients.
- Livestock areas will be targeted for Nutrients and Bacteria.

6.1 Targeting Streambanks

The Stakeholder Leadership Team (SLT) identified improving streambank stabilization along the course of the Smoky Hill River as one major objective that would aid in the decrease in sedimentation/siltation. Subsequently, the SLT contacted The Watershed Institute, Inc. (TWI) to analyze streambank erosion potential.

Critical Targeted Areas were identified by *The Watershed Institute's* (TWI) Assessment of the Upper Portion of the Lower Smoky Hill River Watershed in 2009. The following information was provided in the Assessment by TWI.

Under contract to the Kansas State University Office of Research & Extension, TWI conducted field-level streambank erosion assessments at 90 locations. At 69 of the 90 sites, TWI surveyed the eroding bank length and a detailed cross section to assess channel conditions and bankfull dimensions. TWI also estimated bank erosion potential using the Bank Erodibility Hazard Index (BEHI). Furthermore, TWI examined 1991 and 2006 rectified aerial photographs to calculate the annual erosion rate at each of the 69 sites. Using the collected data, TWI developed a matrix to prioritize potential sites to implement streambank stabilization practices. This report identifies the study sites, outlines the methodology, provides assessment findings, and prioritizes sites for potential streambank stabilization.

Site Selection: Based on aerial photography and personal knowledge, the SLT developed an initial list of landowners and legal descriptions of Smoky Hill River reaches with significant streambank erosion. This list contained 166 potential sites: 8 in Ellsworth County, 53 in McPherson County, and 105 in Saline County. TWI stratified this initial list into the longest contiguous eroding sites and reaches with multiple eroding sites in close proximity. TWI provided the stratified list to the Saline County Conservation District for landowner contact and access permission. Figures 12, 12a, 12b, and 12c identify the 90 assessment sites by county.[10]

Figure 14. Lower Smoky River Watershed, Study Area

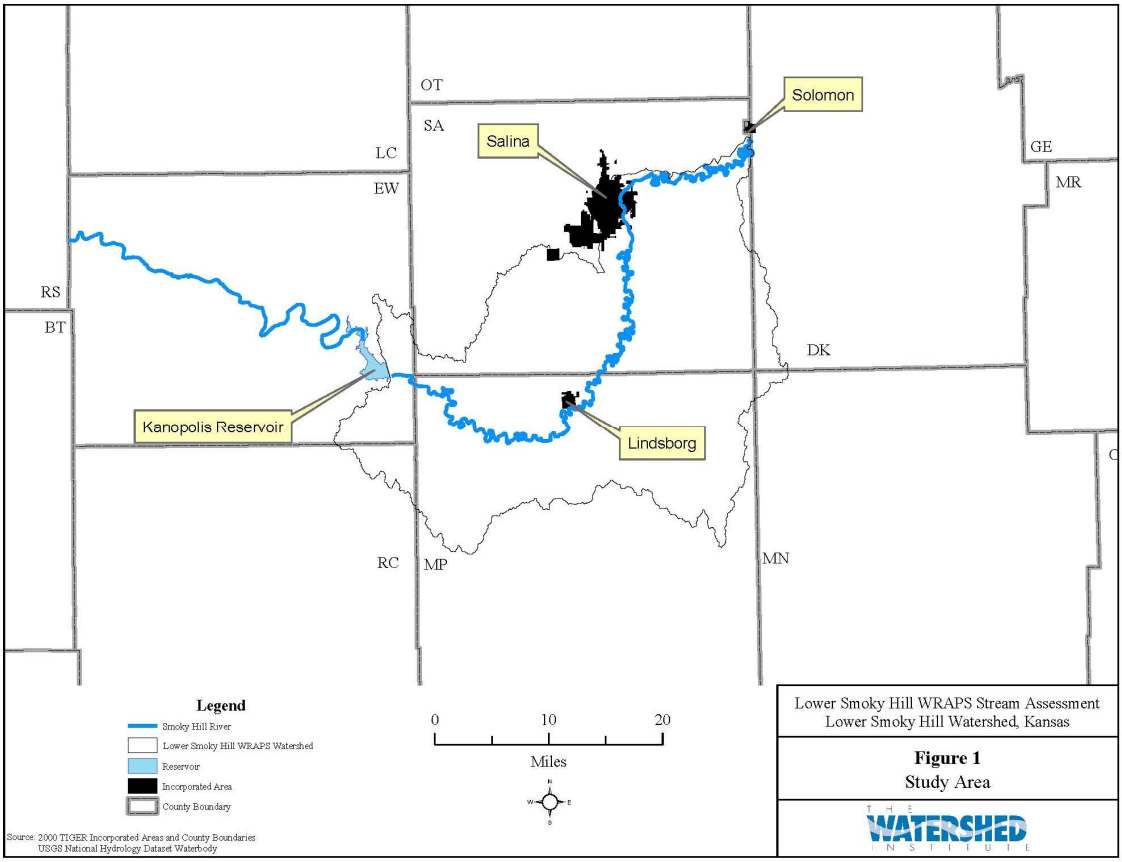

Figure 14a. Ellsworth County Site Locations

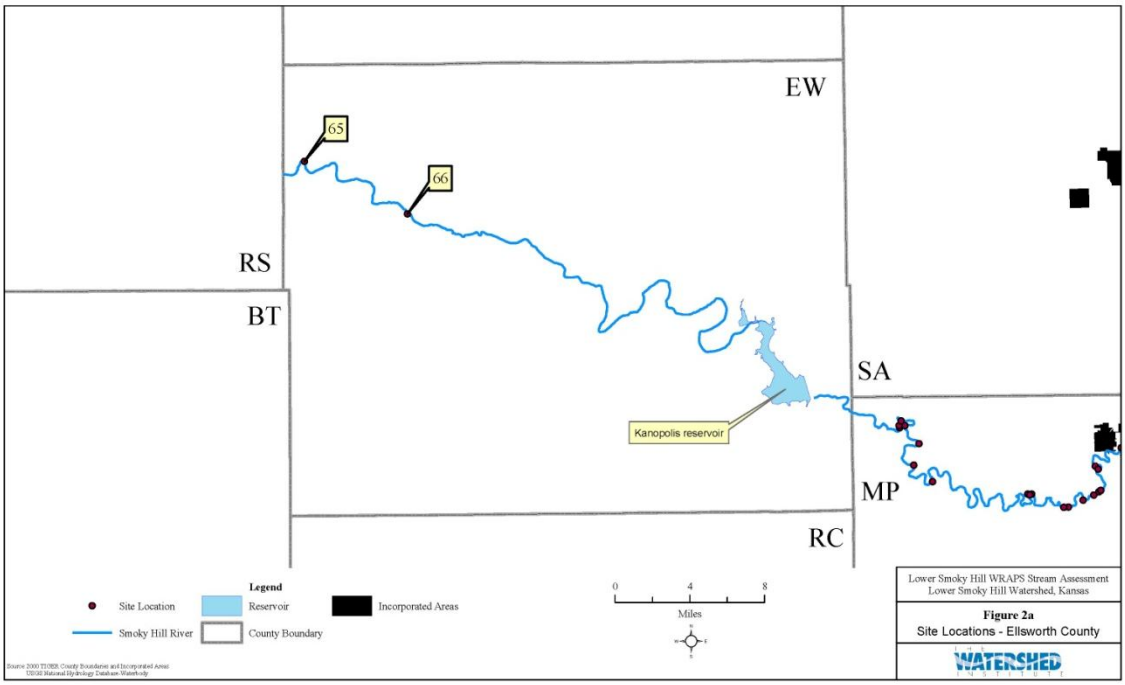

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Figure 14b. McPherson County Site Locations

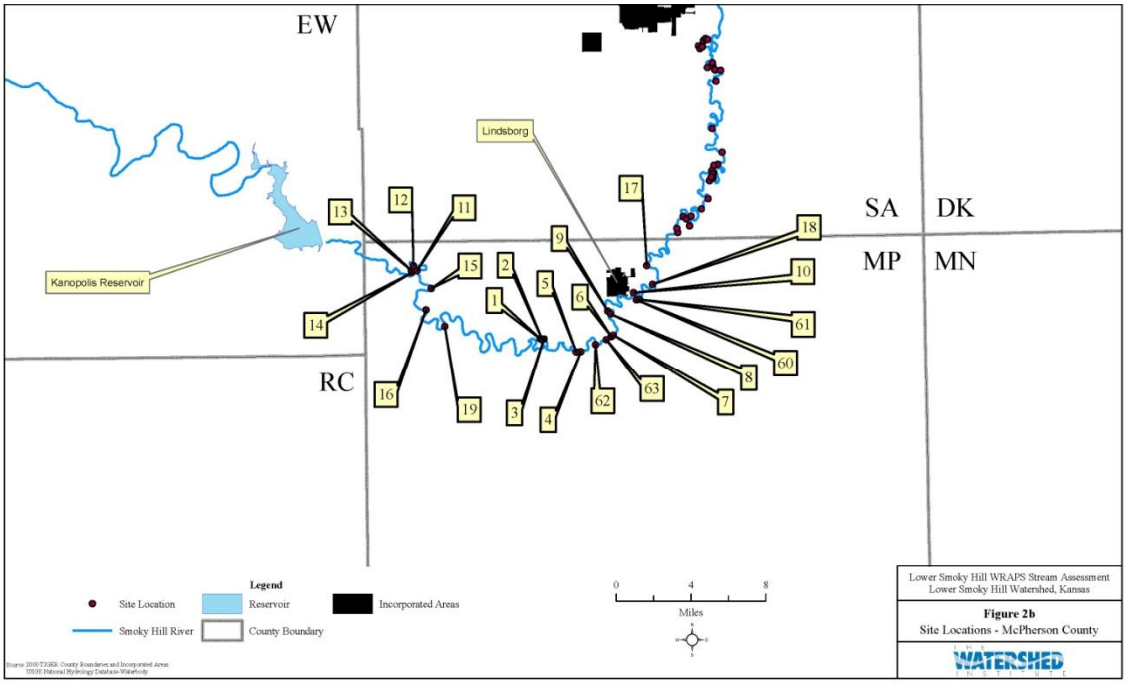

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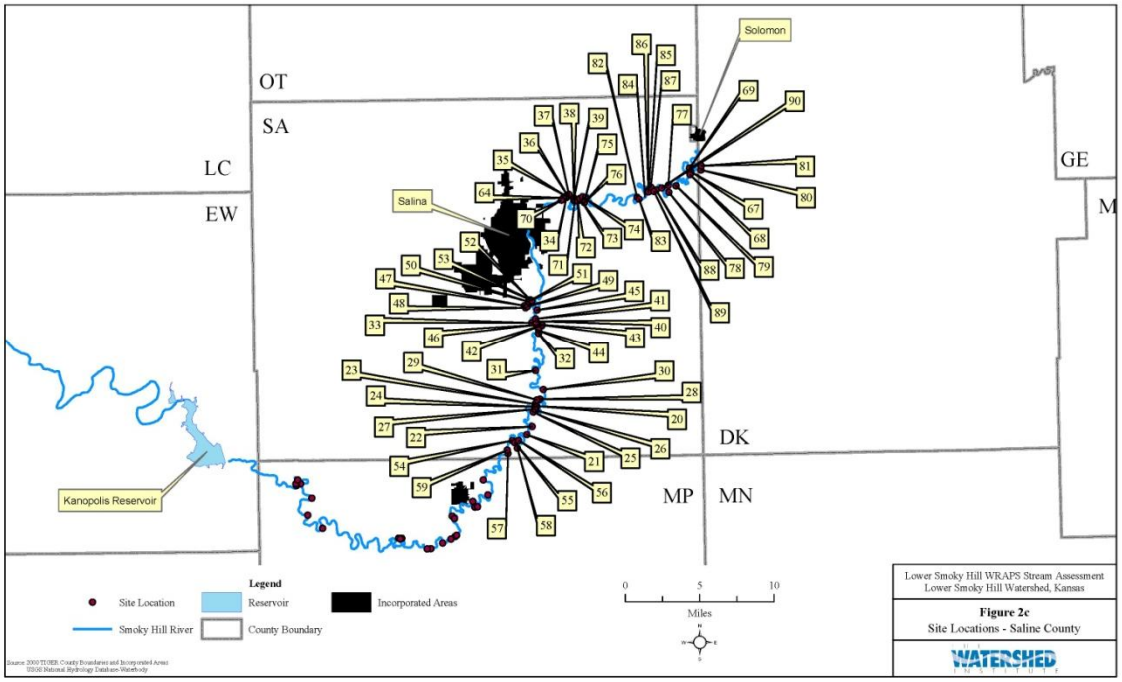
Figure 14c. Saline County Site Locations



Methodology: TWI conducted a visual evaluation—and completed an assessment form of streambank conditions—at 90 sites along the Smoky Hill River from Kanopolis Dam downstream to the City of Solomon. The following sections provide assessment forms for all 90 sites. At 69 sites, TWI surveyed eroding length and channel dimensions. TWI identified channel characteristics sensitive to the various processes of erosion in order to determine a Bank Erosion Hazard Index rating (BEHI; Rosgen 2001a, 2001b). Prior to all field work, TWI obtained access permission from willing landowners through the Saline County Conservation District staff. While bank slumps and erosion occur at the other 22 sites, the existing conditions were not as severe and bank vegetation was more prevalent. Therefore, TWI simply documented the existing conditions by photographs. Also, TWI used the RiverWorks Rapid Assessment System (RRAS) to capture and store miscellaneous data. The RRAS is a waterproof, handheld computer that integrates a digital camera, wireless GPS technology, and data analysis software into one unit. This system allowed TWI to document significant channel features through digital photographs and geographic coordinates.

Channel Dimension: Using a Leica TCR407 total station with a Carlson Explorer II data collector, TWI surveyed eroding bank length and a cross section to obtain channel dimensions. For each cross section, TWI surveyed a transect perpendicular to flow recording measurements at regular intervals to accurately depict the channel shape. Additionally, TWI documented special features—edge of water, channel thalweg (deepest part of the streambed), terraces, vegetation root depth, sand lenses, and bankfull stage indicators—along each cross section transect. Bankfull indicators include

change in bank angle, vegetation changes, and top of sediment deposits. Cross section plots for each site are provided in the following sections.

Bank Erodibility Hazard Index (BEHI): TWI used the BEHI to assess streambank erosion potential (Rosgen 2001a, 2001b). BEHI is a quantitative, objective channel stability assessment that ranks the following series of parameters as important factors in streambank resistance to erosion:
1. Ratio of streambank height to bankfull height
2. Ratio of riparian vegetation rooting depth to streambank height
3. Rooting density percentage
4. Composition of streambank materials
5. Streambank angle
6. Bank material stratigraphy and presence of soil lenses
7. Bank surface protection provided by debris, rock, and vegetation.

BEHI assessment procedures rate these parameters and assign a numeric index rating per parameter. Evaluators total numeric parameter ratings to achieve an overall erosion potential score. BEHI summarizes erosion potential (based on total score) as very low, low, moderate, high, very high, and extreme. TWI entered data collected from each detailed survey into the RIVERMorph software program (2006) to calculate BEHI variables and determine an overall BEHI score. BEHI scores are provided for each site in the following sections.

Bank Erosion Rate: TWI used rectified aerial images of Ellsworth, McPherson, and Saline Counties to calculate streambank erosion rate for the 69 surveyed sites. First, TWI used 1991 rectified aerial photographs (U.S. Geological Survey [USGS] 1997) to plot the channel location in ArcMap (ESRI 2008). Next TWI used ArcMap to overlay the 1991 plotted channel position with a 2006 rectified aerial photograph (U.S. Department of Agriculture Farm Service Agency [USDA FSA] 2006). TWI examined these overlays for pronounced changes in channel position. For all 69 sites, TWI calculated the area eroded during the fifteen-year time span to determine an annual erosion loss (ft/yr). Site assessment forms in the following sections contain the calculated erosion rate.

Site Prioritization: To prioritize sites for potential stabilization, TWI developed a 15-point weighted matrix — consisting of five metrics that reflect streambank erosion—to evaluate each site. TWI applied a scoring range to each metric with a higher score indicating higher priority for stabilization. The five metrics are:
1. Adjacent Land Cover (Wooded Riparian Width) – 2 points
2. Cut-off Potential – 1 point
3. Proximity of Sites – 2 points
4. BEHI Score – 5 points
5. Eroding Length – 5 points.

Wooded Riparian Width – The root structure of woody riparian vegetation increases bank stability. TWI applied a score of 2 points if the site had no trees or shrubs along

the bank. Sites having a woody riparian width up to 25 feet received a score of 1 point while sites with ≥25 feet received 0 points.

Cut-off Potential – The Smoky Hill River is extremely sinuous having several meander bends that loop back very near each other. When growing meanders intersect a meander loop is "cut-off" leaving it without an active flow, increasing channel gradient, and isolating farm fields. TWI assigned sites with <200 feet between meander bends a score of 1 point. Sites with >200 feet were scored 0.

Proximity of Sites – The highly sinuous pattern of the Smoky Hill River results in relatively short reaches with multiple eroding meander bends. Sites with more than two other badly eroding meanders within one mile—either upstream or downstream—scored 2 points. Sites with one or two eroding meanders with one mile scored 1 point while sites without a badly eroding meander within one mile scored 0.

BEHI Score – The BEHI score reflects the erosion potential of a streambank. TWI applied the following numeric scores to the qualitative BEHI ratings: very low = 0, low = 1, moderate = 2, high = 3, very high = 4, extreme = 5.

Eroding Bank Length – TWI assumed longer eroding sites to be of higher priority and applied the following points to various eroding length ranges: <300 feet = 0; 301-500 = 1; 501-800 = 2; 801- 1,100 = 3; 1,100-1,500 = 4; >1,500 = 5. To differentiate among sites with the same final prioritization score, TWI applied two additional metrics: erosion rate and infrastructure threat. Sites having the same final score were prioritized by their erosion rate with a higher rate being of higher priority. If sites had identical erosion rates, those having a threat to infrastructure (i.e. buildings, roads, levees) were given higher priority. If sites were still tied, TWI calculated the surface area of exposed bank face (bank height × eroding length) giving higher priority to those with a greater exposed surface area. Matrix forms and prioritization scores are included in the following sections.

Results: Prioritization scores for the 69 surveyed sites ranged from a low of 4 (sites 10 and 66) to a high of 14 (sites 67 and 69). Table 9 provides the ranked sites according to the described prioritization criteria.

Table 9. TWI's Streambank Assessment: Erosion Rate (tons/year)

Rank	Site	Prioritization Score	Erosion Rate (ft/yr)	Bank Height (ft)	Soil Weight (Cu. Ft)	Tons Erosion/ft/yr	Length of Streambank (ft)	Erosion Rate tons/yr	Land Use	County
1	69	14	6.8	17.4	85	5.03	1,960	9,856.1	Cropland	Saline
2	67	14	3.7	21.3	85	3.35	1,850	6,196.4	Pasture	Saline
3	41	13	3.0	20.7	85	2.64	1,230	3,246.3	Pasture	Saline
4	84	12	5.7	21.1	85	5.11	860	4,395.9	Cropland	Saline
5	82	12	3.6	22.7	85	3.47	1,250	4,341.4	Cropland	Saline
6	70	12	3.2	15.3	85	2.08	960	1,997.6	Cropland	Saline
7	89	12	2.6	20.1	85	2.22	1,850	4,108.9	Cropland	Saline
8	1	12	2.5	23.8	85	2.53	850	2,149.4	Cropland/timber	McPherson
9	68	12	2.0	15.3	85	1.30	2,170	2,822.1		Saline
10	21	12	2.0	23.5	85	2.00	980	1,957.6	Cropland	Saline
11	25	12	0.7	25.0	85	0.74	1,150	855.3	Cropland	Saline
12	34	11	3.9	15.4	85	2.55	700	1,786.8	Cropland	Saline
13	90	11	3.8	19.3	85	3.12	1,440	4,488.4	Cropland	Saline
14	44	11	3.7	19.7	85	3.10	790	2,447.3	Cropland	Saline
15	36	11	3.4	15.5	85	2.24	580	1,299.1	Cropland	Saline
16	27	11	3.1	24.5	85	3.23	650	2,098.1	Cropland	Saline
17	35	11	2.7	14.5	85	1.66	680	1,131.4	Cropland	Saline
18	54	11	2.0	22.4	85	1.90	1,130	2,151.5	Cropland	Saline
19	60	11	1.7	24.5	85	1.77	920	1,628.5	Cropland	McPherson
20	80	11	1.6	23.6	85	1.60	1,270	2,038.1	Cropland	Dickinson
21	73	11	1.6	19.7	85	1.34	510	683.2	Cropland	Saline
22	47	11	0.9	26.3	85	1.01	930	935.6	Cropland	Saline
23	86	10	5.3	21.4	85	4.82	580	2,795.8	Cropland	Saline
24	77	10	4.7	21.5	85	4.29	820	3,521.6	Cropland	Saline
25	3	10	3.8	22.1	85	3.57	435	1,552.6	Cropland	McPherson
26	49	10	3.5	28.3	85	4.21	470	1,978.5	Cropland	Saline
27	40	10	2.7	26.2	85	3.01	350	1,052.3	Pasture	Saline
28	50	10	2.4	23.3	85	2.38	340	808.0	Cropland	Saline
29	13	10	2.4	15.2	85	1.55	440	682.2	Cropland	McPherson
30	42	10	2.1	23.7	85	2.12	540	1,142.2	Cropland	Saline

Rank	Site	Prioritization Score	Erosion Rate (ft/yr)	Bank Height (ft)	Soil Weight (Cu. Ft)	Tons Erosion/ft/yr	Length of Streambank (ft)	Erosion Rate tons/yr	Land Use	County
31	20	10	1.8	22.8	85	1.74	850	1,482.6	Cropland	Saline
32	81	10	1.8	23.0	85	1.76	700	1,231.7	Cropland	Dickinson
33	2	10	1.6	17.2	85	1.17	475	555.6	Cropland/timber	McPherson
34	14	10	1.5	16.6	85	1.06	880	931.3	Cropland	McPherson
35	52	10	1.5	25.4	85	1.62	380	615.3	Cropland	Saline
36	33	10	0.9	27.0	85	1.03	980	1,012.1	Cropland	Saline
37	85	9	4.0	21.7	85	3.69	620	2,287.2	Cropland	Saline
38	38	9	3.3	15.7	85	2.20	350	770.7	Cropland	Saline
39	39	9	2.4		85		458		Cropland	Saline
40	57	9	2.0	21.7	85	1.84	630	1,162.0	Corpland	Saline
41	56	9	1.9	24.2	85	1.95	780	1,524.2	Cropland	Saline
42	64	9	1.9	15.1	85	1.22	680	829.1	Cropland	Saline
43	74	9	1.6	19.8	85	1.35	620	834.8	Cropland	Saline
44	48	9	1.5	26.1	85	1.66	510	848.6	Cropland	Saline
45	26	9	1.3	19.0	85	1.05	260	272.9	Cropland	Saline
46	46	9	0.9	24.3	85	0.93	560	520.5	Cropland	Saline
47	88	8	2.5	20.6	85	2.19	520	1,138.2	Cropland	Saline
48	8	8	2.3	21.5	85	2.10	570	1,197.9	Cropland/timber	McPherson
49	31	8	2.0	25.2	85	2.14	1,010	2,163.4	Cropland/timber	Saline
50	78	8	1.8	22.9	85	1.75	1,000	1,751.9	Cropland	Saline
51	18	8	1.7	24.5	85	1.77	740	1,309.9	Cropland/timber	McPherson
52	62	8	1.2	27.6	85	1.41	500	703.8	Cropland	McPherson
53	23	8	1.1	24.7	85	1.15	320	369.5	Cropland	Saline
54	76	7	2.9	20.2	85	2.49	310	771.8	Cropland	Saline
55	72	7	1.6	18.0	85	1.22	190	232.6	Cropland	Saline
56	15	7	1.4	11.8	85	0.70	700	491.5	Cropland/timber	McPherson
57	28	7	1.2	27.2	85	1.39	740	1,026.5	Cropland	Saline
58	22	7	1.2	13.5	85	0.69	450	309.8	Cropland	Saline
59	24	7	1.1	25.0	85	1.17	260	303.9	Cropland	Saline
60	30	7	0.8	36.5	85	1.24	760	943.2	Cropland	Saline

Rank	Site	Prioritization Score	Erosion Rate (ft/yr)	Bank Height (ft)	Soil Weight (Cu. Ft)	Tons Erosion/ft/yr	Length of Streambank (ft)	Erosion Rate tons/yr	Land Use	County
61	19	7	0.8	19.5	85	0.66	280	185.6	Cropland	McPherson
62	79	6	4.5	21.0	85	4.02	610	2,449.9	Cropland	Saline
63	16	6	1.3	11.0	85	0.61	520	316.0	Cropland/timber	McPherson
64	6	6	1.1	14.5	85	0.68	380	257.6	Cropland/timber	McPherson
65	29	6	0.7	33.3	85	0.99	760	752.9	Cropland	Saline
66	17	5	1.1	20.2	85	0.94	520	491.1	Cropland/timber	McPherson
67	7	5	0.7	15.0	85	0.45	400	178.5	Cropland/timber	McPherson
68	66	4	2.3	14.0	85	1.37	650	889.5	Cropland/timber	Ellsworth
69	10	4	0.7	14.2	85	0.42	270	114.1	Cropland/timber	McPherson
Total Streambank Erosion Tons/Year (based on TWI site selections)								**109,375.6**		

Lower Smoky River Watershed Sediment Reduction Needed = 34,710 tons/year.
Those high-lighed in yellow will achieve this reduction in 4 years with an estimated 2 projects per year, with a total of 41,071 tons/year reduction.
Note: these are the highest ranking in priority and are possibly the most expensive for implementation.
Therefore, projects of less priority may be addressed as money allows, this could extend the time it will take to reach the reduction goal of 34,710 tons/year.

Erosion Calculations:

$$\frac{\text{erosion ft/yr} \times \text{bankheight} \times \text{weight of soil}}{2000} = \text{tons/ft/yr}$$

length of streambank X tons/ft/yr = total erosion (tons/yr)

Soil weight = 85 lbs/cubic foot (NRCS Technical Guide)

Given the TWI assessment, from the 90 project site selected, and 69 that were considered a priority, **109,375.6 tons/year** of sediment are entering the Lower Smoky Hill River Watershed. The SLT has determined that the targeted area for streambank restoration and stabilization will be along the main branch of the Lower Smoky Hill River addressing these 69 priority sites. The SLT will use the assessment and values above to determine which projects they will address to accomplish the necessary sediment load reduction of 34,710 tons/year to meet TMDL standards.

6.2 Targeting Cropland for Sediment and Nutrients

Based on the TWI Assessment and monitoring data and guidance from KDHE, cropland should be targeted for sediment and nutrient sources of pollution. Monitoring upstream of Salina indicates the first point that should be targeted, which would include areas that have the greatest chance of cropfield runoff. Cropland adjacent to the Smoky Hill River should also be targeted according to the TMDL. KDHE's monitoring network and guidance gave the SLT the information needed to determine what areas in the watershed should be targeted for sediment and nutrient runoff.

Cropland will be targeted for sediment loss in two ways. 1) Cropland will be targeted for sediment loss based on high erosion rates from streambanks provided by the TWI assessment. 2) Cropland will also be targeted for TSS along the Smoky Hill River near Salina and Mentor based on their high priority TMDL listings.

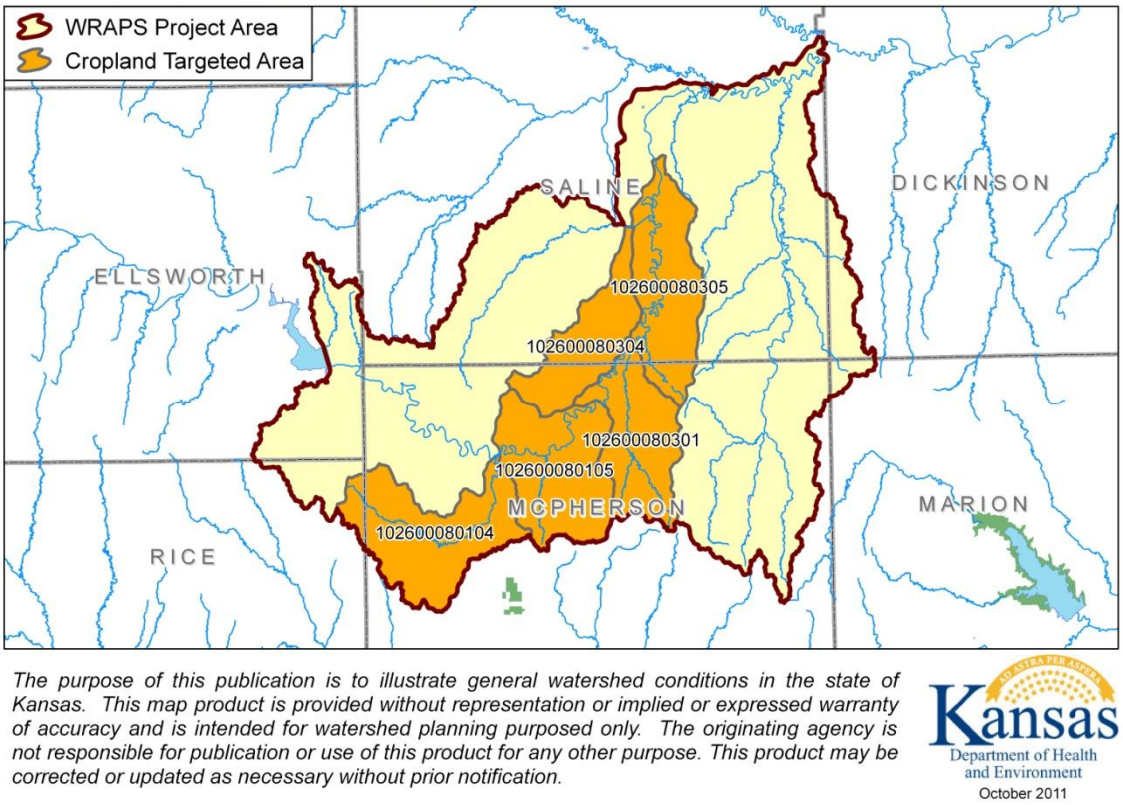
Nutrient runoff and sediment runoff often occur together due to nutrients leaching to the sediment when exiting the crop field. BMPs used to target sediment will therefore be effective in reducing P runoff as well. Therefore, targeting the Smoky Hill River near Mentor for sediment will also result in a reduction of nutrients, both P and N downstream.

This WRAPS plan will target the following HUC 12's for Sediment and Nutrient BMP implementation on cropland, *Figure 13*:

- HUC 102600080104
- HUC 102600080105
- HUC 102600080301
- HUC 102600080304
- HUC 102600080305

Though this WRAPs Plan does not specifically target Nitrates (NO3) in the Smoky Hill River near Salina, targeting sediment and TP with cropland BMP implementation will subsequently address the 303(d) listed NO3 impairment in this water segment.

Figure 15. Targeted Cropland Areas



6.3 Targeting Livestock Areas

Livestock, like any animal, contributes nutrients and bacteria to nearby water sources by directly depositing the source of said pollutants or by runoff events and proximity to water sources. It is difficult to target wild animal contributions but livestock nutrient and bacteria contributions can be targeted with BMPs that will undoubtedly improve water quality for the animals and will protect tributaries that will ultimately deliver the polluted waters to drinking water sources. BMPs used to target livestock nutrients will serve to improve bacteria loading and vice versa.

6.3.1 Targeting Livestock for Nutrients

Livestock can be targeted for the nutrient, phosphorus, which is a low priority on the 303d list for several sites in the Lower Smoky River Watershed but will be targeted by this plan along the Smoky Hill River near Salina for TP.

To determine which specific livestock areas should be targeted, a livestock assessment took place in the Spring of 2011 to determine specific areas in which the SLT will focus BMP implementation. The following steps were followed to complete the assessment:

1. The SLT received a list of current permitted and certified livestock facilities from KDHE.

2. The SLT met and went over the list provided by KDHE and determined other livestock areas that had been noticed to need BMP implementation. For example, if a SLT member noticed that a landowner had a feeding site right on a creek, that livestock area may have been assessed and possibly targeted for BMP implementation.
3. Windshield assessments were also made. The WRAPS and BMP Coordinators located livestock areas in need of BMP implementation by driving in the targeted watershed.
4. Monitoring sites may be established.

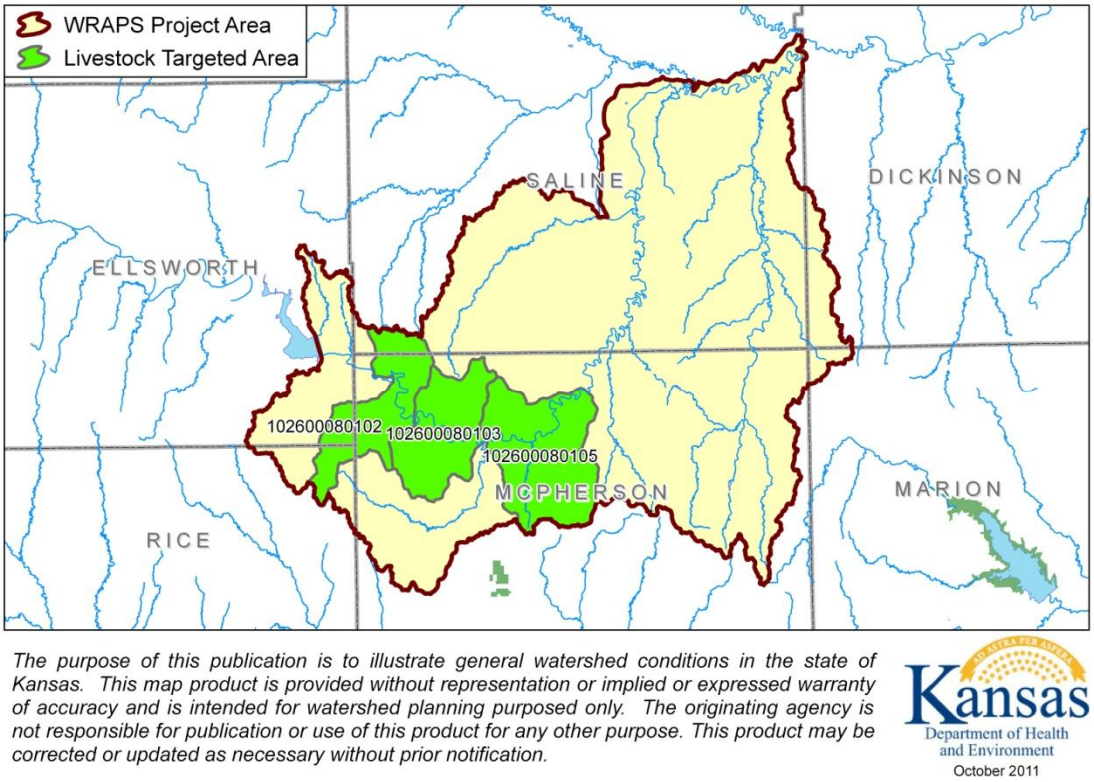
Livestock areas that receive referrals by the Kansas Department of Health and Environment will also be targeted for BMP implementation.

6.3.2 Targeting Livestock Areas for Bacteria

Given that the Smoky Hill River near Mentor has been 303(d) listed for bacteria, this area's livestock facilities will be targeted for bacteria and sediment loss. To accurately target these livestock facilities or operations for BMP implementation, the SLT determined that they would need an assessment of which farms to target. The assessment mentioned above in the Spring of 2011 was also used to target bacteria in livestock areas along the Smoky Hill River near Mentor.

The SLT may consider water monitoring sites along stream segments in the areas near Salina AND Mentor. Those sites may be set up to indicate any spikes in bacteria, phosphorus AND sediment, so that all those possible impairments may be acknowledged and addressed in both those areas if necessary.

Figure 16. Targeted Livestock Areas



As seen in Figure 14, the 2011 assessment and information provided by KDHE has led the WRAPS project team to choose the following areas for targeted livestock BMP implementation:

- HUC 102600080102
- HUC 102600080103
- HUC 102600080105

There are two tiers to this plan. The SLT will first focus their efforts on Tier 1 sub watersheds and if they are unable to achieve optimal BMP implementation in that Tier, the SLT will turn their focus to Tier 2.

Tier 1 – This WRAPS Plan will first target the following areas for nutrient and bacteria BMP implementations in livestock areas:

- HUC 102600080102
- HUC 102600080103

Tier 2 - The WRAPS Plan will focus on this targeted area if unable to achieve implementation and required load reductions in Tier 1 targeted areas:

- HUC 102600080105

6.4 Load Reduction Methodology

6.4.1 Cropland

Best management practice (BMP) load reduction efficiencies are derived from K-State Research and Extension Publication MF-2572.[11] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

6.4.2 Livestock

Baseline nutrient loadings per animal unit are calculated using the Livestock Waste Facilities Handbook.[12] Livestock management practice load reduction efficiencies are derived from numerous sources including K-State Research and Extension Publication MF-2737 and MF-2454.[13] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

The SLT of the Upper Portion of the Lower Smoky Hill River Watershed met twice and considered the TWI Assessment and Water Monitoring data. They used the data to determine priority issues and the most effective BMPs that could be used to address such issues. In doing so, the SLT determined that the focus of the WRAPS process will be on three key concerns of the watershed listed in order of importance:

1. Sediment from Streambank and Cropland Erosion
2. Nutrients from Cropland Erosion and Livestock Areas
3. Bacteria from Livestock Areas

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

7.0 Impairments Addressed by the SLT

7.1 Sediment from Streambank and Cropland Erosion

The TWI assessment and water monitoring analysis confirm that streambank and cropland erosion are major contributors to sediment or silt accumulation in Lower Smoky Hill Watershed streams and rivers.

Reducing erosion is necessary for a reduction in sediment. Agricultural best management practices (BMPs) such as continuous no-till, conservation tillage, grass buffer strips around cropland, terraces, grassed waterways and reducing activities within the riparian areas will reduce erosion and improve water quality. BMPs have been selected by the SLT (and will be discussed later in this section) based on acceptability by the landowners, cost effectiveness and pollutant load reduction effectiveness.

Possible Sources of the Impairment

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

7.1.1 Streambank Erosion

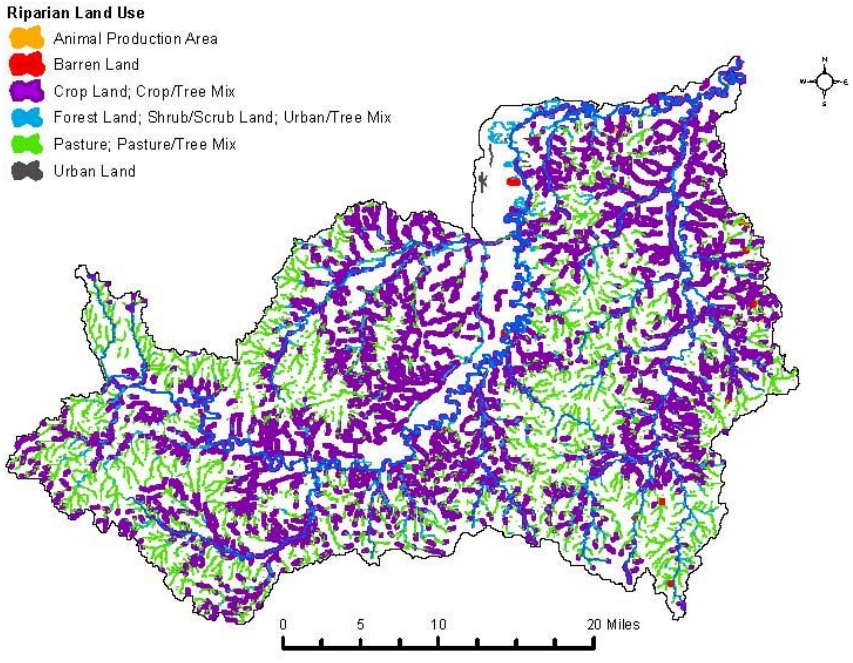
Sediment can originate from streambank erosion and sloughing of the sides of the river and streambank. A lack of riparian cover can cause washing on the banks of streams or rivers and enhance erosion. 29.7 linear miles of Smoky Hill River can use streambank stabilization as well as other tributaries and streams identified by the TWI assessment. 10 tons/acre of soil is lost on highly erodible land. (Information estimates provided by District Conservationists in the watershed, calculated with the NRCS RUSLE model.)

7.1.1.A Riparian Quality

An adequately functioning and healthy riparian area will stop the sediment flow from cropland and rangeland. Cropland lying adjacent to the stream without buffer protection will cause erosion along the streambank.

In the targeted area, the predominant land use in the watershed is grassland at 59 percent. This riparian area can be vulnerable to runoff and erosion from livestock induced activities. Buffers and filter strips along with forested riparian areas can be used to impede erosion and streambank sloughing. Livestock restriction along the stream will prevent livestock from entering the stream and degrading the banks. The SLT has decided because of this, that they will incorporate BMPs aimed at streambank restoration into the WRAPS plan.

Figure 17. Riparian Inventory of the Streambank Targeted Area.[14]
Data from USDA/NRCS, 1991.



KEY:
Forest Land - Areas adjacent to a stream that contains trees with a canopy cover greater than 51% of the 100 foot buffer zone. Includes **Shrub/Scrub Land** - Areas adjacent to a stream that contain shrubs or brush/scrub vegetation with a canopy cover greater than 51% of the 100 foot buffer zone. Areas are composed of multi-stemmed woody plants, shrubs, and vines including areas that contain a wide diversity of vegetative cover that are not distinguishable.
Crop Land - Areas adjacent to a stream where no trees area present and in which 51% of the 100 foot buffer is planted or was planted during the previous growing season for the production of adapted crops for harvest, including row crops, small-grain crops, legume, hay crops, nursery crops, and other specialty crops. Includes **Crop/Tree Mix** - Cropland landuse areas that contain a tree canopy cover of less than 50% of the 100 foot buffer zone.
Pasture- Areas adjacent to a stream in which 51% or more of the 100 foot buffer contains pastureland, native pasture, or range land. Includes **Pasture/Tree Mix** - Grassland land use areas that contain a tree canopy cover of less than 50% of the 100 foot buffer zone.
Urban Land - Areas adjacent to a stream where 51% or more of the 100 foot buffer contains dwellings or is located in an urban area without trees adjacent to the stream. Highways, railroads, and other transportation facilities are considered to be part of the urban & built-up land base if they are surrounded by other urban and built-up areas. Includes. **Urban/Tree Mix** - Urban land use areas that contain a tree canopy cover of less than 50% of the 100 foot buffer zone.
Barren Land - Areas adjacent to a stream where 51% of the 100 foot buffer contains land without any discernible vegetative cover, including quarries, borrows pits, and dry ponds.
Water - Areas adjacent to a stream where 51% of the 100 foot buffer contains water.

7.1.1.B Rainfall and Runoff

Rainfall amounts and subsequent runoff can affect sediment runoff from agricultural areas and urban areas into streams. High rainfall events can cause cropland erosion, rangeland gully erosion and sloughing of streambanks, which add sediment to tributary streams and ultimately the Smoky Hill River. High intensity rainfall events usually occur in late spring and early summer.

7.1.1.C Sediment Goal and BMPs for Streambanks

In reference to Table 9 in Section 6, the TWI data showed the top 10 priority streambank sites in the Upper Portion of the Lower Smoky Hill River Watershed. Those sites are listed in the table below as well as load reduction and cost information. Addressing these sites would reduce sediment loading by 41,071 tons and phosphorus loading by 2,464 tons.

Table 10. Streambank Load Reductions and Costs based on 10 Priority Sites

UL Smoky WRAPS Streambank Load Reductions and Cost							
Site	**Streambank Stabilization (feet)**	**Erosion Rate**	**Soil Load Reduction (tons)**	**Cumulative Erosion Reduction (tons)**	**Phosphorus Reduction (lbs)**	**Cumulative P Load Reduction (lbs)**	**Cost***
69	1,960	5.03	9,859	9,859	592	592	$189,297
67	1,850	3.35	6,198	16,056	372	963	$194,976
41	1,230	2.64	3,247	19,304	195	1,158	$200,825
84	860	5.11	4,395	23,698	264	1,422	$206,850

82	1,250	3.47	4,338	28,036	260	1,682	$213,055
70	960	2.08	1,997	30,032	120	1,802	$219,447
89	1,850	2.22	4,107	34,139	246	2,048	$226,030
1	850	2.53	2,151	36,290	129	2,177	$232,811
68	2,170	1.3	2,821	39,111	169	2,347	$239,796
21	980	2	1,960	41,071	118	2,464	$246,989

Table 11. Streambank Annual Load Reductions and Costs

UL Smoky WRAPS Average Annual Streambank Load Reductions and Cost						
Site	**Streambank Stabilization (feet)**	**Soil Load Reduction (tons)**	**Cumulative Erosion Reduction (tons)**	**Phosphorus Reduction (lbs)**	**Cumulative P Load Reduction (lbs)**	**Cost***
1	698	2,054	2,054	123	123	$67,413
2	698	2,054	4,107	123	246	$69,435
3	698	2,054	6,161	123	370	$71,518
4	698	2,054	8,214	123	493	$73,664
5	698	2,054	10,268	123	616	$75,874
6	698	2,054	12,321	123	739	$78,150
7	698	2,054	14,375	123	862	$80,494
8	698	2,054	16,428	123	986	$82,909
9	698	2,054	18,482	123	1,109	$85,397
10	698	2,054	20,536	123	1,232	$87,958
11	698	2,054	22,589	123	1,355	$90,597
12	698	2,054	24,643	123	1,479	$93,315
13	698	2,054	26,696	123	1,602	$96,115
14	698	2,054	28,750	123	1,725	$98,998
15	698	2,054	30,803	123	1,848	$101,968
16	698	2,054	32,857	123	1,971	$105,027
17	698	2,054	34,910	123	2,095	$108,178
18	698	2,054	36,964	123	2,218	$111,423
19	698	2,054	39,017	123	2,341	$114,766
20	698	2,054	41,071	123	2,464	$118,209

7.1.2 Cropland Erosion

The second most predominant land use in the watershed is cropland at 34 percent. As stated above, cropland lying adjacent to the stream without buffer protection will cause erosion along the streambanks. 163,172 acres in HUC numbers 1026000801, 1026000802 and 1026000803 needs restoration and protection. An estimated 3 tons/acres of soil are lost every year on previously treated land. (Information estimates provided by District Conservationists in the watershed, calculated with the NRCS RUSLE model.)

Soil type has an influence on runoff potential and erosion throughout the watershed. Soils are classified into four hydrologic soil groups (HSG). The soils within each of these groups have the same runoff potential after a rainfall event if the same conditions exist, such as plant cover or storm intensity. Soils are categorized into four groups: A, B, C and D. The watershed area is predominantly (51 percent) soil group B. This soil group has a moderate potential for runoff which leads to erosion. However, thirty seven percent of the watershed is Group C which has a slower infiltration rate. This highlights the importance of slowing water flow from rainfall events to allow the soil adequate time to absorb the water before it flushes into creeks and streams causing erosion and degradation of the streambanks.

Figure 18. Hydrologic Soil Groups of the Watershed[15]

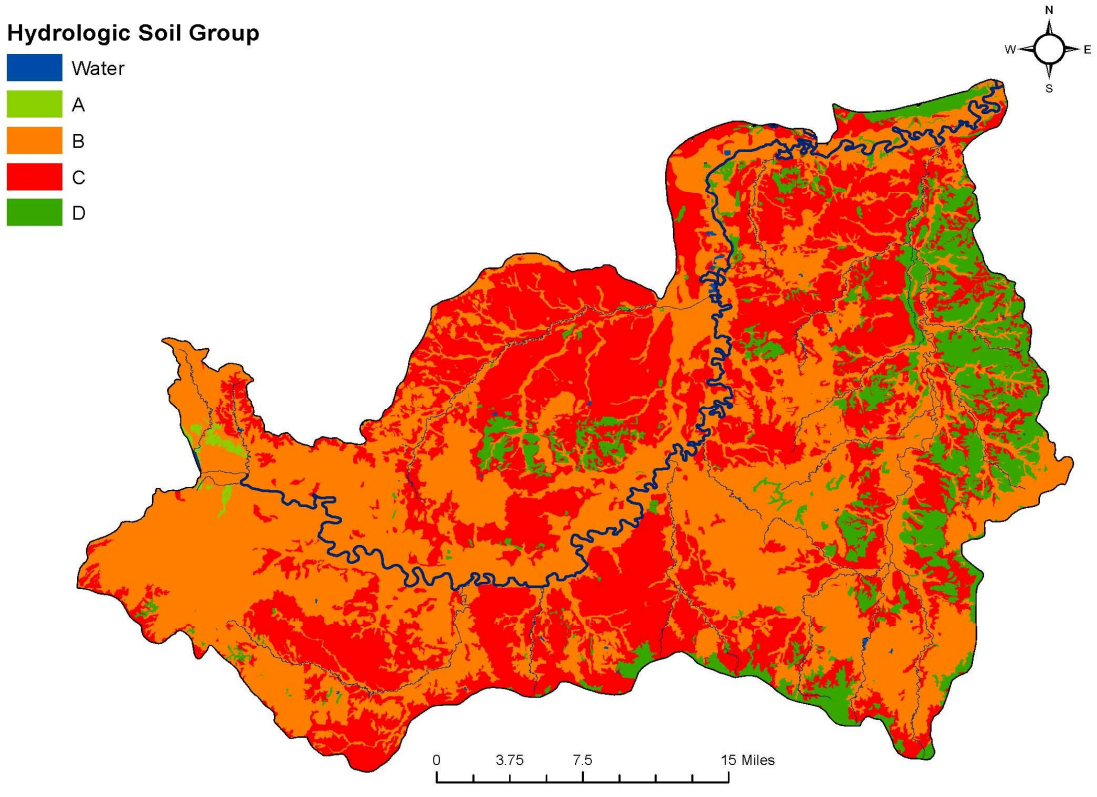
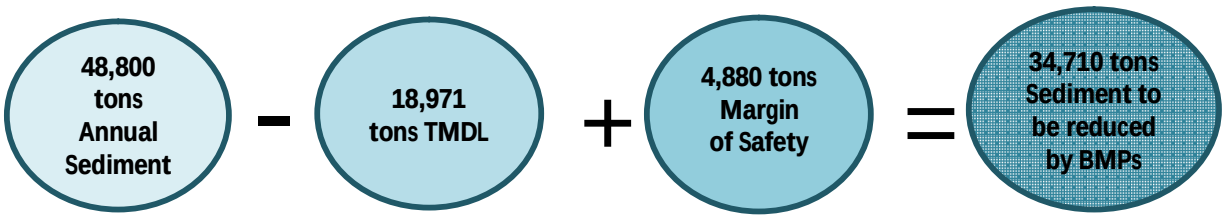


Table 12. Hydrologic Soil Groups of the Watershed and the Targeted Area
Calculated from SSURGO Soil Data Mart.

Hydrologic Soil Group	Definition	Acres of Watershed in HSG	Percentage of Watershed in HSG
A	Soils with low runoff potential. Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep well drained to excessively well-drained sands or gravels.	1,012	0.20
B	Soils having moderate infiltration rates even when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well drained to sell drained soils with moderately fine to moderately coarse textures.	265,494	51.73
C	Soils having slow infiltration rates even when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures.	193,327	37.67
D	Soils with high runoff potential. Soils having very slow infiltration rates even when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious material.	51,027	9.94
Other	Water, dams, pits, sewage lagoons	2,366	0.46
Total		**513,227**	**100.00**

7.1.3 Sediment Pollutant Loads and Load Reductions

The current estimated Total Suspended Solids load in the Upper Portion of the Lower Smoky Hill River Watershed is **48,800** tons per year according to the TMDL section of KDHE. The TMDL for TSS (wasteload allocation + load allocation) equals 18,971 tons. Margin of Safety is 4,880 tons. **Taking the current loading less the TMDL plus the margin of safety leaves 34,710 tons of sediment per year that needs to be reduced.** This is the amount of sediment reduction that will have to be met by implemented BMPs in the watershed.



The SLT has laid out specific BMPs that they have determined will be acceptable to watershed residents as listed below. **These BMPs will be implemented along the streambank and in cropland targeted areas to address SLT goals and objectives.**

The BMPs delineated by the SLT for sediment reductions will also serve to reduce the amount of phosphorus, nitrates and other nutrients entering the river. The Lower Smoky Hill River Watershed near Salina has been listed on the 303(d) list for Total Phosphorus (TP) and Nitrates (NO3). Increases in these nutrients can lead to dissolved oxygen and eutrophication, causing problems for aquatic plants and animals. Dissolved oxygen, eutrophication and aquatic plants and life are all listed as TMDLs for this watershed. By implementing sediment BMPs, reductions in nutrient load levels are inevitable. Therefore, sediment reductions will also prove to reduce TP and NO3.

7.1.4 Sediment Goal and BMPs for Cropland

The SLT has laid out specific BMPs that they have determined will be acceptable to watershed residents as listed below. **These BMPs will be implemented in cropland targeted areas to address SLT goals and objectives for twenty years.**

Table 13. Cropland Sediment BMPs, Costs and Effectiveness

Upper Lower Smoky WRAPS Cropland BMPs, Costs, and Reduction Efficiencies							
Best Management Practice	**Cost per treated acre**	**Available Cost Share**	**Erosion Reduction Efficiency**	**Phosphorus Reduction Efficiency**	**Nitrogen Reduction Efficiency**	**Cost per Unit**	**Unit**
No-Till	$78	39%	75%	40%	25%	$78	acre
Conservation Tillage	$39	0%	38%	20%	13%	$39	acre
Grassed Waterways	$160	50%	40%	40%	40%	$1,600	acre
Vegetative Buffers	$67	90%	50%	50%	25%	$1,000	acre
Nutrient Mgmt Plans	$57	50%	25%	25%	25%	$39	acre
Terraces	$102	50%	30%	30%	30%	$1.25	foot
Incorporate Manure	$6.33	0%	0%	20%	50%	$6.33	acre
Water Retention Structures	$125	50%	50%	50%	50%	$5,000	per structure

Table 14. Cropland Sediment BMP Adoption

Annual Adoption (treated acres), Cropland BMPs									
Year	**No-Till**	**Cons. Tillage**	**Water-ways**	**Buffers**	**Nutrient Mgt. Plans**	**Terraces**	**Incorp-orate Manure**	**Water Retention**	**Total Adoption**
1	349	697	523	349	174	523	174	105	2,893
2	349	697	523	349	174	523	174	105	2,893
3	349	697	523	349	174	523	174	105	2,893
4	349	697	523	349	174	523	174	105	2,893
5	349	697	523	349	174	523	174	105	2,893
6	349	697	523	349	174	523	174	105	2,893
7	349	697	523	349	174	523	174	105	2,893

8	349	697	523	349	174	523	174	105	2,893
9	349	697	523	349	174	523	174	105	2,893
10	349	697	523	349	174	523	174	105	2,893
11	349	697	523	349	174	523	174	105	2,893
12	349	697	523	349	174	523	174	105	2,893
13	349	697	523	349	174	523	174	105	2,893
14	349	697	523	349	174	523	174	105	2,893
15	349	697	523	349	174	523	174	105	2,893
16	349	697	523	349	174	523	174	105	2,893
17	349	697	523	349	174	523	174	105	2,893
18	349	697	523	349	174	523	174	105	2,893
19	349	697	523	349	174	523	174	105	2,893
20	349	697	523	349	174	523	174	105	2,893

Table 15. Cropland Sediment Reduction

Annual Soil Erosion Reduction									
Year	**No-Till**	**Cons. Tillage**	**Waterways**	**Buffers**	**Nutrient Mgt. Plans**	**Terraces**	**Incorp-orate Manure**	**Water Retention**	**Total Load Reduction**
1	392	392	314	261	65	235	0	78	1,739
2	784	784	627	523	131	471	0	157	3,477
3	1,177	1,177	941	784	196	706	0	235	5,216
4	1,569	1,569	1,255	1,046	261	941	0	314	6,955
5	1,961	1,961	1,569	1,307	327	1,177	0	392	8,693
6	2,353	2,353	1,882	1,569	392	1,412	0	471	10,432
7	2,745	2,745	2,196	1,830	458	1,647	0	549	12,171
8	3,137	3,137	2,510	2,092	523	1,882	0	627	13,909
9	3,530	3,530	2,824	2,353	588	2,118	0	706	15,648
10	3,922	3,922	3,137	2,615	654	2,353	0	784	17,387
11	4,314	4,314	3,451	2,876	719	2,588	0	863	19,125
12	4,706	4,706	3,765	3,137	784	2,824	0	941	20,864
13	5,098	5,098	4,079	3,399	850	3,059	0	1,020	22,603

14	5,491	5,491	4,392	3,660	915	3,294	0	1,098	24,341
15	5,883	5,883	4,706	3,922	980	3,530	0	1,177	26,080
16	6,275	6,275	5,020	4,183	1,046	3,765	0	1,255	27,819
17	6,667	6,667	5,334	4,445	1,111	4,000	0	1,333	29,557
18	7,059	7,059	5,647	4,706	1,177	4,236	0	1,412	31,296
19	7,451	7,451	5,961	4,968	1,242	4,471	0	1,490	33,035
20	7,844	7,844	6,275	5,229	1,307	4,706	0	1,569	34,773

The table below indicates that there are 69,721 acres of available cropland in the Sediment and Nutrient targeted areas. To achieve plan goals and meet TMDL requirements, this plan requires 2,893 acres. Therefore, it can be assumed that there are ample acres to implement this WRAPS plan as written.

Table 16. Cropland Inventory for the Project Area

Cropland BMP Needs Inventory						
	Acres of Cropland in Priority Area				Proposed Increased Adoption	Acres of Cropland Required by Plan
	McPherson County	Saline County	Rice County	Total Acres Available		
HUC 10260008	43,756	24,730	1,235	69,721		2,893
No-Till	27.9%	41.7%			10.0%	
Conservation Tillage	4.6%	10.3%			20.0%	
Grassed Waterways*	9.3%				15.0%	
Vegetative Buffers	0.4%				10.0%	
Nutrient Management (soil testing and/or plans)					5.0%	
Terraces*	13.5				15	
Incorporate Manure					5	
Water Retention Structures					2	
**Additional adoption on terraces and waterways includes both installing new and replacing existing systems that are no longer functioning*						

The Table below represents total reductions for Sediment using Cropland BMP Implementation for the Upper Portion of the Lower Smoky Hill River Watershed. The

last line shows what reduction was required to meet the TSS TMDL. After 20 years of BMP implementation, this plan will exceed the load reductions required to meet the TSS TMDL.

Table 17. Total Sediment Load Reductions using Cropland BMPs

Sediment Load Reductions with Cropland BMPs			
Year	**Cropland Reduction**	**Total Reduction (tons)**	**% of TMDL**
1	1,739	**1,739**	5%
2	3,477	**3,477**	10%
3	5,216	**5,216**	15%
4	6,955	**6,955**	20%
5	8,693	**8,693**	25%
6	10,432	**10,432**	30%
7	12,171	**12,171**	35%
8	13,909	**13,909**	40%
9	15,648	**15,648**	45%
10	17,387	**17,387**	50%
11	19,125	**19,125**	55%
12	20,864	**20,864**	60%
13	22,603	**22,603**	65%
14	24,341	**24,341**	70%
15	26,080	**26,080**	75%
16	27,819	**27,819**	80%
17	29,557	**29,557**	85%
18	31,296	**31,296**	90%
19	33,035	**33,035**	95%
20	34,773	**34,773**	100%
Sediment TMDL: 34,710 Tons			

The Table below represents total reductions for Sediment using both Cropland and Streambank BMP Implementation for the Upper Portion of the Lower Smoky Hill River Watershed. Again, the last line shows what reduction was required to meet the TSS TMDL, while the yellow high-lighted line shows the year in which the TMDL will be met. After 20 years of BMP implementation, this plan will far exceed the load reductions required to meet the TSS TMDL when using both Streambank and Cropland BMPs.

Table 18. Total Sediment Load Reductions using Cropland AND Streambank BMPs

Total Sediment Load Reductions

Year	Cropland Reduction	Streambank Stabilization	Total Reduction (tons)	% of TMDL
1	1,739	2,054	**3,792**	11%
2	3,477	4,107	**7,584**	22%
3	5,216	6,161	**11,377**	33%
4	6,955	8,214	**15,169**	44%
5	8,693	10,268	**18,961**	55%
6	10,432	12,321	**22,753**	66%
7	12,171	14,375	**26,546**	76%
8	13,909	16,428	**30,338**	87%
9	15,648	18,482	**34,130**	98%
10	17,387	20,536	**37,922**	109%
11	19,125	22,589	**41,714**	120%
12	20,864	24,643	**45,507**	131%
13	22,603	26,696	**49,299**	142%
14	24,341	28,750	**53,091**	153%
15	26,080	30,803	**56,883**	164%
16	27,819	32,857	**60,675**	175%
17	29,557	34,910	**64,468**	186%
18	31,296	36,964	**68,260**	197%
19	33,035	39,017	**72,052**	208%
20	34,773	41,071	**75,844**	219%
Sediment TMDL: 34,710 Tons				

The BMPs delineated by the SLT for sediment reductions will also serve to reduce the amount of phosphorus, nitrates and other nutrients entering the river. As discussed in Section 5, increases in these nutrients can lead to dissolved oxygen and eutrophication, causing problems for aquatic plants and animals. Dissolved oxygen, aquatic plants, pH, eutrophication and biology are all listed on the project area's TMDL list, while total phosphorus, dissolved oxygen, Bacteria, nitrates are listed on the 303(d) list of impairments for this watershed. By implementing sediment BMPs, reductions in nutrient load levels are inevitable.

7.2 Nutrients from Cropland and Livestock Areas

Nutrients are a common nonpoint source pollutant. Although not listed as a TMDL, Total Phosphorus (TP) is 303d listed for the Smoky Hill River near Salina and several nutrient related issues are listed as TMDLs. These issues include Aquatic Plants, Biology, Dissolved Oxygen, Eutrophication and pH. The relationship between these impairments was explained in Section 5. The SLT wishes to address nutrients in the watershed with an emphasis on phosphorus carried to water bodies by crop field runoff and livestock areas. Nutrients contribute heavily to the eutrophication that is taking

place in McPherson County State Fishing Lake. Phosphorus reductions of 50 percent are required to improve conditions in project area lakes.

Nitrates are 303d listed as a low priority for the Smoky Hill River near Salina. This plan does not target the Nitrate impairment. However, while addressing sediment and P runoff, nitrates will be positively impacted by BMP implementation. This will result in the reduction of Nitrates near Salina.

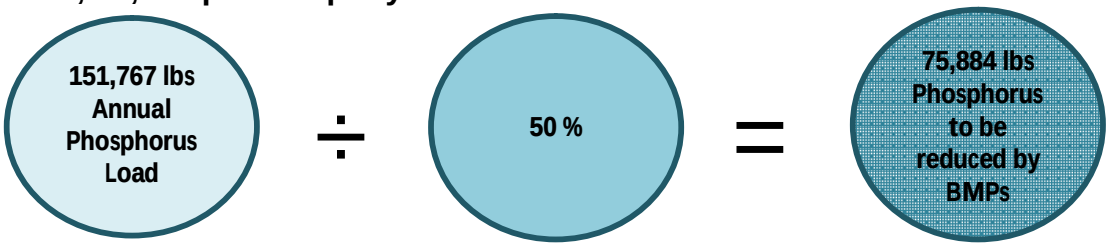
Reducing crop field runoff and erosion is necessary for a reduction in sediment loss and nutrient loading. Agricultural best management practices (BMPs) such as continuous no-till, conservation tillage, grass buffer strips around cropland, terraces, grassed waterways and reducing activities within the riparian areas will reduce erosion and improve water quality.

Possible Sources of the Impairment

Nutrients, primarily phosphorus, are present in manure. Soluble phosphorus can easily be transported in runoff from fields where livestock gather. Other nutrient issues can arise from fertilizers. Nitrogen and phosphorus can originate from fertilizer runoff caused by either excess application or a rainfall event immediately after application. Not all phosphorus and nitrogen contributions can be attributed to agricultural practices. Excess fertilization of lawns, golf courses and urban areas can easily transport nitrogen and phosphorus downstream.

7.2.1 Nutrient Pollutant Loads and Load Reductions

The current estimated nutrient loading, including total phosphorus (TP) entering the Upper Portion of the Lower Smoky Hill River Watershed is above acceptable numbers. Currently, 151,767 pounds of P are entering the watershed annually according to the TMDL section of KDHE (*September 2011*). Therefore, **P loading needs to be reduced by 50%, 75,884 pounds per year**.



As mentioned in Section 6, the SLT will target the following areas:

- HUC 102600080104
- HUC 102600080105
- HUC 102600080301
- HUC 102600080304
- HUC 102600080305

The TMDL section of KDHE has confirmed that achieving the TP load reduction goal of 75,884 pounds per year will also result in meeting TMDL standards for Dissolved Oxygen, Aquatic Plants, pH, and Eutrophication in the project area.

7.2.2 Nutrient Goal and BMPs

The SLT has laid out specific BMPs that they have determined will be acceptable to watershed residents as listed below. **These BMPs will be implemented in cropland targeted areas to address SLT goals and objectives.** The BMPs delineated by the SLT for nutrient reductions will also serve to reduce sediment and bacteria.

7.2.2.A. Cropland BMPs to be Implemented for Nutrients:

Cropland BMP tables for sediment are listed under Section 7.1.4, beginning with Table 13. These tables include BMPs used for Nutrient reductions based on sediment runoff from cropfields:

1. BMPs, Costs, and Reduction Efficiencies for P and N, Table 13
2. Annual Adoption of Cropland BMPs, Table 14
3. Total Annual Soil Erosion Reductions from Cropland BMPs, Table 15

Table 19. Phosphorus BMP Annual Load Reductions

Annual Phosphorus Runoff Reduction									
Year	No-Till	Cons. Tillage	Water-ways	Buffers	Nutrient Mgt. Plans	Terraces	Incorp-orate Manure	Water Retention	Total Load Reduction
1	342	342	513	428	107	385	86	128	2,331
2	684	684	1,026	855	214	770	171	257	4,662
3	1,026	1,026	1,540	1,283	321	1,155	257	385	6,993
4	1,369	1,369	2,053	1,711	428	1,540	342	513	9,324
5	1,711	1,711	2,566	2,139	535	1,925	428	642	11,655
6	2,053	2,053	3,079	2,566	642	2,310	513	770	13,986
7	2,395	2,395	3,593	2,994	748	2,695	599	898	16,317
8	2,737	2,737	4,106	3,422	855	3,079	684	1,026	18,648
9	3,079	3,079	4,619	3,849	962	3,464	770	1,155	20,979
10	3,422	3,422	5,132	4,277	1,069	3,849	855	1,283	23,310
11	3,764	3,764	5,646	4,705	1,176	4,234	941	1,411	25,641
12	4,106	4,106	6,159	5,132	1,283	4,619	1,026	1,540	27,972
13	4,448	4,448	6,672	5,560	1,390	5,004	1,112	1,668	30,303
14	4,790	4,790	7,185	5,988	1,497	5,389	1,198	1,796	32,634
15	5,132	5,132	7,699	6,416	1,604	5,774	1,283	1,925	34,965
16	5,475	5,475	8,212	6,843	1,711	6,159	1,369	2,053	37,296
17	5,817	5,817	8,725	7,271	1,818	6,544	1,454	2,181	39,627
18	6,159	6,159	9,238	7,699	1,925	6,929	1,540	2,310	41,958
19	6,501	6,501	9,752	8,126	2,032	7,314	1,625	2,438	44,289

20	6,843	6,843	10,265	8,554	2,139	7,699	1,711	2,566	46,620

Although N is not a targeted impairment, as previously mentioned, cropland BMPs addressing sediment and P will subsequently remove N as well, the table below exemplifies N load reductions based on BMPs that will already be implemented for sediment and TP targeted areas.

Table 20. Nitrogen BMP Annual Load Reductions

Annual Nitrogen Runoff Reduction									
Year	**No-Till**	**Cons. Tillage**	**Water-ways**	**Buffers**	**Nutrient Mgt. Plans**	**Terraces**	**Incorp-orate Manure**	**Water Retention**	**Total Load Reduction**
1	1,010	1,010	2,424	1,010	505	1,818	1,010	606	9,392
2	2,020	2,020	4,848	2,020	1,010	3,636	2,020	1,212	18,784
3	3,030	3,030	7,271	3,030	1,515	5,453	3,030	1,818	28,176
4	4,040	4,040	9,695	4,040	2,020	7,271	4,040	2,424	37,569
5	5,050	5,050	12,119	5,050	2,525	9,089	5,050	3,030	46,961
6	6,059	6,059	14,543	6,059	3,030	10,907	6,059	3,636	56,353
7	7,069	7,069	16,966	7,069	3,535	12,725	7,069	4,242	65,745
8	8,079	8,079	19,390	8,079	4,040	14,543	8,079	4,848	75,137
9	9,089	9,089	21,814	9,089	4,545	16,360	9,089	5,453	84,529
10	10,099	10,099	24,238	10,099	5,050	18,178	10,099	6,059	93,921
11	11,109	11,109	26,662	11,109	5,554	19,996	11,109	6,665	103,314
12	12,119	12,119	29,085	12,119	6,059	21,814	12,119	7,271	112,706
13	13,129	13,129	31,509	13,129	6,564	23,632	13,129	7,877	122,098
14	14,139	14,139	33,933	14,139	7,069	25,450	14,139	8,483	131,490
15	15,149	15,149	36,357	15,149	7,574	27,267	15,149	9,089	140,882
16	16,159	16,159	38,780	16,159	8,079	29,085	16,159	9,695	150,274
17	17,168	17,168	41,204	17,168	8,584	30,903	17,168	10,301	159,666
18	18,178	18,178	43,628	18,178	9,089	32,721	18,178	10,907	169,058
19	19,188	19,188	46,052	19,188	9,594	34,539	19,188	11,513	178,451
20	20,198	20,198	48,476	20,198	10,099	36,357	20,198	12,119	187,843

These reductions in N and P will aid in the following TMDLs and 303(d) listed areas:

- Biology TMDL for the Smoky Hill River near Salina
- Bacteria on the 303(d) list for Smoky Hill River near Mentor

7.2.2.B Livestock BMPs to be Implemented for Nutrients:

Livestock BMPs have been selected by the SLT based on acceptability by the landowners, cost effectiveness and pollutant load reduction effectiveness. Tables below reflect TP load reductions with livestock BMP implementation over a 20 year span.

Table 21. Livestock BMP Adoption

Annual Livestock BMP Adoption				
Year	**Vegetative Filter Strip**	**Relocate Feeding Pens**	**Relocate Pasture Feeding Site**	**Off Stream Watering System**
1	1	1	1	1
2	1	1	1	1
3	1	1	1	1
4	1	1	1	1
5	1	1	1	1
6	1	1	1	1
7	1	1	1	1
8	1	1	1	1
9	1	1	1	1
10	1	1	1	1
11	1	1	0	0
12	0	0	1	1
13	1	1	0	0
14	0	0	1	1
15	1	1	0	0
16	0	0	1	1
17	1	1	0	0
18	0	0	1	1
19	1	1	0	0
20	0	0	1	1
Total	*15*	*15*	*15*	*15*

Table 22. Phosphorus Reductions using Livestock BMPs

Annual Phosphorus Load Reductions (lbs)					
Year	**Vegetative Filter Strip**	**Relocate Feeding Pens**	**Relocate Pasture Feeding Site**	**Off Stream Watering System**	**Annual Load Reduction**
1	1,276	1,595	63	63	**2,997**
2	2,552	3,189	126	126	**5,993**
3	3,827	4,784	189	189	**8,990**
4	5,103	6,379	252	252	**11,986**
5	6,379	7,973	315	315	**14,983**
6	7,655	9,568	378	378	**17,979**

7	8,930	11,163	441	441	**20,976**
8	10,206	12,758	504	504	**23,972**
9	11,482	14,352	568	568	**26,969**
10	12,758	15,947	631	631	**29,966**
11	14,033	17,542	631	631	**32,836**
12	14,033	17,542	694	694	**32,962**
13	15,309	19,136	694	694	**35,833**
14	15,309	19,136	757	757	**35,959**
15	16,585	20,731	757	757	**38,829**
16	16,585	20,731	820	820	**38,955**
17	17,861	22,326	820	820	**41,826**
18	17,861	22,326	883	883	**41,952**
19	19,136	23,920	883	883	**44,822**
20	19,136	23,920	946	946	**44,948**

Again, Nitrogen is not a targeted impairment, however, much like cropland BMPs, livestock BMPs addressing P will subsequently remove N as well. The table below exemplifies N load reductions based on BMPs that will already be implemented for TP targeted areas.

Table 23. Nitrogen Reductions using Livestock BMPs

Annual Nitrogen Load Reductions (lbs)					
Year	**Vegetative Filter Strip**	**Relocate Feeding Pens**	**Relocate Pasture Feeding Site**	**Off Stream Watering System**	**Annual Load Reduction**
1	2,403	3,004	119	119	**5,644**
2	4,806	6,007	238	238	**11,288**
3	7,209	9,011	356	356	**16,932**
4	9,612	12,014	475	475	**22,576**
5	12,014	15,018	594	594	**28,220**
6	14,417	18,022	713	713	**33,864**
7	16,820	21,025	831	831	**39,508**
8	19,223	24,029	950	950	**45,152**
9	21,626	27,032	1,069	1,069	**50,796**
10	24,029	30,036	1,188	1,188	**56,440**
11	26,432	33,040	1,188	1,188	**61,847**
12	26,432	33,040	1,307	1,307	**62,084**
13	28,835	36,043	1,307	1,307	**67,491**
14	28,835	36,043	1,425	1,425	**67,728**

15	31,237	39,047	1,425	1,425	**73,135**
16	31,237	39,047	1,544	1,544	**73,372**
17	33,640	42,050	1,544	1,544	**78,779**
18	33,640	42,050	1,663	1,663	**79,016**
19	36,043	45,054	1,663	1,663	**84,423**
20	36,043	45,054	1,782	1,782	**84,660**

The Table below indicates that there are 60,602 acres of pasture and rangeland needing BMP treatment/implementation. This is well over the acreage required by this plan's livestock BMP Implementation schedule.

Table 24. Livestock Inventory for the Project Area

Livestock BMP Needs Inventory					
	Acres of Pasture	**Acres of Pasture Needing Treatment**	**Acres of Rangeland**	**Acres of Rangeland Needing Treatment**	**Rangeland / Pasture Needing Treatment**
Upper Lower Smoky WRAPS Project Area	4,494	177	240,868	60,425	60,602
		3.9%		25.1%	
McPherson County Priority HUC 12s	371	15	31,554	7,916	7,930
Saline County Priority HUC 12	0	0	3,188	1,633	1,633
Rice County Priority HUC 12s	0	0	1,628	408	408
Ellsworth County Priority HUC 12	0	0	2,604	653	653

The Tables below represent total reductions for TP using Cropland and Livestock BMP Implementation and then also Cropland, Livestock and Streambank BMP Implementation in the Upper Portion of the Lower Smoky Hill River Watershed. The row high-lighted in yellow demonstrates the year in which the watershed is projected to meet its 303(d) list reductions. The last line of the table shows what reduction is required to achieve the removal of TP from the 303(d) list. By year 20, this plan will far exceed the load reductions needed to meet TP 303(d) list standards.

Table 25. Phosphorus Load Reductions Using Cropland and Livestock BMPs

Phosphorus Reductions using Cropland and Livestock BMPs				
Year	**Cropland Reduction**	**Livestock Reduction**	**Total Reduction (lbs)**	**% of TMDL**
1	2,331	2,997	5,328	7%
2	4,662	5,993	10,655	14%
3	6,993	8,990	15,983	21%
4	9,324	11,986	21,310	28%
5	11,655	14,983	26,638	35%
6	13,986	17,979	31,965	42%
7	16,317	20,976	37,293	49%
8	18,648	23,972	42,621	56%
9	20,979	26,969	47,948	63%
10	23,310	29,966	53,276	70%
11	25,641	32,836	58,477	77%
12	27,972	32,962	60,934	80%
13	30,303	35,833	66,136	87%
14	32,634	35,959	68,593	90%
15	34,965	38,829	73,794	97%
16	37,296	38,955	76,251	100%
17	39,627	41,826	81,453	107%
18	41,958	41,952	83,910	111%
19	44,289	44,822	89,111	117%
20	46,620	44,948	91,569	121%
Phosphorus TMDL: 75,883 Pounds				

Table 26. Total Phosphorus Load Reductions Using Streambank, Cropland AND Livestock BMPs

Total Phosphorus Load Reductions					
Year	**Cropland Reduction**	**Livestock Reduction**	**Streambank Stabilization**	**Total Reduction (lbs)**	**% of TMDL**
1	2,331	2,997	123	5,451	7%
2	4,662	5,993	246	10,902	14%
3	6,993	8,990	370	16,352	22%
4	9,324	11,986	493	21,803	29%
5	11,655	14,983	616	27,254	36%
6	13,986	17,979	739	32,705	43%
7	16,317	20,976	862	38,155	50%
8	18,648	23,972	986	43,606	57%

9	20,979	26,969	1,109	49,057	65%
10	23,310	29,966	1,232	54,508	72%
11	25,641	32,836	1,355	59,832	79%
12	27,972	32,962	1,479	62,413	82%
13	30,303	35,833	1,602	67,737	89%
14	32,634	35,959	1,725	70,318	93%
15	34,965	38,829	1,848	75,642	100%
16	37,296	38,955	1,971	78,223	103%
17	39,627	41,826	2,095	83,547	110%
18	41,958	41,952	2,218	86,128	114%
19	44,289	44,822	2,341	91,452	121%
20	46,620	44,948	2,464	94,033	124%
Phosphorus TMDL: 75,883 Pounds					

7.3 Bacteria from Livestock

Livestock can cause certain pollutants in the water. E. coli bacteria are present in livestock manure and can be transported into waterways if livestock have access to streams. Nutrients, primarily phosphorus, are also present in manure. Soluble phosphorus can easily be transported in runoff from fields where livestock gather. Other nutrient issues can arise from fertilizers. Nitrogen and phosphorus can originate from fertilizer runoff caused by either excess application or a rainfall event immediately after application. E. coli can originate in both rural and urban areas. It can be caused by both point and nonpoint sources. *It must be noted that not all E. coli bacteria can be attributed to livestock. Wildlife has a contribution to E. coli loads. In addition, failing septic systems can be a source of E. coli bacteria from humans. A similar notation is that not all phosphorus and nitrogen contributions can be attributed to agricultural practices. Excess fertilization of lawns, golf courses and urban areas in combination with severe runoff events can easily transport nitrogen and phosphorus downstream. However, for this WRAPS process, targeting will be for livestock.*

Gypsum Creek near Solomon is listed on the 303d list for **E. coli bacteria** impairments and the Smoky Hill River near Mentor was listed as a TMDL in 2010. Fecal coliform bacteria are a broad spectrum of bacteria species which includes E. coli bacteria. While fecal coliform bacteria (FCB) is present in the digestive tract of all warm blooded animals including humans and animals (domestic and wild), its presence in water indicates that the water has been in contact with human or animal waste. FCB is not itself harmful to humans, but its presence indicates that disease causing organisms, or pathogens, may also be present. A few of these are Giardia, Hepatitis, and Cryptosporidium. Presence of E. coli in waterways can originate from runoff from livestock production areas, close proximity of any mammals to water sources, and manure application to agricultural fields.

7.3.1 Manure Runoff from Fields and Livestock Operations

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

7.3.2 Land Use and Manure Transport

Livestock production areas are a source of FCB even though manure generated by any mammal can contain FCB. Livestock that are housed in close proximity to a stream or allowed to loaf in the water source can shed FCB. Wild animals are also contributors in streams and lakes. However, the wild animal population is not as easily controlled as limiting livestock from water sources. Alternative water supplies allow the livestock to have access to fresh water while limiting the time they spend in surrounding areas. This not only reduces FCB, but provides a clean drinking water source. Manure runoff from grasslands close to waterways can add to FCB in the waterways. The SLT has chosen to target high livestock areas for manure BMPs near Mentor. The primary land uses in the livestock targeted areas are grasslands (47%) and pasture (~1%) accounting for 247,264 total acres in the watershed.

As mentioned in Section 5.3.1, FCB and E. Coli will be jointly referred to as “Bacteria” throughout this plan.

7.3.3 Rainfall and Runoff

Rainfall amounts and subsequent runoff along with flooding outside the stream channel can affect Bacteria concentrations in the Lower Smoky Hill River and its tributaries. Manure runoff from livestock that are allowed access to stream or manure applied before a rainfall or on frozen ground is washed into the stream.

7.3.4 Pollutant Load and Load Reductions

The current estimated pollutant load for bacteria is difficult to model. Environmental factors affect the viability of the bacteria since it is a living organism. The fate of the bacteria is affected by variations in its initial loading, ambient temperature, amount of sunlight or UV rays, and a decrease in survivability over time are all factors that affect the viability of bacteria.

The SLT will target livestock areas in those areas that have been 303(d) listed: Smoky Hill River near Mentor. Subsequently, targeting TP and other nutrients and implementing livestock BMPs in HUC’s 102600080102, 102600080103, and 102600080105, Bacteria loading in those HUC’s will also be addressed and improve downstream conditions.

As mentioned in Section 6, the SLT conducted “windshield surveys” to assess and target sites for BMP implementation in the Spring of 2011. The SLT may consider water monitoring at different sites along the stream to check for increases in bacteria for additional assistance in targeting.

The SLT has laid out specific BMPs that they have determined will be acceptable to watershed residents as listed below. **These BMPs will address SLT goals and objectives and will be implemented in livestock areas. Nutrient BMPs as listed in**

the previous section will serve to reduce bacteria loading in the watershed as well.

Table 27. Bacteria Goals and BMPs

Goal: Reduce Bacteria entering the Upper Portion of the Lower Smoky Hill River Watershed.				
TMDL Water Quality Goals: To achieve ECB water quality standards and maintain geometric means of bacteria samples collected within 30-day periods from April – October below 262 cfus/100 ml on the stream.				
Protection Measures	***BMPs and Other Actions***	***Bacteria Load Reduction***	***Timeframe***	***Acres/Projects to be Implemented***
Prohibit Bacteria from entering streams by addressing livestock areas.	Establish vegetative buffer strips along streams	TBD	2010-2030	BMPs will be implemented in Tier 1 to begin with: HUCs 102600080102 and 102600080103. If sufficient improvements cannot be made in these areas or if projects come up that need immediate implementation, the SLT will then move to Tier 2, HUC 102600080105.
	Relocate small feedlots away from streams	TBD	2010-2030	
	Relocate pasture feeding sites away from streams	TBD	2010-2030	
	Promote alternative watering sites away from streams	TBD	2010-2030	
Reduce runoff from manure used as fertilizer	Manure application - incorporate with tillage	20% reduction in P, 50% reduction in N, % Bacteria - unknown	2010-2030	
Develop Nutrient Management Plans	Soil tests will be issued to determine nutrient needs. Nutrients, including manure applications, will then be applied at agronomic rates based on test results.	0-25% P, 0-25% N	2010-2030	on-going

The BMPs delineated by the SLT for Bacteria reductions will also serve to reduce the amount of phosphorus entering the stream.

8.0 Information and Education in Support of BMPs

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

Table 28. Information and Education Activities and Events

BMP	Target Audience	Information / Education Activity / Event	Time Frame	Estimated Costs	Sponsor/ Responsible Agency
Streambank BMP Implementation					
Survey streams to identify and prioritize at risk segments	Landowners and Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	K-State Extension Watershed Specialists, BMP coordinators, K-State Extension County Offices, Conservation Districts
		Seasonal Information Meetings	Ongoing	$150 per year	
Install rock weirs, veins or other practices	Landowners, Agency employees	Bank Stabilization Project Tours	Annually, as requested	None	
	Landowners and Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	
		Seasonal Information Meetings	Ongoing	Combined with streambank BMPs mentioned above.	
Improve and manage existing riparian areas	Landowners and Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	K-State Extension Watershed Specialists, BMP coordinators, K-State Extension County Offices,
		Seasonal Information Meetings	Ongoing	Combined with streambank BMPs mentioned above.	

Remove stream obstructions causing bank erosion.	Landowners and Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	Conservation Districts
		Seasonal Information Meetings	Ongoing	Combined with streambank BMPs mentioned above.	
		Crop Schools to cover weed control and atrazine use - multi-county	Annual - Winter/ Spring	Combined with Split Application of Herbicide BMP	
Establish new wetland areas	Landowners and Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	
		Seasonal Information Meetings	Ongoing	Combined with streambank BMPs mentioned above.	
Cropland BMP Implementation for Sediment and Nutrients					
No-till	Farmers and Rental Operators	Field Day and/or Tour	Annual - Summer	$2,500 per year	K-State Extension Watershed Specialists, K-State Extension County Offices, Conservation Districts, NRCS
		No-till Meetings	Winter	$500 per year	
		Cover Crop Tour, Saline County	Winter	$500	
Conservation Tillage	Farmers and Rental Operators	Residue Alliance (bus tour) - McPherson and Rice Counties	Annual - Summer	$1,000 per year	
Vegetative Buffers along Streams	Landowners and Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	K-State Extension Water Specialists, BMP

		Seasonal Information Meetings	Ongoing	$300 per year for all cropland pollutants in plan	coordinators, K-State Extension County Offices, Conservation Districts
Terraces and Waterways	Landowners and Farmers	One-on-One Technical Assistance	Ongoing	Cost included with Technical Assistance for Watershed Specialist	
		Seasonal Information Meetings	Ongoing	Combined with informational meeting mentioned above for buffers	
Manure Application-Incorporate with Tillage	Landowners and Farmer	Field Day and/or Tour	Annual - Fall	Combined with that of Vegetative Filter Strips listed above	
		Informational Meeting	Fall/Winter	Combined with Meeting on Manure Incorporation for Nutrients	
Nutrient Management Plans	Landowners and Farmers	Information Meetings	Ongoing	Cost included with Technical Assistance for Watershed Specialist	Kansas State Research and Extension
		One on One Meetings with Producers	Annual - Ongoing	Cost included with Technical Assistance for Watershed Specialist	
Water Retention Structure	Landowners and Farmers	One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	K-State Extension Watershed Specialists, BMP coordinators,

		Seasonal Information Meetings	Ongoing	Combined with informational meeting mentioned above for buffers	K-State Extension County Offices, Conservation Districts
Livestock BMP Implementation for Nutrients and Bacteria					
Vegetative Buffer Strips along streams	Landowners and Ranchers	Field Day and/or Tour	Annual - Fall	$500 per year	K-State Extension Watershed Specialists, BMP coordinators, K-State Extension County Offices, Conservation Districts
		One-on-One Technical Assistance*	Ongoing	Cost included with Technical Assistance for Watershed Specialist	
		Seasonal Information Meetings	Ongoing	Combined with informational meeting mentioned above	
Relocate Feeding Pens away from Streams	Landowners and Ranchers	Field Day and/or Tour	Annual - Fall	Combined with that of Vegetative Filter Strips listed above	
		Informational Meeting	Fall/Winter	Combined with Meeting on Manure Incorporation for Nutrients	
Relocate Pasture Feeding Sites away from Streams	Landowners and Ranchers	Field Day and/or Tour	Annual - Fall	Combined with that of Vegetative Filter Strips listed above	
		Informational Meeting	Fall/Winter	Combined with Meeting on Manure Incorporation for Nutrients	
Promote Alternative Watering Sites away from Streams	Landowners and Ranchers	Field Day and/or Tour	Annual - Fall	Combined with that of Vegetative Filter Strips listed above	

		Informational Meeting	Fall/Winter	Combined with Meeting on Manure Incorporation for Nutrients	
General / Watershed Wide Information and Education					
Educational Activities Targeting Youth	3rd-4th Grade Students	Ag in the Classroom ~ 400 kids per year	Annual - Winter/ Spring	$5,000 per year	Conservation Districts, County Extension Offices, K-State Research and Extension
	Educators, K-12 Students	Day on the Farm	Annual – Spring	$500 per event	Conservation Districts, County Extension Offices, K-State Research and Extension
		Environmental education	Ongoing	$500 per year	Kansas FFA Organization, Conservation Districts
	10-12 Grade Students	Range Youth Camp - 4 kids per year	Annual - Summer	$880 ($220 per student)	Farm Bureau, Conservation District
	5th Grade Students and Educators	EARTH Day	Annual - Spring	$1,200	Farm Buearu, Consevation District, K-State Research and Extension, Master Gardners, NRCS, Harvey County Parks and Recreation, and 4-H

	4th Grade Students and Educators	Water Festival (McPherson County)	Annual - Fall	$15,200 per event	Conservation Districts, Kansas State Research and Extension and Cargill
Educational Activities Targeting Adults	Watershed Residents	Budget Hearings with County Commissioners	Annual - Spring	No charge	Conservation Districts
		Bankers Awards (No-Till, Soil and Water Conservation, Water Quality, Pasture Management and Wildlife Habitat) - Publicity and Tour	Annual - Winter	No charge	Kansas State Research and Extension and Conservation Districts
		Conservation District Annual Meetings (Saline and McPherson)	Annual - Winter	$2,000 per event	Conservation Districts
Total annual cost for Information and Education if all events are implemented				**$31,230**	

* *One-on-One Technical Assistance includes on-farm assessments and consultations to encourage BMP implementation, proper operation and maintenance techniques for BMP longevity.*

9.0 Costs of Implementing BMPs and Possible Funding Sources

The SLT has reviewed all the recommended BMPs listed in Section 7 of this report for each individual impairment. It has been determined by the SLT that specific BMPs will be the target of implementation funding for both cropland and livestock. Most of the BMPs that are targeted will be advantageous to more than one impairment, thus being more efficient.

Summarized Derivation of Cropland BMP Cost Estimates

No-Till: After being presented with information from K-State Research and Extension (Craig Smith and Josh Roe) on the costs and benefits of no-till, the SLT decided that a fair price to entice a producer to adopt no-till would be to pay them $10 per acre for 10 years, or a net present value of $78.00 per acre upfront assuming the NRCS discount rate of 4.75%.

Conservation Tillage: $39 per acre based on contour farming numbers and that figured by Josh Roe in Fall 2011.

Grassed Waterway: $1,600 per acre installed was arrived at using average cost of installation figures from the conservation districts within the watershed and updated costs of brome grass seeding from Josh Roe.

Vegetative Buffer: The cost of $1,000 per acre was arrived at using average cost of installation figures from the conservation districts within the watershed and cost estimates from the KSU Vegetative Buffer Tool developed by Craig Smith. It has been determined that for every acre of a vegetative buffer installed, 15 acres have been treated, this cuts the cost down to $67.00 per acre affected.

Nutrient Management Plan: After being presented with information from K-State Research and Extension (Craig Smith and Josh Roe) on the costs and benefits of nutrient management plans, the SLT decided that a fair price to entice a producer to adopt nutrient management plans would be to pay them $7.30 per acre for 10 years, or a net present value of $57 per acre upfront assuming the NRCS discount rate of 4.75%.

Terraces: In consulting with numerous conservation districts it was determined by Josh Roe that the average cost of building a terrace at this point in time is $102 per acre.

Incorporate Manure with Tillage: It has been determined that it costs about $6.33 per acre to incorporate manure with tillage. This estimate was provided by Josh Roe of Kansas State University in July 2011.

Water Retention Structure: Approximately $5,000 per structure, treats 40 acres, $125 per treated acre. This estimate was provided by Josh Roe of Kansas State University in September 2011.

Summarized Derivation of Livestock BMP Cost Estimates

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

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

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

Off-stream/Alternative Watering Sites: The average cost of installing an alternative watering system of $3,795 was estimated by Herschel George, Marais des Cygnes Watershed Specialist who has installed numerous systems and has detailed average cost estimates.

Prices below reflect current prices (2011) for implementation and also include technical assistance costs.

Streambank costs are reported in Section 7.1.1 in Tables 10 and 11 for Streambank Restoration Implementation.

Table 29. Estimated Costs for Cropland Implemented BMPs for Sediment and Nutrients *– following two tables*

Total Annual Cost Before Cost-Share, Cropland BMPs									
Year	No-Till	Cons. Tillage	Waterways	Buffers	Nutrient Mgt. Plans	Terraces	Incorp-orate Manure	Water Retention	Total Cost
1	$27,083	$27,083	$83,665	$23,240	$9,885	$53,337	$1,103	$13,073	$238,469
2	$27,896	$27,896	$86,175	$23,938	$10,181	$54,937	$1,136	$13,465	$245,623
3	$28,732	$28,732	$88,760	$24,656	$10,487	$56,585	$1,171	$13,869	$252,992
4	$29,594	$29,594	$91,423	$25,395	$10,801	$58,282	$1,206	$14,285	$260,582
5	$30,482	$30,482	$94,166	$26,157	$11,125	$60,031	$1,242	$14,713	$268,399
6	$31,397	$31,397	$96,991	$26,942	$11,459	$61,832	$1,279	$15,155	$276,451
7	$32,339	$32,339	$99,901	$27,750	$11,803	$63,687	$1,317	$15,609	$284,745
8	$33,309	$33,309	$102,898	$28,583	$12,157	$65,597	$1,357	$16,078	$293,287
9	$34,308	$34,308	$105,985	$29,440	$12,522	$67,565	$1,398	$16,560	$302,085
10	$35,337	$35,337	$109,164	$30,323	$12,897	$69,592	$1,440	$17,057	$311,148
11	$36,397	$36,397	$112,439	$31,233	$13,284	$71,680	$1,483	$17,569	$320,482
12	$37,489	$37,489	$115,812	$32,170	$13,683	$73,830	$1,527	$18,096	$330,097

13	$38,614	$38,614	$119,287	$33,135	$14,093	$76,045	$1,573	$18,639	$340,000
14	$39,772	$39,772	$122,865	$34,129	$14,516	$78,327	$1,620	$19,198	$350,200
15	$40,966	$40,966	$126,551	$35,153	$14,951	$80,676	$1,669	$19,774	$360,706
16	$42,195	$42,195	$130,348	$36,208	$15,400	$83,097	$1,719	$20,367	$371,527
17	$43,460	$43,460	$134,258	$37,294	$15,862	$85,590	$1,771	$20,978	$382,673
18	$44,764	$44,764	$138,286	$38,413	$16,338	$88,157	$1,824	$21,607	$394,153
19	$46,107	$46,107	$142,434	$39,565	$16,828	$90,802	$1,878	$22,255	$405,978
20	$47,490	$47,490	$146,707	$40,752	$17,333	$93,526	$1,935	$22,923	$418,157

Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Cons. Tillage	Waterways	Buffers	Nutrient Mgt. Plans	Terraces	Incorp-orate Manure	Water Retention	Total Cost
1	$16,521	$27,083	$41,833	$2,324	$4,942	$26,668	$1,103	$6,536	$127,011
2	$17,016	$27,896	$43,088	$2,394	$5,091	$27,468	$1,136	$6,732	$130,821
3	$17,527	$28,732	$44,380	$2,466	$5,243	$28,292	$1,171	$6,934	$134,746
4	$18,053	$29,594	$45,712	$2,540	$5,401	$29,141	$1,206	$7,142	$138,788
5	$18,594	$30,482	$47,083	$2,616	$5,563	$30,015	$1,242	$7,357	$142,952
6	$19,152	$31,397	$48,495	$2,694	$5,730	$30,916	$1,279	$7,577	$147,240
7	$19,727	$32,339	$49,950	$2,775	$5,901	$31,843	$1,317	$7,805	$151,658
8	$20,318	$33,309	$51,449	$2,858	$6,078	$32,799	$1,357	$8,039	$156,207
9	$20,928	$34,308	$52,992	$2,944	$6,261	$33,783	$1,398	$8,280	$160,893
10	$21,556	$35,337	$54,582	$3,032	$6,449	$34,796	$1,440	$8,528	$165,720
11	$22,202	$36,397	$56,220	$3,123	$6,642	$35,840	$1,483	$8,784	$170,692
12	$22,869	$37,489	$57,906	$3,217	$6,841	$36,915	$1,527	$9,048	$175,813
13	$23,555	$38,614	$59,643	$3,314	$7,047	$38,023	$1,573	$9,319	$181,087
14	$24,261	$39,772	$61,433	$3,413	$7,258	$39,163	$1,620	$9,599	$186,520
15	$24,989	$40,966	$63,276	$3,515	$7,476	$40,338	$1,669	$9,887	$192,115
16	$25,739	$42,195	$65,174	$3,621	$7,700	$41,548	$1,719	$10,183	$197,879
17	$26,511	$43,460	$67,129	$3,729	$7,931	$42,795	$1,771	$10,489	$203,815
18	$27,306	$44,764	$69,143	$3,841	$8,169	$44,079	$1,824	$10,804	$209,929
19	$28,125	$46,107	$71,217	$3,957	$8,414	$45,401	$1,878	$11,128	$216,227
20	$28,969	$47,490	$73,354	$4,075	$8,666	$46,763	$1,935	$11,462	$222,714

Table 30. Estimated Costs for Implementing Livestock BMPs *– following two tables*

Annual Cost*Before Cost-Share of Implementing Livestock BMPs					
Year	**Vegetative Filter Strip**	**Relocate Feeding Pens**	**Relocate Pasture Feeding Site**	**Off Stream Watering System**	**Annual Cost**
1	$2,814	$12,000	$2,203	$3,795	**$20,812**
2	$2,898	$12,360	$2,269	$3,909	**$21,436**
3	$2,985	$12,731	$2,337	$4,026	**$22,079**
4	$3,075	$13,113	$2,407	$4,147	**$22,742**
5	$3,167	$13,506	$2,479	$4,271	**$23,424**
6	$3,262	$13,911	$2,554	$4,399	**$24,127**
7	$3,360	$14,329	$2,630	$4,531	**$24,851**
8	$3,461	$14,758	$2,709	$4,667	**$25,596**
9	$3,565	$15,201	$2,791	$4,807	**$26,364**
10	$3,672	$15,657	$2,874	$4,952	**$27,155**
11	$3,782	$16,127	$0	$0	**$19,909**
12	$0	$0	$3,049	$5,253	**$8,303**
13	$4,012	$17,109	$0	$0	**$21,121**
14	$0	$0	$3,235	$5,573	**$8,808**
15	$4,256	$18,151	$0	$0	**$22,408**
16	$0	$0	$3,432	$5,912	**$9,345**
17	$4,516	$19,256	$0	$0	**$23,772**
18	$0	$0	$3,641	$6,273	**$9,914**
19	$4,791	$20,429	$0	$0	**$25,220**
20	$0	$0	$3,863	$6,655	**$10,518**
3% Annual Cost Inflation					

Annual Cost* After Cost-Share of Implementing Livestock BMPs					
Year	**Vegetative Filter Strip**	**Relocate Feeding Pens**	**Relocate Pasture Feeding Site**	**Off Stream Watering System**	**Annual Cost**
1	$1,407	$6,000	$1,102	$1,898	**$10,406**
2	$1,449	$6,180	$1,135	$1,954	**$10,718**
3	$1,493	$6,365	$1,169	$2,013	**$11,040**
4	$1,537	$6,556	$1,204	$2,073	**$11,371**
5	$1,584	$6,753	$1,240	$2,136	**$11,712**
6	$1,631	$6,956	$1,277	$2,200	**$12,063**
7	$1,680	$7,164	$1,315	$2,266	**$12,425**
8	$1,730	$7,379	$1,355	$2,334	**$12,798**

9	$1,782	$7,601	$1,395	$2,404	**$13,182**
10	$1,836	$7,829	$1,437	$2,476	**$13,577**
11	$1,891	$8,063	$0	$0	**$9,954**
12	$0	$0	$1,525	$2,627	**$4,151**
13	$2,006	$8,555	$0	$0	**$10,561**
14	$0	$0	$1,618	$2,787	**$4,404**
15	$2,128	$9,076	$0	$0	**$11,204**
16	$0	$0	$1,716	$2,956	**$4,672**
17	$2,258	$9,628	$0	$0	**$11,886**
18	$0	$0	$1,821	$3,136	**$4,957**
19	$2,395	$10,215	$0	$0	**$12,610**
20	$0	$0	$1,931	$3,327	**$5,259**
3% Annual Cost Inflation					

Table 31. Total Annual Cost of WRAPS Plan for BMO Implementation

Total Annual WRAPS Cost after Cost-Share by BMP Category				
Year	**Cropland**	**Livestock**	**Streambanks**	**Total Annual Cost**
1	$127,011	$4,356	$67,413	$198,780
2	$130,821	$2,984	$69,435	$203,241
3	$134,746	$10,608	$71,518	$216,872
4	$138,788	$3,166	$73,664	$215,618
5	$142,952	$4,501	$75,874	$223,326
6	$147,240	$3,359	$78,150	$228,749
7	$151,658	$4,775	$80,494	$236,927
8	$156,207	$3,564	$82,909	$242,680
9	$160,893	$5,066	$85,397	$251,356
10	$165,720	$4,246	$87,958	$257,925
11	$170,692	$5,374	$90,597	$266,663
12	$175,813	$4,011	$93,315	$273,139
13	$181,087	$14,256	$96,115	$291,458
14	$186,520	$4,255	$98,998	$289,773
15	$192,115	$6,049	$101,968	$300,132
16	$197,879	$4,514	$105,027	$307,420
17	$203,815	$6,417	$108,178	$318,410
18	$209,929	$4,789	$111,423	$326,142
19	$216,227	$6,808	$114,766	$337,801
20	$222,714	$5,081	$118,209	$346,004

Table 32. Technical Assistance Needed to Implement BMPs

BMP		Technical Assistance	Projected Annual Cost
Streambank	Restoration and Stabilization	WRAPS Coordinator, DOC Buffer Technician, NRCS	TA from outside funding sources which can/might be utilized to help with watershed plan implementation.
Cropland	No-till	WRAPS Coordinator, DOC Buffer Technician	WRAPS Coordinator $16,504
	Conservation Tillage	WRAPS Coordinator, DOC Buffer Technician	
	Waterways	WRAPS Coordinator, DOC Buffer Technician	
	Vegetative Buffers	WRAPS Coordinator, DOC Buffer Technician	
	Nutrient Management Plans	WRAPS Coordinator, DOC Buffer Technician	
	Terraces	WRAPS Coordinator, DOC Buffer Technician	
	Incorporate Manure	WRAPS Coordinator, DOC Buffer Technician	
	Water Retention Structures	WRAPS Coordinator, DOC Buffer Technician	
Livestock	Vegetative Buffers	WRAPS Coordinator, DOC Buffer Technician	DOC Buffer Coordinator - position is presently vacant
	Relocate Feeding Pens	WRAPS Coordinator	
	Relocate Pasture Feeding Sites	WRAPS Coordinator	
	Promote off-Stream / Alternative water sites	WRAPS Coordinator	
Total			**$16,504**

Table 33. Total Annual Costs for Implementing Entire WRAPS Plan

Total Annual Costs of Implementing Streambank, Cropland and Livestock BMPs, in addition to Information and Education and Technical Assistance						
Year	BMPs Implemented			I&E and Technical Assistance		Total
	Streambank	Cropland	Livestock	I&E	Technical Assistance	
1	$67,413	$127,011	$4,356	$31,730	$16,504	$247,014
2	$69,435	$130,821	$2,984	$32,682	$16,999	$252,921
3	$71,518	$134,746	$10,608	$33,662	$17,509	$268,043
4	$73,664	$138,788	$3,166	$34,672	$18,034	$268,324
5	$75,874	$142,952	$4,501	$35,712	$18,575	$277,614
6	$78,150	$147,240	$3,359	$36,784	$19,133	$284,666
7	$80,494	$151,658	$4,775	$37,887	$19,706	$294,520
8	$82,909	$156,207	$3,564	$39,024	$20,298	$302,002
9	$85,397	$160,893	$5,066	$40,195	$20,907	$312,458
10	$87,958	$165,720	$4,246	$41,400	$21,534	$320,858
11	$90,597	$170,692	$5,374	$42,642	$22,180	$331,485
12	$93,315	$175,813	$4,011	$43,922	$22,845	$339,906
13	$96,115	$181,087	$14,256	$45,239	$23,530	$360,227
14	$98,998	$186,520	$4,255	$46,596	$24,236	$360,605
15	$101,968	$192,115	$6,049	$47,994	$24,964	$373,090
16	$105,027	$197,879	$4,514	$49,434	$25,712	$382,566
17	$108,178	$203,815	$6,417	$50,917	$26,484	$395,811
18	$111,423	$209,929	$4,789	$52,445	$27,278	$405,864
19	$114,766	$216,227	$6,808	$54,018	$28,097	$419,916
20	$118,209	$222,714	$5,081	$55,639	$28,940	$430,583
**3% Annual Cost Inflation*						

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

Table 34. Potential BMP Funding Sources

Potential Funding Sources	Potential Funding Programs
Natural Resources Conservation Service	Environmental Quality Incentives Program (EQIP)
	Wetland Reserve Program (WRP)
	Conservation Reserve Program (CRP)
	Wildlife Habitat Incentive Program (WHIP)
	Forestland Enhancement Program (FLEP)
	State Acres for Wildlife Enhancement (SAFE)
	Grassland Reserve Program (GRP)
	Farmable Wetlands Program (FWP)
EPA/KDHE	319 Funding Grants
	State Water Plan Funds
	KDHE WRAPS Funding
	Clean Water Neighbor Grants
Kansas Department of Wildlife and Parks	
Kansas Alliance for Wetlands and Streams	
State Conservation Commission	Nonpoint Source Pollution Cost Share Program
Conservation Districts	
Kansas Forest Service	
U.S. Fish and Wildlife	

Table 35. Potential Service Providers for BMP Implementation

BMP		Services Needed to Implement BMP	Service Provider *
		Technical Assistance	
Streambank	Restoration Projects	Design, cost share and maintenance	KSRE NRCS DOC KRC CD KDWP
Cropland	No-till	Design, cost share and maintenance	KSRE NRCS DOC KRC CD KDWP
	Conservation Tillage	Design, cost share and maintenance	
	Waterways	Design, cost share and maintenance	
	Vegetative Buffers	Design, cost share and maintenance	
	Nutrient Management Plans	Writing	
	Terraces	Design, cost share and maintenance	
	Incorporate manure with tillage	Design, cost share and maintenance	
	Water Retention Structures	Design, cost share and maintenance	
Livestock	Vegetative Filterstrip	Design, cost share and maintenance	KSRE NRCS DOC KRC CD KDWP
	Relocate feeding pens	Design, cost share and maintenance	
	Relocate pasture feeding sites	Design, cost share and maintenance	
	Promote off-stream/alternative water sites	Design, cost share and maintenance	
****See Appendix for Service Provider Directory***			

10.0 Timeframe

The plan will be reviewed every five years starting in 2015. The Plan will be reviewed approximately one year after the Pollutants and BMPs are reviewed so that the Plan can be altered to accommodate any changes in pollutant status or BMP needs. The timeframe of this document for BMP implementation for sediment and phosphorus is twenty years and bacteria is to be determined. The SLT will re-examine BMP placement and implementation in 2015 and every subsequent five years after.

Table 36. Review Schedule for Pollutants and BMPs

Year Ending in September	Implementation Period	Possible TMDLs to Revise	TMDLs to Evaluate
2009	2010-2019	2003	N/A
2014	2015-2024	2003, 2004	2003, 2004, 2006
2019	2020-2029	2003, 2004, 2009	2003, 2004, 2006, 2009

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

- The timeframe for meeting the **sediment TMDL** will be twenty years if all BMPs are implemented in the watershed. After the sediment TMDL is met, the BMPs directed at sediment will be considered “protection measures” instead of “restoration measures”. At this point, the SLT may decide to redirect their funding to impairments and areas in need at that time.
- The timeframe for meeting the **phosphorus TMDL** will also be twenty years if all BMPs are implemented in the watershed. After the sediment TMDL is met, the BMPs directed at sediment will be considered “protection measures” instead of “restoration measures”. At this point, the SLT may decide to redirect their funding to impairments and areas in need at that time.
- The timeframe for meeting the **Bacteria TMDL** is to be determined by additional monitoring and guidance from KDHE on desired bacteria parameters.

11.0 Measurable Milestones

11.1 Adoption Rates

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

Table 37. Short, Medium and Long Term Goals for Streambank BMPs

Annual Adoption (treated feet), Streambank BMPs			
	Year	**Streambank Stabilization**	**Total Adoption**
Short Term	1	698	698
	2	698	1,396
	3	698	2,094
	4	698	2,792
	5	698	3,490
Total		*3,490*	*3,490*
Medium Term	6	698	4,188
	7	698	4,886
	8	698	5,584
	9	698	6,282
	10	698	6,980
Total		*6,980*	*6,980*
Long Term	11	698	7,678
	12	698	8,376
	13	698	9,074
	14	698	9,772
	15	698	10,470
	16	698	11,168
	17	698	11,866
	18	698	12,564
	19	698	13,262
	20	698	13,960
Total		*13,960*	*13,660*

Table 38. Short, Medium and Long Term Goals for Cropland BMPs

Annual Adoption (treated acres), Cropland BMPs										
	Year	**No-Till**	**Cons Tillage**	**Water-ways**	**Buffers**	**Nutrient Mgt. Plans**	**Terraces**	**Incorp-orate Manure**	**Water Retention**	**Total Adoption**
Short Term	1	349	697	523	349	174	523	174	105	2,893
	2	349	697	523	349	174	523	174	105	2,893
	3	349	697	523	349	174	523	174	105	2,893
	4	349	697	523	349	174	523	174	105	2,893
	5	349	697	523	349	174	523	174	105	2,893
Total		*1,743*	*3,486*	*2,615*	*1,743*	*872*	*2,615*	*872*	*523*	*14,467*
Medium Term	6	349	697	523	349	174	523	174	105	2,893
	7	349	697	523	349	174	523	174	105	2,893
	8	349	697	523	349	174	523	174	105	2,893
	9	349	697	523	349	174	523	174	105	2,893
	10	349	697	523	349	174	523	174	105	2,893
Total		*3,486*	*6,972*	*5,229*	*3,486*	*1,743*	*5,229*	*1,743*	*1,046*	*28,934*
Long Term	11	349	697	523	349	174	523	174	105	2,893
	12	349	697	523	349	174	523	174	105	2,893
	13	349	697	523	349	174	523	174	105	2,893
	14	349	697	523	349	174	523	174	105	2,893
	15	349	697	523	349	174	523	174	105	2,893
	16	349	697	523	349	174	523	174	105	2,893
	17	349	697	523	349	174	523	174	105	2,893
	18	349	697	523	349	174	523	174	105	2,893
	19	349	697	523	349	174	523	174	105	2,893
	20	349	697	523	349	174	523	174	105	2,893
Total		*6,972*	*13,944*	*10,458*	*6,972*	*3,486*	*10,458*	*3,486*	*2,092*	*57,868*

Table 39. Short, Medium and Long Term Goals for Livestock BMPs

Livestock BMP Adoption Milestones					
	Year	**Vegetative Filter Strip**	**Relocate Feeding Pens**	**Relocate Pasture Feeding Site**	**Off Stream Watering System**
Short-Term	1	1	1	1	1
	2	1	1	1	1
	3	1	1	1	1
	4	1	1	1	1
	5	1	1	1	1
Total		5	5	5	5
Medium-Term	6	1	1	1	1
	7	1	1	1	1
	8	1	1	1	1
	9	1	1	1	1
	10	1	1	1	1
Total		10	10	10	10
Long-Term	11	1	1	0	0
	12	0	0	1	1
	13	1	1	0	0
	14	0	0	1	1
	15	1	1	0	0
	16	0	0	1	1
	17	1	1	0	0
	18	0	0	1	1
	19	1	1	0	0
	20	0	0	1	1
Total		15	15	15	15

Table 40. Watershed Total Reduction Milestones for Sediment BMP Implementation

Sediment		
Best Management Practice Category	**Total Load Reduction (lbs)**	**% of TSS TMDL**
Streambank	41,071	118%
Cropland	34,773	100%
Total	**75,844**	**219%**

Table 41. Watershed Total Reduction Milestones for Phosphorus BMP Implementation

Phosphorus		
Best Management Practice Category	**Total Load Reduction (lbs)**	**% of Phosphorus TMDL**
Livestock	44,948	59%
Streambank	2,464	3%
Cropland	46,620	61%
Total	**94,033**	**124%**

11.2 Water Quality Milestones to Determine Improvements

The primary goal that is focused on within the Upper Lower Smoky Hill River WRAPS Watershed Plan is restoration of water quality of high priority TMDL waters to meet designated uses supportive of aquatic life, domestic water supply, recreation, and other designated uses within the Upper Lower Smoky Hill River WRAPS project area. The plan specifically addresses high priority TMDLs within the upper portion of the Lower Smoky Hill HUC 8 (10260008) in Kansas. The following is a list of the impairments being directly addressed by the plan:

Smoky Hill River Near Mentor (KDHE Station SC514)

- High Priority Bacteria TMDL
- High Priority TSS TMDL

Smoky Hill River Near Salina (KDHE Station SC268)

- High Priority TSS TMDL

In order to reach the load reduction goals associated with the Upper Lower Smoky Hill River WRAPS Project Area impairments, an implementation schedule for BMP implementation spanning 20 years has been developed.

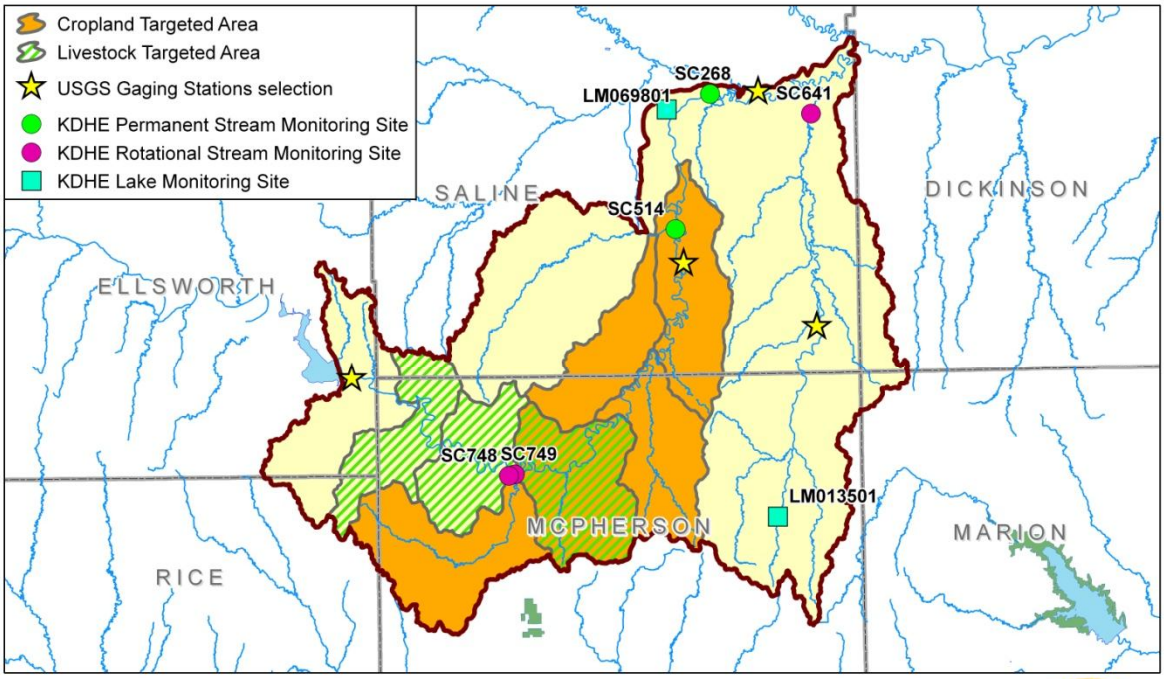
The selected practices included in the plan will be implemented throughout the targeted areas within the Upper Lower Smoky Hill River WRAPS project area. Water quality milestones have been developed for the Smoky Hill River within the WRAPS project area. The purpose of the milestones and indicators are to measure water quality improvements associated with the implementation schedule contained in this plan.

Monitoring Sites in the Upper Lower Smoky Hill River 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 Upper Lower Smoky Hill River WRAPS Project Area. The following stations will be utilized to measure water quality improvements throughout the implementation of the plan.

Station ID	Water Body	Type of Station
SC268	Smoky Hill River Near Salina	Permanent
SC514	Smoky Hill River Near Mentor	Permanent
SC641	Gypsum Creek Near Solomon	Rotational
SC748	Smoky Hill River Near Freemount	Rotational
SC749	Sharps Creek Near Freemount	Rotational

Water Monitoring Network



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Kansas Department of Health and Environment
November 2011

The previous map shows both the permanent and rotational KDHE stream monitoring stations as well as monitored lakes located within the Upper Lower Smoky Hill River 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 Upper Lower Smoky Hill River WRAPS project area has several USGS gaging stations located within the watershed that provide real-time flow information. Streamflow information for these sites as well as other gaging stations within Kansas can be found at http://ks.water.usgs.gov/.

Water Quality Milestones for Upper Lower Smoky Hill River WRAPS Project Area

As previously stated, this plan estimates that it will take 20 years to implement the planned BMPs necessary to meet the load reduction goals for the impairments being addressed in the Upper Lower Smoky Hill River WRAPS Project Area. Several water quality milestones and indicators have been developed, as included herein. The tables below include water quality goals for various parameters monitored in the watershed. Sediment-related water quality milestones for the Smoky Hill River and tributaries have been developed as benchmarks to evaluate TSS loads noted within these respective TMDLs. Nutrient-related water quality milestones have been developed as milestones to measure improvements in nutrient loads for water bodies within the project area.

Table 42. Sediment Water Quality Milestones

Sediment Water Quality Milestones for Smoky Hill River and Tributaries						
			10-Year Goal		Long Term Goal	
	Current Condition Period	Current Condition Median TSS	Improved Condition (2012 - 2021) Median TSS	Total Reduction Needed	Improved Condition Median TSS	Total Reduction Needed
Sampling Site	**Total Suspended Solids (median of data collected during indicated period), µg/L**					
Smoky Hill River Near Salina SC268	2000-2011	67	59	13%	50	25%
Smoky Hill River Near Mentor SC514	2000-2011	62	56	10%	50	19%
Gypsum Creek Near Solomon SC641	1991-2010	37.5	37.5	Maintain	37.5	Maintain
Smoky Hill River Near Freemount SC748	2007-2011	17	17	Maintain	17	Maintain
Sharps Creek Near Freemount SC749	2007-2011	12	12	Maintain	12	Maintain

Table 43. Nutrient Water Quality Milestones

Nutrient Water Quality Milestones for Smoky Hill River and Tributaries							
				10-Year Goal		Long Term Goal	
	Current Condition Period	Current Condition Median TP	Current Condition Minus Point Source/Urban Contribution Median TP	Improved Condition (2012 - 2021) Median TP	Total Reduction Needed	Improved Condition Median TP	Total Reduction Needed
Sampling Site	**Total Phosphorus (median of data collected during indicated period), ppb**						
Smoky Hill River Near Salina SC268	2000-2011	362	166	125*	25%	83*	50%
Smoky Hill River Near Mentor SC514	2000-2011	130	--	98	25%	65	50%
Gypsum Creek Near Solomon SC641	1991-2010	183	--	183	Maintain	183	Maintain
Smoky Hill River Near Freemount SC748	2007-2011	124	--	109	13%	93	25%
Sharps Creek Near Freemount SC749	2007-2011	242	--	221	9%	200	17%

**Salina urban runoff/point source contribution not included*

Water Quality Milestones for Bacteria

The water quality goal associated with the bacteria impairments in the Upper Lower Smoky Hill River 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.

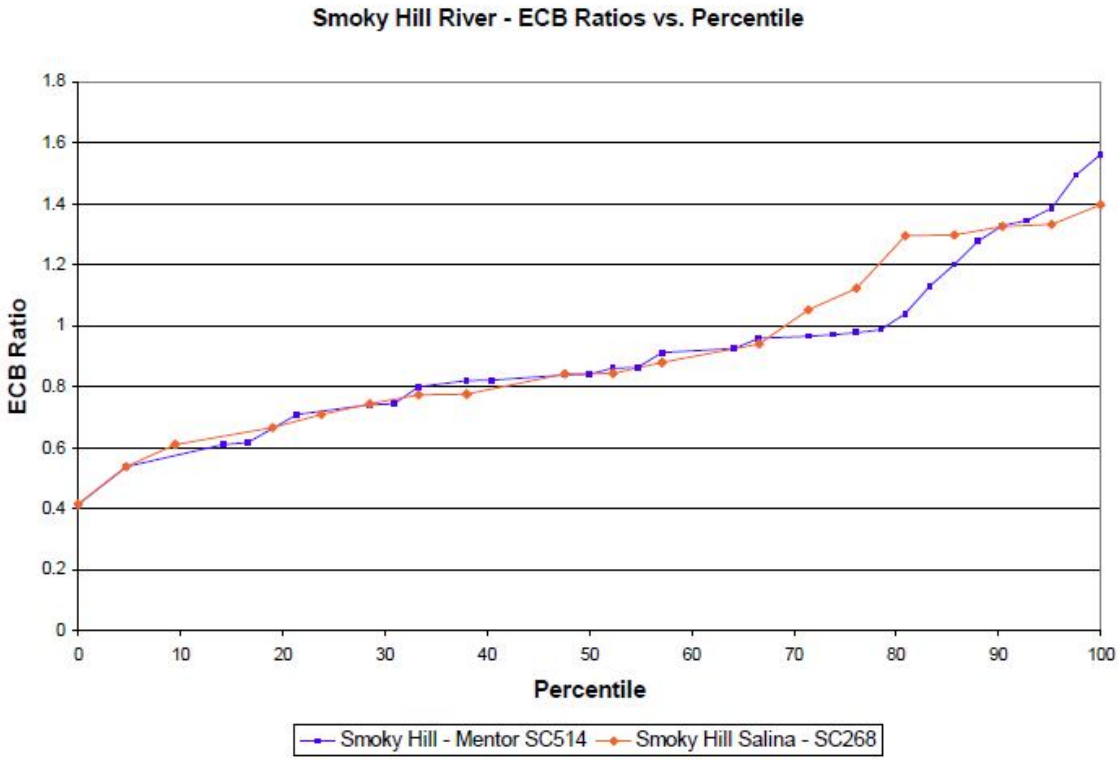
Bacteria load reductions should result in less frequent exceedance of the nominal ECB criterion for the Smoky Hill River Near Mentor (SC514) and the Smoky Hill River Near Salina (SC268). These bacteria index values represent the natural logarithm of each sample value taken during the April-October Primary Recreation season, divided by the natural logarithm of the bacteria criteria for applicable contract recreation designated use for the assessed water body.

The calculated bacteria index for the Smoky Hill River sampling stations SC268 (Salina) and SC514 (Mentor) is 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 B [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 improves over time with the upper decile (90^{th} percentile) value approaching or falling below 1.

Station	Upper Quartile	**Upper Decile (90^{th} Percentile)**	Median Index of Rec Season Samples
SC514 Mentor	0.97	**1.32**	0.84
SC268 Salina	1.11	**1.32**	0.84



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 sources located within the Upper Lower Smoky Hill WRAPS project area
- Occurrence of algal blooms in lakes within the project area
- Visitor traffic to lakes within the project area
- Trends of quantity and quality of fishing within the water bodies of the project area

Evaluation of Monitoring Data

Monitoring data in the Upper Lower Smoky Hill River WRAPS project area 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 Upper Lower Smoky Hill River WRAPS project area extend through a 20-year period from 2012 to 2031. 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 Upper Lower Smoky Hill River 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 2031, at the end of the plan, a final determination can be made as to whether the water quality standards have been attained for the high priority TMDLs addressed within the Upper Lower Smoky Hill River WRAPS project area as a result of this plan.

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.

12.0 Monitoring Water Quality Progress

The SLT and WRAPS Coordinator will meet to develop a monitoring plan of action. Monitoring site data that will be generated will be of great benefit to the SLT. Once monitoring resumes, analysis of the data generated will be used to determine effectiveness of implemented BMPs. If the SLT decides at some point in the future that more data is required, they can discuss this with KDHE. All KDHE monitoring data will be shared with the SLT and can then be passed on to the watershed residents by way of the information and education efforts discussed previously.

Year 1 Monitoring Draft Plan:
At the time in which this WRAPS plan was written, a sample plan for monitoring and analyses for the first year of the plan was formulated using the estimated cost of $2,500 as agreed upon in the SFY12 PIP for Year 1.

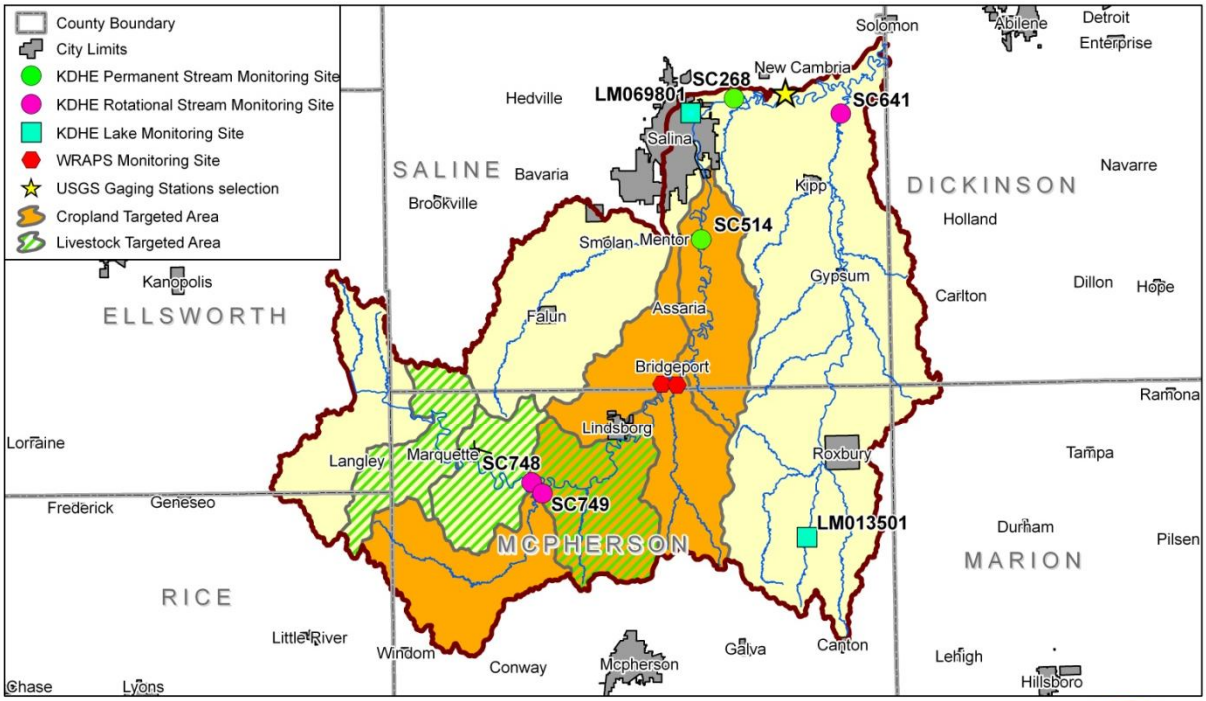
The monitoring draft plan below and $2,500 expense is ONLY for Year 1 monitoring activities. Changes in budget and/or monitoring needs will require additional evaluation and may result in monitoring strategy and plan changes.

Monitoring for TP, TSS and Bacteria: The KDHE, the Lower Smoky Hill River Watershed stakeholder leadership and project management teams are interested in maintaining some of the current sampling sites for long term data collection. The KDHE sampling sites that will continue to be used by the SLT will include SC748 and SC749, one site near Bridgeport will be added. KDHE will not monitor SC748 or SC749 for several years, therefore the SLT and the WRAPS Coordinator will find someone to continue to pull those samples as well as the Bridgeport sample. Analysis will likely be done at Continental in Salina or SDK in Hutchinson, as these are both certified facilities.

Samples will be pulled at comparable times in which KDHE has pulled them in the past, KDHE is to provide a schedule.

Samples collected for sediment, nutrients and bacteria would be taken from April through June. Judgment will be made considering fertilizer application periods and rainfall events (to include storm intensity and runoff). If there is an unusual runoff event in the Winter months, water samples may also be collected during that timeframe as well.

Figure 19. Water Monitoring Network to include KDHE and WRAPS Monitoring Sites



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Kansas
Department of Health and Environment
April 2012

This map shows both the permanent and rotational KDHE and WRAPS stream monitoring stations as well as KDHE monitored lakes located within the Upper Lower Smoky Hill River WRAPS project area as well as the targeted areas for implementation that have been identified and discussed in previous sections of this plan.

Monitoring data will be used to direct the SLT in their evaluation of water quality progress. KDHE will be requested to meet with the SLT to review the monitoring data accumulated by their sites as that information becomes available. However, the overall strategy and alterations of the WRAPS plan will be discussed with KDHE immediately after each update of the 303d list and subsequent TMDL designation, which will take place in 2014 and 2019.

13.0 Review of the Watershed Plan in 2015

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

1. The SLT will ask KDHE for a report on the milestone achievements in **sediment** load reductions.
2. The SLT will ask KDHE for a report on the milestone achievements in nutrients, specifically **phosphorus** load reductions.
3. The SLT will ask KDHE for a report on the milestone achievements in Bacteria load reductions.
4. The SLT will report on progress towards achieving the adoption rates listed in Section 11.1 of this report.
5. The SLT will report on progress towards achieving the water quality benchmarks listed in Section 11.2 of this report.
6. The SLT will discuss the impairments on the 303d list and the possibility of addressing these impairments prior to listing as TMDLs.
7. The SLT will discuss the effect of implementing BMPs aimed at specific TMDLs on the impairments listed on the 303d list.
8. The SLT will discuss necessary adjustments and revisions needed in the targets listed in this plan.

14.0 Appendix

14.1 Service Providers

Table 44. State and Federal Organizations and Agencies

Organizations	Program	Purpose	Phone	Website address
Kansas Dept. of Agriculture	Watershed structures permitting.	Available for watershed districts and multipurpose small lakes development.	785-296-2933	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.	785-296-5500	www.kdhe.state.ks.us
Kansas Water Office	Public Information and Education	Provide information and education to the public on Kansas Water Resources	785-296-3185	www.kwo.org
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.	913-551-7003 913-551-7003	www.epa.gov

State Conservation Commission	Water Resources Cost Share Nonpoint Source Pollution Control Fund Riparian and Wetland Protection Program Stream Rehabilitation Program Kansas Water Quality Buffer Initiative Watershed district and multipurpose lakes	Provide cost share assistance to landowners for establishment of water conservation practices. Provides financial assistance for nonpoint pollution control projects which help restore water quality. Funds to assist with wetland and riparian development and enhancement. Assist with streams that have been adversely altered by channel modifications. Compliments Conservation Reserve Program by offering additional financial incentives for grass filters and riparian forest buffers. Programs are available for watershed district and multipurpose small lakes.	785-296-3600	www.accesskansas.org/kscc
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.	620-241-3636	www.kaws.org

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

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.	785-532-3312 785-532-3310	www.kansasforests.org
Kansas Department of Wildlife and Parks	Land and Water Conservation Funds Conservation Easements for Riparian and Wetland Areas Wildlife Habitat Improvement Program North American Waterfowl Conservation Act MARSH program	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.	620-672-5911 785-296-2780 620-672-5911 620-342-0658 620-672-5911	www.kdwp.state.ks.us/about/grants.html

US Army Corps of Engineers	Planning Assistance to States Environmental Restoration	Assistance in development of plans for development, utilization and conservation of water and related land resources of drainage Funding assistance for aquatic ecosystem restoration.	816-983-3157 816-983-3157	www.usace.army.mil
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.	913-873-3431	http://www.kansasruralcenter.org
Kansas Corporation Commission	Online Site Specific Remediation Planner	Remediation of brine scar sites	620-432-2300	http://www.kcc.state.ks.us/conservation/scar/index.htm
US Fish and Wildlife Service	Fish and Wildlife Enhancement Program Private Lands Program	Supports field operations which include technical assistance on wetland design. Contracts to restore, enhance, or create wetlands.	785-539-3474 785-539-3474	www.fws.gov

USDA- Natural Resources Conservation Service and Farm Service Agency	Conservation Compliance	Primarily for the technical assistance to develop conservation plans on cropland.	785-823-4565	www.ks.nrcs.usda.gov
	Conservation Operations	To provide technical assistance on private land for development and application of Resource Management Plans.	785-823-4565	
	Watershed Planning and Operations	Primarily focused on high priority areas where agricultural improvements will meet water quality objectives.	785-823-4565	
	Wetland Reserve Program	Cost share and easements to restore wetlands.	785-823-4565	
	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.		

Table 45. Regional Organizations and Agencies and Contact Information

Organization	Contact Person	Email Address	Contact Information
Kansas State Research and Extension	Ron Graber Watershed Specialist – Lower Arkansas River Watershed	rgraber@ksu.edu	7001 W. 21st Street N Wichita, KS 67205 316-660-0100 ext.155
Kansas Department of Health and Environment	Matt Unruh Environmental Scientist	munruh@kdheks.gov	1000 SW Jackson St Suite 420 Topeka, KS 66612 785-296-1683
Natural Resources Conservation Service	Kenneth Bowell Saline County District Conservationist	ken.bowell@ks.usda.gov	1410 E Iron Ave. Suite 12 Salina, KS 67401 785-825-8269
	Baron Shively McPherson County District Conservationist	baron.shively@ks.usda.gov	200 S. Centennial Dr. McPherson, KS 67460 785-241-1836
Conservation District	Megan Whitehair Saline County Conservation District Manager	megan.whitehair@ks.nacdnet.net	1410 E Iron Ave. Suite 12 Salina, KS 67401 785-825-8269
	Brenda Peters McPherson County Conservation District Manager	brenda.peters@ks.nacdnet.net	200 S. Centennial Dr. McPherson, KS 67460 785-241-1836
Central Prairie Resource Conservation & Development	Dan Curtis Coordinator	dan.curtis@ks.usda.gov	1817 16th St. Great Bend, KS 67530 620-792-6224

14.2 BMP Definitions

Cropland BMPs

No-Till
- A management system in which chemicals may be used for weed control and seedbed preparation.
- The soil surface is never disturbed except for planting or drilling operations in a 100% no-till system.
- 75% erosion reduction efficiency, 40% phosphorus reduction efficiency.

Conservation Tillage
- Involves the planting, growing and harvesting of crops with minimal disturbance to the soil surface through the use of minimum tillage, ridge tillage, or no-till.

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

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

Nutrient Management Plan
- Managing the amount, source, placement, form and timing of the application of nutrients and soil amendments.
- Intensive soil testing
- 25% erosion and 25% P reduction efficiency.

Terraces
- Earth embankment and/or channel constructed across the slope to intercept runoff water and trap soil.
- One of the oldest/most common BMPs
- 30% Erosion Reduction Efficiency, 30% phosphorus reduction efficiency

Incorporate Manure with Tillage
Incorporating manure with tillage reduces surface residue cover.

Water Retention Structure
-May include sediment basin that is a water impoundment made by constructing an earthen dam.
-May include grade stabilization structures that control runoff and prevent gully erosion.

-Traps sediment and nutrients from leaving edge of field.
-Provides source of water.
-50% soil erosion, nitrogen, and phosphorus reduction efficiency.

Livestock BMPs

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

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

Relocate Pasture Feeding Site
- Pasture- Move feeding site that is in a pasture away from a stream, waterway, or body of water to increase the filtration and waste removal (eg. move bale feeders away from stream).
- Average P reduction: 30-80%

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

14.3 Appendix Tables

14.3.1 Cropland BMP Tables

McPherson County Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Management	Terraces	Incorporate Manure	Water Retention	Total Adoption
1	219	438	328	219	109	328	109	66	1,816
2	219	438	328	219	109	328	109	66	1,816
3	219	438	328	219	109	328	109	66	1,816
4	219	438	328	219	109	328	109	66	1,816
5	219	438	328	219	109	328	109	66	1,816
6	219	438	328	219	109	328	109	66	1,816
7	219	438	328	219	109	328	109	66	1,816
8	219	438	328	219	109	328	109	66	1,816
9	219	438	328	219	109	328	109	66	1,816
10	219	438	328	219	109	328	109	66	1,816
11	219	438	328	219	109	328	109	66	1,816
12	219	438	328	219	109	328	109	66	1,816
13	219	438	328	219	109	328	109	66	1,816
14	219	438	328	219	109	328	109	66	1,816
15	219	438	328	219	109	328	109	66	1,816
16	219	438	328	219	109	328	109	66	1,816
17	219	438	328	219	109	328	109	66	1,816
18	219	438	328	219	109	328	109	66	1,816
19	219	438	328	219	109	328	109	66	1,816
20	219	438	328	219	109	328	109	66	1,816

Saline County Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Management	Terraces	Incorporate Manure	Water Retention	Total Adoption
1	124	247	185	124	62	185	62	37	1,026
2	124	247	185	124	62	185	62	37	1,026
3	124	247	185	124	62	185	62	37	1,026
4	124	247	185	124	62	185	62	37	1,026
5	124	247	185	124	62	185	62	37	1,026
6	124	247	185	124	62	185	62	37	1,026
7	124	247	185	124	62	185	62	37	1,026
8	124	247	185	124	62	185	62	37	1,026
9	124	247	185	124	62	185	62	37	1,026
10	124	247	185	124	62	185	62	37	1,026
11	124	247	185	124	62	185	62	37	1,026
12	124	247	185	124	62	185	62	37	1,026
13	124	247	185	124	62	185	62	37	1,026
14	124	247	185	124	62	185	62	37	1,026
15	124	247	185	124	62	185	62	37	1,026
16	124	247	185	124	62	185	62	37	1,026
17	124	247	185	124	62	185	62	37	1,026
18	124	247	185	124	62	185	62	37	1,026
19	124	247	185	124	62	185	62	37	1,026
20	124	247	185	124	62	185	62	37	1,026

Rice County Annual Adoption (treated acres), Cropland BMPs

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Management	Terraces	Incorporate Manure	Water Retention	Total Adoption
1	6	12	9	6	3	9	3	2	51
2	6	12	9	6	3	9	3	2	51
3	6	12	9	6	3	9	3	2	51
4	6	12	9	6	3	9	3	2	51
5	6	12	9	6	3	9	3	2	51
6	6	12	9	6	3	9	3	2	51
7	6	12	9	6	3	9	3	2	51
8	6	12	9	6	3	9	3	2	51
9	6	12	9	6	3	9	3	2	51
10	6	12	9	6	3	9	3	2	51
11	6	12	9	6	3	9	3	2	51
12	6	12	9	6	3	9	3	2	51
13	6	12	9	6	3	9	3	2	51
14	6	12	9	6	3	9	3	2	51
15	6	12	9	6	3	9	3	2	51
16	6	12	9	6	3	9	3	2	51
17	6	12	9	6	3	9	3	2	51
18	6	12	9	6	3	9	3	2	51
19	6	12	9	6	3	9	3	2	51
20	6	12	9	6	3	9	3	2	51

McPherson County Annual Adoption (treated acres), Cropland BMPs

	Year	No-Till	Cons Till	Waterways	Buffers	Nutrient Mgmt	Terraces	Incorporate Manure	Water Retention	Total Adoption
Short Term	1	219	438	328	219	109	328	109	66	1,816
	2	219	438	328	219	109	328	109	66	1,816
	3	219	438	328	219	109	328	109	66	1,816
	4	219	438	328	219	109	328	109	66	1,816
	5	219	438	328	219	109	328	109	66	1,816
Total		*1,094*	*2,188*	*1,641*	*1,094*	*547*	*1,641*	*547*	*328*	*9,079*
Medium Term	6	219	438	328	219	109	328	109	66	1,816
	7	219	438	328	219	109	328	109	66	1,816
	8	219	438	328	219	109	328	109	66	1,816
	9	219	438	328	219	109	328	109	66	1,816
	10	219	438	328	219	109	328	109	66	1,816
Total		*2,188*	*4,376*	*3,282*	*2,188*	*1,094*	*3,282*	*1,094*	*656*	*18,159*
Long Term	11	219	438	328	219	109	328	109	66	1,816
	12	219	438	328	219	109	328	109	66	1,816
	13	219	438	328	219	109	328	109	66	1,816
	14	219	438	328	219	109	328	109	66	1,816
	15	219	438	328	219	109	328	109	66	1,816
	16	219	438	328	219	109	328	109	66	1,816
	17	219	438	328	219	109	328	109	66	1,816
	18	219	438	328	219	109	328	109	66	1,816
	19	219	438	328	219	109	328	109	66	1,816
	20	219	438	328	219	109	328	109	66	1,816
Total		*4,376*	*8,751*	*6,563*	*4,376*	*2,188*	*6,563*	*2,188*	*1,313*	*36,317*

Saline County Annual Adoption (treated acres), Cropland BMPs

	Year	No-Till	Cons Till	Waterways	Buffers	Nutrient Mgmt	Terraces	Incorporate Manure	Water Retention	Total Adoption
Short Term	1	124	247	185	124	62	185	62	37	1,026
	2	124	247	185	124	62	185	62	37	1,026
	3	124	247	185	124	62	185	62	37	1,026
	4	124	247	185	124	62	185	62	37	1,026
	5	124	247	185	124	62	185	62	37	1,026
Total		*618*	*1,237*	*927*	*618*	*309*	*927*	*309*	*185*	*5,131*
Medium Term	6	124	247	185	124	62	185	62	37	1,026
	7	124	247	185	124	62	185	62	37	1,026
	8	124	247	185	124	62	185	62	37	1,026
	9	124	247	185	124	62	185	62	37	1,026
	10	124	247	185	124	62	185	62	37	1,026
Total		*1,237*	*2,473*	*1,855*	*1,237*	*618*	*1,855*	*618*	*371*	*10,263*
Long Term	11	124	247	185	124	62	185	62	37	1,026
	12	124	247	185	124	62	185	62	37	1,026
	13	124	247	185	124	62	185	62	37	1,026
	14	124	247	185	124	62	185	62	37	1,026
	15	124	247	185	124	62	185	62	37	1,026
	16	124	247	185	124	62	185	62	37	1,026

	17	124	247	185	124	62	185	62	37	1,026
	18	124	247	185	124	62	185	62	37	1,026
	19	124	247	185	124	62	185	62	37	1,026
	20	124	247	185	124	62	185	62	37	1,026
Total		*2,473*	*4,946*	*3,710*	*2,473*	*1,237*	*3,710*	*1,237*	*742*	*20,526*

Priority Area #3 Annual Adoption (treated acres), Cropland BMPs

	Year	No-Till	Cons Till	Waterways	Buffers	Nutrient Mgmt	Terraces	Incorporate Manure	Water Retention	Total Adoption
Short Term	1	6	12	9	6	3	9	3	2	51
	2	6	12	9	6	3	9	3	2	51
	3	6	12	9	6	3	9	3	2	51
	4	6	12	9	6	3	9	3	2	51
	5	6	12	9	6	3	9	3	2	51
Total		*31*	*62*	*46*	*31*	*15*	*46*	*15*	*9*	*256*
Medium Term	6	6	12	9	6	3	9	3	2	51
	7	6	12	9	6	3	9	3	2	51
	8	6	12	9	6	3	9	3	2	51
	9	6	12	9	6	3	9	3	2	51
	10	6	12	9	6	3	9	3	2	51
Total		*62*	*124*	*93*	*62*	*31*	*93*	*31*	*19*	*513*
Long Term	11	6	12	9	6	3	9	3	2	51
	12	6	12	9	6	3	9	3	2	51
	13	6	12	9	6	3	9	3	2	51
	14	6	12	9	6	3	9	3	2	51
	15	6	12	9	6	3	9	3	2	51
	16	6	12	9	6	3	9	3	2	51
	17	6	12	9	6	3	9	3	2	51
	18	6	12	9	6	3	9	3	2	51
	19	6	12	9	6	3	9	3	2	51
	20	6	12	9	6	3	9	3	2	51
Total		*124*	*247*	*185*	*124*	*62*	*185*	*62*	*37*	*1,025*

McPherson County Annual Soil Erosion Reduction

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Management	Terraces	Incorporate Manure	Water Retention	Total Adoption
1	246	246	197	164	41	148	0	49	1,091
2	492	492	394	328	82	295	0	98	2,182
3	738	738	591	492	123	443	0	148	3,273
4	985	985	788	656	164	591	0	197	4,365
5	1,231	1,231	985	820	205	738	0	246	5,456
6	1,477	1,477	1,181	985	246	886	0	295	6,547
7	1,723	1,723	1,378	1,149	287	1,034	0	345	7,638
8	1,969	1,969	1,575	1,313	328	1,181	0	394	8,729
9	2,215	2,215	1,772	1,477	369	1,329	0	443	9,820
10	2,461	2,461	1,969	1,641	410	1,477	0	492	10,912
11	2,707	2,707	2,166	1,805	451	1,624	0	541	12,003
12	2,954	2,954	2,363	1,969	492	1,772	0	591	13,094
13	3,200	3,200	2,560	2,133	533	1,920	0	640	14,185
14	3,446	3,446	2,757	2,297	574	2,067	0	689	15,276
15	3,692	3,692	2,954	2,461	615	2,215	0	738	16,367
16	3,938	3,938	3,150	2,625	656	2,363	0	788	17,459
17	4,184	4,184	3,347	2,789	697	2,511	0	837	18,550
18	4,430	4,430	3,544	2,954	738	2,658	0	886	19,641
19	4,676	4,676	3,741	3,118	779	2,806	0	935	20,732
20	4,923	4,923	3,938	3,282	820	2,954	0	985	21,823

Saline County Annual Soil Erosion Reduction

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Management	Terraces	Incorporate Manure	Water Retention	Total Adoption
1	139	139	111	93	23	83	0	28	617
2	278	278	223	185	46	167	0	56	1,233
3	417	417	334	278	70	250	0	83	1,850
4	556	556	445	371	93	334	0	111	2,467
5	696	696	556	464	116	417	0	139	3,084
6	835	835	668	556	139	501	0	167	3,700
7	974	974	779	649	162	584	0	195	4,317
8	1,113	1,113	890	742	185	668	0	223	4,934
9	1,252	1,252	1,002	835	209	751	0	250	5,550
10	1,391	1,391	1,113	927	232	835	0	278	6,167
11	1,530	1,530	1,224	1,020	255	918	0	306	6,784
12	1,669	1,669	1,335	1,113	278	1,002	0	334	7,400
13	1,808	1,808	1,447	1,206	301	1,085	0	362	8,017
14	1,947	1,947	1,558	1,298	325	1,168	0	389	8,634
15	2,087	2,087	1,669	1,391	348	1,252	0	417	9,251
16	2,226	2,226	1,781	1,484	371	1,335	0	445	9,867
17	2,365	2,365	1,892	1,577	394	1,419	0	473	10,484
18	2,504	2,504	2,003	1,669	417	1,502	0	501	11,101
19	2,643	2,643	2,114	1,762	441	1,586	0	529	11,717
20	2,782	2,782	2,226	1,855	464	1,669	0	556	12,334

Rice County Annual Soil Erosion Reduction

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Management	Terraces	Incorporate Manure	Water Retention	Total Adoption
1	7	7	6	5	1	4	0	1	31
2	14	14	11	9	2	8	0	3	62
3	21	21	17	14	3	13	0	4	92
4	28	28	22	19	5	17	0	6	123
5	35	35	28	23	6	21	0	7	154
6	42	42	33	28	7	25	0	8	185
7	49	49	39	32	8	29	0	10	216
8	56	56	44	37	9	33	0	11	246
9	63	63	50	42	10	38	0	13	277
10	69	69	56	46	12	42	0	14	308
11	76	76	61	51	13	46	0	15	339
12	83	83	67	56	14	50	0	17	370
13	90	90	72	60	15	54	0	18	400
14	97	97	78	65	16	58	0	19	431
15	104	104	83	69	17	63	0	21	462
16	111	111	89	74	19	67	0	22	493
17	118	118	94	79	20	71	0	24	524
18	125	125	100	83	21	75	0	25	554
19	132	132	106	88	22	79	0	26	585
20	139	139	111	93	23	83	0	28	616

McPherson County Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Mgmt	Terraces	Incorporate Manure	Water Retention	Total Cost
1	$16,997	$16,997	$52,507	$14,585	$6,204	$33,473	$692	$8,204	$149,660
2	$17,507	$17,507	$54,082	$15,023	$6,390	$34,478	$713	$8,450	$154,150
3	$18,032	$18,032	$55,705	$15,474	$6,581	$35,512	$735	$8,704	$158,774
4	$18,573	$18,573	$57,376	$15,938	$6,779	$36,577	$757	$8,965	$163,538
5	$19,130	$19,130	$59,097	$16,416	$6,982	$37,675	$779	$9,234	$168,444
6	$19,704	$19,704	$60,870	$16,908	$7,192	$38,805	$803	$9,511	$173,497
7	$20,295	$20,295	$62,696	$17,416	$7,407	$39,969	$827	$9,796	$178,702
8	$20,904	$20,904	$64,577	$17,938	$7,630	$41,168	$852	$10,090	$184,063
9	$21,531	$21,531	$66,515	$18,476	$7,858	$42,403	$877	$10,393	$189,585
10	$22,177	$22,177	$68,510	$19,031	$8,094	$43,675	$903	$10,705	$195,272
11	$22,843	$22,843	$70,565	$19,601	$8,337	$44,985	$931	$11,026	$201,131
12	$23,528	$23,528	$72,682	$20,190	$8,587	$46,335	$958	$11,357	$207,165
13	$24,234	$24,234	$74,863	$20,795	$8,845	$47,725	$987	$11,697	$213,380
14	$24,961	$24,961	$77,109	$21,419	$9,110	$49,157	$1,017	$12,048	$219,781
15	$25,710	$25,710	$79,422	$22,062	$9,383	$50,631	$1,047	$12,410	$226,374
16	$26,481	$26,481	$81,805	$22,723	$9,665	$52,150	$1,079	$12,782	$233,166
17	$27,275	$27,275	$84,259	$23,405	$9,955	$53,715	$1,111	$13,165	$240,161
18	$28,093	$28,093	$86,786	$24,107	$10,253	$55,326	$1,144	$13,560	$247,365
19	$28,936	$28,936	$89,390	$24,831	$10,561	$56,986	$1,179	$13,967	$254,786
20	$29,804	$29,804	$92,072	$25,575	$10,878	$58,696	$1,214	$14,386	$262,430

Saline County Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Mgmt	Terraces	Incorporate Manure	Water Retention	Total Cost
1	$9,606	$9,606	$29,676	$8,243	$3,506	$18,918	$391	$4,637	$84,585
2	$9,895	$9,895	$30,566	$8,491	$3,611	$19,486	$403	$4,776	$87,122
3	$10,191	$10,191	$31,483	$8,745	$3,720	$20,071	$415	$4,919	$89,736
4	$10,497	$10,497	$32,428	$9,008	$3,831	$20,673	$428	$5,067	$92,428
5	$10,812	$10,812	$33,401	$9,278	$3,946	$21,293	$440	$5,219	$95,201
6	$11,136	$11,136	$34,403	$9,556	$4,065	$21,932	$454	$5,375	$98,057
7	$11,471	$11,471	$35,435	$9,843	$4,186	$22,590	$467	$5,537	$100,999
8	$11,815	$11,815	$36,498	$10,138	$4,312	$23,267	$481	$5,703	$104,029
9	$12,169	$12,169	$37,593	$10,442	$4,441	$23,965	$496	$5,874	$107,150
10	$12,534	$12,534	$38,720	$10,756	$4,575	$24,684	$511	$6,050	$110,364
11	$12,910	$12,910	$39,882	$11,078	$4,712	$25,425	$526	$6,232	$113,675
12	$13,297	$13,297	$41,079	$11,411	$4,853	$26,188	$542	$6,419	$117,085
13	$13,696	$13,696	$42,311	$11,753	$4,999	$26,973	$558	$6,611	$120,598
14	$14,107	$14,107	$43,580	$12,106	$5,149	$27,782	$575	$6,809	$124,216
15	$14,530	$14,530	$44,888	$12,469	$5,303	$28,616	$592	$7,014	$127,942
16	$14,966	$14,966	$46,234	$12,843	$5,462	$29,474	$610	$7,224	$131,780
17	$15,415	$15,415	$47,621	$13,228	$5,626	$30,359	$628	$7,441	$135,734
18	$15,878	$15,878	$49,050	$13,625	$5,795	$31,269	$647	$7,664	$139,806
19	$16,354	$16,354	$50,521	$14,034	$5,969	$32,207	$666	$7,894	$144,000
20	$16,845	$16,845	$52,037	$14,455	$6,148	$33,174	$686	$8,131	$148,320

Rice County Total Annual Cost Before Cost-Share, Cropland BMPs

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Mgmt	Terraces	Incorporate Manure	Water Retention	Total Cost
1	$480	$480	$1,482	$412	$175	$945	$20	$232	$4,224
2	$494	$494	$1,526	$424	$180	$973	$20	$239	$4,351
3	$509	$509	$1,572	$437	$186	$1,002	$21	$246	$4,481
4	$524	$524	$1,619	$450	$191	$1,032	$21	$253	$4,616
5	$540	$540	$1,668	$463	$197	$1,063	$22	$261	$4,754
6	$556	$556	$1,718	$477	$203	$1,095	$23	$268	$4,897
7	$573	$573	$1,770	$492	$209	$1,128	$23	$276	$5,044
8	$590	$590	$1,823	$506	$215	$1,162	$24	$285	$5,195
9	$608	$608	$1,877	$521	$222	$1,197	$25	$293	$5,351
10	$626	$626	$1,934	$537	$228	$1,233	$26	$302	$5,512
11	$645	$645	$1,992	$553	$235	$1,270	$26	$311	$5,677
12	$664	$664	$2,051	$570	$242	$1,308	$27	$321	$5,847
13	$684	$684	$2,113	$587	$250	$1,347	$28	$330	$6,023
14	$705	$705	$2,176	$605	$257	$1,387	$29	$340	$6,203
15	$726	$726	$2,242	$623	$265	$1,429	$30	$350	$6,389
16	$747	$747	$2,309	$641	$273	$1,472	$30	$361	$6,581
17	$770	$770	$2,378	$661	$281	$1,516	$31	$372	$6,778
18	$793	$793	$2,450	$680	$289	$1,562	$32	$383	$6,982
19	$817	$817	$2,523	$701	$298	$1,608	$33	$394	$7,191
20	$841	$841	$2,599	$722	$307	$1,657	$34	$406	$7,407

McPherson County Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Mgmt	Terraces	Incorporate Manure	Water Retention	Total Cost
1	$10,368	$16,997	$26,254	$1,459	$3,102	$16,737	$692	$4,102	$79,710
2	$10,679	$17,507	$27,041	$1,502	$3,195	$17,239	$713	$4,225	$82,102
3	$11,000	$18,032	$27,852	$1,547	$3,291	$17,756	$735	$4,352	$84,565
4	$11,330	$18,573	$28,688	$1,594	$3,389	$18,289	$757	$4,483	$87,102
5	$11,669	$19,130	$29,549	$1,642	$3,491	$18,837	$779	$4,617	$89,715
6	$12,020	$19,704	$30,435	$1,691	$3,596	$19,402	$803	$4,755	$92,406
7	$12,380	$20,295	$31,348	$1,742	$3,704	$19,984	$827	$4,898	$95,178
8	$12,752	$20,904	$32,289	$1,794	$3,815	$20,584	$852	$5,045	$98,034
9	$13,134	$21,531	$33,257	$1,848	$3,929	$21,202	$877	$5,196	$100,975
10	$13,528	$22,177	$34,255	$1,903	$4,047	$21,838	$903	$5,352	$104,004
11	$13,934	$22,843	$35,283	$1,960	$4,168	$22,493	$931	$5,513	$107,124
12	$14,352	$23,528	$36,341	$2,019	$4,294	$23,167	$958	$5,678	$110,338
13	$14,783	$24,234	$37,431	$2,080	$4,422	$23,862	$987	$5,849	$113,648
14	$15,226	$24,961	$38,554	$2,142	$4,555	$24,578	$1,017	$6,024	$117,057
15	$15,683	$25,710	$39,711	$2,206	$4,692	$25,316	$1,047	$6,205	$120,569
16	$16,153	$26,481	$40,902	$2,272	$4,832	$26,075	$1,079	$6,391	$124,186
17	$16,638	$27,275	$42,129	$2,341	$4,977	$26,857	$1,111	$6,583	$127,912
18	$17,137	$28,093	$43,393	$2,411	$5,127	$27,663	$1,144	$6,780	$131,749
19	$17,651	$28,936	$44,695	$2,483	$5,281	$28,493	$1,179	$6,984	$135,701
20	$18,181	$29,804	$46,036	$2,558	$5,439	$29,348	$1,214	$7,193	$139,773

Saline County Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Mgmt	Terraces	Incorporate Manure	Water Retention	Total Cost
1	$5,860	$9,606	$14,838	$824	$1,753	$9,459	$391	$2,318	$45,051
2	$6,036	$9,895	$15,283	$849	$1,806	$9,743	$403	$2,388	$46,402
3	$6,217	$10,191	$15,742	$875	$1,860	$10,035	$415	$2,460	$47,794
4	$6,403	$10,497	$16,214	$901	$1,916	$10,336	$428	$2,533	$49,228
5	$6,595	$10,812	$16,700	$928	$1,973	$10,646	$440	$2,609	$50,705
6	$6,793	$11,136	$17,201	$956	$2,032	$10,966	$454	$2,688	$52,226
7	$6,997	$11,471	$17,717	$984	$2,093	$11,295	$467	$2,768	$53,793
8	$7,207	$11,815	$18,249	$1,014	$2,156	$11,634	$481	$2,851	$55,407
9	$7,423	$12,169	$18,796	$1,044	$2,221	$11,983	$496	$2,937	$57,069
10	$7,646	$12,534	$19,360	$1,076	$2,287	$12,342	$511	$3,025	$58,781
11	$7,875	$12,910	$19,941	$1,108	$2,356	$12,712	$526	$3,116	$60,544
12	$8,111	$13,297	$20,539	$1,141	$2,427	$13,094	$542	$3,209	$62,361
13	$8,355	$13,696	$21,155	$1,175	$2,499	$13,487	$558	$3,306	$64,231
14	$8,605	$14,107	$21,790	$1,211	$2,574	$13,891	$575	$3,405	$66,158
15	$8,864	$14,530	$22,444	$1,247	$2,652	$14,308	$592	$3,507	$68,143
16	$9,130	$14,966	$23,117	$1,284	$2,731	$14,737	$610	$3,612	$70,187
17	$9,403	$15,415	$23,811	$1,323	$2,813	$15,179	$628	$3,720	$72,293
18	$9,685	$15,878	$24,525	$1,362	$2,898	$15,635	$647	$3,832	$74,462
19	$9,976	$16,354	$25,261	$1,403	$2,984	$16,104	$666	$3,947	$76,696
20	$10,275	$16,845	$26,019	$1,445	$3,074	$16,587	$686	$4,065	$78,997

Rice County Total Annual Cost After Cost-Share, Cropland BMPs

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Mgmt	Terraces	Incorporate Manure	Water Retention	Total Cost
1	$293	$480	$741	$41	$88	$472	$20	$116	$2,250
2	$301	$494	$763	$42	$90	$487	$20	$119	$2,317
3	$310	$509	$786	$44	$93	$501	$21	$123	$2,387
4	$320	$524	$810	$45	$96	$516	$21	$127	$2,458
5	$329	$540	$834	$46	$99	$532	$22	$130	$2,532
6	$339	$556	$859	$48	$101	$548	$23	$134	$2,608
7	$349	$573	$885	$49	$105	$564	$23	$138	$2,686
8	$360	$590	$911	$51	$108	$581	$24	$142	$2,767
9	$371	$608	$939	$52	$111	$598	$25	$147	$2,850
10	$382	$626	$967	$54	$114	$616	$26	$151	$2,935
11	$393	$645	$996	$55	$118	$635	$26	$156	$3,024
12	$405	$664	$1,026	$57	$121	$654	$27	$160	$3,114
13	$417	$684	$1,056	$59	$125	$674	$28	$165	$3,208
14	$430	$705	$1,088	$60	$129	$694	$29	$170	$3,304
15	$443	$726	$1,121	$62	$132	$715	$30	$175	$3,403
16	$456	$747	$1,154	$64	$136	$736	$30	$180	$3,505
17	$470	$770	$1,189	$66	$140	$758	$31	$186	$3,610
18	$484	$793	$1,225	$68	$145	$781	$32	$191	$3,719
19	$498	$817	$1,262	$70	$149	$804	$33	$197	$3,830
20	$513	$841	$1,299	$72	$154	$828	$34	$203	$3,945

14.3.2 Livestock BMP Tables

McPherson County Annual Phosphorus Runoff Reduction

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Management	Terraces	Incorporate Manure	Water Retention	Total Adoption
1	218	218	327	272	68	245	54	82	1,484
2	436	436	654	545	136	490	109	163	2,969
3	654	654	981	817	204	735	163	245	4,453
4	872	872	1,307	1,090	272	981	218	327	5,938
5	1,090	1,090	1,634	1,362	340	1,226	272	409	7,422
6	1,307	1,307	1,961	1,634	409	1,471	327	490	8,907
7	1,525	1,525	2,288	1,907	477	1,716	381	572	10,391
8	1,743	1,743	2,615	2,179	545	1,961	436	654	11,876
9	1,961	1,961	2,942	2,451	613	2,206	490	735	13,360
10	2,179	2,179	3,269	2,724	681	2,451	545	817	14,845
11	2,397	2,397	3,595	2,996	749	2,697	599	899	16,329
12	2,615	2,615	3,922	3,269	817	2,942	654	981	17,814
13	2,833	2,833	4,249	3,541	885	3,187	708	1,062	19,298
14	3,051	3,051	4,576	3,813	953	3,432	763	1,144	20,783
15	3,269	3,269	4,903	4,086	1,021	3,677	817	1,226	22,267
16	3,486	3,486	5,230	4,358	1,090	3,922	872	1,307	23,752
17	3,704	3,704	5,557	4,630	1,158	4,167	926	1,389	25,236
18	3,922	3,922	5,883	4,903	1,226	4,413	981	1,471	26,721
19	4,140	4,140	6,210	5,175	1,294	4,658	1,035	1,553	28,205
20	4,358	4,358	6,537	5,448	1,362	4,903	1,090	1,634	29,690

Saline County Annual Phosphorus Runoff Reduction

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Management	Terraces	Incorporate Manure	Water Retention	Total Adoption
1	119	119	178	148	37	134	30	45	809
2	237	237	356	297	74	267	59	89	1,617
3	356	356	534	445	111	401	89	134	2,426
4	475	475	712	594	148	534	119	178	3,235
5	594	594	890	742	185	668	148	223	4,043
6	712	712	1,068	890	223	801	178	267	4,852
7	831	831	1,246	1,039	260	935	208	312	5,661
8	950	950	1,424	1,187	297	1,068	237	356	6,469
9	1,068	1,068	1,603	1,335	334	1,202	267	401	7,278
10	1,187	1,187	1,781	1,484	371	1,335	297	445	8,087
11	1,306	1,306	1,959	1,632	408	1,469	326	490	8,895
12	1,424	1,424	2,137	1,781	445	1,603	356	534	9,704
13	1,543	1,543	2,315	1,929	482	1,736	386	579	10,513
14	1,662	1,662	2,493	2,077	519	1,870	415	623	11,321
15	1,781	1,781	2,671	2,226	556	2,003	445	668	12,130
16	1,899	1,899	2,849	2,374	594	2,137	475	712	12,939
17	2,018	2,018	3,027	2,522	631	2,270	504	757	13,747
18	2,137	2,137	3,205	2,671	668	2,404	534	801	14,556
19	2,255	2,255	3,383	2,819	705	2,537	564	846	15,365
20	2,374	2,374	3,561	2,968	742	2,671	594	890	16,173

Rice County Annual Phosphorus Runoff Reduction

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Management	Terraces	Incorporate Manure	Water Retention	Total Adoption
1	6	6	8	7	2	6	1	2	38
2	11	11	17	14	3	13	3	4	76
3	17	17	25	21	5	19	4	6	114
4	22	22	33	28	7	25	6	8	151
5	28	28	42	35	9	31	7	10	189
6	33	33	50	42	10	38	8	13	227
7	39	39	58	49	12	44	10	15	265
8	44	44	67	56	14	50	11	17	303
9	50	50	75	63	16	56	13	19	341
10	56	56	83	69	17	63	14	21	379
11	61	61	92	76	19	69	15	23	416
12	67	67	100	83	21	75	17	25	454
13	72	72	108	90	23	81	18	27	492
14	78	78	117	97	24	88	19	29	530
15	83	83	125	104	26	94	21	31	568
16	89	89	133	111	28	100	22	33	606
17	94	94	142	118	30	106	24	35	644
18	100	100	150	125	31	113	25	38	681
19	106	106	158	132	33	119	26	40	719
20	111	111	167	139	35	125	28	42	757

McPherson County Annual Nitrogen Runoff Reduction

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Management	Terraces	Incorporate Manure	Water Retention	Total Adoption
1	646	646	1,550	646	323	1,163	646	388	6,007
2	1,292	1,292	3,101	1,292	646	2,325	1,292	775	12,015
3	1,938	1,938	4,651	1,938	969	3,488	1,938	1,163	18,022
4	2,584	2,584	6,201	2,584	1,292	4,651	2,584	1,550	24,029
5	3,230	3,230	7,751	3,230	1,615	5,814	3,230	1,938	30,037
6	3,876	3,876	9,302	3,876	1,938	6,976	3,876	2,325	36,044
7	4,522	4,522	10,852	4,522	2,261	8,139	4,522	2,713	42,051
8	5,168	5,168	12,402	5,168	2,584	9,302	5,168	3,101	48,059
9	5,814	5,814	13,952	5,814	2,907	10,464	5,814	3,488	54,066
10	6,459	6,459	15,503	6,459	3,230	11,627	6,459	3,876	60,073
11	7,105	7,105	17,053	7,105	3,553	12,790	7,105	4,263	66,080
12	7,751	7,751	18,603	7,751	3,876	13,952	7,751	4,651	72,088
13	8,397	8,397	20,154	8,397	4,199	15,115	8,397	5,038	78,095
14	9,043	9,043	21,704	9,043	4,522	16,278	9,043	5,426	84,102
15	9,689	9,689	23,254	9,689	4,845	17,441	9,689	5,814	90,110
16	10,335	10,335	24,804	10,335	5,168	18,603	10,335	6,201	96,117
17	10,981	10,981	26,355	10,981	5,491	19,766	10,981	6,589	102,124
18	11,627	11,627	27,905	11,627	5,814	20,929	11,627	6,976	108,132
19	12,273	12,273	29,455	12,273	6,137	22,091	12,273	7,364	114,139
20	12,919	12,919	31,006	12,919	6,459	23,254	12,919	7,751	120,146

Saline County Annual Nitrogen Runoff Reduction

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Management	Terraces	Incorporate Manure	Water Retention	Total Adoption
1	347	347	834	347	174	625	347	208	3,231
2	695	695	1,668	695	347	1,251	695	417	6,463
3	1,042	1,042	2,502	1,042	521	1,876	1,042	625	9,694
4	1,390	1,390	3,336	1,390	695	2,502	1,390	834	12,925
5	1,737	1,737	4,169	1,737	869	3,127	1,737	1,042	16,157
6	2,085	2,085	5,003	2,085	1,042	3,753	2,085	1,251	19,388
7	2,432	2,432	5,837	2,432	1,216	4,378	2,432	1,459	22,619
8	2,780	2,780	6,671	2,780	1,390	5,003	2,780	1,668	25,851
9	3,127	3,127	7,505	3,127	1,564	5,629	3,127	1,876	29,082
10	3,475	3,475	8,339	3,475	1,737	6,254	3,475	2,085	32,313
11	3,822	3,822	9,173	3,822	1,911	6,880	3,822	2,293	35,545
12	4,169	4,169	10,007	4,169	2,085	7,505	4,169	2,502	38,776
13	4,517	4,517	10,841	4,517	2,258	8,130	4,517	2,710	42,007
14	4,864	4,864	11,675	4,864	2,432	8,756	4,864	2,919	45,239
15	5,212	5,212	12,508	5,212	2,606	9,381	5,212	3,127	48,470
16	5,559	5,559	13,342	5,559	2,780	10,007	5,559	3,336	51,702

17	5,907	5,907	14,176	5,907	2,953	10,632	5,907	3,544	54,933
18	6,254	6,254	15,010	6,254	3,127	11,258	6,254	3,753	58,164
19	6,602	6,602	15,844	6,602	3,301	11,883	6,602	3,961	61,396
20	6,949	6,949	16,678	6,949	3,475	12,508	6,949	4,169	64,627

Rice County Annual Nitrogen Runoff Reduction

Year	No-Till	Conservation Till	Waterways	Buffers	Nutrient Management	Terraces	Incorporate Manure	Water Retention	Total Adoption
1	17	17	40	17	8	30	17	10	153
2	33	33	79	33	17	59	33	20	307
3	50	50	119	50	25	89	50	30	460
4	66	66	158	66	33	119	66	40	614
5	83	83	198	83	41	149	83	50	767
6	99	99	238	99	50	178	99	59	921
7	116	116	277	116	58	208	116	69	1,074
8	132	132	317	132	66	238	132	79	1,228
9	149	149	356	149	74	267	149	89	1,381
10	165	165	396	165	83	297	165	99	1,535
11	182	182	436	182	91	327	182	109	1,688
12	198	198	475	198	99	356	198	119	1,842
13	215	215	515	215	107	386	215	129	1,995
14	231	231	554	231	116	416	231	139	2,149
15	248	248	594	248	124	446	248	149	2,302
16	264	264	634	264	132	475	264	158	2,456
17	281	281	673	281	140	505	281	168	2,609
18	297	297	713	297	149	535	297	178	2,763
19	314	314	753	314	157	564	314	188	2,916
20	330	330	792	330	165	594	330	198	3,069

Livestock BMP Adoption by Sub Watershed

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Total Adoption
102	5	5	5	5	20
103	5	5	5	5	20
105	5	5	5	5	20
Total	15	15	15	15	60

Livestock BMP Cost Before Cost-Share by Sub Watershed

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Total Cost
102	$14,070	$60,000	$11,015	$18,975	$104,060
103	$14,070	$60,000	$11,015	$18,975	$104,060
105	$14,070	$60,000	$11,015	$18,975	$104,060
Total	$42,210	$180,000	$33,045	$56,925	$312,180

Livestock BMP Cost After Cost-Share by Sub Watershed

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Total Cost
102	$7,035	$30,000	$5,508	$9,488	$52,030
103	$7,035	$30,000	$5,508	$9,488	$52,030
105	$7,035	$30,000	$5,508	$9,488	$52,030
Total	$21,105	$90,000	$16,523	$28,463	$156,090

Livestock BMP Phosphorus Load Reduction by Sub Watershed (lbs)

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Total Load Reduction
102	6,379	7,973	315	315	14,983
103	6,379	7,973	315	315	14,983
105	6,379	7,973	315	315	14,983
Total	19,136	23,920	946	946	44,948

Livestock BMP Nitrogen Load Reduction by Sub Watershed (lbs)

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Total Load Reduction
102	12,014	15,018	594	594	28,220
103	12,014	15,018	594	594	28,220
105	12,014	15,018	594	594	28,220
Total	36,043	45,054	1,782	1,782	84,660

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