# Toronto Watershed – 9 Element Watershed Plan Summary

<u>Impairments to be addressed:</u>

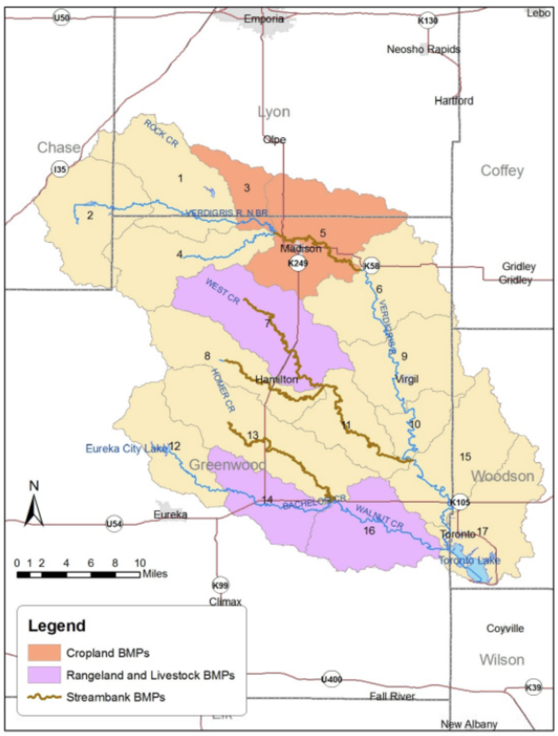
Toronto Reservoir (DO,EU, Silt)

Walnut Creek (with Homer Creek) (DO)

West Creek (DO)

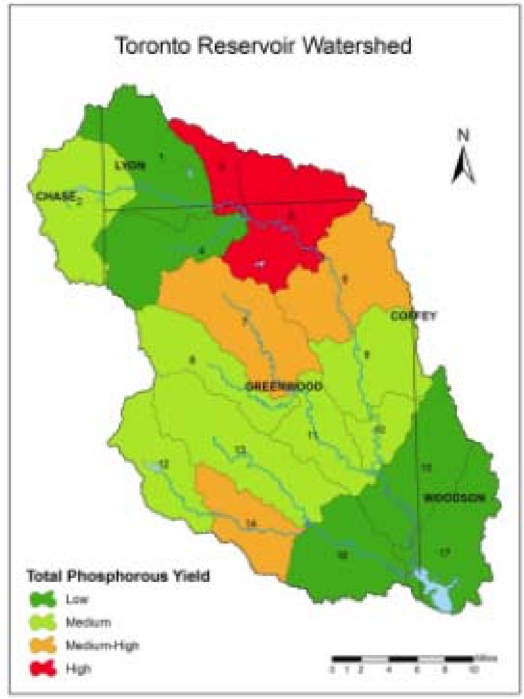
<u>Prioritized Critical Areas for Targeting BMPs</u>

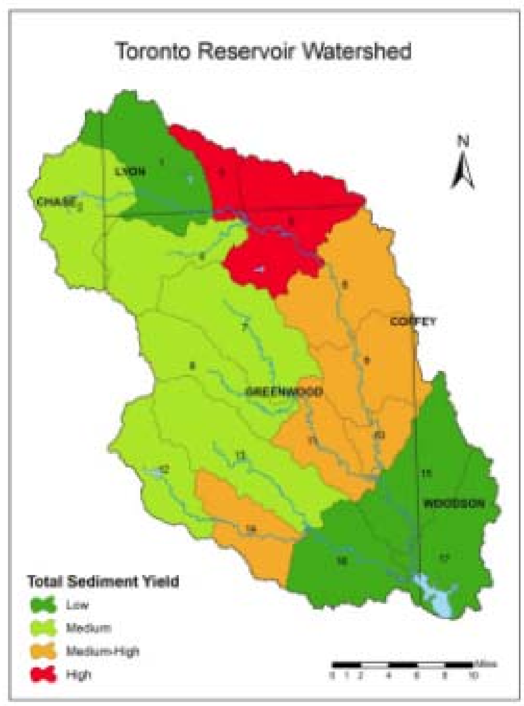
Toronto Reservoir Watershed





<u>Targeting Considerations:</u>



# Toronto Watershed – 9 Element Watershed Plan Summary

- Cropland BMP Targeted areas were identified through SWAT (Soil and Water Assessment Tool) modeling to determine where high levels of phosphorous and sediment where coming from within the Toronto watershed.
- Livestock/Rangeland Targeted areas were identified by comparing landowner knowledge and SWAT identified areas for high phosphorus runoff potential.
- Streambank Targeted areas were determined using the 1991 USDA/NRCS GIS Riparian layer originating from the Kansas Geospatial Community Commons.

## Best Management Practices and Load Reduction Goals

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

Phosphorus/Sediment Reducing Cropland BMPs

- Riparian Buffers
- No-Till cultivation Practice
- Terraces
- Conservation Rotation
- Grassed Waterways

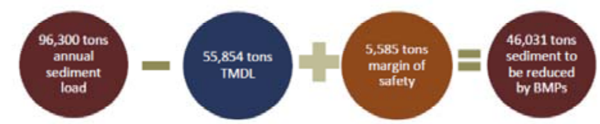
Phosphorus/Sediment Reducing Rangeland BMPs

- Repair Ephemeral Gullies
- Repair Brine Scars

Phosphorus/Sediment Reducing Livestock BMPs

- Vegetative Filter Strip
- Ponds
- Relocate Pasture Feeding Sites
- Alternative (Off-Stream) Watering System
- Rotational Grazing

<u>Sediment reduction needed:</u>




<u>Nitrogen reduction needed:</u>


<u>Phosphorus reduction needed:</u>

# TORONTO RESERVOIR

## Watershed Restoration and Protection Strategy

Final Draft Plan October 5, 2010

*Funding for the development of this plan was provided through an EPA 319 grant 2007-0031 from the Kansas Department of Health and Environment.*

### *K-State Research and Extension Project Staff*

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

## Stakeholder Leadership Team

***Watershed Representatives***
*Jim and Sharon Beeman* (Landowners/Producer/Watershed District), *Clyde Boone* (Landowners/Producer), *Ron Boone* (Landowners/Producer), *Thaine and Betty Boone* (Landowners/Producer/Watershed District), *Ed Buckle* (Landowners/Producer/Local Government), *Melvin Casey* (Landowners/Producer), *Keith Dalton* (Landowners/Producer), *Harold and Karen Engle* (Landowners/Producer/Watershed District/Economic Development), *George Esslinger* (Landowners/Producer), *J.D. and Karla Fowler* (Landowners/Producer), *Mike and Laverne Hawkins* (Landowners/Producer), *Dale Kirkham* (Landowners/Producer/Kansas Rural Center), *Jacob Knobloch* (Landowners/Producer), *Ken Lewis* (Landowners/Producer), *Diltz Lindamood* (Landowners/Producer/Watershed District/Economic Development), *Jack and Becky Lindamood* (Landowners/Producer/Watershed District), *Lloyd Luthi* (Landowners/Producer), *Albert Mann* (Landowners/Producer), *Gordon McNitt (Watershed District), Bud and Patty Moore* (Landowners/Producer), *Earl and Patsy Murphy (Watershed District/Local Government), Gene and Cindy Rayburn* (Landowners/Producer), *Cliff and Leo Schanke* (Landowners/Producer/Oil Production), *Stanley Skaer* (Landowners/Producer), *Gordon Smith* (Landowners/Producer/Watershed District), *Charles Williams* (Landowners/Producer), *Allen Wyckoff* (Landowners/Producer)

***Project Management Team***
*Lexie Biering,* Greenwood County Conservation District
*Doug Blex, Kansas A*lliance for Wetlands and Streams
*Jeff Davidson,* Greenwood County Extension Service
*Steve Carlson,* Kansas Forest Service
*Terry Lyons,* U.S. Army Corps of Engineers
*Brian Meiwes,* Kansas Department of Wildlife and Parks
*Ken Jones,* Kansas Department of Wildlife and Parks
*Bernie Obermeyer,* Greenwood County Conservation District
*Bruce Wells,* Flint Hills RC&D
*Luke Westerman,* USDA Natural Resources Conservation Service

***Kansas Department of Health and Environment Project Officer***
*Ann D'Alfonso*, Watershed Management Section

***Additional Technical Assistance Provided by:***
*Debra Baker,* Kansas Water Office
*Rich Basehor,* Kansas Department of Health and Environment

## Table of Contents

***List of Figures***

### *List of Tables*

# Glossary of Terms

**Best Management Practices (BMP):** Environmental protection practices used to control pollutants, such as sediment or nutrients, from common agricultural or urban land use activities.
**Biological Oxygen Demand (BOD)**: Measure of the amount of oxygen removed from aquatic environments by aerobic microorganisms for their metabolic requirements.
**Biota:** Plant and animal life of a particular region.
**Chlorophyll a:** Common pigment found in algae and other aquatic plants that is used in photosynthesis.
**Designated Uses:** Recognized uses by KDHE that should be attained in a water body.
**Dissolved Oxygen (DO):** Amount of oxygen dissolved in water.
**E. coli bacteria:** Bacteria normally found in gastrointestinal tracts of animals. Some strains cause diarrheal diseases.
**Eutrophication (E):** Excess of mineral and organic nutrients that promote a proliferation of plant life in lakes and ponds.
**Fecal coliform bacteria (FCB):** Bacteria that originate in the intestines of all warm-blooded animals.
**Municipal Water System:** Water system that serves at least 25 people or has more than 15 service connections.
**National Pollutant Discharge Elimination System (NPDES) Permit:** Required by Federal law for all point source discharges into waters.
**Nitrates:** Final product of ammonia's biochemical oxidation. Primary source of nitrogen for plants. Contained in manure and fertilizers.
**Nitrogen(N or TN):** Element that is essential for plants and animals. TN or total nitrogen is a chemical measurement of all nitrogen forms in a water sample.
**Nutrients:** Nitrogen and phosphorus in water source.
**Phosphorus (P or TP):** Element in water that, in excess, can lead to increased biological activity.
**Riparian Zone:** Margin of vegetation within approximately 100 feet of waterway.
**Sedimentation:** Deposition of slit, clay or sand in slow moving waters.
**Secchi Disk:** Circular plate 10-12" in diameter with alternating black and white quarters used to measure water clarity by measuring the depth at which it can be seen.
**Stakeholder Leadership Team (SLT):** Organization of watershed residents, landowners, farmers, ranchers, agency personnel and all persons with an interest in water quality.
**Total Maximum Daily Load (TMDL):** Maximum amount of pollutant that a specific body of water can receive without violating the surface water-quality standards, resulting in failure to support their designated uses.
**Total Suspended Solids (TSS):** Measure of the suspended organic and inorganic solids in water. Used as an indicator of sediment or silt.
**Water Quality Standard (WQS):** Mandated in the Clean Water Act. Defines goals for a waterbody by designating its uses, setting criteria to protect those uses and establishing provisions to protect waterbodies from pollutants.

# 1.0 Preface

The purpose of this Watershed Restoration and Protection Strategy (WRAPS) report for Toronto 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 (WQS), 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 WQS, but are in need of protection from future degradation.

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

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

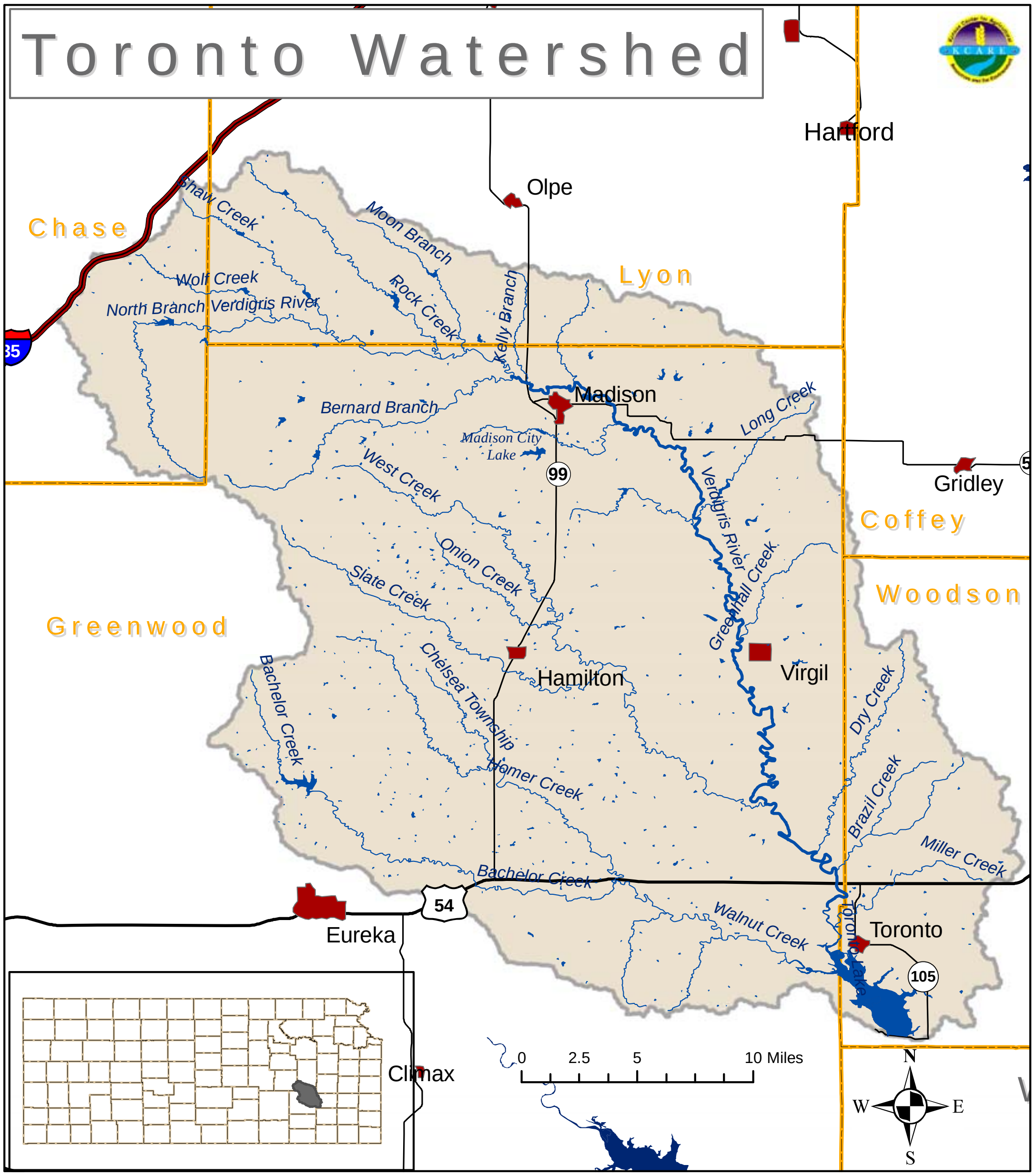



**Figure 1 Map of the Watershed**

## 2.0 Watershed Goals

The Stakeholder Leadership Team (SLT) was formed out of concern for the health and lifespan of Toronto Reservoir. In addition to flood control, Toronto Reservoir provides drinking water to the town of Toronto. Construction of the dam began in 1954 by the U.S. Army Corps of Engineers, Tulsa District (USACE) and the multipurpose pool was filled in 1960. In 1960, the reservoir had a storage capacity of 27,320 acre feet. The estimated current capacity of the latest survey year (1990) is 15,010 acre feet. This represents a loss of 45 percent due to sediment that has entered the Reservoir from the watershed with a calculated sedimentation rate of 242 acre feet per year. Toronto Reservoir has the highest percentage of capacity loss of all reservoirs in the state of Kansas.

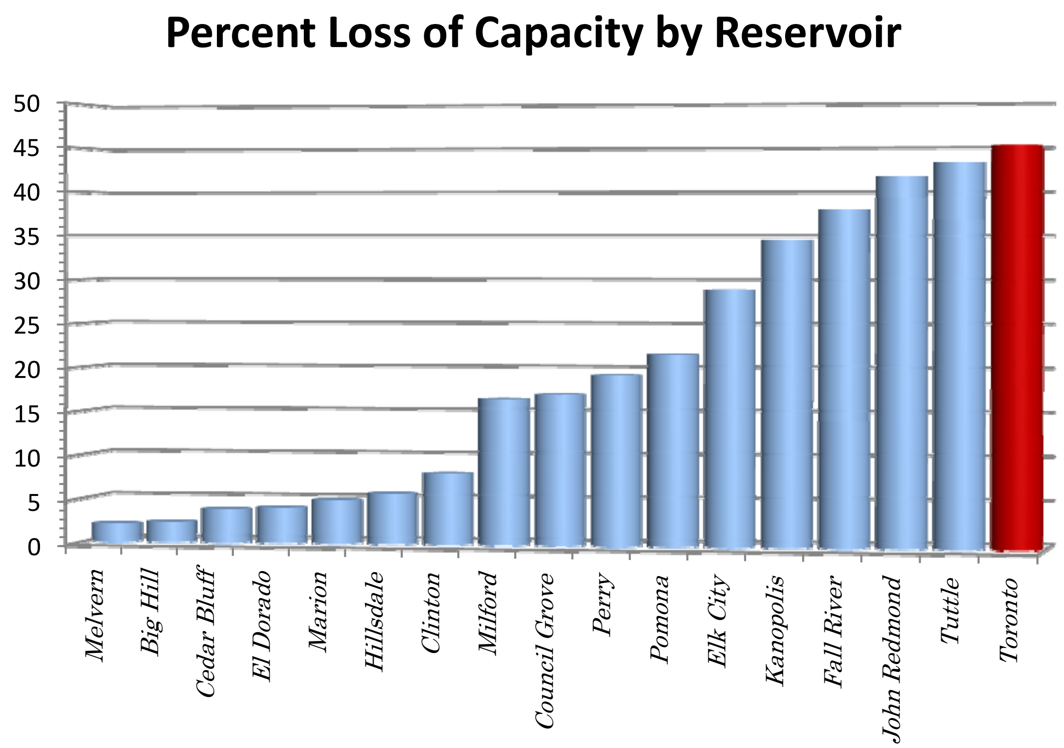



**Figure 2 Percent of Reservoir Loss Due to Sedimentation (1990).** [1]

The SLT hopes to slow this rate of sedimentation by improving conditions in the watershed. Watershed-wide additional benefits will be an improvement of water quality, an increase in yields in agricultural production and an increase in the health of wildlife and natural ecosystems.

The SLT has been meeting since 2008 and they have set their **watershed restoration and protection goals** as:

1. protect public drinking water and livestock watering supplies,

2. protect and restore recreational uses at Toronto Reservoir,
3. promote economic development,
4. protect groundwater quantity and quality,
5. protect the agricultural productivity of grassland and pastureland,
6. continue sustainability of land conservation, and
7. increase public awareness and education about watershed/water quality issues.

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.

# 3.0 Watershed Review

There are twelve river basins located in Kansas. The scope of this WRAPS project is a portion of the Verdigris Basin in south-east Kansas. The entire basin drains the Verdigris River and its tributaries into Oklahoma and eventually empties into the Gulf of Mexico. The extent of the WRAPS area is the Verdigris River and its tributaries upstream of and including Toronto Reservoir. The dam at Toronto Reservoir is the geographical endpoint of this WRAPS project.

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

**HUC** is an acronym for **H**ydrologic **U**nit **C**odes. HUCs are an identification system for watersheds. Each watershed has a unique HUC number in addition to a common name. As watersheds become smaller, the HUC number will become larger. For example, the Verdigris Basin is one of twelve basins in the state of Kansas. Within the Verdigris Basin are five HUC 8 classifications. The Toronto Watershed, which contains Toronto Reservoir, covers approximately one-half of the HUC 8 numbered 11070101 (named Upper Verdigris). HUC 8s can further be split into smaller watersheds that are given HUC 10 numbers and HUC 10 watersheds can be further divided into smaller HUC 12s. The Toronto Watershed is comprised of 17 HUC 12 delineations.


**Figure 3 HUC 12 Delineations in the Toronto Watershed.**

The Upper Verdigris Watershed is designated as Category I watershed indicating that it is in need of restoration as defined by the Kansas Unified Watershed Assessment 1999 submitted by the Kansas Department of Health and Environment (KDHE) and the United States Department of Agriculture (USDA)[2]. A Category I watershed does not meet state WQS or fails to achieve aquatic system goals related to habitat and ecosystem health. Category I watersheds are also assigned a priority for restoration. The Upper Verdigris is ranked fifty-eighth in priority out of ninety-two watersheds in the state.

The Toronto Watershed covers 458,395 acres. There are numerous towns and cities in this watershed in addition to developed areas surrounding Toronto Reservoir. Toronto Reservoir is a 2,800 acre Reservoir, located in the Cross Timbers Region of Kansas, but drains from the Flint Hills and Osage Cuestas Regions, has a maximum depth of approximately 18 feet and a mean depth of 7 feet. Construction was completed by the USACE in 1960 by damming the Verdigris River.

## *3.1 Land Cover/Land Uses*

Land use activities have a significant impact on the types and quantity of pollutants in the watershed.

The major land use in the watershed is grassland covering 85 percent of the watershed. Even though it may not be an obvious conclusion, grassland can be a major contributor of **sediment**. Gullies in rangeland are a major source of erosion and sedimentation in this watershed. Numerous factors contribute to gully formation but overgrazing, putting yearling cattle on grass during high flow rain events, noxious weeds and tree growth are overarching themes in range areas of the watershed with large gullies. Brine scar sites are also prevalent in the central region of this watershed. Brine scar sites, a side effect of oil and gas drilling, are areas where natural vegetation has been eliminated and the ground is bare, which leaves the area prone to greater erosion. Sources of sediment originating from cropland (7 percent of the watershed land use) can originate from overland flow across conventional tilled crop fields and ephemeral gullies that are plowed through each year. Failing and sloughing streambanks with undercuts will also contribute to sediment.

**Nutrients** can also originate from grasslands through overgrazing and allowing livestock access to streams and creeks. Cropland nutrients can originate from application of fertilizers prior to a rainfall event or over application of fertilizers and manure used as a fertilizer. Humans can contribute to nutrients through failing or inadequately constructed septic systems.

**E. coli bacteria** can originate from manure applied before a rainfall event, livestock and wildlife in the streams and failing septic systems.

The remaining land uses in the watershed are woodlands (4 percent), water (1 percent) and other (3 percent).


**Figure 4 Land Cover of the Watershed, 2005.** [3]

**Table 1 Land Use Calculations.** [4]

| Toronto Watershed | | |
|---|---|---|
| **Land Use** | **Acres** | **Percentage** |
| **Range-Grasses** | 324,848 | 70.87 |
| **Hay** | 68,560 | 14.96 |
| **Forest-Deciduous** | 21,164 | 4.62 |
| **Agricultural Land-Row Crops** | 17,882 | 3.90 |
| **Residential-Low Density** | 16,040 | 3.50 |
| **Water** | 6,256 | 1.36 |
| **Wetlands-Forested** | 1,525 | 0.33 |
| **Residential-Medium Density** | 1,324 | 0.29 |
| **Forest-Mixed** | 384 | 0.08 |
| **Residential-High Density** | 125 | 0.03 |
| **Southwestern US (Arid) Range** | 77 | 0.02 |
| **Range-Brush** | 104 | 0.02 |
| **Wetlands-Non-Forested** | 98 | 0.02 |

| Land Use Calculations, Cont. | | |
|---|---|---|
| **Land Use** | ***Acres*** | ***Percentage*** |
| **Industrial** | 5 | 0.00 |
| ***Total*** | 458,392 | 100.00 |

## *3.2 Designated Uses*

Toronto Reservoir is a Class A primary contact recreational water for public swimming. All other surface waters in this watershed are generally used for aquatic life support (fish), human health purposes, domestic water supply, recreation (fishing, boating, swimming), groundwater recharge, industrial water supply, irrigation and livestock watering. These are commonly referred to as "designated uses" as stated in the Kansas Surface Water Register, 2004, issued by KDHE.

**Table 2 Designated Water Uses for the Toronto Watershed.** [5]

| Designated Uses Table | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Stream Name** | **AL** | **CR** | **DS** | **FP** | **GR** | **IW** | **IR** | **LW** |
| Bachelor Cr, Bernard Cr, Homer Cr | E | | X | X | | | | |
| Brazil Cr, Dry Cr, Greenhall Cr, Kelly Br, Kuntz Br, Long Cr, Miller Cr, Moon Br, Onion Cr, Shaw Cr, Tate Branch Cr, Van Horn Cr, Wolf Cr | E | | | | | | | |
| Holderman Cr | E | | X | | | | | |
| Rock Cr, Slate Cr, Walnut Cr, West Cr | E | | | X | | | | |
| Verdigris R | E | C | X | X | X | X | X | X |
| Verdigris R, N Br | E | | X | X | X | X | X | X |
| Madison City Lake, Toronto Reservoir, Eureka City Lake | E | A | X | X | | X | | |
| Toronto Wildlife Area | E | | | 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
A=Primary contact recreation lakes that have a posted public swimming area
B=Primary contact recreation stream segment is by law or written permission of the landowner open to and accessible by the public
b=Secondary contact recreation stream segment is not open to and accessible by the public under Kansas law
C=Primary contact recreation lakes that are not open to and accessible by the public under Kansas law
S=Special aquatic life use water
E = Expected aquatic life use water
X = Referenced stream segment is assigned the indicated designated use
O = Referenced stream segment does not support the indicated beneficial use
Blank=Capacity of the referenced stream segment to support the indicated designated use has not been determined by use attainability analysis

## 3.3 Special Aquatic Life Use Waters

Special aquatic life use waters are defined as "surface waters that contain combinations of habitat types and indigenous biota not found commonly in the state, or surface waters that contain representative populations of threatened or endangered species". The Toronto Watershed has a special aquatic life use designation in the Verdigris River. The Verdigris River has been selected due to the presence of a threatened or endangered species of mussels in the river as identified by KDHE. Although not addressed by this WRAPS project, lack of stream flow especially during periods of drought, also stresses these sensitive populations of mussels.

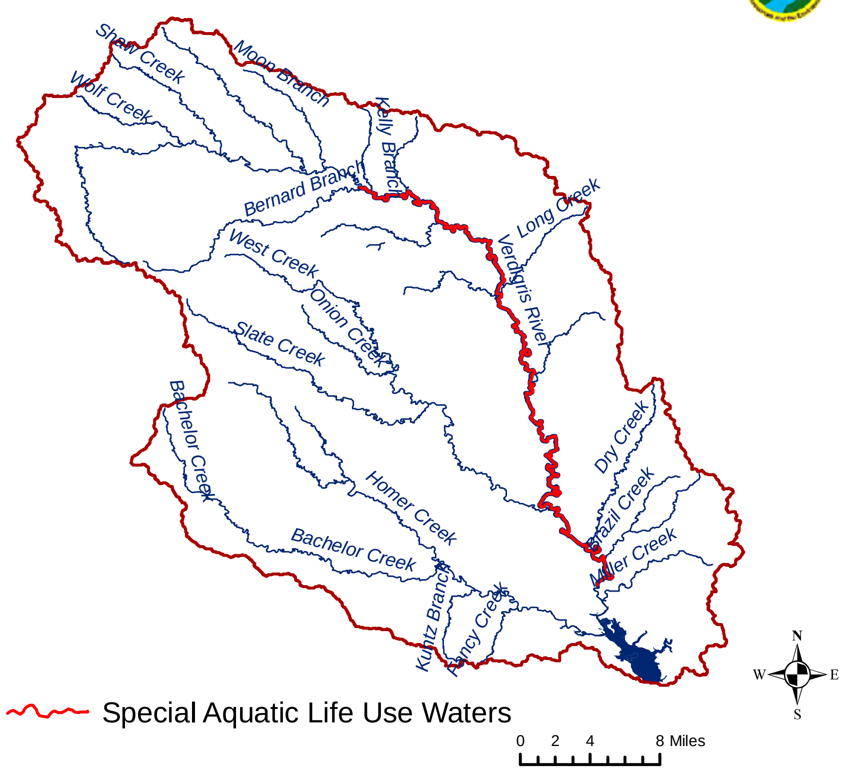



**Figure 5 Special Aquatic Life Use Waters in the Watershed.** [6]

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

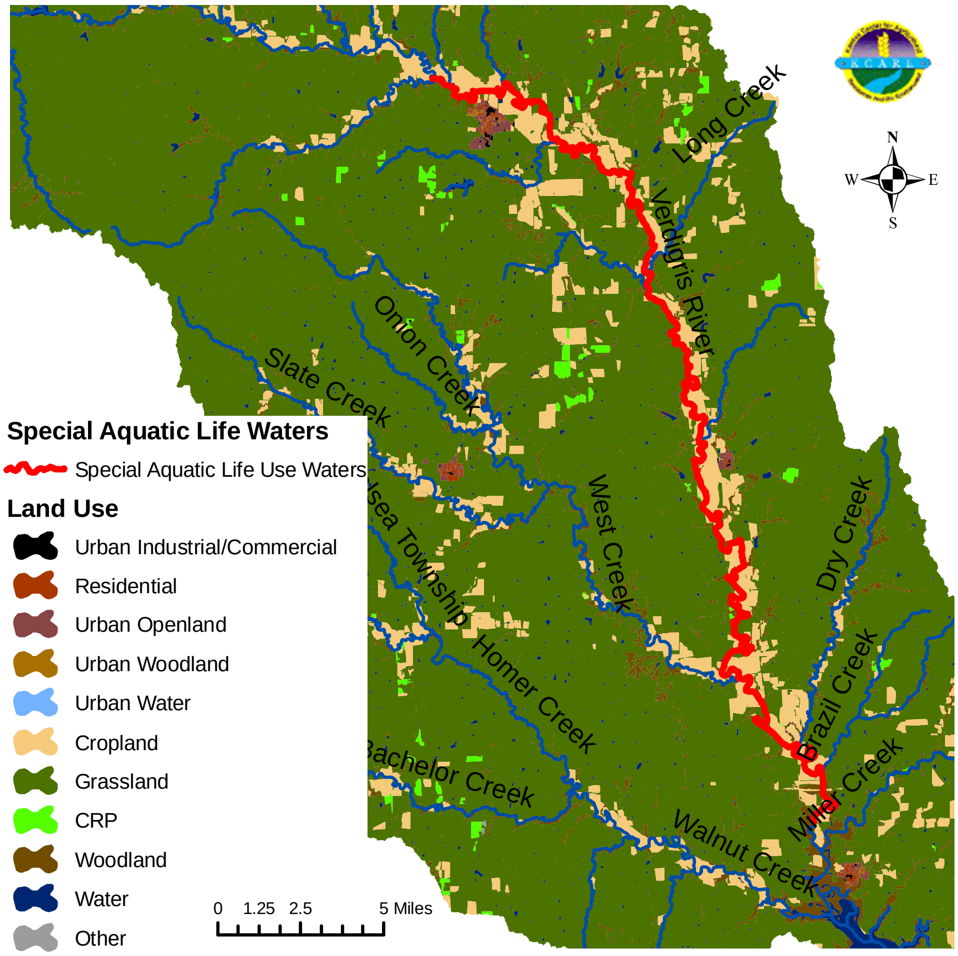



**Figure 6 Special Aquatic Life Use Waters in the Watershed with Land Use Showing the Predominance of Grassland near the River.** [7]

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

A PWS that derives its water from a surface water supply can be affected by sediment – either in difficulty at the intake in accessing the water or in treatment of the water prior to consumption. Nutrients and fecal coliform bacteria will also affect surface water supplies causing excess cost in treatment prior to public consumption. The table below lists the public water supplies in the Toronto Watershed.

**Table 3 PWS of Toronto Watershed.** [8]

| Water Supplier | County | Source of Water | Population Served |
|---|---|---|---|
| **Greenwood County RWD 01** | GW | Eureka | 1,271 |
| **Greenwood County RWD 02** | GW | Eureka | 1,000 |
| **Greenwood County RWD 03** | GW | Madison | 310 |
| **Hamilton** | GW | Madison | 328 |
| **Madison** | GW | 2 Wells, City Lake | 834 |

| PWS of Toronto Watershed, Cont. | | | |
|---|---|---|---|
| **Water Supplier** | **County** | **Source of Water** | **Population Served** |
| **Toronto** | GW | Toronto Reservoir, Yates Center Lake | 300 |
| **Virgil** | GW | 2 Wells | 120 |
| **Total Population Served** | | | **4,163** |

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 these point sources located on streams or rivers may impact water quality in the waterways. For example, municipal waste water can contain suspended solids, biological pollutants that reduce oxygen in the water column, inorganic compounds or bacteria. Waste water will be treated to remove solids and organic materials, disinfected to kill bacteria and viruses, and discharged to surface water. Treatment of municipal waste water is similar across the country. [9] Any pollutant discharge from point sources that is allowed by the state is considered to be Wasteload Allocation (WLA). The watershed has three NPDES facilities.

In this watershed, there are three municipalities that have NPDES sites in close proximity with PWS sites. There could be a possible threat of nitrates and bacteria in the PWS from the NPDES site. The PWS for Madison is groundwater and the PWS for Toronto is Toronto Reservoir. Madison City Lake, another PWS, has two diversion points in the lake. Surface water intakes are more at risk for contamination than groundwater intakes. The cities that have both a NPDES site and public water supply diversion point are highlighted in the table below in tan.

**Table 4 NPDES Sites.** [10] All three NPDES sites have PWS sites.

| NPDES | Facility Name | Owner-ship | Descrip-tion | Industrial Classification | City | County |
|---|---|---|---|---|---|---|
| KS0021890 | Toronto, City Of Stp | Public | Sewerage Systems | Municipal | Toronto | WO |
| KS0030538 | Madison, City Of Wwtf | Public | Sewerage Systems | Municipal | Madison | GW |
| KS0046001 | Hamilton, City Of Stp | Public | Sewerage Systems | Municipal | Hamilton | GW |

Numerous onsite wastewater systems exist in the watershed. There is no accurate accounting number of these systems and their functional condition is generally unknown. Best guess is that ten percent of onsite wastewater systems are either failing or inadequately constructed. [11] All counties in the watershed have sanitary codes.

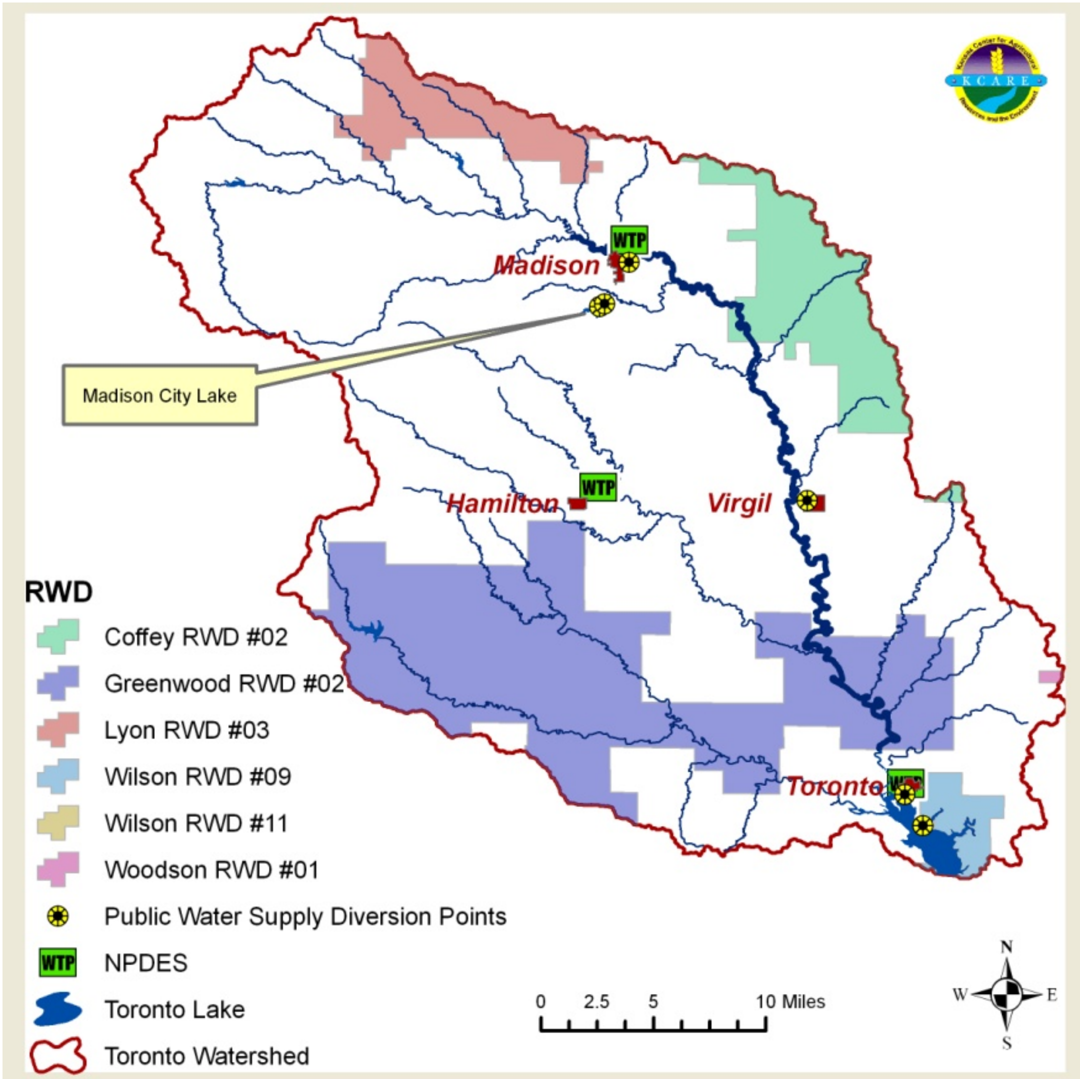



**Figure 7 Rural Water Districts, Public Water Supply Diversion Points and NPDES Treatment Facilities.** [12] PWS surface water intakes include those that are currently in use and those that have been functional in the past.

## *3.5 Aquifers* [13.]

One aquifer underlies the watershed:

- Alluvial Aquifer - The alluvial aquifer is a part of and connected to a river system and consists of sediments deposited by rivers in the stream valleys. The Verdigris River has an alluvial aquifer that lies along and below the rivers.

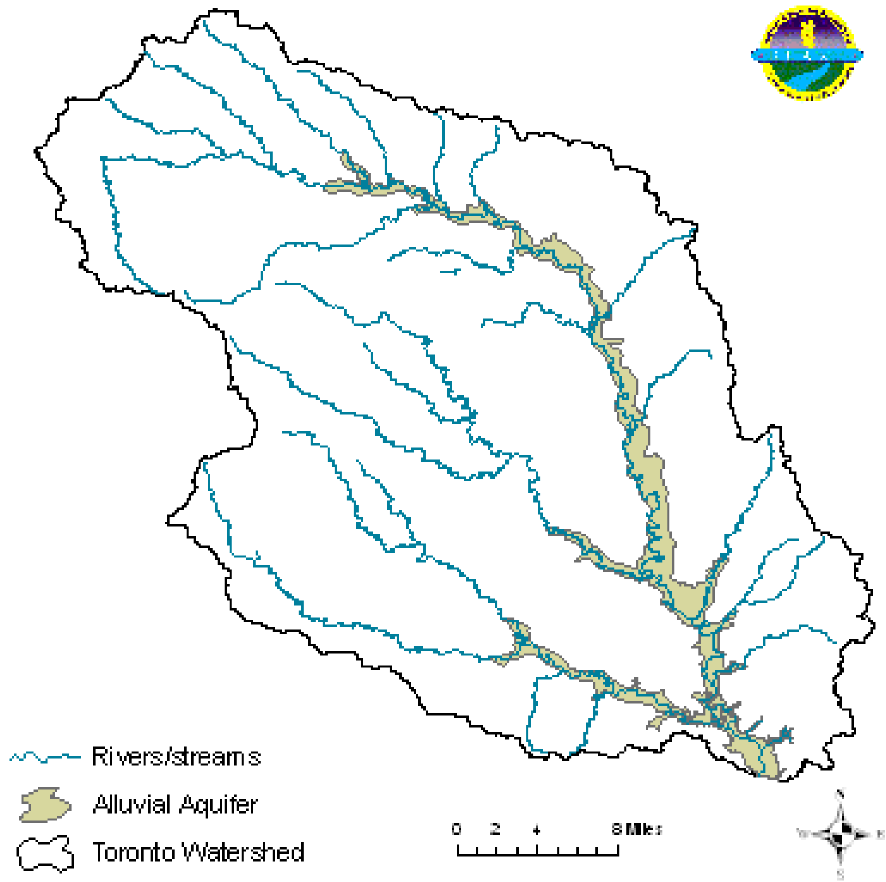



**Figure 8 Alluvial Aquifer in the Watershed.** [14]

## 3.6 Total Maximum Daily Loads (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 and approved by EPA. The desired outcome of the TMDL process is indicated, using the current situation as the baseline. Deviations from the WQS 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. [15] In summary, TMDLs provide a tool to target and reduce point and nonpoint pollution sources. The goal of the WRAPS process is to address high priority TMDLs.

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

**Table 5 TMDL Review Schedule for the Verdigris Basin.** [16]

| Year Ending in September | Implementation Period | Possible TMDLs to Revise | TMDLs to Evaluate |
|---|---|---|---|
| 2013 | 2014-2023 | 2002 | 2002 |
| 2018 | 2019-2028 | 2000, 2004, 2005, 2008 | 2000, 2004, 2005, 2008 |

TMDLs in the watershed are listed in the table below.

**Table 6 TMDLs in the Watershed.** [17] The shaded lines indicate high, medium or low priorities. The TMDLs in **bold** print indicate the ones that will be affected by this WRAPS plan.

| Water Segment | TMDL Pollutant | Endgoal of TMDL | Priority | Sampling Station |
|---|---|---|---|---|
| **High Priority TMDLs** | | | | |
| **Toronto Reservoir** | **Eutrophication/Dissolved Oxygen/Siltation** | **Summer chlorophyll a concentrations < 10 ug/L**<br><br>**Secchi disk depth >0.7 meters**<br><br>**DO > 5mg/L** | **High** | **LM24001** |
| **Medium Priority TMDLs** | | | | |
| Eureka City Lake | Eutrophication/Siltation | Chlorophyll a < 10 ppb for eutrophication, 50% of lake area with >10' in depth in 2016 for siltation, Average depth near shorelines should not decrease by < 0.5' by 2016 for siltation | Medium | LM040201 |
| **Walnut Creek (with Homer Creek)** | **Dissolved Oxygen** | **BOD<2.7mg/l under critical flow conditions**<br><br>**DO>5mg/l** | **Medium** | **SC576** |

| TMDLs in the Watershed, Cont. | | | | |
|---|---|---|---|---|
| **Water Segment** | **TMDL Pollutant** | **Endgoal of TMDL** | **Priority** | **Sampling Station** |
| **West Creek** | **Dissolved Oxygen** | **DO>5mg/l**<br><br>**BOD< or =3.1mg/l** | **Medium** | **SC290** |

**Table 7 Desired Water Quality Endpoint for Toronto Reservoir.** [17]

| Parameter | Current Avg. Condition | TMDL | Percent Reduction |
|---|---|---|---|
| Total Phosphorus Annual Load (lbs/year) | 71,686 | 50,585 | 29.4% |
| Total Phosphorus Daily Load (lbs/day)* | 373.2 | 263.3 | 29.4% |
| Total Nitrogen Annual Load (lbs/year) | 691,437 | 490,450 | 29.1% |
| Total Nitrogen Daily Load (lbs/day)* | 5077 | 3601 | 29.1% |
| Total Phosphorus Main Basin (µg/L) | 73.0 | 52.4 | 28% |
| Total Nitrogen Main Basin (µg/L) | 636.0 | 492.3 | 23% |
| Secchi Depth (m) | 0.4 | > 0.70 | 75% Increase |

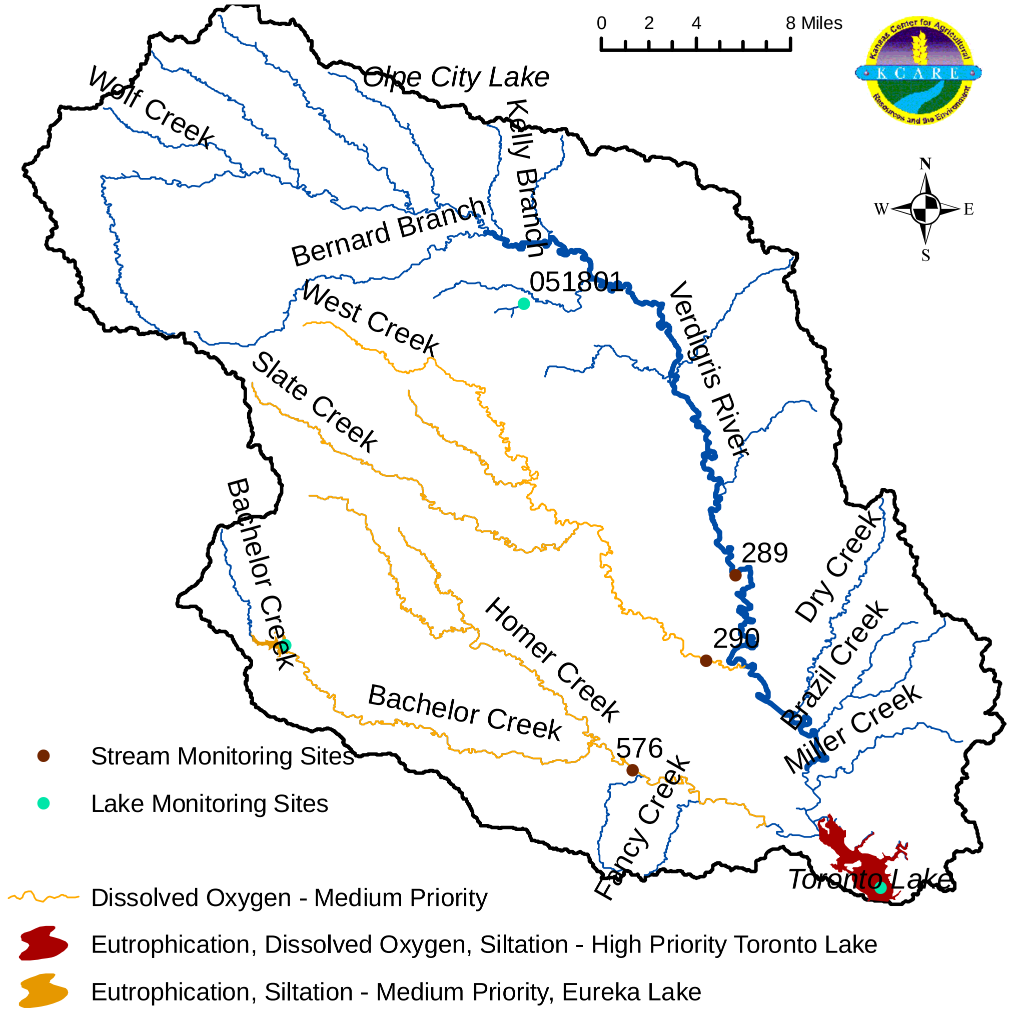



**Figure 9 TMDLs in the Watershed. [18].**

## 3.7 303d Listings in the Watershed[19]

The Toronto Watershed has several new listings on the 2008 “303d list”. A 303d list of impaired waters is developed biennially and submitted by KDHE to EPA. To be included on the 303d list, samples taken during the KDHE monitoring program must show that WQS are not being met. This in turn means that designated uses are not met. TMDL development and revision for waters of the Toronto Watershed is scheduled for 2013. TMDLs will be developed over the subsequent two years for “high” priority impairments. Priorities are set by work schedule and TMDL development timeframe rather than severity of pollutant. If it will be greater than two years until the pollutant can be assessed, the priority will be listed as “low”. Water bodies are assigned “categories” based on their impairment status:

- Category 5 – Waters needing TMDLs

- Category 4a – Waters that have TMDLs developed for them and remain impaired
- Category 4b – NPDES permits addressed impairment or watershed planning is addressing atrazine problem
- Category 4c – Pollution (typically insufficient hydrology) is causing impairment
- Category 3 – Waters that are indeterminate and need more data or information
- Category 2 – Waters that are now compliant with certain WQS
- Category 1 – All designation uses are supported, no use is threatened.

**Table 8 2010 303d List of Impaired Waters in the Toronto Watershed.** [20]

| Category | Water Segment | Impairment | Priority | Sampling Station |
|---|---|---|---|---|
| **Low Priority** | | | | |
| 5 – Needing TMDL | Verdigris River near Virgil | E. coli | Low | SC289 |

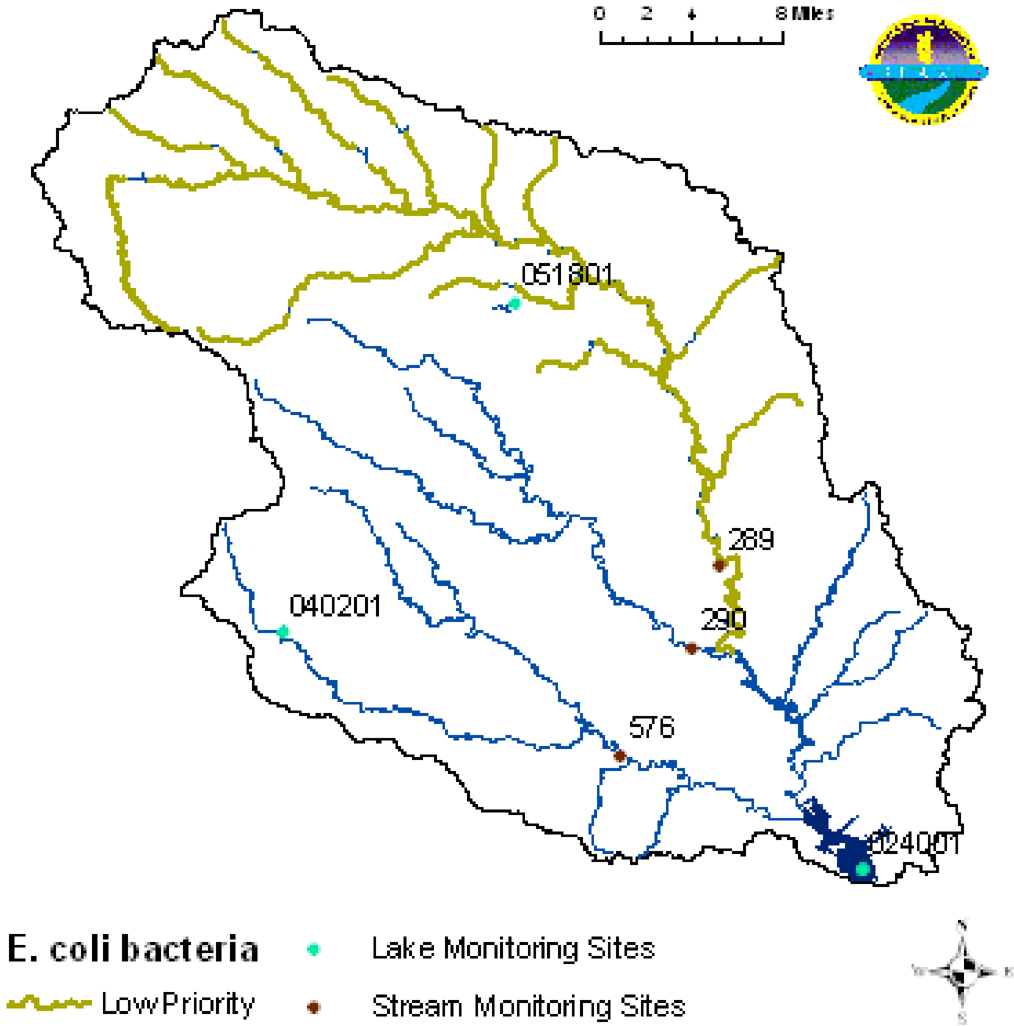



**Figure 10 303d Listings in the Watershed.** [19]

## 3.8 TMDL Load Allocations [21]

TMDL loading is based on several factors. A total load is derived from the TMDL. Part of this total load is WLA. 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 allocations. 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 allocations by nonpoint sources.

BATHTUB is an empirical receiving water quality model that was developed by the USACE. The BATHTUB model was utilized for the eutrophication assessment of Toronto Reservoir. Based on modeling results, a 30 percent reduction of both Total Phosphorus (TP) and Total Nitrogen (TN) within the inflow of Walnut Creek and the Verdigris River is necessary to achieve the TMDL endpoint of 10 µg/L of Chlorophyll *a* within the main basin of the Toronto Reservoir.

**LOAD ALLOCATIONS for Toronto Reservoir Summary:**

1) **TP nonpoint source load allocations = 26,160 lbs/year**
2) **TN nonpoint source allocation = 250,032 lbs/year**
3) **Total Suspended Solids (TSS) nonpoint source load allocations = 46,031 tons/year**

### 3.8.1 Eutrophication

Nonpoint sources are the main contributor for the nutrient input and impairment in Toronto Reservoir. Background levels may be attributed to nutrient recycling and leaf litter. The assessment suggests that runoff transporting nutrient loads associated with animal wastes and cultivated crops where fertilizer has been applied, to include pasture and hay, contribute to the eutrophic condition of the Reservoir. Nutrient load allocationss for Toronto Reservoir were calculated using the BATHTUB model.

Total phosphorus currently entering the Reservoir annually, as calculated in the TMDL, is 71,686 pounds.

**Table 9 Toronto Reservoir TMDL Summary for TP.**

| TP Load | TP pounds/year |
|---|---|
| Load Allocation | 50,585 |
| Margin of Safety | 5,059 |
| ***TSS Nonpoint Load that needs to be Reduced*** | ***26,160*** |

Total nitrogen currently entering the Reservoir annually, as calculated in the TMDL, is 691,437 pounds per year of Total Nitrogen (TN).

**Table 10 Toronto Reservoir Summary for TN.**

| TN Load | TN pounds/year |
|---|---|
| Load Allocation | 490,450 |
| Margin of Safety | 49,045 |
| ***TSS Nonpoint Load that needs to be Reduced*** | ***250,032*** |

### 3.8.2 Siltation and Sediment

Siltation loading comes predominantly from nonpoint sources. Based on the soil characteristics of the watershed, overland runoff can easily carry sediment to the stream segments and eventually to the Reservoir. TSS and secchi depth show a strong relationship for Toronto Reservoir. A 42 percent TSS reduction is necessary to reach the endpoint, a secchi depth of 0.70 m. The sediment currently entering the Reservoir annually, as calculated in the TMDL, is 96,300 tons/year of TSS.

**Table 11 Toronto Reservoir TMDL Summary for TSS.**

| TSS Load | TSS tons/year |
|---|---|
| Load Allocation | 50,248 |
| Margin of Safety | 5,585 |
| ***TSS Nonpoint Load that needs to be Reduced*** | ***46,031*** |

# 4.0 Critical Targeted Areas and Load Reduction Methodology

## 4.1 Critical Targeted Areas

The Toronto Watershed was assessed using the Soil and Water Assessment Tool (SWAT) by Kansas State University Department of Biological and Agricultural Engineering. SWAT was used as an assessment tool to estimate annual average pollutant loadings such as nutrients and sediment that are coming from the land into the stream. At the end of simulation runs the average annual loads are calculated for each sub watershed. Some subbasins have higher loads than the others. All subbasins are ranked based on the values of an average annual load, sorted from highest to lowest, and form the ranking list. Subbasins within the top 20 to 30 percent of the list are selected as critical (targeted) areas for cropland and livestock BMPs implementation.

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

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

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

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

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

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

In every watershed, there are specific locations that contribute a greater pollutant load due to soil type, proximity to a stream and land use practices. By focusing BMPs in these areas; pollutants can be reduced at a more efficient rate. Through research at the University of Wisconsin, it has been shown that there is a “bigger bang for the buck” with streamlining BMP placement in contrast to a “shotgun” approach of applying BMPs in a random nature throughout the watershed. Therefore, the SLT has targeted areas in the watershed to focus BMP placement for sediment runoff, nutrients and E. coli bacteria from livestock production and streambank erosion. Targeting for this watershed will be accomplished in three different areas:

1. Cropland will be targeted for sediment,
2. Rangeland will be targeted for sediment and the same geographic area will be targeted for livestock related phosphorus, and
3. Streambanks will be targeted for sediment.

After locating initial critical targeted areas, the area was groundtruthed. Groundtruthing is a method used to determine what BMPs are currently being utilized in the targeted areas. It involves conducting windshield surveys throughout the targeted areas identified by the watershed models to determine which BMPs are currently installed. These surveys are conducted by local agency personnel and members of the SLT that are familiar with the area and its land use history. Groundtruthing provides the current adoption rate of BMPs, pictures of the targeted areas, and may bring forth additional water quality concerns not captured by watershed modeling. In 2009, the groundtruthing provided the current adoption rates for five common BMPs (buffers, no-till, terraces, conservation crop rotation and grassed waterways) in the cropland targeted area of the watershed averaged across counties. The results are as follows:

- Vegetative buffer strips – current adoption rate of 30 percent
- No-till cultivation – current adoption rate of 20 percent
- Grassed terraces – current adoption rate of 70 percent
- Conservation Crop Rotation – current adoption rate of 95 percent
- Grassed waterways – current adoption rate of 10 percent

The SWAT model was revised using the groundtruthing information. This allows the SWAT model to develop a more accurate determination of appropriate targeted areas. The SWAT model then determined number of acres needed to be implemented for each BMP. This information is provided in Tables 17 and 25.

The maps produced by the modeling are displayed below. It is noted that the areas are characterized by low, medium, medium-high and high. The sub-watersheds at the northern end of the basin show the highest potential for erosion, phosphorous, and nitrogen runoff. As stated earlier, this model accounts for land use, soil type, slope, and current conservation practices. This is the area of the watershed with the greatest percentage of cropland, which leads to a higher potential for erosion compared to areas that are mainly composed of grassland.

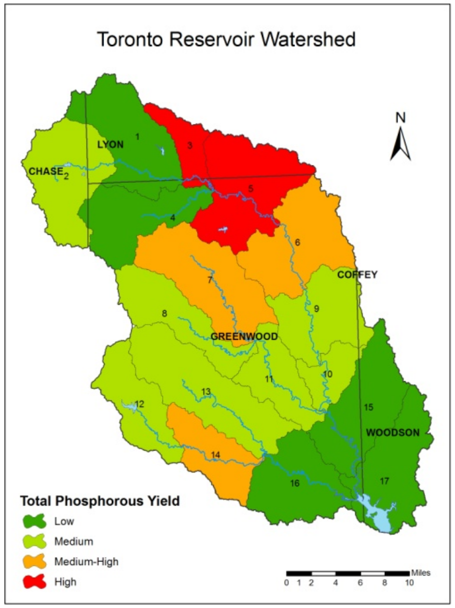



**Figure 11  Phosphorus Yield as Determined by SWAT.**

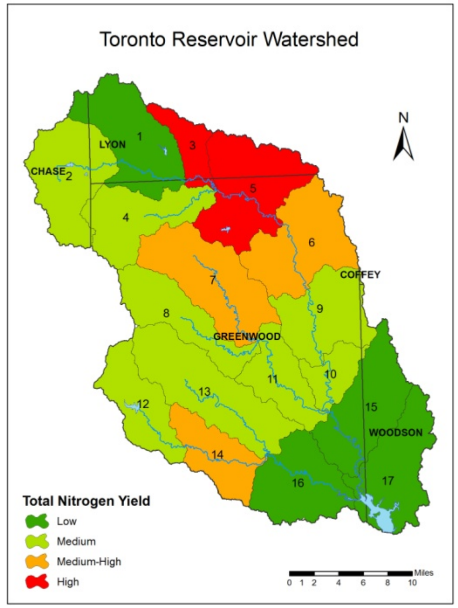



**Figure 12  Nitrogen Yield as Determined by SWAT.**

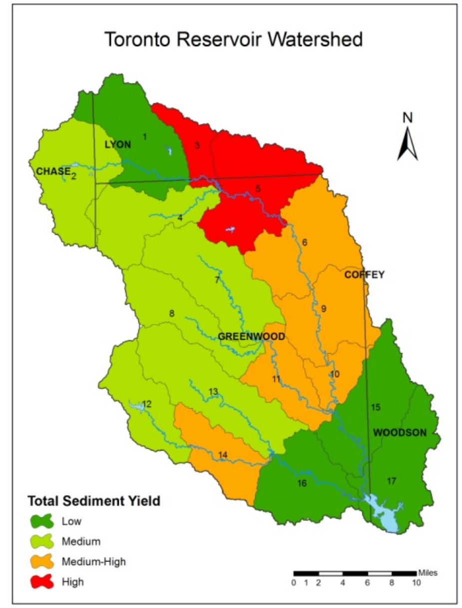



**Figure 13  Sediment Yield as Determined by SWAT.**

Toronto Reservoir Watershed

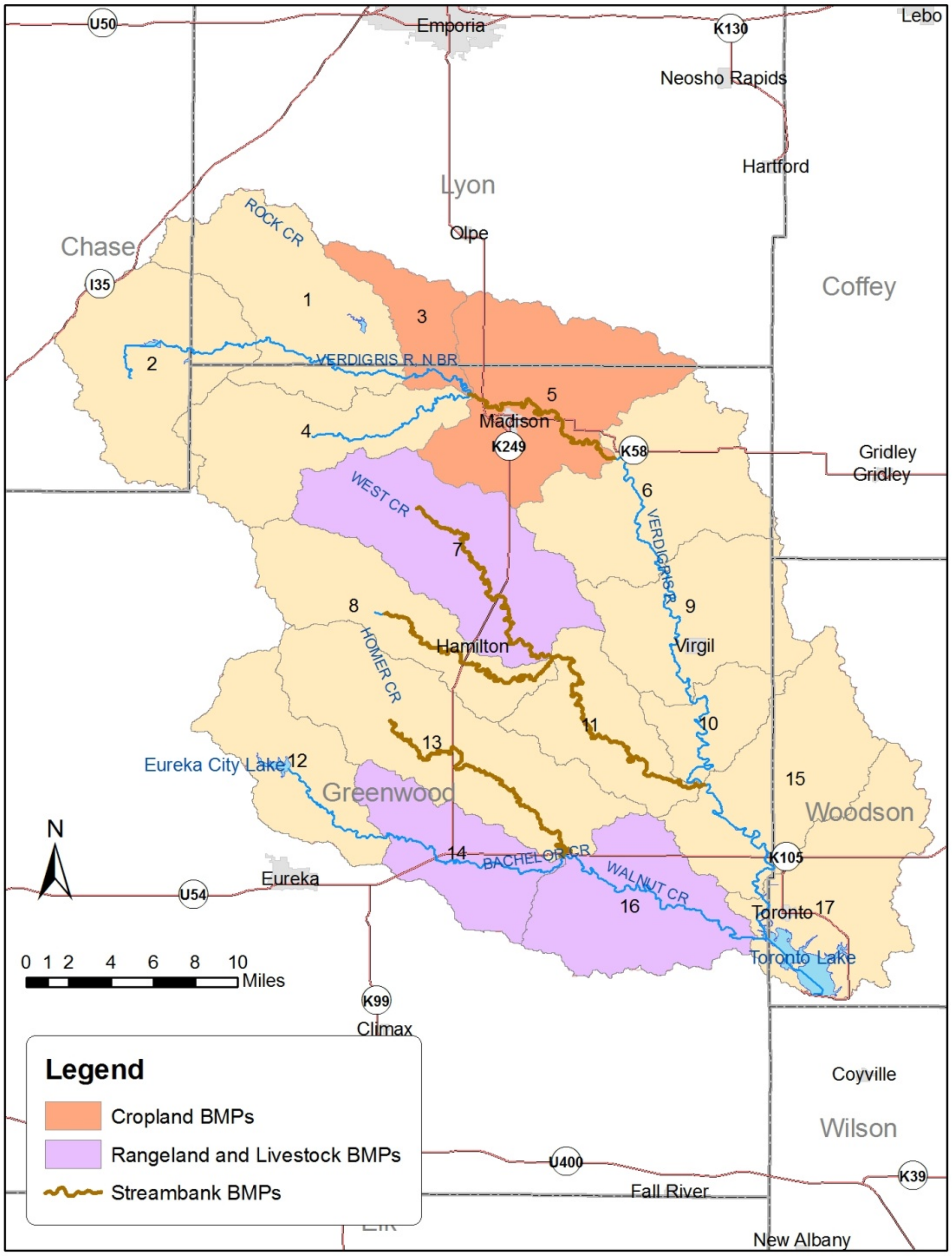



**Figure 14 Targeted Areas for Cropland, Rangeland and Livestock, and Streambanks.**

## 4.2 Cropland Erosion

The SWAT delineated (primary ranked) Targeted Area of this project is to be used for the determination of BMP placement for sediment (overland origin). This area includes a portion of the Verdigris River, Moon Branch, Kelly Branch and Tate Branch. This area contains HUC numbers:

- 110701010105 (subbasin 3), and
- the lower portion of HUC 110701010103 (subbasin 5).


**Figure 15 SWAT Targeted Area for Cropland.**

**Table 12 Land Use in the Cropland Targeted Area.** [22]

| Subbasin 3 (110701010105) | | | |
|---|---|---|---|
| **LANDUSE:** | Area[acres] | Percent Watershed Area | Subbasin Area |
| **Range-Grasses** | 6,022 | 1.31 | 58.74 |
| **Hay -** | 1,943 | 0.42 | 18.95 |
| **Agricultural Land-Row Crops** | 1,064 | 0.23 | 10.38 |

| Subbasin 3 (110701010105) Land Use, Cont. | | | |
|---|---|---|---|
| **LANDUSE:** | Area[acres] | Percent Watershed Area | Subbasin Area |
| **Forest-Deciduous** | 547 | 0.12 | 5.33 |
| **Residential-Low Density** | 361 | 0.08 | 3.52 |
| **Wetlands-Forested** | 190 | 0.04 | 1.85 |
| **Water** | 102 | 0.02 | 0.99 |
| **Residential-Medium Density** | 11 | 0.00 | 0.11 |
| **Residential-High Density** | 1 | 0.00 | 0.01 |
| **Forest-Mixed** | 6 | 0.00 | 0.06 |
| **Range-Brush** | 3 | 0.00 | 0.03 |
| **Wetlands-Non-Forested** | 2 | 0.00 | 0.02 |
| **Total** | **10,253** | **2.22** | **99.99** |

| **Subbasin 5 (110701010103)** | | | |
|---|---|---|---|
| **LANDUSE:** | Area[acres] | Percent Watershed Area | Percent Subbasin Area |
| **Range-Grasses** | 24,428 | 5.33 | 66.29 |
| **Hay** | 5,743 | 1.25 | 15.58 |
| **Agricultural Land-Row Crops** | 2,072 | 0.45 | 5.62 |
| **Forest-Deciduous** | 1,995 | 0.44 | 5.41 |
| **Residential-Low Density** | 1,665 | 0.36 | 4.52 |
| **Water** | 391 | 0.09 | 1.06 |
| **Residential-Medium Density** | 273 | 0.06 | 0.74 |
| **Wetlands-Forested** | 219 | 0.05 | 0.6 |
| **Residential-High Density** | 36 | 0.01 | 0.1 |
| **Industrial** | 2 | 0.00 | 0.01 |
| **Southwestern US (Arid) Range** | 1 | 0.00 | 0 |
| **Forest-Mixed** | 16 | 0.00 | 0.04 |
| **Range-Brush** | 6 | 0.00 | 0.02 |
| **Wetlands-Non-Forested** | 4 | 0.00 | 0.01 |
| **Total** | **36,852** | **8.04** | **100** |

## 4.3 Rangeland and Livestock Targeted Areas

The SLT has determined an area for targeting **rangeland** erosion in the watershed. This area will also be targeted for **livestock** related phosphorus pollutants. Rangeland BMPs will be placed in this area. These SWAT areas are HUC numbers:

- 110701010201 (subbasin 7),
- 110701010304 (subbasin 14), and
- 110701010305 (subbasin 16).

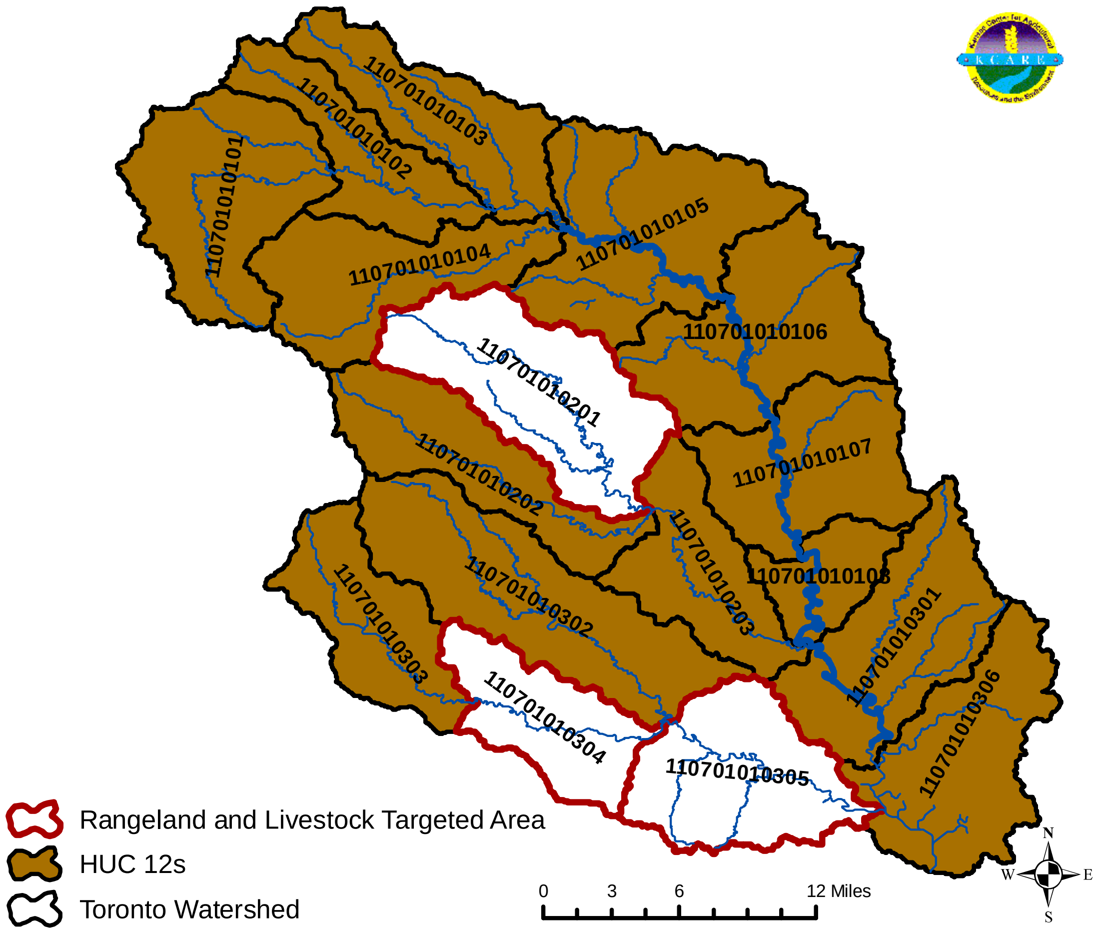



**Figure 16 Rangeland and Livestock Targeted Areas.**

**Table 13 Land Use in the Range and Livestock Targeted Area.** [22]

| LANDUSE: | Area[acres] | Percent Subbasin.Area |
|---|---|---|
| Grassland/Herbaceous | 59,318 | 72.74 |
| Pasture/Hay | 11,780 | 14.45 |
| Deciduous Forest | 3,458 | 4.24 |
| Developed - Open Space | 3,199 | 3.92 |
| Cultivated Crops | 2,626 | 3.22 |
| Water | 611 | 0.75 |
| Developed - Low Intensity | 365 | 0.45 |
| Mixed Forest | 78 | 0.10 |
| Woody Wetlands | 52 | 0.06 |
| Shrub/Scrub | 16 | 0.02 |
| Herbaceous Wetlands | 17 | 0.02 |
| Developed - Medium Intensity | 11 | 0.01 |
| Barren Land | 12 | 0.01 |
| **Total** | **81,544** | **100.00** |

## 4.4 Streambank Erosion

In the absence of a streambank assessment, the SLT has determined that the targeted area for **streambank** restoration will be Homer Creek and West Creek along with their tributaries. This area was determined by the 1991 USDA/NRCS GIS Riparian layer originating from the Kansas Geospatial Community Commons. It will be targeted for sediment that originates from streambank failures and lack of riparian cover. These areas are contained in HUC numbers:

- 110701010201 (subbasin 7),
- 110701010202 (subbasin 8),
- 110701010203 (subbasin 11), and
- 110701010302 (subbasin 13).

**Table 14 Riparian Land Use in the Streambank Targeted Area for a 100 foot Buffer.** [23]

| Land Use | Acres | Percent |
|---|---|---|
| Pasture | 8,664 | 57.54 |
| Forest Land | 2,197 | 14.59 |
| Pasture/Tree Mix | 1,621 | 10.76 |
| Water | 948 | 6.30 |
| Crop Land | 820 | 5.44 |
| Crop/Tree Mix | 698 | 4.63 |
| Urban Land | 44 | 0.29 |
| Shrub/Shrub Land | 32 | 0.21 |
| Urban/Tree Mix | 29 | 0.19 |
| Barren Land | 7 | 0.05 |
| | 15,059 | 100.00 |


**Figure 17 Streambank Targeted Areas.**

## 4.5 Load Reduction Estimate Methodology

### 4.5.1 Cropland

Baseline loadings are calculated using the SWAT model delineated to the HUC 14 watershed scale. Best management practice (BMP) load reduction efficiencies are derived from K-State Research and Extension Publication MF-2572. [24] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

### 4.5.2 Livestock

Baseline nutrient loadings per animal unit are calculated using the Livestock Waste Facilities Handbook.[25] Livestock management practice load reduction efficiencies are derived from numerous sources including K-State Research and Extension Publication MF-2737 and MF-2454.[26] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

### 4.5.3 Estimating Annual Loads [27]

An analysis of the 1991 USDA/NRCS Riparian Inventory concluded that 32.4 miles of buffers along the main stem of the Verdigris River contained cropland, livestock, and barren land. Within these areas are prime spots to target streambank stabilization. Baseline soil erosion values were arrived at assuming a soil erosion value of 2 tons per linear foot of degraded buffer taken from TWI assessments on the Cottonwood and Neosho Rivers.

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

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

Rangeland Load Reduction Estimates:

Soil erosion from brine sites that kill vegetation and allow gullies to form as well as gullies formed by cattle trails in pastures are converted to tons via the following NRCS formula:

Soil Loss Equation for Gullies

$$\frac{\text{(Bottom Width+Top Width) X Depth X Length X Soil Weight (lbs/ft}^3\text{)}}{2 \text{ X } 2{,}000} = \text{Tons of Soil}$$

Where: Average soil weight for the watershed= 85 lbs/ft$^3$

Cost estimates for brine site and ephemeral gully repair are from the Greenwood County Conservation District and Flint Hills RC&D.

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

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

1. **Sedimentation,**
    a. Cropland erosion,
    b. Rangeland erosion, and
    c. Streambank erosion
2. **Livestock related pollutants**
    a. Nutrients and
    b. E. coli bacteria
3. **Protection of Madison City Lake drinking water supply**
4. **Natural resources**
    a. Cross timbers ecosystem and
    b. Prairie chicken habitat

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.

# 5.0 Impairments Addressed by the SLT

## 5.1 Sediment

Toronto Reservoir and Eureka Lake have new TMDLs for **siltation.**

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

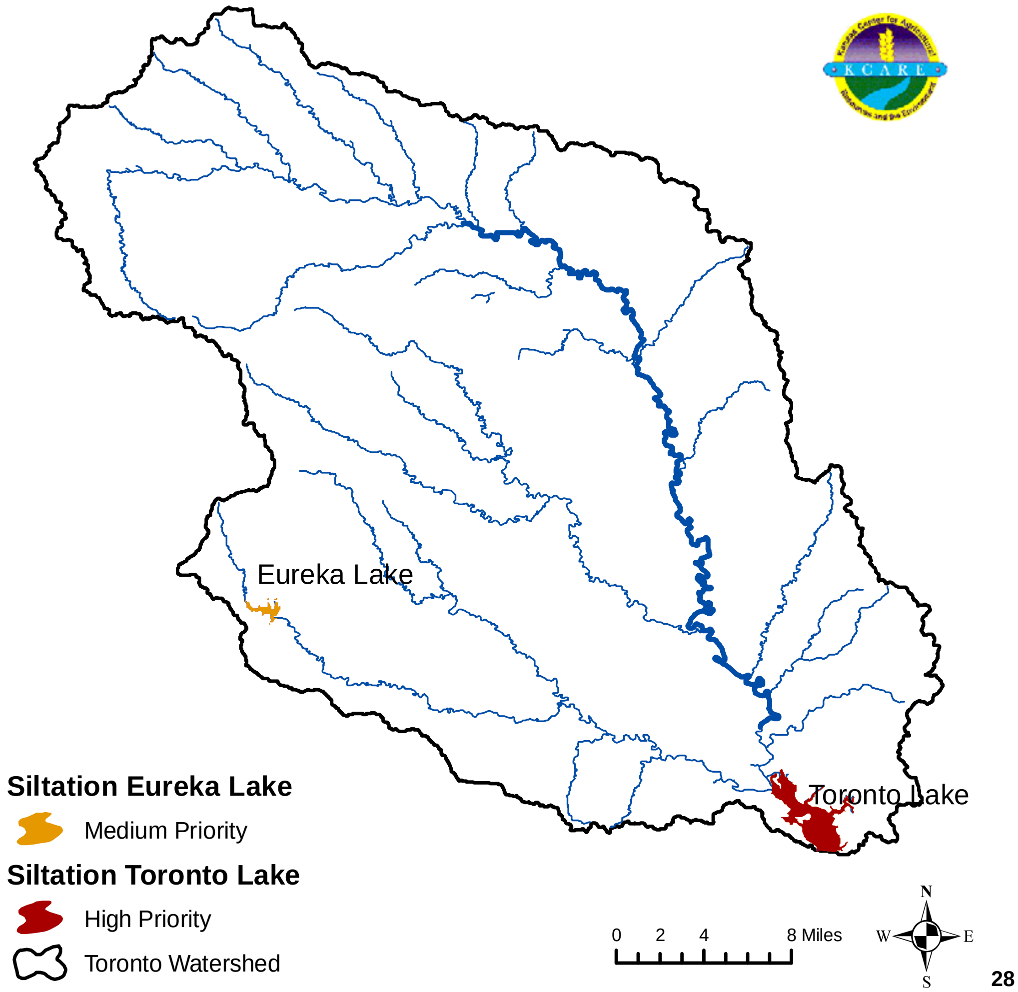



**Figure 18 TMDL and 303d Listings for Siltation in the Watershed.** [19]

## Possible Sources of the Impairment

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

### 5.1.1 Cropland Erosion

Cropland erosion BMPs have been targeted by SWAT modeling analysis. This area is located along the upper reaches of the Verdigris River surrounding the town of Madison. Causes of erosion are discussed in more detail in the rest of this section.

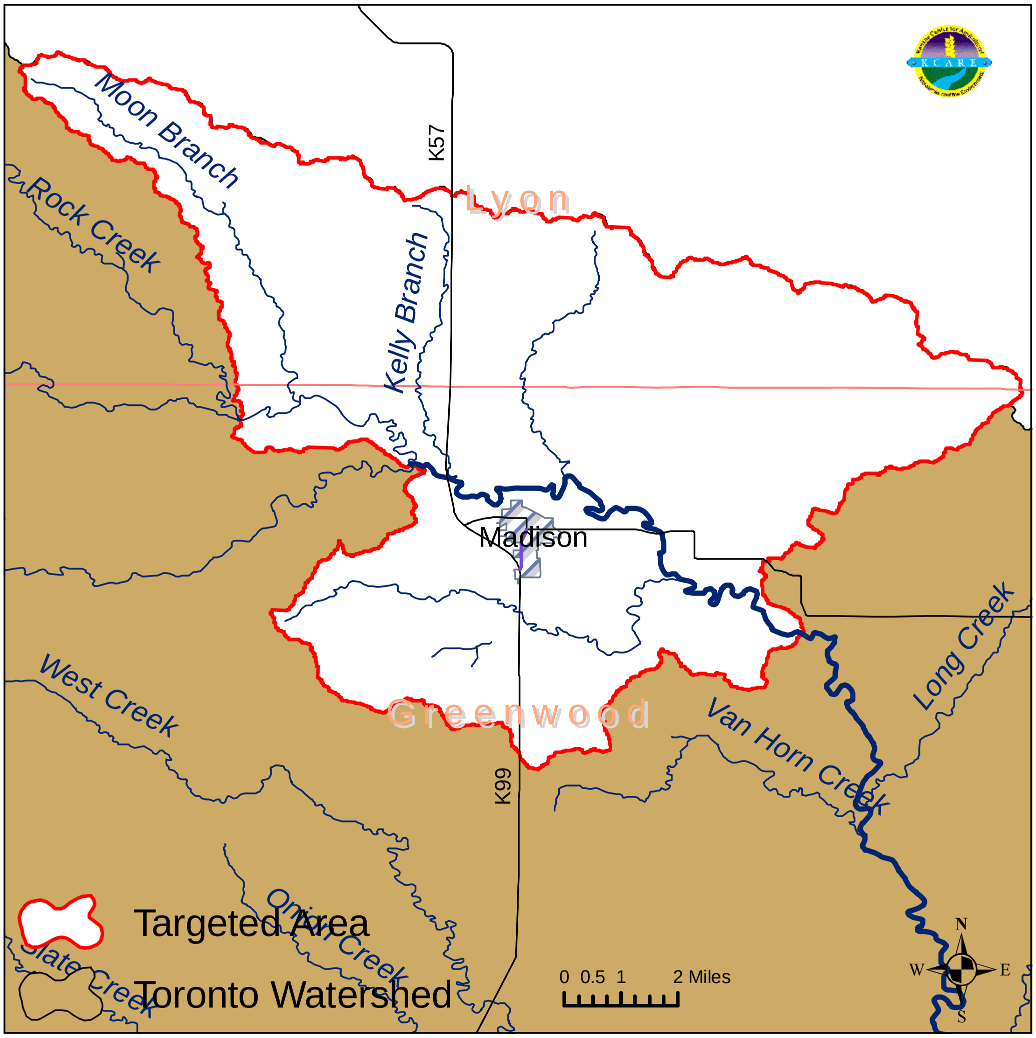



**Figure 19 Targeted Area for Cropland in the Watershed.**

**Table 15 Land Use in the Cropland Targeted Area.** [22]

| Land Use | Acres | Percent of Targeted Area |
|---|---|---|
| **Range-Grasses** | 30,450 | 64.64 |
| **Hay** | 7,686 | 16.32 |
| **Agricultural Land-Row Crops** | 3,136 | 6.66 |
| **Forest-Deciduous** | 2,542 | 5.40 |
| **Residential-Low Density** | 2,026 | 4.30 |
| **Water** | 493 | 1.05 |
| **Wetlands-Forested** | 409 | 0.87 |
| **Residential-Medium Density** | 285 | 0.60 |

| Land Use in the Cropland Targeted Area, Cont. | | |
|---|---|---|
| **Land Use** | Acres | Percent of Targeted Area |
| **Residential-High Density** | 38 | 0.08 |
| **Forest-Mixed** | 22 | 0.05 |
| **Range-Brush** | 9 | 0.02 |
| **Wetlands-Non-Forested** | 6 | 0.01 |
| **Industrial** | 2 | 0.00 |
| **Southwestern US (Arid) Range** | 1 | 0.00 |
| **Total** | **47,104** | **100.00** |

### *5.1.1.A Soil Erosion Caused by Wind and/or Water*

NRCS has established a "T factor" in evaluating soil erosion. T is the soil loss tolerance factor. It is defined as the maximum rate of annual soil loss that will permit crop productivity to be sustained economically and indefinitely on a given soil. It is assigned to soils without respect to land use or cover and ranges from 1 ton per acre for shallow soils to 5 tons per acre for deep soils that are not as affected by loss of productivity by erosion. T factor represents the goal for maximum annual soil loss in sustaining productivity of the land use. Erosion is considered to be greater than T if either the water (sheet and rill) or wind erosion rate exceeds the soil loss tolerance rate. [29]

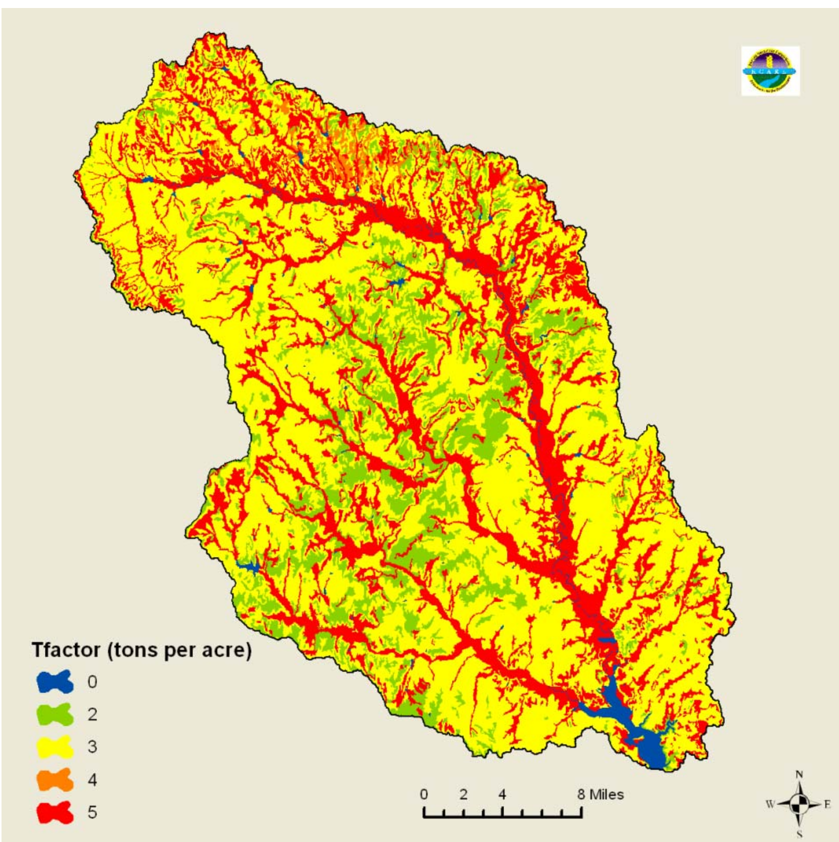



**Figure 20 T Factor in the Watershed.** [30]

*5.1.1.B Soil Erosion Influenced by Soil Type and Runoff Potential*

Soil type has an influence on runoff potential and erosion throughout the watershed. Soils are classified into four hydrologic soil groups (HSG). The soils within each of these groups have the same runoff potential after a rainfall event if the same conditions exist, such as plant cover or storm intensity. Soils are categorized into four groups: A, B, C and D. The cropland targeted area of the watershed is predominantly (55 percent) soil group C. This soil group has the second highest potential for runoff.

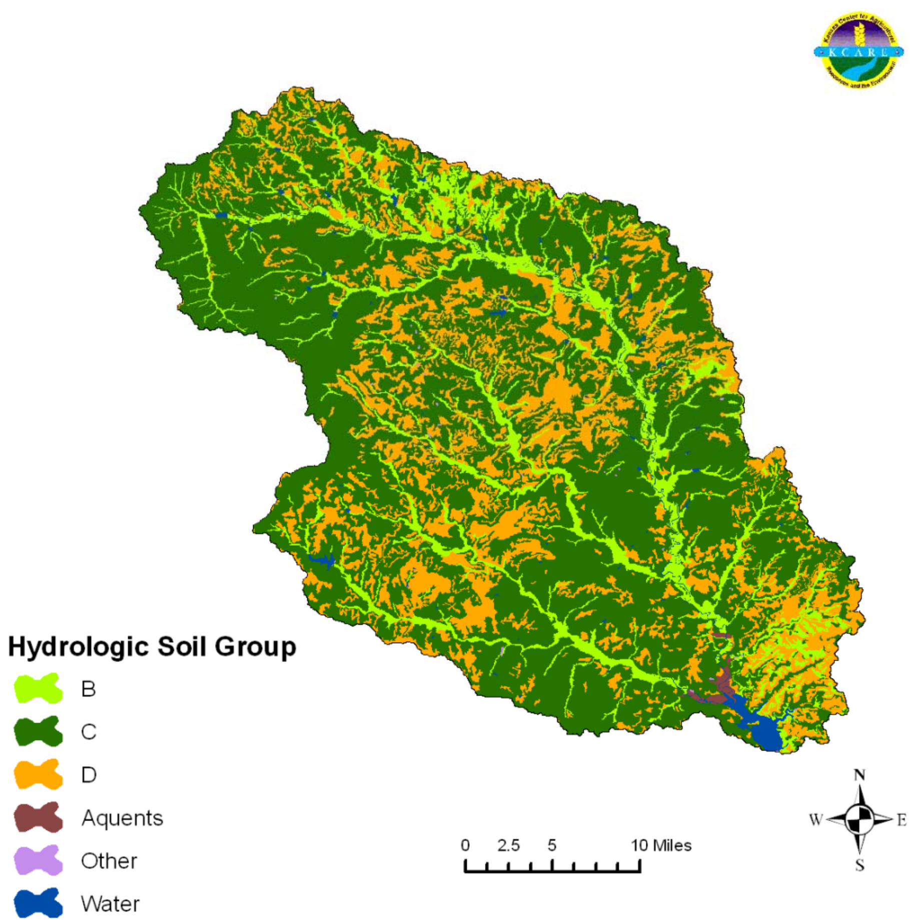



**Figure 21 Hydrologic Soil Groups of the Watershed.** [30]

**Table 16 Hydrologic Soil Groups of the Watershed.** [31]

| 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. | 0 | 0 |

| Hydrologic Soil Groups of the Watershed, Cont. | | | |
|---|---|---|---|
| **Hydrologic Soil Group** | **Definition** | **Acres of Watershed in HSG** | **Percentage of Watershed in HSG** |
| **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. | 55,495 | 12.1 |
| **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. | 288,446 | 62.9 |
| **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. | 107,663 | 23.5 |
| **Other** | Water, dams, pits, sewage lagoons | 6,791 | 1.5 |
| **Total** | | 459,530 | 100 |
| **Hydrologic Soil Group** | **Definition** | **Acres of Cropland Targeted Area in HSG** | **Percentage of Cropland Targeted Area in HSG** |
| **A** | See definition above. | 0 | 0 |
| **B** | See definition above. | 9,570 | 20.3 |
| **C** | See definition above. | 25,792 | 54.8 |
| **D** | See definition above. | 11,093 | 23.6 |
| **Other** | See definition above. | 562 | 1.2 |
| **Total** | | 47,048 | 100 |

### 5.1.2 Rangeland Erosion

Much of the rangeland erosion can be attributed to ephemeral gullies formed by livestock trails. The SLT would like to repair these gullies to prevent further degradation. In addition to gullies, brine scar sites that originated with oil wells are a source of erosion. Drilling for oil and gas production has occurred in the watershed since the early 1900s. Much of this was done before regulations were developed by the Kansas Corporation Commission (KCC) to minimize pollution resulting from salt water used/generated in the drilling process. Disposal of the salt brine on the landscape was a common activity before regulations mandated proper disposal techniques. Due to excessive salt levels, plants cannot grow and thrive in the brine scar areas, leaving it exposed to erosion and runoff. This past unregulated activity has resulted in an unknown number of acres of the landscape that has barren soil. Hundreds of oil and gas wells exist in the watershed today. They are regulated by KCC and follow strict guidelines in disposal of salf brine into injection wells, therefore, the new wells do not pose a surface water pollutant hazard.

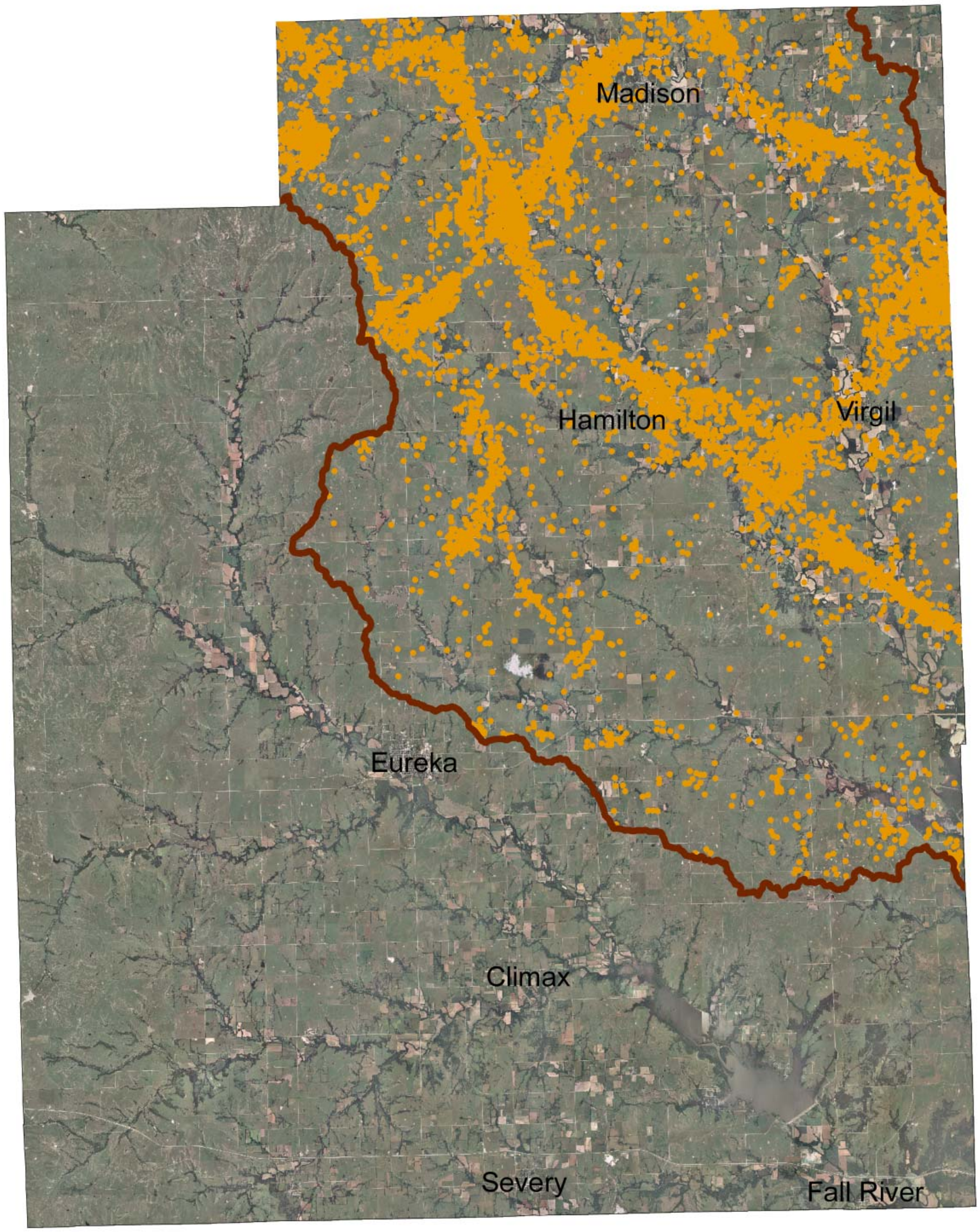



**Figure 22 All Well Points (Gas, Oil and Other Oil and Gas Related Wells) in the Toronto Watershed in Greenwood County**. [32] Each dot represents a well.

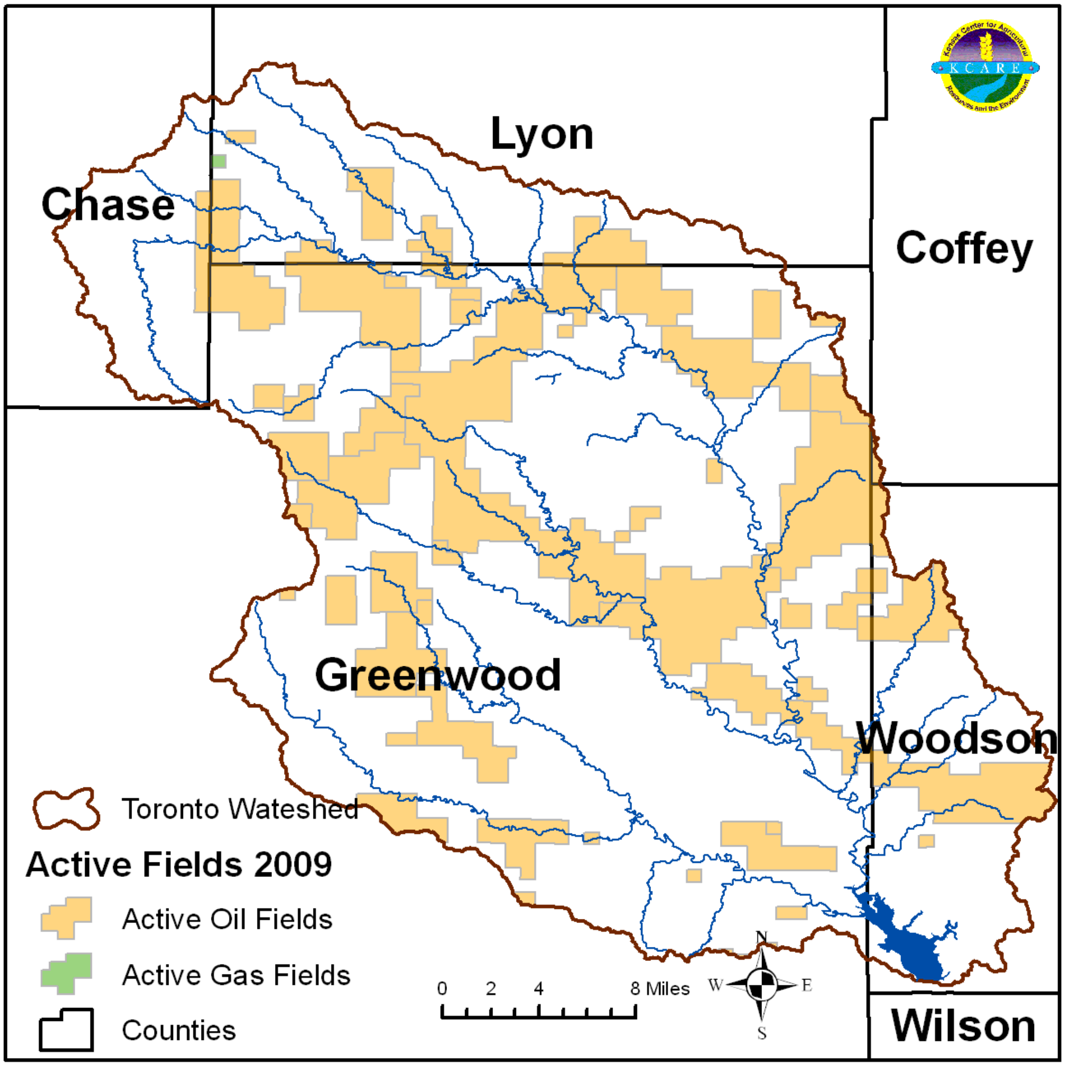



**Figure 23 Oil and Gas Fields in the Toronto Watershed.** [32]

The SLT is concerned about brine scars that exist in the watershed. These scars are nonvegetated areas that are susceptible to erosion and each individual scar will enlarge over time. Rehabilitation of these areas will require sloping and grading of the area, the addition of soil amendments and plantings of salt tolerant plants. A demonstration project has been conducted in the Fall River Watershed by the local WRAPS SLT which includes grading, addition of compost to the soil and salt tolerant plantings. The Toronto Watershed SLT would like to see the same projects installed in their watershed.

### 5.1.3 Streambank Erosion

Sediment can originate 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.

### *5.1.3.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 streambanks.

**Table 17 Riparian Land use in the Streambank Targeted Area for a 100 foot Buffer.** [23]

| Land Use | Acres | Percent |
|---|---|---|
| Pasture | 8,664 | 57.54 |
| Forest Land | 2,197 | 14.59 |
| Pasture/Tree Mix | 1,621 | 10.76 |
| Water | 948 | 6.30 |
| Crop Land | 820 | 5.44 |
| Crop/Tree Mix | 698 | 4.63 |
| Urban Land | 44 | 0.29 |
| Shrub/Shrub Land | 32 | 0.21 |
| Urban/Tree Mix | 29 | 0.19 |
| Barren Land | 7 | 0.05 |
| | 15,059 | 100.00 |

**KEY:**
**Pasture**- Areas adjacent to a stream in which 51 percent or more of the 100 foot buffer contains pastureland, native pasture, or range land.
**Forest Land -** Areas adjacent to a stream that contains trees with a canopy cover greater than 51 percent of the 100 foot buffer zone.
**Pasture/Tree Mix** - Grassland land use areas that contain a tree canopy cover of less than 50 percent of the 100 foot buffer zone.
**Water** - Areas adjacent to a stream where 51 percent of the 100 foot buffer contains water.
**Crop Land -** Areas adjacent to a stream where no trees area present and in which 51 percent of the 100 foot buffer is planted or was planted during the previous growing season for the production of adapted crops for harvest, including row crops, small-grain crops, legume, hay crops, nursery crops, and other specialty crops.
**Crop/Tree Mix** - Cropland landuse areas that contain a tree canopy cover of less than 50 percent of the 100 foot buffer zone.
**Urban Land -** Areas adjacent to a stream where 51 percent 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.
**Shrub/Scrub Land -** Areas adjacent to a stream that contain shrubs or brush/scrub vegetation with a canopy cover greater than 51 percent 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.
**Urban/Tree Mix -** Urban land use areas that contain a tree canopy cover of less than 50 percent of the 100 foot buffer zone.
**Barren Land** - Areas adjacent to a stream where 51 percent of the 100 foot buffer contains land without any discernible vegetative cover, including quarries, borrows pits, and dry ponds.

In the targeted area, the predominant land use in the riparian areas is pastureland at 57 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.

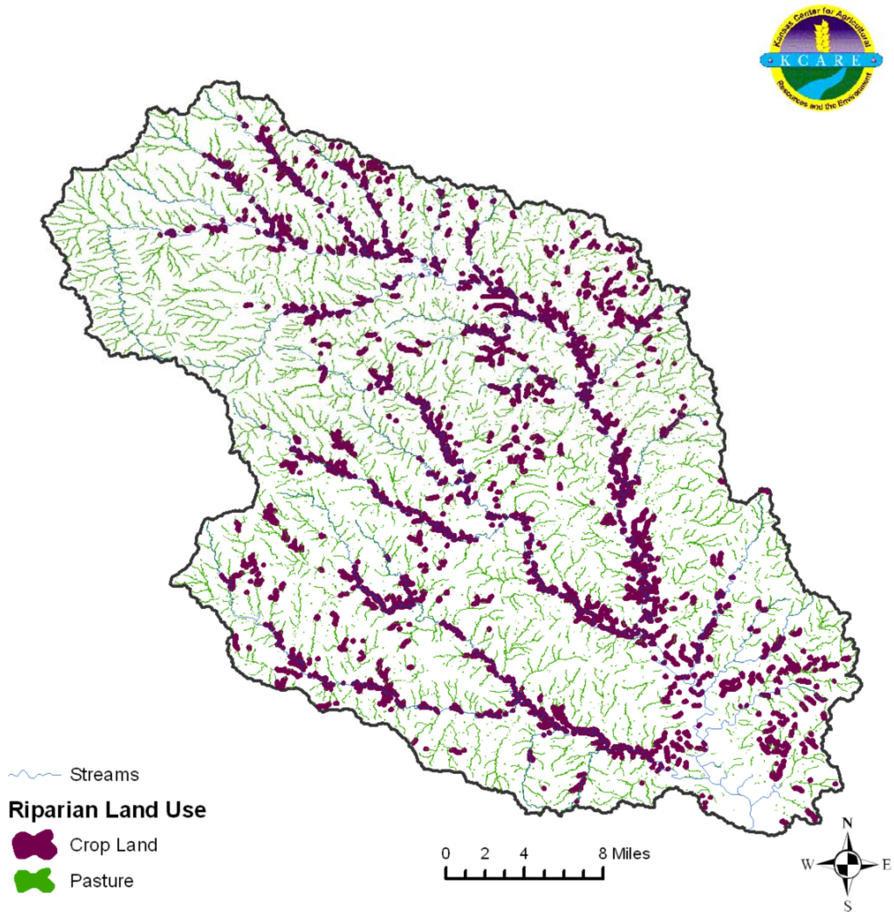



**Figure 24 Riparian Inventory of the Streambank Targeted Area**. [33] Only crop and pasture land are displayed on the map.

### *5.1.3.B Rainfall and Runoff*

Rainfall amounts and subsequent runoff can affect sediment delivery from agricultural areas and urban areas into streams and Toronto Reservoir. High rainfall events can cause cropland erosion, rangeland gully erosion and sloughing of streambanks. High intensity rainfall events usually occur in late spring and early summer.

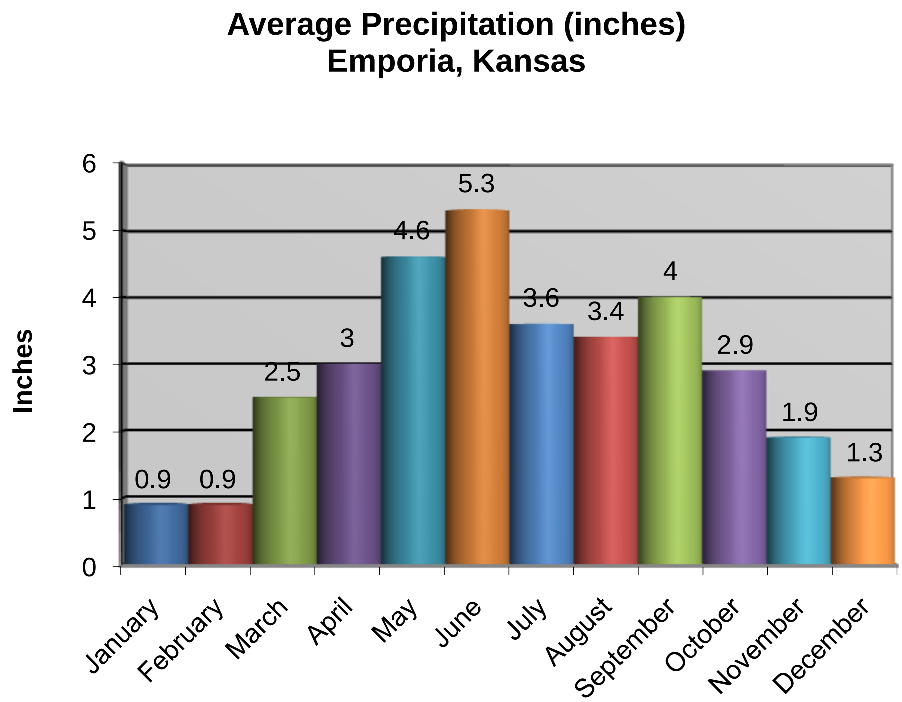
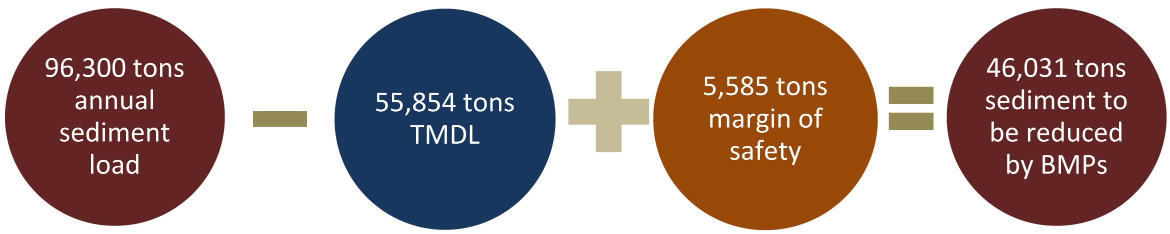



**Figure 25 Average precipitation by month.** [34] Emporia, Kansas.

### 5.1.4 Sediment Pollutant Loads and Load Reductions

The current estimated Total Suspended Solids load in the Toronto Watershed is **96,300** tons per year according to the TMDL section of KDHE. The TMDL for TSS (WLA + load allocations + margin of safety) equals 55,854 tons. **Taking the current loading less the TMDL plus the margin of safety leaves 46,031 tons** of sediment per year that needs to be reduced in order to meet the TMDL. 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 in the cropland, rangeland and streambank targeted areas.** Specific acreages or projects that need to be implemented per year have been determined through modeling and economic analysis and approved by the SLT as listed below.

**Table 18 BMPs in Support of the Management Practices to Reduce Sediment Contribution Aimed at Meeting the Sediment TMDL in Toronto Reservoir.**

| Protection Measures | Best Management Practices and Other Actions | Acres or Projects to be Implemented | | |
|---|---|---|---|---|
| | | Cropland Groundtruthing Determined by Adoption Rates | | |
| 1.0 Prevention of sediment contribution from **cropland** | 1.1 Establish riparian buffers along waterways | Current adoption rate = 30% | Adoption rate goal = 50% | 125 acres per year |
| | 1.2 Encourage no-till cultivation practice | Current adoption rate = 20% | Adoption rate goal = 50% | 94 acres per year |
| | 1.3 Establish terraces | Current adoption rate = 70% | Adoption rate goal = 80% | 31 acres per year |
| | 1.4 Establish conservation rotation | Current adoption rate = 95% | Adoption rate goal = 100% | 16 acres per year |
| | 1.5 Establish grassed waterways in crop fields | Current adoption rate = 10% | Adoption rate goal = 20% | 31 acres per year |
| 2.0 Prevention of sediment contribution from **rangeland** | 2.1 Repair ephemeral gullies | 2 sites per year | | |
| | 2.2 Repair brine scar sites | 1 site per year | | |

| BMPs to Reduce Sediment, Cont. | | |
|---|---|---|
| **Protection Measures** | **Best Management Practices and Other Actions** | **Acres or Projects to be Implemented** |
| 3. Prevention of sediment contribution from **streambank** erosion | 3.1 Repair streambanks | 1,000 feet of streambank per year |

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

**Table 19 Estimated Sediment Load Reductions for Implemented BMPs on Cropland Aimed at Meeting the Sediment TMDL in Toronto Reservoir.**

| Annual Soil Erosion Reduction (tons per year), Cropland BMPs | | | | | | |
|---|---|---|---|---|---|---|
| Year | Buffer | No-Till | Terraces | Conservation Crop Rotation | Waterways | Total Load Reduction |
| 1 | 59 | 66 | 9 | 4 | 12 | 149 |
| 2 | 118 | 132 | 18 | 7 | 24 | 299 |
| 3 | 176 | 199 | 26 | 11 | 35 | 448 |
| 4 | 235 | 265 | 35 | 15 | 47 | 597 |
| 5 | 294 | 331 | 44 | 19 | 59 | 747 |
| 6 | 353 | 397 | 53 | 22 | 71 | 896 |
| 7 | 412 | 463 | 62 | 26 | 83 | 1,045 |
| 8 | 470 | 530 | 70 | 30 | 94 | 1,194 |
| 9 | 529 | 596 | 79 | 33 | 106 | 1,344 |
| 10 | 588 | 662 | 88 | 37 | 118 | 1,493 |
| 11 | 647 | 728 | 97 | 37 | 130 | 1,639 |
| 12 | 706 | 794 | 106 | 37 | 142 | 1,784 |
| 13 | 764 | 861 | 114 | 37 | 153 | 1,930 |
| 14 | 823 | 927 | 123 | 37 | 165 | 2,075 |
| 15 | 882 | 993 | 132 | 37 | 177 | 2,221 |
| 16 | 941 | 1,059 | 141 | 37 | 189 | 2,367 |
| 17 | 1,000 | 1,125 | 150 | 37 | 201 | 2,512 |
| 18 | 1,058 | 1,192 | 158 | 37 | 212 | 2,658 |
| 19 | 1,117 | 1,258 | 167 | 37 | 224 | 2,803 |
| 20 | 1,176 | 1,324 | 176 | 37 | 236 | 2,949 |
| 21 | 1,176 | 1,324 | 176 | 37 | 236 | 2,949 |
| 22 | 1,176 | 1,324 | 176 | 37 | 236 | 2,949 |
| 23 | 1,176 | 1,324 | 176 | 37 | 236 | 2,949 |
| 24 | 1,176 | 1,324 | 176 | 37 | 236 | 2,949 |
| 25 | 1,176 | 1,324 | 176 | 37 | 236 | 2,949 |

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

**Table 20 Estimated Sediment Load Reductions for Implemented BMPs on Rangeland Aimed at Meeting the Sediment TMDL in Toronto Reservoir.**

| Annual Rangeland BMP Erosion Reduction (tons per year) | | | |
|---|---|---|---|
| Year | Repair Grazing Land Gullies | Brine Site Repair | Total |
| 1 | 200 | 50 | **250** |
| 2 | 400 | 100 | **500** |
| 3 | 600 | 150 | **750** |
| 4 | 800 | 200 | **1,000** |
| 5 | 1,000 | 250 | **1,250** |
| 6 | 1,200 | 300 | **1,500** |
| 7 | 1,400 | 350 | **1,750** |
| 8 | 1,600 | 400 | **2,000** |
| 9 | 1,800 | 450 | **2,250** |
| 10 | 2,000 | 500 | **2,500** |
| 11 | 2,200 | 550 | **2,750** |
| 12 | 2,400 | 600 | **3,000** |
| 13 | 2,600 | 650 | **3,250** |
| 14 | 2,800 | 700 | **3,500** |
| 15 | 3,000 | 750 | **3,750** |
| 16 | 3,200 | 800 | **4,000** |
| 17 | 3,400 | 850 | **4,250** |
| 18 | 3,600 | 900 | **4,500** |
| 19 | 3,800 | 950 | **4,750** |
| 20 | 4,000 | 1,000 | **5,000** |
| 21 | 4,000 | 1,000 | **5,000** |
| 22 | 4,000 | 1,000 | **5,000** |
| 23 | 4,000 | 1,000 | **5,000** |
| 24 | 4,000 | 1,000 | **5,000** |
| 25 | 4,000 | 1,000 | **5,000** |

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

**Table 21 Sediment Load Reductions for Implemented Streambank BMPs Aimed at Meeting the Sediment TMDL in Toronto Reservoir.**

| Year | Streambank* Reduction (tons per year) |
|---|---|
| 1 | 2,000 |

| Sediment Load Reductions for Streambank BMPs, Cont. | |
|---|---|
| **Year** | **Streambank* Reduction (tons per year)** |
| 2 | 4,000 |
| 3 | 6,000 |
| 4 | 8,000 |
| 5 | 10,000 |
| 6 | 12,000 |
| 7 | 14,000 |
| 8 | 16,000 |
| 9 | 18,000 |
| 10 | 20,000 |
| 11 | 22,000 |
| 12 | 24,000 |
| 13 | 26,000 |
| 14 | 28,000 |
| 15 | 30,000 |
| 16 | 32,000 |
| 17 | 34,000 |
| 18 | 36,000 |
| 19 | 38,000 |
| 20 | 40,000 |
| 21 | 40,000 |
| 22 | 40,000 |
| 23 | 40,000 |
| 24 | 40,000 |
| 25 | 40,000 |

**Sediment Load Reductions for Streambank BMPs, Cont.**

**Assume 2 tons per year per linear foot of degraded streambank, repair 1,000 feet/year for 20 years.*

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

**Table 22 Combined Cropland, Rangeland and Streambank Sediment Reductions Aimed at Meeting the Sediment TMDL in Toronto Reservoir in Twenty Years.**

| Combination of Cropland, Range and Streambank* BMPs to Meet the Toronto Sediment TMDL | | | | | |
|---|---|---|---|---|---|
| **Year** | **Cropland Reduction (tons/yr)** | **Rangeland Reduction (tons/yr)** | **Streambank* Reduction (tons/yr)** | **Total Reduction (tons/yr)** | **Percent of TMDL** |
| 1 | 149 | 250 | 2,000 | 2,399 | 5.2% |
| 2 | 299 | 500 | 4,000 | 4,799 | 10.4% |
| 3 | 448 | 750 | 6,000 | 7,198 | 15.6% |
| 4 | 597 | 1,000 | 8,000 | 9,597 | 20.8% |
| 5 | 747 | 1,250 | 10,000 | 11,997 | 26.1% |
| 6 | 896 | 1,500 | 12,000 | 14,396 | 31.3% |
| 7 | 1,045 | 1,750 | 14,000 | 16,795 | 36.5% |
| 8 | 1,194 | 2,000 | 16,000 | 19,194 | 41.7% |
| 9 | 1,344 | 2,250 | 18,000 | 21,594 | 46.9% |
| 10 | 1,493 | 2,500 | 20,000 | 23,993 | 52.1% |
| 11 | 1,639 | 2,750 | 22,000 | 26,389 | 57.3% |
| 12 | 1,784 | 3,000 | 24,000 | 28,784 | 62.5% |
| 13 | 1,930 | 3,250 | 26,000 | 31,180 | 67.7% |
| 14 | 2,075 | 3,500 | 28,000 | 33,575 | 72.9% |
| 15 | 2,221 | 3,750 | 30,000 | 35,971 | 78.1% |
| 16 | 2,367 | 4,000 | 32,000 | 38,367 | 83.3% |
| 17 | 2,512 | 4,250 | 34,000 | 40,762 | 88.6% |
| 18 | 2,658 | 4,500 | 36,000 | 43,158 | 93.8% |
| 19 | 2,803 | 4,750 | 38,000 | 45,553 | 99.0% |
| 20 | 2,949 | 5,000 | 40,000 | 47,949 | 104.2% |
| 21 | 2,949 | 5,000 | 40,000 | 47,949 | 104.2% |
| 22 | 2,949 | 5,000 | 40,000 | 47,949 | 104.2% |
| 23 | 2,949 | 5,000 | 40,000 | 47,949 | 104.2% |
| 24 | 2,949 | 5,000 | 40,000 | 47,949 | 104.2% |
| 25 | 2,949 | 5,000 | 40,000 | 47,949 | 104.2% |

Sed-
iment
TMDL
has
been
met.

***Toronto Sediment TMDL: 44,940 Tons Reduced per Year.***

**Table 23  Annual Sediment Load Reduction by Category Aimed at Meeting the Sediment TMDL in Toronto Reservoir.**

| Achieving the Sediment TMDL | | | |
|---|---|---|---|
| **Best Management Practice Category** | **Installation Quantity** | **Total Annual Load Reduction (tons)** | **Percent of Sediment TMDL** |
| Cropland (acres) | 5,802 | 2,949 | 6.4% |
| Rangeland (practices) | 30 | 5,000 | 10.9% |
| Streambank (feet) | 20,000 | 40,000 | 86.9% |
| | **Total** | **47,949** | **104.2%** |
| | | | |
| | | *Reduction to meet sediment TMDL (tons)* | *46,031* |

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

## 5.2 Livestock Related Pollutants

Livestock can cause certain pollutants in the water. E. coli bacteria is 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. ***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 can easily transport nitrogen and phosphorus downstream. However, for this WRAPS process, targeting will be for livestock.***

### 5.2.1 E. coli Bacteria

The Verdigris River near Virgil is listed on the 303d list **E. coli bacteria**. Fecal coliform bacteria (FCB) are a broad spectrum of bacteria species which includes E. coli bacteria. Since FCB is present in the digestive tract of all warm blooded animals including humans and animals (domestic and wild), its presence in water indicates that the water has been in contact with human or animal waste. FCB is not itself harmful to humans, but its presence indicates that disease causing organisms, or pathogens, may also be present. A few of these are Giardia, Hepatitis, and Cryptosporidium. In the past, KDHE has measured FCB in determination of issuance of a TMDL. Currently, however, KDHE is transitioning to the use of E. coli bacteria as it is a more reliable indicator of human health risk. Consequently, the new methodology for assessing E. coli bacteria levels in waterbodies requires the average of five samples taken over a month's time to exceed the criteria level. This is much more stringent than the former FCB methodology which required a single exceedance to indicate impairment. Presence of E. coli in waterways can originate from failing septic systems, runoff from livestock production areas, close proximity of any mammals to water sources, and manure application to agricultural fields.

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

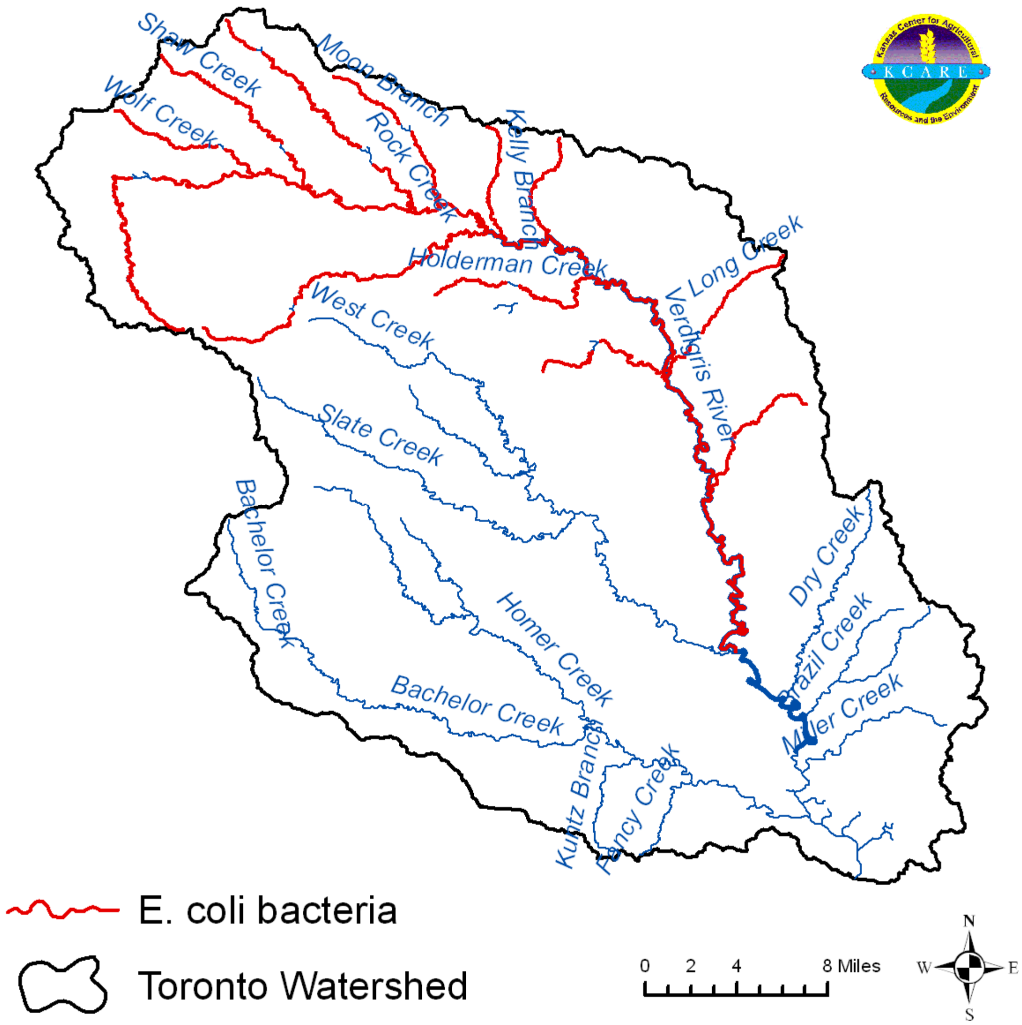



**Figure 26 E. Coli Bacteria on the 303d List in the Watershed.** Error! Bookmark not defined.

### *5.2.1.A. 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.

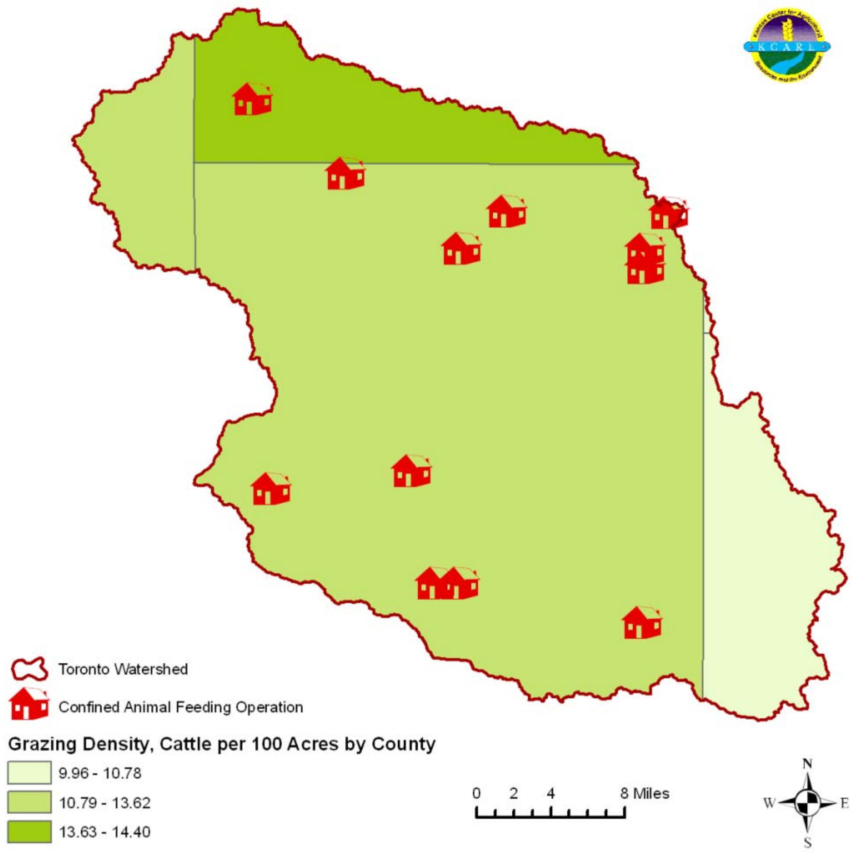



**Figure 27 Confined Animal Feeding Operations and Grazing Density in the Watershed.**[35]

### *5.2.1.B 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. The primary land uses in the range and livestock targeted areas are grasslands (72 percent) and pasture (14 percent).


**Figure 28 Land Cover in the Watershed, 2005** [36]

**Table 24 Land Use in the Range and Livestock Targeted Area.** [22]

| LANDUSE: | Area[acres] | Percent Subbasin Area |
|---|---|---|
| Grassland/Herbaceous | 59,318 | 72.74 |
| Pasture/Hay | 11,780 | 14.45 |
| Deciduous Forest | 3,458 | 4.24 |
| Developed - Open Space | 3,199 | 3.92 |
| Cultivated Crops | 2,626 | 3.22 |
| Water | 611 | 0.75 |
| Developed - Low Intensity | 365 | 0.45 |
| Mixed Forest | 78 | 0.10 |
| Woody Wetlands | 52 | 0.06 |
| Shrub/Scrub | 16 | 0.02 |
| Herbaceous Wetlands | 17 | 0.02 |
| Developed - Medium Intensity | 11 | 0.01 |
| Barren Land | 12 | 0.01 |
| **Total** | **81,544** | **100.00** |

### *5.2.1.C Population and Wastewater Systems*

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

**Table 25 Population in the Watershed.** [37]

| County | Population | Persons per square mile |
|---|---|---|
| Chase | 2,804 | 3.9 |
| Greenwood | 6,861 | 6.7 |
| Lyon | 9,374 | 11.1 |
| Woodson | 3,285 | 7.6 |
| | **Total: 22,324** | **Average: 7.3** |

Most of the watershed would be considered low population. The Kansas average for persons per square mile is 32.9, whereas, the average for the watershed is 7.3.

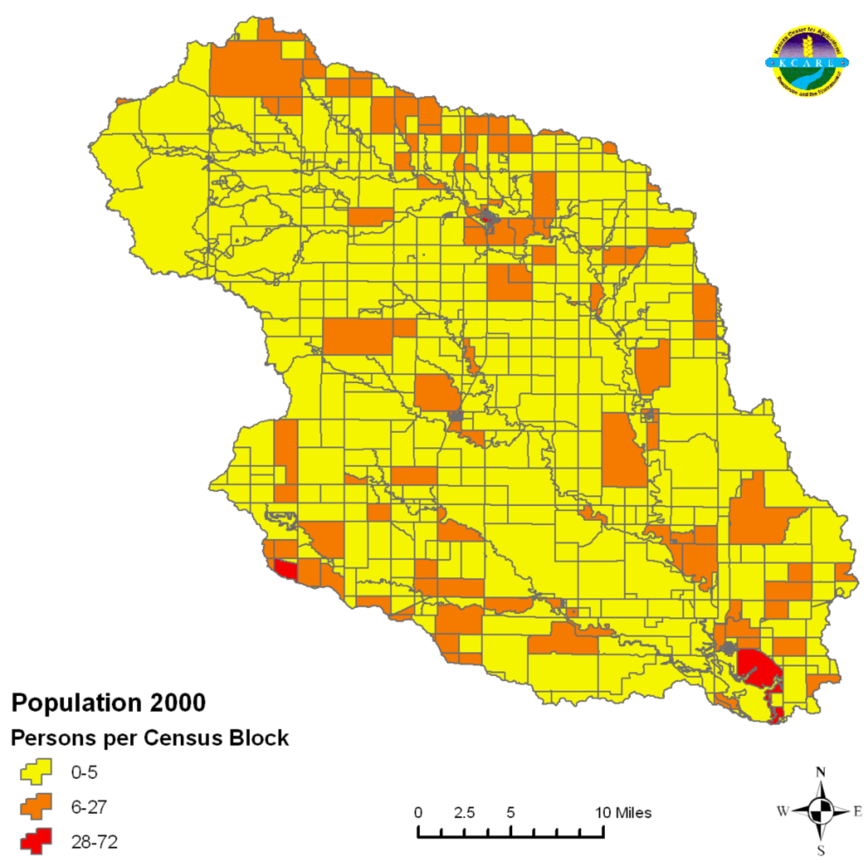



**Figure 29 Census Count, 2000.** [38]

### 5.2.1.D Rainfall and Runoff

Rainfall amounts and subsequent runoff along with flooding outside the stream channel can affect FCB concentrations in rivers and Toronto Reservoir. Manure in streams can originate from livestock that are allowed access to wade or loaf directly in the stream. Manure from cropland can originate from fields where the manure that has been applied either before a rainfall event or on frozen ground. Manure and livestock management is important in preventing FCB or phosphorus runoff from the targeted area.

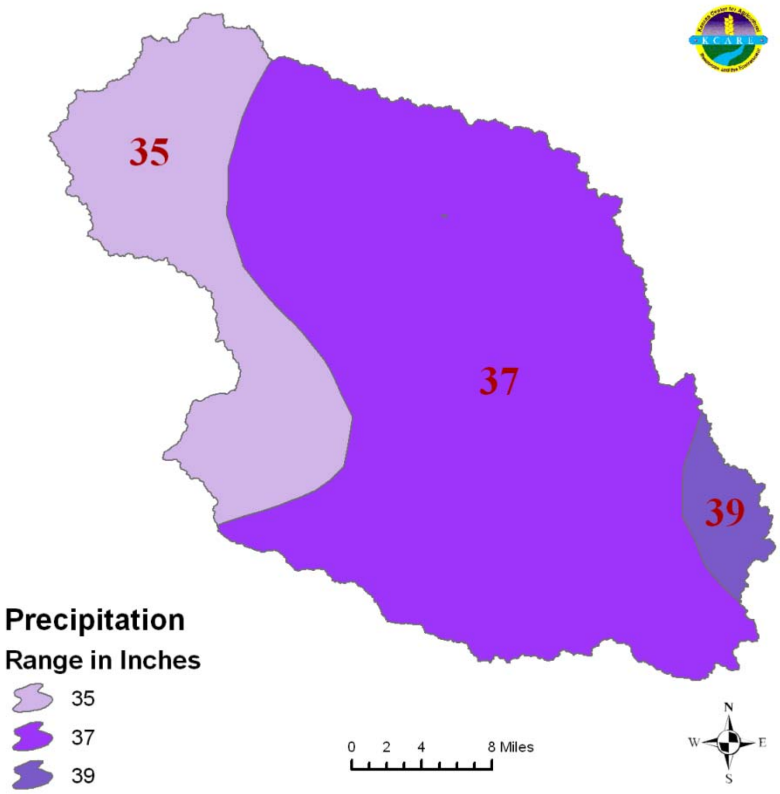



**Figure 30 Average Yearly Precipitation in the Watershed.** [39]

### 5.2.1.E Pollutant Load and Load Reductions

The current pollutant load for E. coli bacteria cannot be estimated. E. coli concentrations are difficult to model. The scope of this WRAPS project does not include modeling for E. coli bacteria. Environmental factors affect the viability of the bacteria since it is a living organism. The fate of E. coli is affected by variations in initial bacteria loading, ambient temperature, amount of sunlight or UV rays, and a decrease in survivability over time are all factors that affect the viability of FCB. All FCB BMPs are grouped with phosphorus targeted BMPs. The BMPs delineated by the SLT for phosphorus, discussed in the next section, will reduce FCB simultaneously.

### 5.2.2 Nutrients

Walnut Creek (and its tributary Homer Creek) and West Creek have TMDLs for low **dissolved oxygen.** Dissolved oxygen is related to other pollutant issues: eutrophication, biological oxygen demand, excessive aquatic plants and pH. The Verdigris River, Toronto Reservoir and Eureka Lake are listed on the 303d listing (refer to Section 3.7) for nutrient problems. [40]

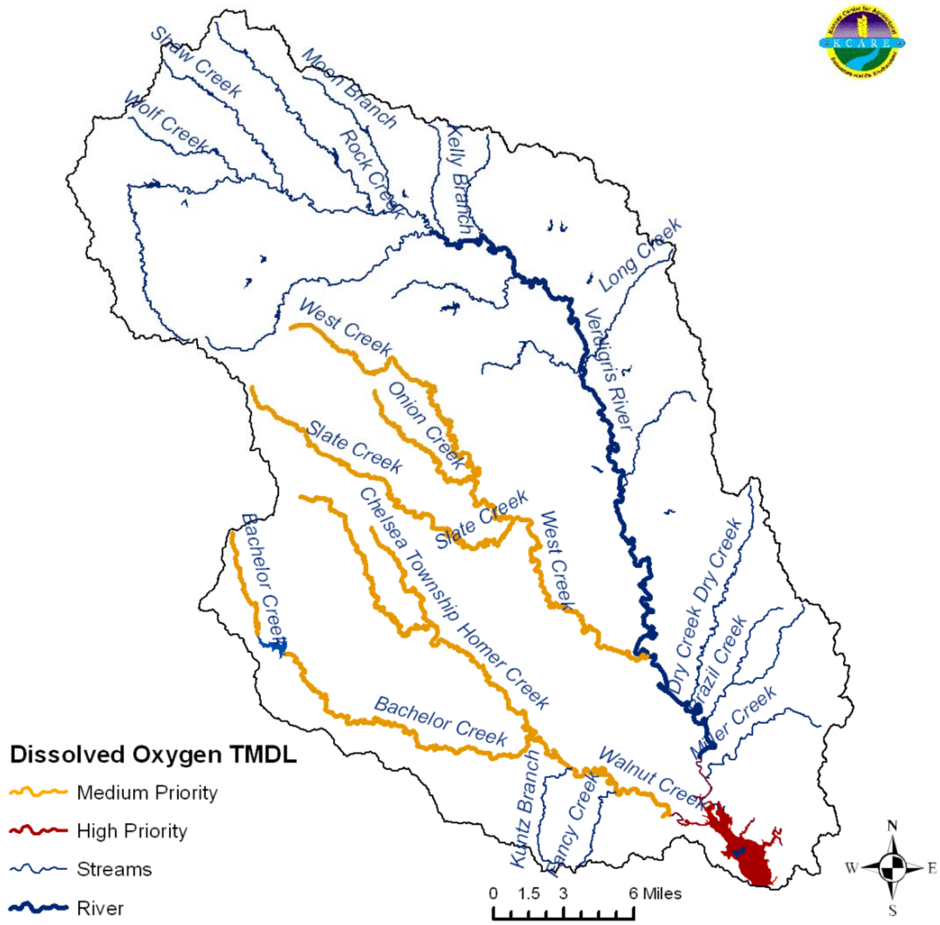



**Figure 31 Dissolved Oxygen TMDLs in the Watershed, 2006.** [41]

**Eutrophication** is a natural process that occurs when a water body receives excess nutrients. These excess nutrients, primarily nitrogen and phosphorus, create optimum conditions that are favorable for algal blooms and plant growth. Toronto Reservoir and Eureka Lake have TMDLs for eutrophication. Proliferation of algae and subsequent decomposition depletes available **dissolved oxygen** in the water profile. This lack of oxygen is devastating for aquatic species and can lead to fish kills. West Creek and Walnut Creek have TMDLs for low dissolved oxygen. Toronto Reservoir has a TMDL for low dissolved oxygen. Desirable criteria for a healthy water profile include dissolved oxygen rates greater than 5 milligrams per liter and biological oxygen demand (BOD) less than 3.5 milligrams per liter. BOD is a measure of the amount of oxygen removed in water while stabilizing biodegradable organic matter. It can be used to indicate organic pollution levels. Excess nutrients can originate from failing septic systems and manure and fertilizer runoff in rural and urban areas. [40]

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

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

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

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

#### *5.2.2.A Land Uses*

Land use activities have a significant impact on the types and quantity of nutrient runoff in the watershed. Agricultural cropland in the watershed lies along and adjacent to the river and tributaries. If this cropland is under conventional tillage practices and/or lacks maintenance of agricultural BMP structures, there can be an increase in runoff which will carry nitrogen and phosphorus into streams and lakes. Cropland in the Toronto Watershed consists of 3.9 percent of the land use.

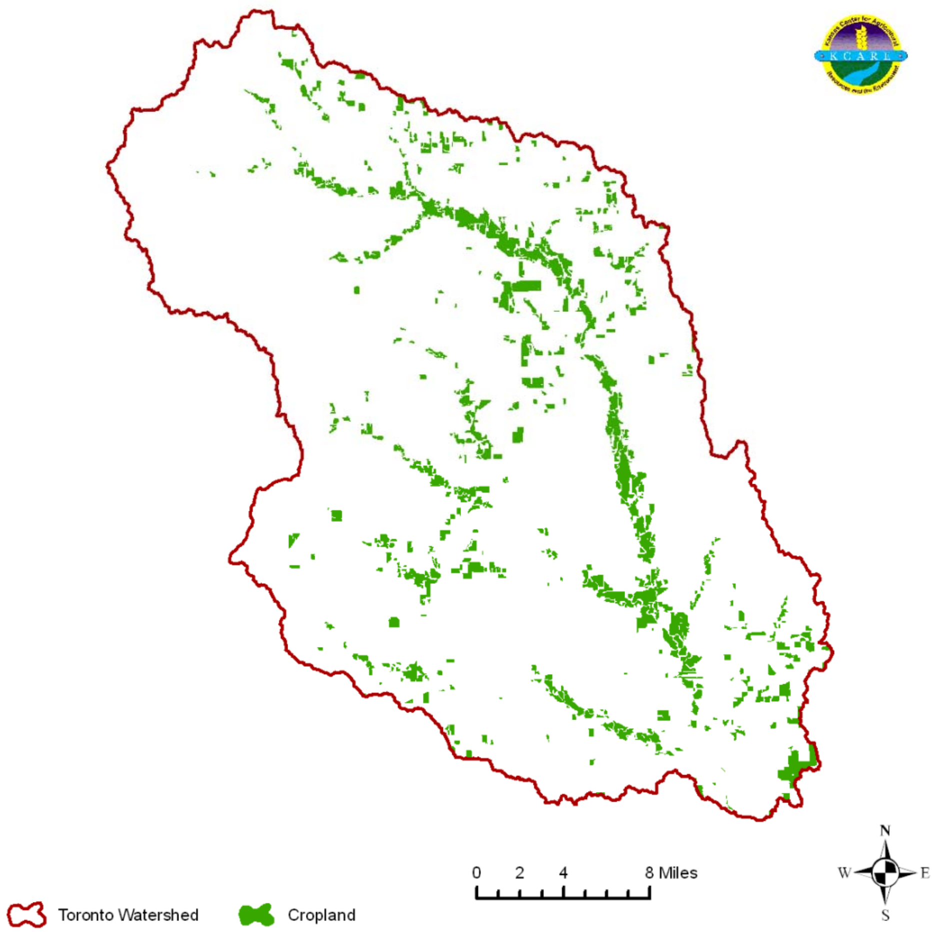



**Figure 32 Cropland in the Watershed, 2005.** [42]

Cropland in the watershed consists of mainly sorghum for grain, soybeans, wheat and corn.

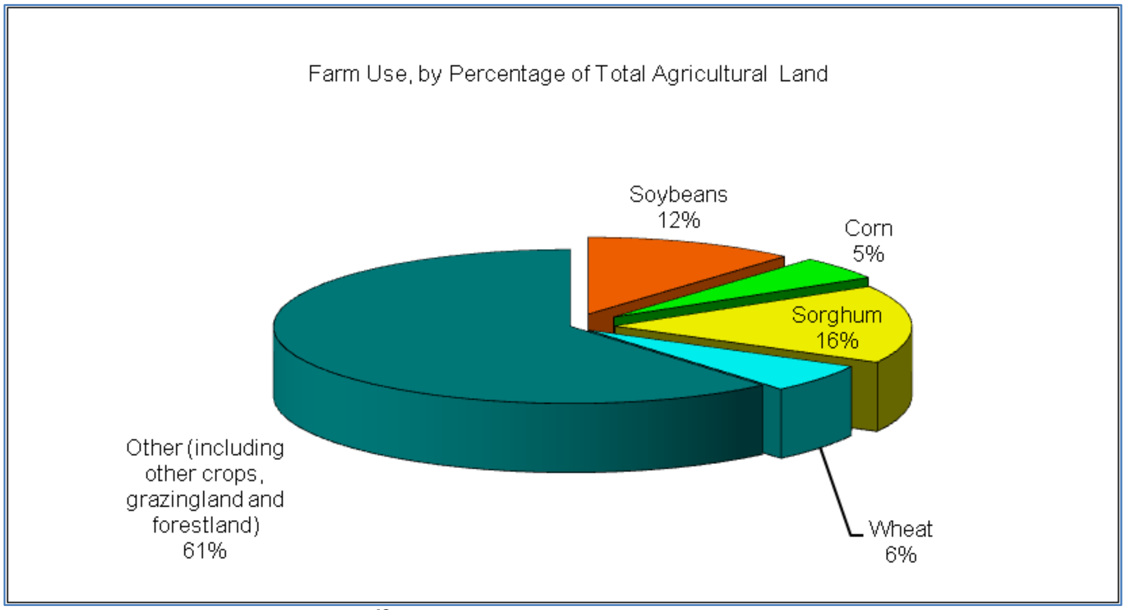



**Figure 33 Farm Crop Usage** [43]

### *5.2.2.B Population and Onsite Wastewater Facilities*

Population has an effect on the number of onsite wastewater system failures. Older systems or systems that are not functioning properly can leak nitrogen and phosphorus into surface water or ground water. Best guess is that ten percent of all wastewater systems are either failing or inadequate. Therefore, tracking population is important when considering remediation measures for nutrient loading. The watershed has seen a decrease in population in the counties that it occupies. Population in the counties of the watershed (excluding the city of Emporia which is not included in the watershed) is 22,324 (according to the US Census Bureau, population estimate 2008). This represents a 10.5 percent decrease in population across the watershed from 2000 to 2008. Additionally, population density is much lower than the statewide average of 32.9 persons per square mile. The population density of the counties of the watershed (excluding Emporia) is 7.3 persons per square mile. Refer to Section 5.2.1.C.

### *5.2.2.C Grazing Density and Confined Animal Feeding Operations*

Grasslands consist of approximately 85 percent of the watershed. This area is a highly productive forage source for beef cattle. Grazing density will affect grass cover and potential manure runoff. In Kansas, animal feeding operations (AFOs) with greater than 300 animal units must register with KDHE. Confined animal feeding operations (CAFOs), those with more than 999 animal units, must be permitted with EPA. An animal unit or AU is an equal standard for all animals based on size and manure production. For example: 1 AU=one animal weighing 1,000 pounds. The watershed contains numerous CAFOs. (This data is derived from KDHE, 2003. It may be dated and subject to change). Number of and location of CAFOs is important in nutrient reduction because of the manure that is generated and must be disposed of by the CAFOs. Most farmers haul manure to cropland and incorporate it to be used as fertilizer for the crops. However, due to hauling costs, fields close to the feedlot tend to receive more manure over the course of time than fields that are at a more distant location. These close fields will have a higher concentration of soil phosphorus and therefore, a higher incidence of runoff potential as phosphorus can be attached to the soil particles. Prevention of erosion is a part of reduction of phosphorus in surface water. Refer to Section 5.2.1.A.

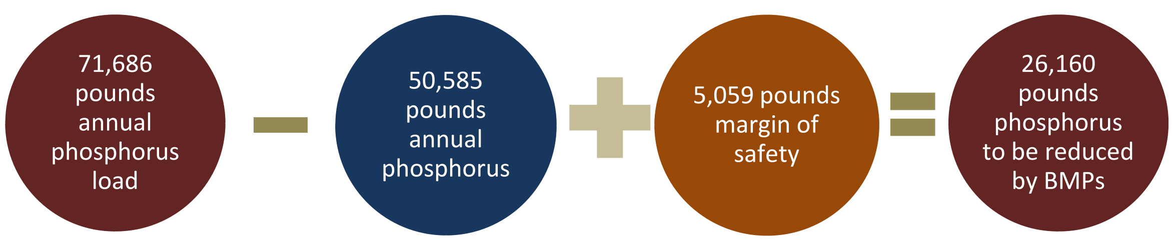
#### *5.2.2.D Rainfall and Runoff*

Rainfall amounts and subsequent runoff can affect nutrient runoff from agricultural areas and urban areas into streams and lakes. Manure runoff from livestock that are allowed access to stream or manure applied before a rainfall or on frozen ground is affected by the amount and timing of rainfall events. Refer to Section 5.2.1.D.

### 5.2.3 Pollutant Loads and Load Reductions

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

The current estimated phosphorus load in the Toronto Watershed s **71,686 pounds** per year according to the TMDL section of KDHE. **Taking the current loading less the TMDL plus the margin of safety leaves 26,160 pounds** of phosphorus per year that needs to be reduced in order to meet the TMDL. This is the amount of phosphorus reduction that will have to be met by implemented BMPs in the watershed.




The current estimated nitrogen load in the Toronto Watershed s **691,437 pounds** per year according to the TMDL section of KDHE. **Taking the current loading less the TMDL plus the margin of safety leaves 250,032 pounds** of nitrogen per year that needs to be reduced in order to meet the TMDL. This is the amount of nitrogen reduction that will have to be met by implemented BMPs in the watershed.

691,437 pounds annual nitrogen load − 490,450 pounds TMDL + 49,045 pounds margin of safety = 250,032 pounds nitrogen to be reduced with BMPs

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

**Table 26 BMPs in Support of the Management Practices Aimed at Meeting the Eutrophication TMDL in Toronto Reservoir and Dissolved Oxygen TMDL in Toronto Reservoir, Homer Creek and West Creek.**

| Protection Measures | Best Management Practices and Other Actions | Number of Acres or Projects to be Installed | | |
|---|---|---|---|---|
| 1.0 Prevention of phosphorus contribution from **livestock** sources | 1.1 Establish filter strips along waterways | 1 site every other year | | |
| | 1.2 Ponds | 2 sites every 3 years | | |
| | 1.3 Relocate pasture feeding sites | 1 site every 3 years | | |
| | 1.4 Provide off-stream watering systems | 1 site every year | | |
| | 1.5 Rotational grazing | 1 site every 3 years | | |
| | | **Cropland Groundtruthing Determined by Adoption Rates** | | |
| 2.0 Prevention of phosphorus contribution from **cropland** | 2.1 Establish riparian buffers along waterways | Current adoption rate = 30% | Current adoption rate = 50% | 125 acres per year |
| | 2.2 Encourage no-till cultivation practice | Current adoption rate = 20% | Current adoption rate = 50% | 94 acres per year |
| | 2.3 Establish terraces | Current adoption rate = 70% | Current adoption rate = 80% | 31 acres per year |
| | 2.4 Establish conservation rotation | Current adoption rate = 95% | Current adoption rate = 100% | 16 acres per year |
| | 2.5 Establish grassed waterways in crop fields | Current adoption rate = 10% | Current adoption rate = 20% | 31 acres per year |

| BMPs Aimed at Nutrient Reduction, Cont. | | |
|---|---|---|
| **Protection Measures** | **Best Management Practices and Other Actions** | **Number of Acres or Projects to be Installed** |
| 3.0 Prevention of phosphorus contribution from **streambank** erosion | 3.1 Repair streambank | Repair 1,000 feet of streambank per year |
| 4.0 Prevention of phosphorus contribution from **rangeland** | 4.1 Repair ephemeral gullies | 2 sites per year |
| | 4.2 Repair brine scar sites | 1 site per year |

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

**Table 27 Estimated Load Reductions for Implemented Livestock BMPs Aimed at Meeting the Eutrophication TMDL in Toronto Reservoir and Dissolved Oxygen TMDL in Toronto Reservoir, Homer Creek and West Creek.**

| Annual Phosphorous Load Reductions (lbs) | | | | | | |
|---|---|---|---|---|---|---|
| **Year** | **Vegetative Filter Strip** | **Pond** | **Relocate Pasture Feeding Site** | **Off Stream Watering System** | **Rotational Grazing** | **Annual Load Reduction** |
| 1 | | 76 | | 76 | | 152 |
| 2 | 638 | 152 | 76 | 153 | 76 | 1,096 |
| 3 | 638 | 152 | 76 | 229 | 76 | 1,172 |
| 4 | 1,276 | 228 | 153 | 306 | 153 | 2,115 |
| 5 | 1,276 | 304 | 153 | 382 | 153 | 2,268 |
| 6 | 1,914 | 380 | 229 | 459 | 229 | 3,211 |
| 7 | 1,914 | 380 | 229 | 535 | 229 | 3,287 |
| 8 | 2,552 | 456 | 306 | 611 | 306 | 4,230 |
| 9 | 2,552 | 532 | 306 | 688 | 306 | 4,383 |
| 10 | 3,189 | 532 | 382 | 764 | 382 | 5,250 |
| 11 | 3,189 | 608 | 382 | 841 | 382 | 5,403 |
| 12 | 3,827 | 684 | 459 | 917 | 459 | 6,346 |
| 13 | 3,827 | 684 | 459 | 994 | 459 | 6,422 |
| 14 | 4,465 | 760 | 535 | 1,070 | 535 | 7,365 |
| 15 | 4,465 | 836 | 535 | 1,147 | 535 | 7,518 |
| 16 | 5,103 | 836 | 611 | 1,223 | 611 | 8,385 |
| 17 | 5,103 | 912 | 611 | 1,299 | 611 | 8,537 |
| 18 | 5,741 | 988 | 688 | 1,376 | 688 | 9,481 |
| 19 | 5,741 | 1,064 | 688 | 1,452 | 688 | 9,633 |

| Load Reductions for Implemented Livestock BMPs, Cont. | | | | | | |
|---|---|---|---|---|---|---|
| Annual Phosphorous Load Reductions (lbs) | | | | | | |
| Year | Vegetative Filter Strip | Pond | Relocate Pasture Feeding Site | Off Stream Watering System | Rotational Grazing | Annual Load Reduction |
| 20 | 6,379 | 1,064 | 764 | 1,529 | 764 | 10,500 |
| 21 | 6,379 | 1,064 | 841 | 1,605 | 841 | 10,730 |
| 22 | 7,017 | 1,064 | 917 | 1,682 | 917 | 11,597 |
| 23 | 7,017 | 1,064 | 994 | 1,758 | 994 | 11,826 |
| 24 | 7,655 | 1,064 | 1,070 | 1,834 | 1,070 | 12,693 |
| 25 | 7,655 | 1,064 | 1,147 | 1,911 | 1,147 | 12,923 |

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

**Table 28 Estimated Phosphorus Load Reductions for Implemented Cropland BMPs Aimed at Meeting the Eutrophication TMDL in Toronto Reservoir and Dissolved Oxygen TMDL in Toronto Reservoir, Homer Creek and West Creek.**

| Annual P Load Reduction (lbs), Cropland BMPs | | | | | | |
|---|---|---|---|---|---|---|
| Year | Buffer | No-Till | Terraces | Conservation Crop Rotation | Waterways | Total Load Reduction |
| 1 | 272 | 163 | 41 | 17 | 54 | 548 |
| 2 | 544 | 327 | 82 | 34 | 109 | 1,095 |
| 3 | 816 | 490 | 122 | 51 | 163 | 1,643 |
| 4 | 1,088 | 653 | 163 | 68 | 218 | 2,190 |
| 5 | 1,360 | 816 | 204 | 85 | 272 | 2,738 |
| 6 | 1,633 | 980 | 245 | 102 | 327 | 3,286 |
| 7 | 1,905 | 1,143 | 286 | 119 | 381 | 3,833 |
| 8 | 2,177 | 1,306 | 327 | 136 | 435 | 4,381 |
| 9 | 2,449 | 1,469 | 367 | 153 | 490 | 4,928 |
| 10 | 2,721 | 1,633 | 408 | 170 | 544 | 5,476 |
| 11 | 2,993 | 1,796 | 449 | 170 | 599 | 6,006 |
| 12 | 3,265 | 1,959 | 490 | 170 | 653 | 6,537 |
| 13 | 3,537 | 2,122 | 531 | 170 | 707 | 7,068 |
| 14 | 3,809 | 2,286 | 571 | 170 | 762 | 7,598 |
| 15 | 4,081 | 2,449 | 612 | 170 | 816 | 8,129 |
| 16 | 4,353 | 2,612 | 653 | 170 | 871 | 8,659 |
| 17 | 4,626 | 2,775 | 694 | 170 | 925 | 9,190 |
| 18 | 4,898 | 2,939 | 735 | 170 | 980 | 9,721 |
| 19 | 5,170 | 3,102 | 775 | 170 | 1,034 | 10,251 |
| 20 | 5,442 | 3,265 | 816 | 170 | 1,088 | 10,782 |
| 21 | 5,442 | 3,265 | 816 | 170 | 1,088 | 10,782 |
| 22 | 5,442 | 3,265 | 816 | 170 | 1,088 | 10,782 |

| Load Reductions for Cropland BMPs, Cont. | | | | | | |
|---|---|---|---|---|---|---|
| Annual P Load Reduction (lbs), Cropland BMPs | | | | | | |
| Year | Buffer | No-Till | Terraces | Conservation Crop Rotation | Waterways | Total Load Reduction |
| 23 | 5,442 | 3,265 | 816 | 170 | 1,088 | 10,782 |
| 24 | 5,442 | 3,265 | 816 | 170 | 1,088 | 10,782 |
| 25 | 5,442 | 3,265 | 816 | 170 | 1,088 | 10,782 |

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

**Table 29 Estimated Phosphorus Load Reductions for Implemented Streambank BMPs Aimed at Meeting the Eutrophication TMDL in Toronto Reservoir and Dissolved Oxygen TMDL in Toronto Reservoir, Homer Creek and West Creek.**

| Year | Streambank* Reduction (lbs/yr) |
|---|---|
| 1 | 120 |
| 2 | 240 |
| 3 | 360 |
| 4 | 480 |
| 5 | 600 |
| 6 | 720 |
| 7 | 840 |
| 8 | 960 |
| 9 | 1,080 |
| 10 | 1,200 |
| 11 | 1,320 |
| 12 | 1,440 |
| 13 | 1,560 |
| 14 | 1,680 |
| 15 | 1,800 |
| 16 | 1,920 |
| 17 | 2,040 |
| 18 | 2,160 |
| 19 | 2,280 |
| 20 | 2,400 |
| 21 | 2,400 |
| 22 | 2,400 |
| 23 | 2,400 |
| 24 | 2,400 |
| 25 | 2,400 |

*Assume average Phosphorous content in floodplain soil is 20 ppm.

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

**Table 30  Estimated Phosphorus Load Reductions for Implemented Rangeland BMPs Aimed at Meeting the Eutrophication TMDL in Toronto Reservoir and Dissolved Oxygen TMDL in Toronto Reservoir, Homer Creek and West Creek.**

| Annual Rangeland BMP Phosphorous Reduction (lbs.) | | | |
|---|---|---|---|
| **Year** | **Repair Grazing Land Gullies** | **Brine Site Repair** | **Total** |
| 1 | 8 | 2 | **10** |
| 2 | 16 | 4 | **20** |
| 3 | 24 | 6 | **30** |
| 4 | 32 | 8 | **40** |
| 5 | 40 | 10 | **50** |
| 6 | 48 | 12 | **60** |
| 7 | 56 | 14 | **70** |
| 8 | 64 | 16 | **80** |
| 9 | 72 | 18 | **90** |
| 10 | 80 | 20 | **100** |
| 11 | 88 | 22 | **110** |
| 12 | 96 | 24 | **120** |
| 13 | 104 | 26 | **130** |
| 14 | 112 | 28 | **140** |
| 15 | 120 | 30 | **150** |
| 16 | 128 | 32 | **160** |
| 17 | 136 | 34 | **170** |
| 18 | 144 | 36 | **180** |
| 19 | 152 | 38 | **190** |
| 20 | 160 | 40 | **200** |
| 21 | 160 | 40 | **200** |
| 22 | 160 | 40 | **200** |
| 23 | 160 | 40 | **200** |
| 24 | 160 | 40 | **200** |
| 25 | 160 | 40 | **200** |

The table below shows the combined load reduction for phosphorus that is attained if all livestock, cropland, streambank and rangeland BMPs are implemented annually.  The percent of TMDL achievement is illustrated in the right column.  At the end of twenty-five years (the life of the plan), phosphorus will be reduced which will include the goal of meeting the Eutrophication TMDL in Toronto Reservoir and Dissolved Oxygen TMDL in Toronto Reservoir, Walnut Creek (and its tributary Homer Creek) and West Creek.

**Table 31 Combined Livestock, Cropland, Streambank and Rangeland Phosphorus Reductions Aimed at Meeting the Eutrophication TMDL in Toronto Reservoir and Dissolved Oxygen TMDL in Toronto Reservoir, Homer Creek and West Creek in Twenty Five Years.** The TMDL will be met at the end of twenty five years.

| Combination of Livestock, Cropland, Streambank* and Rangeland BMPs to Meet the Toronto Phosphorous TMDL | | | | | | |
|---|---|---|---|---|---|---|
| Year | Livestock Reduction (lbs/yr) | Cropland Reduction (lbs/yr) | Streambank* Reduction (lbs/yr) | Rangeland* Reduction (lbs/yr) | Total Reduction (lbs/yr) | Percent of TMDL |
| 1 | 152 | 548 | 120 | 10 | 830 | 3.2% |
| 2 | 1,096 | 1,095 | 240 | 20 | 2,451 | 9.4% |
| 3 | 1,172 | 1,643 | 360 | 30 | 3,205 | 12.3% |
| 4 | 2,115 | 2,190 | 480 | 40 | 4,826 | 18.4% |
| 5 | 2,268 | 2,738 | 600 | 50 | 5,656 | 21.6% |
| 6 | 3,211 | 3,286 | 720 | 60 | 7,276 | 27.8% |
| 7 | 3,287 | 3,833 | 840 | 70 | 8,030 | 30.7% |
| 8 | 4,230 | 4,381 | 960 | 80 | 9,651 | 36.9% |
| 9 | 4,383 | 4,928 | 1,080 | 90 | 10,481 | 40.1% |
| 10 | 5,250 | 5,476 | 1,200 | 100 | 12,026 | 46.0% |
| 11 | 5,403 | 6,006 | 1,320 | 110 | 12,839 | 49.1% |
| 12 | 6,346 | 6,537 | 1,440 | 120 | 14,443 | 55.2% |
| 13 | 6,422 | 7,068 | 1,560 | 130 | 15,180 | 58.0% |
| 14 | 7,365 | 7,598 | 1,680 | 140 | 16,784 | 64.2% |
| 15 | 7,518 | 8,129 | 1,800 | 150 | 17,597 | 67.3% |
| 16 | 8,385 | 8,659 | 1,920 | 160 | 19,124 | 73.1% |
| 17 | 8,537 | 9,190 | 2,040 | 170 | 19,937 | 76.2% |
| 18 | 9,481 | 9,721 | 2,160 | 180 | 21,541 | 82.3% |
| 19 | 9,633 | 10,251 | 2,280 | 190 | 22,354 | 85.5% |
| 20 | 10,500 | 10,782 | 2,400 | 200 | 23,882 | 91.3% |
| 21 | 10,730 | 10,782 | 2,400 | 200 | 24,111 | 92.2% |
| 22 | 11,597 | 10,782 | 2,400 | 200 | 24,978 | 95.5% |
| 23 | 11,826 | 10,782 | 2,400 | 200 | 25,208 | 96.4% |
| 24 | 12,693 | 10,782 | 2,400 | 200 | 26,075 | 99.7% |
| 25 | 12,923 | 10,782 | 2,400 | 200 | 26,304 | 100.6% |

*Assume average Phosphorous content in floodplain soil is 20 ppm.

***Toronto P TMDL: 26,160 Pounds Reduced per Year***

P TMDL
has
been met.

**Table 32 Annual Phosphorus Load Reduction by Category Aimed at Meeting the Eutrophication TMDL in Toronto Reservoir and Dissolved Oxygen TMDL in Toronto Reservoir, Homer Creek and West Creek.**

| Achieving the Phosphorous TMDL | | | |
|---|---|---|---|
| **Best Management Practice Category** | **Installation Quantity** | **Total Annual Load Reduction (tons)** | **Percent of Sediment TMDL** |
| Cropland (acres) | 5,802 | 10,782 | 41.2% |
| Livestock (practices) | 32 | 12,923 | 49.4% |
| Rangeland (acres) | 30 | 200 | 0.8% |
| Streambank (feet) | 20,000 | 2,400 | 9.2% |
| | **Total** | **26,304** | **109.0%** |
| | | | |
| | | *Reduction to meet phosphorous TMDL (lbs)* | *26,160* |

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

## 5.3 Madison City Lake

Madison City Lake is the only water supply for the City of Madison. The SLT believes that it is important to be proactive in preserving the water quality of the lake. At this time, the water quality is good and no TMDLs or 303d listings are in place for the lake. Therefore, all BMPs would be aimed at protection of the water instead of restoration. The goal of the BMP installation will be to control sediment and phosphorus entering the lake.

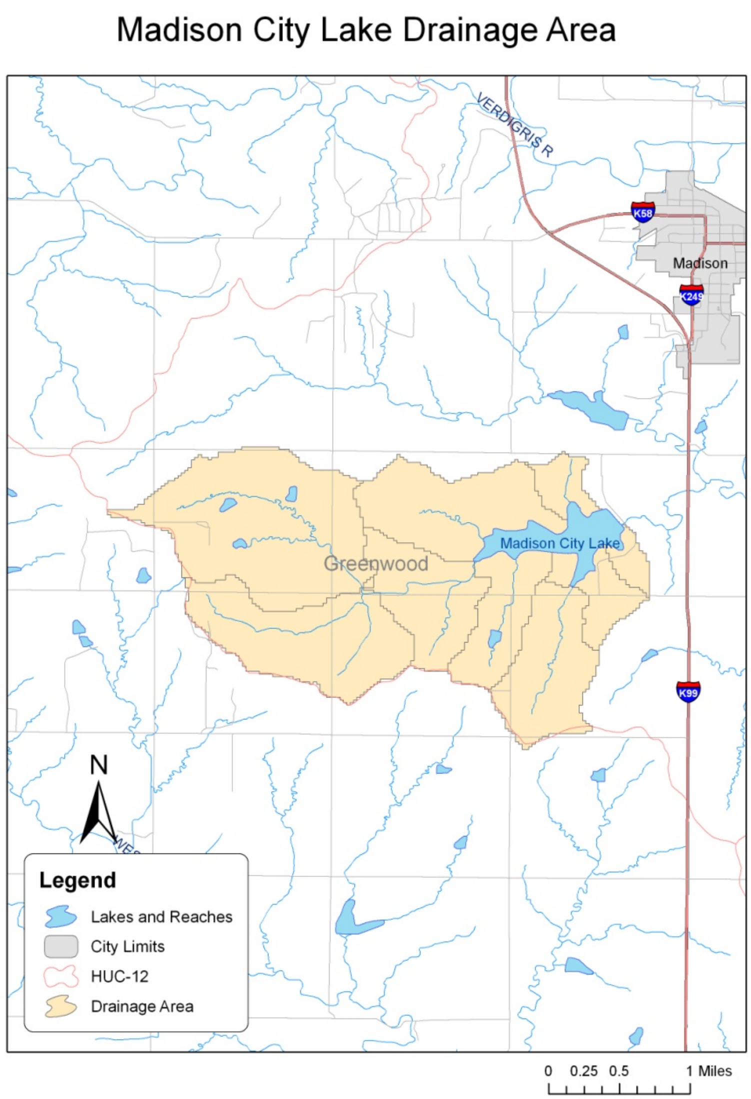



**Figure 34 Madison City Lake.**

***It is to be noted that all BMPs in the Madison City Lake watershed are already incorporated in the sediment, phosphorus, adoption rates and costs sections of this report. It is only in this section that they are separate for the purpose of highlighting the importance of the water quality in the lake.***

**Table 33  BMPs, Adoption Rates, Load Reductions and Costs for Madison City Lake.**

| Best Management Practices to Protect Madison City Lake | | | | | | |
|---|---|---|---|---|---|---|
| **BMP** | **Installation Quantity** | **Annual Sediment Reduction (tons)** | **Annual Phosphorous Reduction (lbs)** | **Total Cost** | **Available Cost Share** | **Net Cost** |
| Vegetative Buffer (acres) | 9 | 68 | 232 | $9,000 | $8,100 | $900 |
| Gully Repair (practices) | 7 | 700 | 28 | $10,500 | $5,250 | $5,250 |
| Brine Site Restoration (acres) | 2 | 100 | 4 | $6,000 | $3,000 | $3,000 |
| Alternative Watering System | 1 | 0 | 76 | $3,795 | $1,898 | $1,898 |
| | **Total** | **868** | **340** | **$29,295** | **$18,248** | **$11,048** |

## 5.4 Preservation of Natural Resources

### 5.4.1 Cross Timbers Ecoregion

The Cross Timbers Ecoregion is a unique area of interspersed dense woodlands with meadows and valleys that spreads from Kansas to Texas. It is the ecotone of mixed vegetation between the eastern forests and western grasslands. Early settlers had difficulty crossing the woodlands because of the impenetrable nature of the forest, hence the name “Cross Timbers”. The southern tip of the Toronto Watershed and the area surrounding Toronto Reservoir intersects with the Cross Timbers Ecoregion. The SLT believes that because of the area’s unique history and environmental resource adequate protection and preservation measures should be granted to the Cross Timbers area.

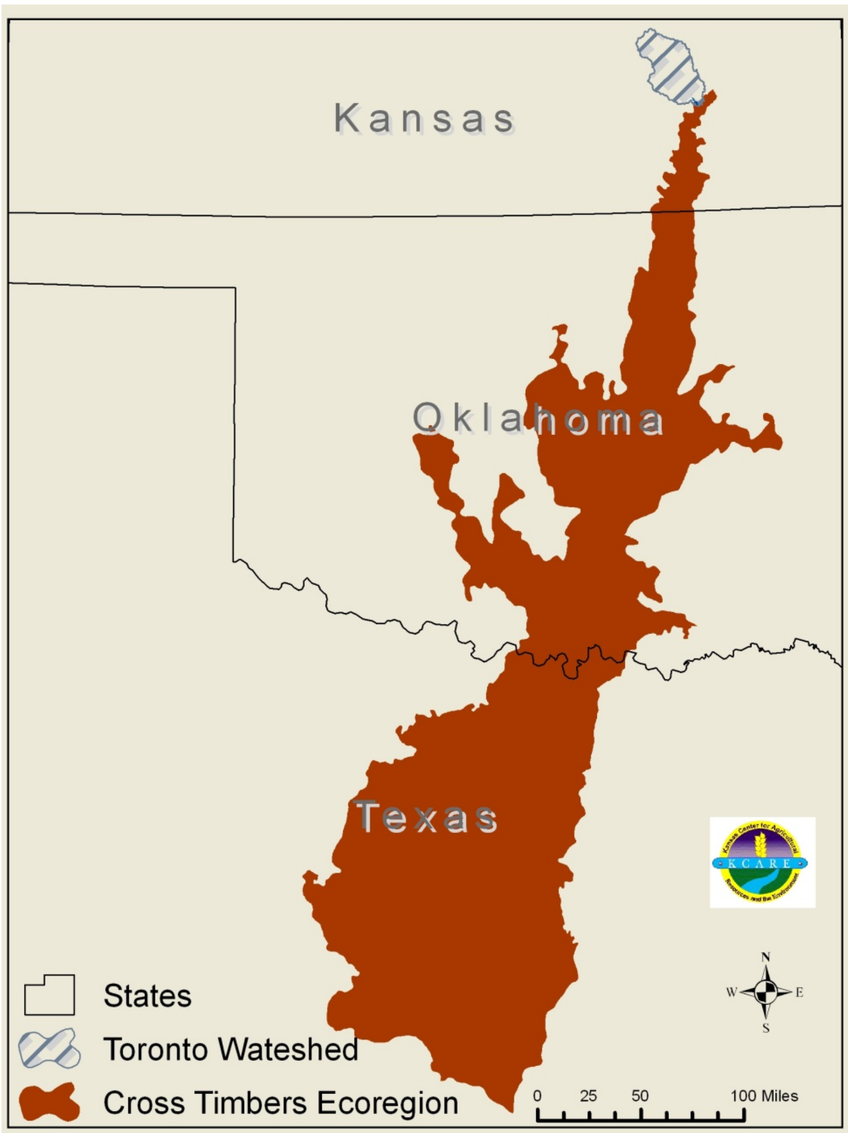



**Figure 35 Cross Timbers Ecoregion.** [44]

### 5.4.2 Decline of Prairie Chicken Habitat

The Greater Prairie Chicken is a wildlife species that was once common in their native habitat of the Flint Hills Ecoregion of Kansas. The Flint Hills Ecoregion covers most of the Toronto Watershed. Threats to the survival and proliferation of this species are human encroachment, traditional annual burning of native pastures, conversion of pastureland to cropland and invasion of trees, such as red cedar, into traditional prairies. Local landowners in the Toronto Watershed can have a large impact on prairie chicken populations. Any advances made in providing better prairie chicken habitat will also be an advantage for water quality.

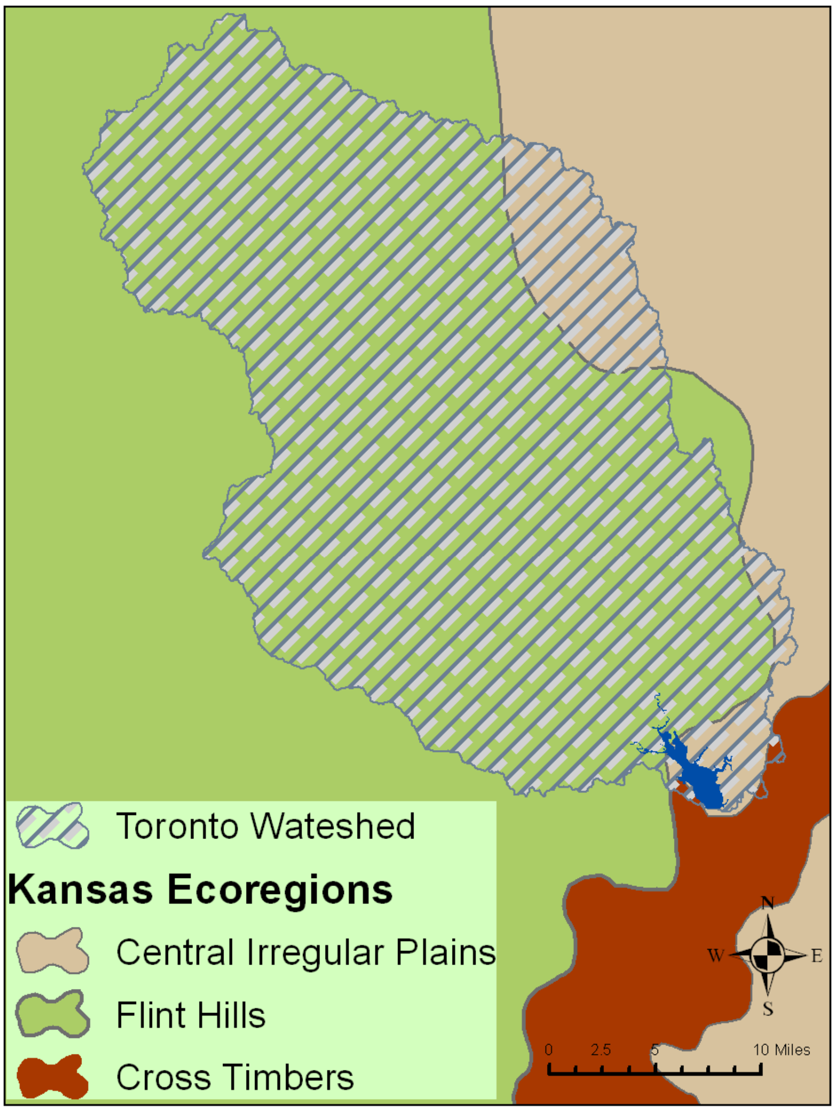



**Figure 36 Toronto Watershed Ecoregions.** [44]

### 5.4.3 Management of Riparian Forests

Management of the riparian forest resource provides economic benefits to landowners, provides recreational opportunities and habitat for many stream and woodland wildlife species. Riparian forests are defined as those woodlands located near perennial streams, river bottoms and growing in soil suitability groups of one and two as identified by the Natural Resources Conservation Service (NRCS) in Kansas Forestry Technical note KS-10. [45] These woodlands often have occasional flooding. These forests have a species mix of black walnut, bur oak, green ash, hackberry and several other mixed hardwood trees.

Riparian forests are located adjacent to perennial streams and rivers primarily being bordered by cropland and to a lesser degree, rangeland. They provide a vegetative buffer for streams and rivers. Riparian forests help filter nutrients and sediment moving off cropland and rangeland areas. These forested areas also provide buffers to maintain stream bank stability during floods. [46]

Historically, riparian forests areas are not actively managed. In many cases, two or three cycles of timber harvesting have occurred without follow up practices to re-forest or improve the forest with commercially viable species since settlement. In rangeland areas, forests are sometimes grazed and cattle congregate in the riparian areas resulting in increased soil compaction and placing manure near the streams.

The SLT believes management of these riparian forests is important to protect rivers and streams. It is also important to help landowners realize the importance of management to sustain riparian forests for future generations. Best management practices for riparian forests includes technology transfer along with methods to establish, manage and harvest woodlands along rivers, streams, and lakes in Kansas. [47] Any sound management activities made in improving the riparian forests will also be an advantage for water quality.

# 6.0 Information and Education in Support of BMPs

## 6.1 Information and Education Activities

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

**Table 34 Information and Education Activities and Events as Requested by the SLT.**

| BMP | Target Audience | Information/Education Activity/Event | Time Frame | Estimated Costs | Sponsor/Responsible Agency |
|---|---|---|---|---|---|
| **Cropland BMP Implementation** | | | | | |
| Riparian and Vegetative Buffers | Landowners and Farmers | Demonstration Project | Annual – Spring | $5,000 per demonstration project | Flint Hills RC&D, Conservation District |
| | | Tour/Field Day Highlighting Grassed Buffer | Annual - Summer | $1,000 per tour or field day | Flint Hills RC&D, Conservation District |
| | | One on One Technical Assistance with Producers | Annual - Ongoing | No Charge | SCC Buffer Technician |
| No-till | Farmers and Rental Operators | Scholarships for 5 farmers to attend No-Till Winter Conference | Annual – Winter | $750 ($150 per person) | No-till on the Plains |
| | | Neighborhood Gatherings | Annual – Summer | $1,500 | Conservation District and County Extension Offices |
| | | One on One Technical Assistance for Farmers Soil profiling | Annual - Ongoing | $2,000 per year | County Extension Offices |
| | | Seasonal Informational Meetings (planting) | Bi-annual spring (plant) summer (harvest) | $1,000 per year | County Extension Offices Other watersheds |

| Information and Education Activities, Cont. | | | | | |
|---|---|---|---|---|---|
| BMP | Target Audience | Information/Education Activity/Event | Time Frame | Estimated Costs | Sponsor/Responsible Agency |
| **Cropland BMP Implementation, Cont.** | | | | | |
| Terraces<br>Conservation Crop Rotation and Cover Crops<br>Grassed Waterways | Farmers | Tour/Field Day (covering all three BMPs) | Annual – Summer | $1,500 per tour | Conservation Districts, County Extension Offices |
| **Livestock BMP Implementation** | | | | | |
| Ponds | Landowners and Ranchers | Tour/Field Day including Pond Location and Maintenance | Annual – Summer | $2,000 per tour | Flint Hills RC&D, Conservation Districts, Rural Farm Center, County Extension Office |
| Relocated Pasture Feeding Sites | Ranchers | Demonstration Project | Annual – Spring | $5,000 per demonstration project | Kansas Rural Center |
| | | Tour/Field Day | Annual - Summer | $500 per tour or field day | Kansas Rural Center |
| | | Informational Meeting/Workshop | Annual – Fall | $500 per meeting | Kansas Rural Center |
| Off-Stream Watering System | Ranchers | Demonstration Projects for pond construction and spring development | Annual – Fall | $10,000 per demonstration project | Kansas Rural Center, County Extension Offices, Conservation Districts |
| | | Tour/Field Day | Annual - Summer | $500 per tour or field day | Kansas Rural Center, County Extension Offices, Conservation Districts |
| | | Informational Meeting/Workshop | Annual - Fall | Combined with relocating pasture feeding site meeting | Kansas Rural Center, County Extension Offices |

| Information and Education Activities, Cont. | | | | | |
|---|---|---|---|---|---|
| BMP | Target Audience | Information/Education Activity/Event | Time Frame | Estimated Costs | Sponsor/Responsible Agency |
| **Livestock BMP Implementation, Cont.** | | | | | |
| Rotational Grazing | Landowners and Ranchers | Tour/Field Day | Annual – Summer | Combine with Pond Meeting | Kansas Rural Center, County Extension Offices |
| **Streambank BMP Implementation** | | | | | |
| Streambank Stabilization | Landowners | Demonstration Projects | Annual – Ongoing | $25,000 per project | Flint Hills RC&D, Kansas Alliance for Wetlands and Streams |
| | | Demonstration project & tour focusing on streambank assessment methodology | Annual - Summer | $5,000 per project/tour | Kansas Alliance for Wetlands and Streams |
| **Rangeland BMP Implementation** | | | | | |
| Repair Ephemeral Gullies | Landowners | Tour/Field Day | Annual – Summer | Combine with Pond Meeting | Flint Hills RC&D, Conservation Districts |
| Restore Brine Scar Sites | Landowners | Tour/Field Day | Annual – Summer | Combine with Pond Meeting | Flint Hills RC&D, Conservation Districts |
| **Source Water Protection BMP Implementation** | | | | | |
| **Zebra mussel control** | Boaters at Madison City Lake and Toronto Reservoir, Property owners of watershed dams, and Water district boards | Educational campaign / boater awareness day | Annual - Summer | $1,500 per year | Flint Hills RC&D<br>Kansas Wildlife and Parks<br>Madison City<br>Verdigris watershed board |

| Information and Education Activities, Cont. | | | | | |
|---|---|---|---|---|---|
| BMP | Target Audience | Information/Education Activity/Event | Time Frame | Estimated Costs | Sponsor/Responsible Agency |
| **Source Water Protection BMP Implementation, Cont.** | | | | | |
| **Vegetative Buffers** | Landowners in Madison City Lake watershed | Combined with Livestock BMP Implementation activities outlined above | | | |
| **Repair Ephemeral Gullies** | | | | | |
| **Restore Brine Scar Sites** | | | | | |
| **Rotational Grazing** | | | | | |
| **Off-Stream Watering Systems** | | | | | |
| **General / Watershed Wide Information and Education** | | | | | |
| Educational Activities Targeting Youth | Educators, K-12 Students | Day on the Farm | Annual – Spring | $500 per event | Conservation Districts, Kansas Farm Bureaus, Kansas FFA Organization, Kansas State Research and Extension |
| | | Poster, essay and speech contests promoting water quality | Annual – Spring | $200 per year | Conservation Districts |
| | | Envirothon | Annual - Spring | $250 per year | Conservation Districts |
| | | Curriculum workshop for K-12 educators | Annual – Summer | $2,000 per workshop | KACEE |
| | | Environmental education | Ongoing | $500 per year | County Extension Offices, Conservation Districts |
| | | Service Learning project | Ongoing | $500 per year | County Extension Offices, Conservation Districts |

| Information and Education Activities, Cont. | | | | | |
|---|---|---|---|---|---|
| BMP | Target Audience | Information/Education Activity/Event | Time Frame | Estimated Costs | Sponsor/Responsible Agency |
| **General / Watershed Wide Information and Education, Cont.** | | | | | |
| Educational Activities Targeting Adults | Watershed Residents | Newspaper/newsletter articles | Annual – Ongoing | No charge | Conservation Districts, County Extension Offices |
| | | Presentation about water quality issues & WRAPS update at annual meetings | Annual – Winter | No charge | Conservation Districts, County Extension Offices, Flint Hills RC&D |
| | | River Friendly Farms Informational Meetings | Annual - Ongoing | $450 per meeting | Kansas Rural Center |
| | | Educational campaign to promote forestry practices to conserve Cross Timbers forest | Ongoing | $1,500 per year | Kansas Forest Service |
| | | Educational campaign to about leaking/failing septic systems | Ongoing | $1,500 per year | Local Environmental Protection Programs Kansas Rural Center Conservation District |
| **Total annual cost for Information and Education if all events are implemented** | | | | **$70,150** | |

## 6.2 Evaluation of Information and Education Activities

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

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

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

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

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

# 7.0 Costs of Implementing BMPs and Possible Funding Sources

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

**Summarized Derivation of Cropland BMP Cost Estimates**

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

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

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 $1.25 per foot.

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

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

**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.

Ponds: In consulting with numerous conservation districts it was determined by Josh Roe that the average cost of constructing a pond at this point in time is $12,000.

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

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

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

**Prices below reflect current prices (2009) for implementation and also include technical assistance costs such as NRCS planning and engineering design in the case of streambank stabilization.**

**Table 35 Estimated Costs and Net Costs for Cropland Implemented BMPs.** Expressed in 2009 dollar amounts. 3 percent Annual Cost Inflation.

| Total Annual Cost Before Cost-Share, Cropland BMPs | | | | | | |
|---|---|---|---|---|---|---|
| Year | Buffer | No-Till | Terraces | Conservation Crop Rotation | Waterways | Total Cost |
| 1 | $8,363 | $7,309 | $3,199 | $609 | $2,509 | $21,988 |
| 2 | $8,614 | $7,528 | $3,295 | $627 | $2,584 | $22,648 |
| 3 | $8,872 | $7,754 | $3,394 | $646 | $2,662 | $23,327 |
| 4 | $9,138 | $7,987 | $3,495 | $665 | $2,741 | $24,027 |
| 5 | $9,412 | $8,226 | $3,600 | $685 | $2,824 | $24,748 |
| 6 | $9,695 | $8,473 | $3,708 | $706 | $2,908 | $25,490 |
| 7 | $9,985 | $8,727 | $3,819 | $727 | $2,996 | $26,255 |
| 8 | $10,285 | $8,989 | $3,934 | $749 | $3,086 | $27,043 |
| 9 | $10,594 | $9,259 | $4,052 | $771 | $3,178 | $27,854 |
| 10 | $10,911 | $9,537 | $4,174 | $795 | $3,273 | $28,690 |

| Total Annual Cost Before Cost-Share, Cropland BMPs, Cont. | | | | | | |
|---|---|---|---|---|---|---|
| Year | Buffer | No-Till | Terraces | Conservation Crop Rotation | Waterways | Total Cost |
| 11 | $11,239 | $9,823 | $4,299 | $0 | $3,372 | $28,732 |
| 12 | $11,576 | $10,117 | $4,428 | $0 | $3,473 | $29,594 |
| 13 | $11,923 | $10,421 | $4,561 | $0 | $3,577 | $30,482 |
| 14 | $12,281 | $10,734 | $4,697 | $0 | $3,684 | $31,396 |
| 15 | $12,649 | $11,056 | $4,838 | $0 | $3,795 | $32,338 |
| 16 | $13,029 | $11,387 | $4,984 | $0 | $3,909 | $33,308 |
| 17 | $13,420 | $11,729 | $5,133 | $0 | $4,026 | $34,307 |
| 18 | $13,822 | $12,081 | $5,287 | $0 | $4,147 | $35,337 |
| 19 | $14,237 | $12,443 | $5,446 | $0 | $4,271 | $36,397 |
| 20 | $14,664 | $12,817 | $5,609 | $0 | $4,399 | $37,489 |
| 21 | $0 | $0 | $0 | $0 | $0 | $0 |
| 22 | $0 | $0 | $0 | $0 | $0 | $0 |
| 23 | $0 | $0 | $0 | $0 | $0 | $0 |
| 24 | $0 | $0 | $0 | $0 | $0 | $0 |
| 25 | $0 | $0 | $0 | $0 | $0 | $0 |

| Total Annual Cost After Cost-Share, Cropland BMPs | | | | | | |
|---|---|---|---|---|---|---|
| Year | Buffer | No-Till | Terraces | Conservation Crop Rotation | Waterways | Total Cost |
| 1 | $836 | $4,459 | $1,599 | $609 | $1,254 | $8,758 |
| 2 | $861 | $4,592 | $1,647 | $627 | $1,292 | $9,020 |
| 3 | $887 | $4,730 | $1,697 | $646 | $1,331 | $9,291 |
| 4 | $914 | $4,872 | $1,748 | $665 | $1,371 | $9,570 |
| 5 | $941 | $5,018 | $1,800 | $685 | $1,412 | $9,857 |
| 6 | $969 | $5,169 | $1,854 | $706 | $1,454 | $10,152 |
| 7 | $999 | $5,324 | $1,910 | $727 | $1,498 | $10,457 |
| 8 | $1,029 | $5,483 | $1,967 | $749 | $1,543 | $10,771 |
| 9 | $1,059 | $5,648 | $2,026 | $771 | $1,589 | $11,094 |
| 10 | $1,091 | $5,817 | $2,087 | $795 | $1,637 | $11,427 |
| 11 | $1,124 | $5,992 | $2,149 | $0 | $1,686 | $10,951 |
| 12 | $1,158 | $6,172 | $2,214 | $0 | $1,736 | $11,280 |
| 13 | $1,192 | $6,357 | $2,280 | $0 | $1,788 | $11,618 |
| 14 | $1,228 | $6,548 | $2,349 | $0 | $1,842 | $11,966 |
| 15 | $1,265 | $6,744 | $2,419 | $0 | $1,897 | $12,325 |
| 16 | $1,303 | $6,946 | $2,492 | $0 | $1,954 | $12,695 |
| 17 | $1,342 | $7,155 | $2,567 | $0 | $2,013 | $13,076 |
| 18 | $1,382 | $7,369 | $2,643 | $0 | $2,073 | $13,468 |
| 19 | $1,424 | $7,590 | $2,723 | $0 | $2,136 | $13,872 |

| Total Annual Cost After Cost-Share, Cropland BMPs, Cont. | | | | | | |
|---|---|---|---|---|---|---|
| Year | Buffer | No-Till | Terraces | Conservation Crop Rotation | Waterways | Total Cost |
| 20 | $1,466 | $7,818 | $2,804 | $0 | $2,200 | $14,289 |
| 21 | $0 | $0 | $0 | $0 | $0 | $0 |
| 22 | $0 | $0 | $0 | $0 | $0 | $0 |
| 23 | $0 | $0 | $0 | $0 | $0 | $0 |
| 24 | $0 | $0 | $0 | $0 | $0 | $0 |
| 25 | $0 | $0 | $0 | $0 | $0 | $0 |

**Table 36 Estimated Costs of Implementing Livestock BMPs.** Expressed in 2009 dollar amounts. 3 percent Annual Cost Inflation.

| Annual Cost of Implementing Livestock BMPs | | | | | | |
|---|---|---|---|---|---|---|
| Year | Vegetative Filter Strip | Pond | Relocate Pasture Feeding Site | Off Stream Watering System | Rotational Grazing | Annual Cost |
| 1 | | $6,000 | | $1,898 | | **$7,898** |
| 2 | $357 | $6,180 | $1,102 | $1,954 | $3,605 | **$13,198** |
| 3 | | $0 | | $2,013 | | **$2,013** |
| 4 | $379 | $6,556 | $1,169 | $2,073 | $3,825 | **$14,002** |
| 5 | | $6,753 | | $2,136 | | **$8,889** |
| 6 | $402 | $0 | $1,240 | $2,200 | $4,057 | **$7,899** |
| 7 | | $7,164 | | $2,266 | | **$9,430** |
| 8 | $426 | $7,379 | $1,315 | $2,334 | $4,305 | **$15,759** |
| 9 | | $7,601 | | $2,404 | | **$10,004** |
| 10 | $452 | $0 | $1,395 | $2,476 | $4,567 | **$8,890** |
| 11 | | $8,063 | | $2,550 | | **$10,614** |
| 12 | $480 | $8,305 | $1,480 | $2,627 | $4,845 | **$17,737** |
| 13 | | $0 | | $2,705 | | **$2,705** |
| 14 | $509 | $8,811 | $1,570 | $2,787 | $5,140 | **$18,817** |
| 15 | | $9,076 | | $2,870 | | **$11,946** |
| 16 | $540 | $0 | $1,666 | $2,956 | $5,453 | **$10,615** |
| 17 | | $9,628 | | $3,045 | | **$12,673** |
| 18 | $573 | $9,917 | $1,768 | $3,136 | $5,785 | **$21,179** |
| 19 | | $10,215 | | $3,230 | | **$13,445** |
| 20 | $608 | $0 | $1,875 | $3,327 | $6,137 | **$11,948** |
| 21 | | $10,837 | | $3,427 | $6,321 | **$20,585** |
| 22 | $645 | $11,162 | $1,989 | $3,530 | $6,511 | **$23,837** |
| 23 | | $11,497 | | $3,636 | | **$15,132** |
| 24 | $684 | $0 | $2,111 | $3,745 | $6,908 | **$13,447** |
| 25 | | $12,197 | | $3,857 | | **$16,054** |

**Table 37 Estimated Costs of Implementing Streambank BMPs.** Expressed in 2009 dollar amounts. 3 percent Annual Cost Inflation.

| Year | Streambank |
|---|---|
| 1 | $41,660 |
| 2 | $42,910 |
| 3 | $44,197 |
| 4 | $45,523 |
| 5 | $46,889 |
| 6 | $48,295 |
| 7 | $49,744 |
| 8 | $51,237 |
| 9 | $52,774 |
| 10 | $54,357 |
| 11 | $55,988 |
| 12 | $57,667 |
| 13 | $59,397 |
| 14 | $61,179 |
| 15 | $63,014 |
| 16 | $64,905 |
| 17 | $66,852 |
| 18 | $68,858 |
| 19 | $70,923 |
| 20 | $73,051 |
| 21 | $0 |
| 22 | $0 |
| 23 | $0 |
| 24 | $0 |
| 25 | $0 |

**Table 38 Estimated Costs of Implementing Rangeland BMPs.** Expressed in 2009 dollar amounts. 3 percent Annual Cost Inflation.

| Annual Cost of Implementing Rangeland BMPs After Cost-Share | | | |
|---|---|---|---|
| Year | Repair Ephemeral Gullies | Brine Site Repair | Total |
| 1 | $750 | $1,500 | **$2,250** |
| 2 | $773 | $1,545 | **$2,318** |
| 3 | $796 | $1,591 | **$2,387** |
| 4 | $820 | $1,639 | **$2,459** |
| 5 | $844 | $1,688 | **$2,532** |
| 6 | $869 | $1,739 | **$2,608** |
| 7 | $896 | $1,791 | **$2,687** |
| 8 | $922 | $1,845 | **$2,767** |

| Annual Cost of Implementing Rangeland BMPs After Cost-Share, Cont. | | | |
|---|---|---|---|
| **Year** | **Repair Ephemeral Gullies** | **Brine Site Repair** | **Total** |
| 9 | $950 | $1,900 | **$2,850** |
| 10 | $979 | $1,957 | **$2,936** |
| 11 | $1,008 | $2,016 | **$3,024** |
| 12 | $1,038 | $2,076 | **$3,115** |
| 13 | $1,069 | $2,139 | **$3,208** |
| 14 | $1,101 | $2,203 | **$3,304** |
| 15 | $1,134 | $2,269 | **$3,403** |
| 16 | $1,168 | $2,337 | **$3,505** |
| 17 | $1,204 | $2,407 | **$3,611** |
| 18 | $1,240 | $2,479 | **$3,719** |
| 19 | $1,277 | $2,554 | **$3,830** |
| 20 | $1,315 | $2,630 | **$3,945** |
| 21 | $0 | $0 | $0 |
| 22 | $0 | $0 | $0 |
| 23 | $0 | $0 | $0 |
| 24 | $0 | $0 | $0 |
| 25 | $0 | $0 | $0 |

**Table 39 Technical Assistance Needed to Implement BMPs.**

| BMP | | *Technical Assistance* | *Projected Annual Cost* |
|---|---|---|---|
| Cropland | 1. Buffers | SCC Buffer Technician<br>WRAPS Coordinator<br>KRC River Friendly Farms Technician | **SCC Buffer Technician No Charge**<br><br>**WRAPS Coordinator $25,000**<br><br>**KRC River Friendly Farms Technician $20,000** |
| | 2. Continuous No-till | WRAPS Coordinator<br>KRC River Friendly Farms Technician | |
| | 3. Terraces | SCC Buffer Technician<br>KRC River Friendly Farms Technician | |
| | 4. Conservation Crop Rotation | SCC Buffer Technician<br>KRC River Friendly Farms Technician | |
| | 5. Waterways | SCC Buffer Technician<br>KRC River Friendly Farms Technician | |
| Livestock | 1. Vegetative filter strips | SCC Buffer Technician<br>KRC River Friendly Farms Technician | |
| | 2. Ponds | SCC Buffer Technician<br>KRC River Friendly Farms Technician | |
| | 3. Relocate pasture feeding sites | KRC River Friendly Farms Technician | |
| | 4. Establish off stream watering systems | KRC River Friendly Farms Technician | |
| | 5. Rotational grazing | KRC River Friendly Farms Technician | |
| Streambank | 4. Streambank restoration | WRAPS Coordinator<br>SCC Buffer Technician<br>KRC River Friendly Farms Technician | |
| Rangeland | 1. Repair ephemeral gullies | KRC River Friendly Farms Technician | |
| | 2. Repair brine scars | KRC River Friendly Farms Technician | |
| **Total** | | | **$45,000** |

**Table 40 Total Annual Costs for Implementing Entire WRAPS Plan in Support of Attaining TMDLs.**

| Total Annual Costs of Implementing Cropland, Livestock, Streambank and Rangeland BMPs, in addition to Information and Education and Technical Assistance | | | | | | | |
|---|---|---|---|---|---|---|---|
| | BMPs Implemented | | | | I&E and Technical Assistance | | |
| Year | Cropland | Livestock | Streambank | Rangeland | I&E | Technical Assistance | Total |
| 1 | $8,758 | $7,898 | $41,660 | $2,250 | $70,150 | $45,000 | $175,715 |
| 2 | $9,020 | $13,198 | $42,910 | $2,318 | $72,255 | $46,350 | $186,051 |
| 3 | $9,291 | $2,013 | $44,197 | $2,387 | $74,422 | $47,741 | $180,051 |
| 4 | $9,570 | $14,002 | $45,523 | $2,459 | $76,655 | $49,173 | $197,381 |

| Total Annual Costs of Implementing Cropland, Livestock, Streambank and Rangeland BMPs, in addition to Information and Education and Technical Assistance, Cont. | | | | | | | |
|---|---|---|---|---|---|---|---|
| | BMPs Implemented | | | | I&E and Technical Assistance | | |
| Year | Cropland | Livestock | Streambank | Rangeland | I&E | Technical Assistance | Total |
| 5 | $9,857 | $8,889 | $46,889 | $2,532 | $78,954 | $50,648 | $197,769 |
| 6 | $10,152 | $7,899 | $48,295 | $2,608 | $81,323 | $52,167 | $202,445 |
| 7 | $10,457 | $9,430 | $49,744 | $2,687 | $83,763 | $53,732 | $209,813 |
| 8 | $10,771 | $15,759 | $51,237 | $2,767 | $86,276 | $55,344 | $222,153 |
| 9 | $11,094 | $10,004 | $52,774 | $2,850 | $88,864 | $57,005 | $222,591 |
| 10 | $11,427 | $8,890 | $54,357 | $2,936 | $91,530 | $58,715 | $227,854 |
| 11 | $11,769 | $10,614 | $55,988 | $3,024 | $94,276 | $60,476 | $236,146 |
| 12 | $12,123 | $17,737 | $57,667 | $3,115 | $97,104 | $62,291 | $250,036 |
| 13 | $12,486 | $2,705 | $59,397 | $3,208 | $100,017 | $64,159 | $241,973 |
| 14 | $12,861 | $18,817 | $61,179 | $3,304 | $103,018 | $66,084 | $265,263 |
| 15 | $13,247 | $11,946 | $63,014 | $3,403 | $106,108 | $68,067 | $265,785 |
| 16 | $13,644 | $10,615 | $64,905 | $3,505 | $109,291 | $70,109 | $272,070 |
| 17 | $14,053 | $12,673 | $66,852 | $3,611 | $112,570 | $72,212 | $281,971 |
| 18 | $14,475 | $21,179 | $68,858 | $3,719 | $115,947 | $74,378 | $298,555 |
| 19 | $14,909 | $13,445 | $70,923 | $3,830 | $119,426 | $76,609 | $299,143 |
| 20 | $15,356 | $11,948 | $73,051 | $3,945 | $123,008 | $78,908 | $306,216 |
| 21 | $0 | $20,585 | $0 | $0 | $126,698 | $81,275 | $228,559 |
| 22 | $0 | $23,837 | $0 | $0 | $130,499 | $83,713 | $238,050 |
| 23 | $0 | $15,132 | $0 | $0 | $134,414 | $86,225 | $235,771 |
| 24 | $0 | $13,447 | $0 | $0 | $138,447 | $88,812 | $240,705 |
| 25 | $0 | $16,054 | $0 | $0 | $142,600 | $91,476 | $250,130 |

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

**Table 41 Potential BMP Funding Sources.**

| Potential Funding Sources | Potential Funding Programs |
|---|---|
| Natural Resources Conservation Service | Environmental Quality Incentives Program (EQIP)<br>Wetland Reserve Program (WRP)<br>Conservation Reserve Program (CRP)<br>Wildlife Habitat Incentive Program (WHIP)<br>Forestland Enhancement Program (FLEP)<br>State Acres for Wildlife Enhancement (SAFE)<br>Grassland Reserve Program (GRP)<br>Farmable Wetlands Program (FWP) |

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

**Table 42 Potential Service Providers for BMP Implementation. ***

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

<table>
<tr><th colspan="5">Potential Service Providers, Cont.</th></tr>
<tr><th colspan="2" rowspan="2">BMP</th><th colspan="2">Services Needed to Implement BMP</th><th rowspan="2">Service Provider **</th></tr>
<tr><th>Technical Assistance</th><th>Information and Education</th></tr>
<tr><td>Streambank</td><td>1. Streambank restoration</td><td>Design, cost share and maintenance</td><td>BMP workshops, field days, tours</td><td>KAWS<br>NRCS<br>KFS<br>KSRE<br>CD<br>RC&D</td></tr>
<tr><td rowspan="2">Rangeland</td><td>1.Ephemeral gullies</td><td>Design, cost share and maintenance</td><td>BMP workshops, field days, tours</td><td rowspan="2">KAWS<br>NRCS<br>SCC<br>FSA<br>KRC<br>KSRE<br>CD<br>RC&D<br>KDWP</td></tr>
<tr><td>2.Brine scars</td><td>Design, cost share and maintenance</td><td>BMP workshops, field days, tours</td></tr>
<tr><td colspan="5">** See Appendix for service provider directory</td></tr>
</table>

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

# 8.0 Timeframe

The plan will be reviewed every five years starting in 2015. In 2013, the SLT will request a review of data by KDHE for the Verdigris Basin. It is this year that the TMDLs will officially be reviewed for additions or revisions. The timeframe of this document for BMP implementation to meet both sediment and phosphorus TMDLs would be twenty years from the date of publication of this report. Sediment and phosphorus reductions in the water column will not be noticeable by the year 2015 due to a lag time from implementation of BMPs and resulting improvements in water quality. Therefore, the SLT will review sediment and phosphorus concentrations in year 2020. They will examine BMP placement and implementation in 2015 and every subsequent five years after.

**Table 43 Review Schedule for Pollutants and BMPs.**

| Review Year | Sediment | Phosphorus | BMP Placement |
|---|---|---|---|
| 2015 | | | X |
| 2020 | X | X | X |
| 2025 | X | X | X |
| 2030 | X | X | X |
| 2035 | X | X | X |

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 phosphorus related BMPs.
- The timeframe for meeting the **phosphorus TMDL** will be twenty-five years if all BMPs are implemented in the watershed.

# 9.0 Interim Measureable Milestones

## 9.1 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 three, six and twenty-five years for cropland. 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 44 Short, Medium and Long Term Goals for BMP Cropland Adoption Rate in the Cropland Targeted Area.**

| Annual Adoption (acres), Cropland BMPs | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Year | Buffer | No-Till | Terraces | Conservation Crop Rotation | Waterways | Total Acreage |
| Short Term | 1 | 125 | 94 | 31 | 16 | 31 | 298 |
| | 2 | 125 | 94 | 31 | 16 | 31 | 298 |
| | 3 | 125 | 94 | 31 | 16 | 31 | 298 |
| | 4 | 125 | 94 | 31 | 16 | 31 | 298 |
| | 5 | 125 | 94 | 31 | 16 | 31 | 298 |
| **Total** | | 625 | 470 | 155 | 80 | 155 | 1,490 |
| Medium Term | 6 | 125 | 94 | 31 | 16 | 31 | 298 |
| | 7 | 125 | 94 | 31 | 16 | 31 | 298 |
| | 8 | 125 | 94 | 31 | 16 | 31 | 298 |
| | 9 | 125 | 94 | 31 | 16 | 31 | 298 |
| | 10 | 125 | 94 | 31 | 16 | 31 | 298 |
| | | 1,250 | 940 | 310 | 160 | 310 | 2,980 |
| Long Term | 12 | 125 | 94 | 31 | 0 | 31 | 282 |
| | 13 | 125 | 94 | 31 | 0 | 31 | 282 |
| | 14 | 125 | 94 | 31 | 0 | 31 | 282 |
| | 15 | 125 | 94 | 31 | 0 | 31 | 282 |
| | 16 | 125 | 94 | 31 | 0 | 31 | 282 |
| | 17 | 125 | 94 | 31 | 0 | 31 | 282 |
| | 18 | 125 | 94 | 31 | 0 | 31 | 282 |
| | 19 | 125 | 94 | 31 | 0 | 31 | 282 |
| | 20 | 125 | 94 | 31 | 0 | 31 | 282 |
| | 21 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 22 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 23 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 24 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 25 | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Total*** | | *2,500* | *1,880* | *620* | *160* | *620* | *5,640* |

Milestones for rangeland BMPs will be examined at the end of ten and twenty years.

**Table 45 Short, Medium and Long Term Goals for BMP Rangeland Adoption Rate in the Rangeland Targeted Area.**

| Rangeland BMPs Adopted Each Year | | | |
|---|---|---|---|
| | **Year** | **Repair Grazing Land Gullies** | **Brine Site Repair** |
| **Short Term** | 1 | 2 | 1 |
| | 2 | 2 | 1 |
| | 3 | 2 | 1 |
| | 4 | 2 | 1 |
| | 5 | 2 | 1 |
| **Total** | | | |
| **Medium Term** | 6 | 2 | 1 |
| | 7 | 2 | 1 |
| | 8 | 2 | 1 |
| | 9 | 2 | 1 |
| | 10 | 2 | 1 |
| ***Total*** | | *20* | *10* |
| **Long Term** | 11 | 2 | 1 |
| | 12 | 2 | 1 |
| | 13 | 2 | 1 |
| | 14 | 2 | 1 |
| | 15 | 2 | 1 |
| | 16 | 2 | 1 |
| | 17 | 2 | 1 |
| | 18 | 2 | 1 |
| | 19 | 2 | 1 |
| | 20 | 2 | 1 |
| | 21 | | |
| | 22 | | |
| | 23 | | |
| | 24 | | |
| | 25 | | |
| ***Total*** | | *40* | *20* |

**Table 46 Short, Medium and Long Term Goals for BMP Livestock Adoption Rate in the Livestock Targeted Area.**

| Livestock BMPs Adopted Each Year | | | | | | |
|---|---|---|---|---|---|---|
| | Year | Vegetative Filter Strip | Pond | Relocate Pasture Feeding Site | Off Stream Watering System | Rotational Grazing |
| Short Term | 1 | | 1 | | 1 | |
| | 2 | 1 | 1 | 1 | 1 | 1 |
| | 3 | | | | 1 | |
| | 4 | 1 | 1 | 1 | 1 | 1 |
| | 5 | | 1 | | 1 | |
| ***Total*** | | *2* | *4* | *2* | *5* | *2* |
| Medium Term | 6 | 1 | | 1 | 1 | 1 |
| | 7 | | 1 | | 1 | |
| | 8 | 1 | 1 | 1 | 1 | 1 |
| | 9 | | 1 | | 1 | |
| | 10 | 1 | | 1 | 1 | 1 |
| ***Total*** | | 5 | 7 | 5 | 10 | 5 |
| Long Term | 11 | | 1 | | 1 | |
| | 12 | 1 | 1 | 1 | 1 | 1 |
| | 13 | | | | 1 | |
| | 14 | 1 | 1 | 1 | 1 | 1 |
| | 15 | | 1 | | 1 | |
| | 16 | 1 | | 1 | 1 | 1 |
| | 17 | | 1 | | 1 | |
| | 18 | 1 | 1 | 1 | 1 | 1 |
| | 19 | | 1 | | 1 | |
| | 20 | 1 | | 1 | 1 | 1 |
| | 21 | | 1 | | 1 | 1 |
| | 22 | 1 | 1 | 1 | 1 | |
| | 23 | | 1 | | 1 | 1 |
| | 24 | 1 | | 1 | 1 | |
| | 25 | | 1 | | 1 | 1 |
| ***Total*** | | *12* | *18* | *12* | *25* | *13* |

**Table 47 Short, Medium and Long Term Goals for Information and Education Adoption Rates in the Entire Watershed.**

| | Year | Demo Projects | Workshops | Tours and Field Days | Presentations | Newsletter Inserts | One on One Meetings | Conference Attendees | Educational Events | Media Campaign | Contacts made by Tech Assistance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Short Term | 1 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 2 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 3 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 4 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 5 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | *Total* | *25* | *20* | *25* | *5* | *5* | *15* | *30* | *35* | *10* | *1,250* |
| Medium Term | 6 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 7 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 8 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 9 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 10 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | *Total* | *50* | *40* | *50* | *10* | *10* | *30* | *60* | *70* | *20* | *2,500* |
| Long Term | 11 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 12 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 13 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 14 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 15 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 16 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 17 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 18 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 19 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 20 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 21 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 22 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 23 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 24 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | 25 | 5 | 4 | 5 | 1 | 1 | 3 | 6 | 7 | 2 | 250 |
| | *Total* | *125* | *100* | *125* | *25* | *25* | *75* | *150* | *175* | *50* | *6,250* |

Over a twenty five year time frame, this WRAPS project hopes to improve water quality throughout the watershed and in Toronto Reservoir. Measurements taken at Toronto Reservoir are important because it is the drainage endpoint of the watershed. Any water quality improvements will be observed by conducting tests in Toronto Reservoir. Social indicators will also be examined by tracking traffic in Toronto Reservoir Parks. An example of a healthy lake ecosystem is frequent visits by the public to enjoy the outdoor recreation of the lake and park. After reviewing the benchmark criteria, the SLT will assess and revise the overall strategy plan for the watershed. New goals will be set and new BMPs will be implemented in order to achieve improved water quality.

**Table 48 Benchmarks to Measure Water Quality Progress.**

| Criteria to Measure Water Quality Progress | Information Source |
|---|---|
| Post 2010 average Total Phosphorus, Total Nitrogen and Total Suspended Solids data from KDHE field collection on all streams and Toronto Reservoir should show a decline in values from those seen in 2000-2009 | KDHE |
| Main basin Total Phosphorus concentrations should average < 50 ug/L | KDHE |
| Main basin Total Nitrogen should average < 500 ug/L | KDHE |
| Main basin Total Suspended Solids should average < 20 mg/L | KDHE |
| Concentrations for Total Nitrogen and Total Phosphorus should be reduced at the stream sampling stations from the 2000-2009 levels | KDHE |
| In lake secchi disk depths should increase in Toronto Reservoir | KDHE |
| Boat ramps should continue to function with lake levels below 900 ft. elevation | COE |
| No taste and odor problems in public water supply of City of Toronto | KDHE |
| No algal blooms in main lake basin | COE |
| Bathymetric survey conducted every ten years | KBS |
| Fewer high event stream flow rates entering Toronto Reservoir indicating better retention and slower release of storm water in the upper end of the watershed due to an increase in BMPs that slow flow (buffers, riparian areas, no-till, grassed waterways, etc) | USGS |
| Beach closures at Toronto Reservoir | KDHE |
| **Social Indicators to Measure Water Quality Progress** | **Information Source** |
| Visitor traffic to Toronto Reservoir | KDWP |
| Boating traffic in Toronto Reservoir | KDWP |
| Quantity and quality of fishing in Toronto Reservoir | KDWP |
| Survey of water quality issues to determine whether information and education programs are having an effect on public perception | KSRE |
| Number of attendees at workshops and field days | KSRE |
| BMP adoptability rates | NRCS |

## 9.2 Phosphorus and Sediment Milestones

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

**Table 49  Water Quality Goals for Phosphorus and Sediment.**

| | Current Condition | Improved Condition | Reduction Needed to Meet TMDL | Current Condition | Improved Condition | Reduction Needed to Meet TMDL |
|---|---|---|---|---|---|---|
| | 2000-2009 Upper 75 percent | 2010-2019 Upper 75 percent | | 2000-2009 Upper 90 percent | 2010-2019 Upper 90 percent | |
| **Sampling Sites** | **Total Phosphorus (median of data collected during indicated period), ppb** | | | **Total Suspended Solids (median of data collected during indicated period), ppm** | | |
| Verdigris River at Virgil | 76 | 50 | **26** | 58 | 27 | **31** |
| West Creek | 68 | 55 | **13** | 37 | 27 | **10** |
| Walnut Creek | 75 | 51 | **24** | 30 | 25 | **5** |


## 9.3 BMP Implementation Milestones

The SLT will review the number of acres, projects or contacts made in the watershed every five years until the end of this WRAPS plan, which is the year 2035.  At the end of each five year period, the SLT will have the option to reassess the goals and alter BMP implementations as they determine is best. Below is the outline of BMP implementations over a twenty five year period.

**Table 50 BMP Implementation Milestones from 2015 to 2035.**

| | Cropland | | | | | Livestock | | | | | Rangeland | | Streambank | Information and Education | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Buffers, acres | No –till, acres | Terraces, acres | Conservation Crop Rotation, acres | Waterways, acres | Filter strips, number | Ponds, number | Relocate Pasture Feeding Sites, number | Off-stream Watering Systems, number | Rotational Grazing, number | Repair Ephemeral Gullies, number | Repair Brine Scars, number | Restoration, feet | Demonstrations/Workshops/ Tours/Field Days. number | I&E and Technical Assistance Contacts/Participants, number |
| 2015 | 625 | 470 | 155 | 80 | 155 | 2 | 4 | 2 | 5 | 2 | 10 | 5 | 5,000 | 70 | 1,250 |
| 2020 | 1,250 | 940 | 310 | 160 | 310 | 4 | 8 | 4 | 10 | 4 | 20 | 10 | 10,000 | 140 | 2,500 |
| 2025 | 1,875 | 1,410 | 465 | 240 | 465 | 6 | 12 | 6 | 15 | 6 | 30 | 15 | 15,000 | 210 | 3,750 |
| 2030 | 2,500 | 1,880 | 620 | 320 | 620 | 8 | 16 | 8 | 20 | 8 | 40 | 20 | 20,000 | 280 | 5,000 |
| 2035 | 2,500 | 1,880 | 620 | 320 | 620 | *12* | *18* | *12* | *25* | *13* | 40 | 20 | 25,000 | 350 | 6,250 |

# 10.0 Monitoring Water Quality Progress

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

KDHE has ongoing monitoring sites in the watershed. There are two types of monitoring sites utilized by KDHE: permanent and rotational. Permanent sites are routinely sampled, whereas rotational sites are only sampled every fourth year. All sampling sites will be continued into the future. Each site is tested for nutrients, metals, ammonia, solid fractions, turbidity, alkalinity, pH, dissolved oxygen, e. coli bacteria and chemicals. Not all sites are tested for these pollutant indicators at each collection time. This is dependent upon the anticipated pollutant concern as well as other factors. For example, herbicide analysis would not be necessary in the winter months as there are no applications at that time.

There are no USGS stream flow data stations in the watershed.

USACE has three sampling sites in Toronto Reservoir. Samples are taken monthly, except in the winter, when conditions allow. Samples taken are analyzed for temperature, turbidity, dissolved oxygen, pH, hardness, salinity, ammonia, nitrate, nitrogen, phosphorus, alkalinity, and total organic carbon.

Much of the evaluative information can be obtained through the existing networks and sampling plans of KDHE and USACE. Public engagement can be obtained through observations of lake clarity, ease of boating and the physical appearance of Toronto Reservoir. Some communications with USACE will supplement any information on the conditions in the Verdigris drainage and on Toronto Reservoir.

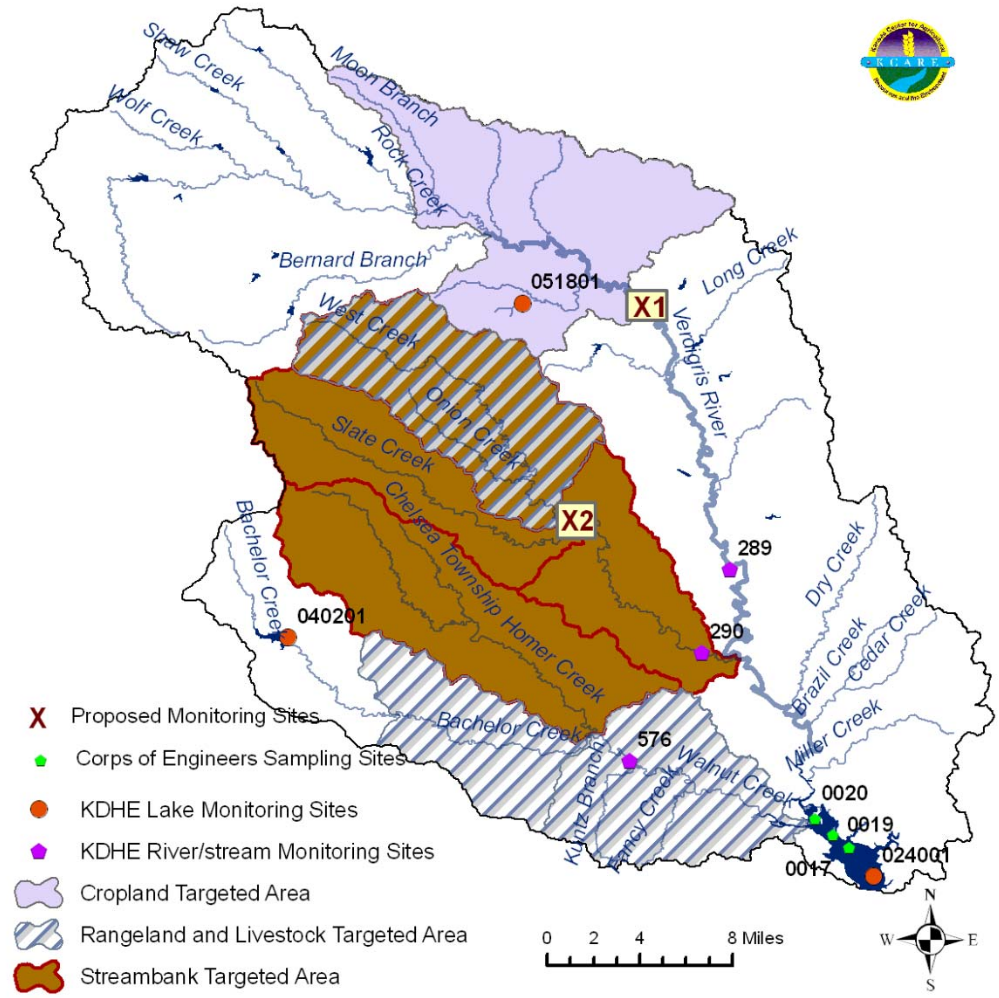



**Figure 37 Monitoring Sites in the Watershed.** [48]

Monitoring data will be used to direct the SLT in their evaluation of water quality progress. The table below indicates which current monitoring sites data will be used by the SLT in determination of effectiveness of BMP implementation. KDHE will be requested to provide any additional monitoring sites that need to be installed. The cost and implementation of these sites will be dependent on KDHE funding.

**Table 51 Monitoring Sites and Tests Needed to Direct SLT in Water Quality Evaluation.**

| Cropland Targeted Area | | | | |
|---|---|---|---|---|
| **Agency** | **Site Number or Name** | **Pollutant Target** | **River, Stream or Lake** | **Sampling Tests Needed** |
| KDHE | 051801 | Sediment Phosphorus | Madison City Lake | Secchi Disk Depth, Turbidity, TSS, pH, DO, Phosphorus, Nitrogen |
| KDHE | 289 | Sediment Phosphorus | Verdigris River | TSS, pH, DO, Phosphorus, Nitrogen |

| Monitoring Sites and Tests Needed, Cont. | | | | |
|---|---|---|---|---|
| **Cropland Targeted Area, Cont.** | | | | |
| **Agency** | **Site Number or Name** | **Pollutant Target** | **River, Stream or Lake** | **Sampling Tests Needed** |
| COE | 0020 | Sediment Phosphorus | Toronto Reservoir | Secchi Disk Depth, Turbidity, TSS, pH, DO, Phosphorus, Nitrogen |
| COE | 0019 | Sediment Phosphorus | Toronto Reservoir | Secchi Disk Depth, Turbidity, TSS, pH, DO, Phosphorus, Nitrogen |
| COE | 0017 | Sediment Phosphorus | Toronto Reservoir | Secchi Disk Depth, Turbidity, TSS, pH, DO, Phosphorus, Nitrogen |
| KDHE | 024001 | Sediment Phosphorus | Toronto Reservoir | Secchi Disk Depth, Turbidity, TSS, pH, DO, Phosphorus, Nitrogen |
| KDHE | Proposed Site X1 | Sediment Phosphorus | Verdigris River | TSS, pH, DO, Phosphorus, Nitrogen |
| **Range and Livestock Targeted Area** | | | | |
| **Agency** | **Site Number or Name** | **Pollutant Target** | **River, Stream or Lake** | **Sampling Tests Needed** |
| KDHE | 576 | Sediment Phosphorus | Homer Creek | TSS, pH, DO, Phosphorus, Nitrogen |
| COE | 0020 | Sediment Phosphorus | Toronto Reservoir | Secchi Disk Depth, Turbidity, TSS, pH, DO, Phosphorus, Nitrogen |
| COE | 0019 | Sediment Phosphorus | Toronto Reservoir | Secchi Disk Depth, Turbidity, TSS, pH, DO, Phosphorus, Nitrogen |
| COE | 0017 | Sediment Phosphorus | Toronto Reservoir | Secchi Disk Depth, Turbidity, TSS, pH, DO, Phosphorus, Nitrogen |
| KDHE | 024001 | Sediment Phosphorus | Toronto Reservoir | Secchi Disk Depth, Turbidity, TSS, pH, DO, Phosphorus, Nitrogen |
| KDHE | Proposed Site X2 | Sediment Phosphorus | West Creek | TSS, pH, DO, Phosphorus, Nitrogen |

*Continued on next page*.

| Monitoring Sites and Tests Needed, Cont. | | | | |
|---|---|---|---|---|
| **Streambank Targeted Area** | | | | |
| **Agency** | **Site Number or Name** | **Pollutant Target** | **River, Stream or Lake** | **Sampling Tests Needed** |
| KDHE | 290 | Sediment Phosphorus | West Creek | TSS, pH, DO, Phosphorus, Nitrogen |
| COE | 0020 | Sediment Phosphorus | Toronto Reservoir | Secchi Disk Depth, Turbidity, TSS, pH, DO, Phosphorus, Nitrogen |
| COE | 0019 | Sediment Phosphorus | Toronto Reservoir | Secchi Disk Depth, Turbidity, TSS, pH, DO, Phosphorus, Nitrogen |
| COE | 0017 | Sediment Phosphorus | Toronto Reservoir | Secchi Disk Depth, Turbidity, TSS, pH, DO, Phosphorus, Nitrogen |
| KDHE | 024001 | Sediment Phosphorus | Toronto Reservoir | Secchi Disk Depth, Turbidity, TSS, pH, DO, Phosphorus, Nitrogen |

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

- The Cropland Targeted Area could benefit with an additional monitoring site on the Verdigris River at the base of the Targeted Area (site X1 on Figure 36).
- The Livestock Targeted Area could benefit from a monitoring site at the confluence of West Creek and Slate Creek (site X2 on Figure 36). The Livestock Targeted Area along Walnut Creek has monitoring sites at the entrance to Toronto Reservoir.
- The Streambank Targeted Area has a monitoring site at the confluence of West Creek and the Verdigris River that is sufficient for West Creek. Walnut Creek has a monitoring site slightly downstream from the end of the Streambank Targeted Area that should be sufficient.

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 and COE data will be shared with the SLT and can then be passed on to the watershed residents by way of the information and education efforts discussed previously.

Monitoring data will be used to direct the SLT in their evaluation of water quality progress. KDHE will be requested to meet with the SLT to review the monitoring data accumulated by their sites on a yearly basis. However, the overall strategy and alterations of the WRAPS plan will be discussed with KDHE immediately after each update of the 303d list and subsequent TMDL designation. The upcoming years for this in the Toronto Watershed is 2013 and 2018. At this time, the plan can be altered or modified in order to meet the water quality goals as assigned by the SLT in the beginning of the WRAPS process.

# 11.0 Review of the Watershed Plan in 2015

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

1. The SLT will ask KDHE for a report on the milestone achievements in **sediment** load reductions. The 2015 milestone for sediment should be based on the total suspended solids concentration in the watershed. In 2020, the milestones for total suspended solids reductions for the Verdigris River at Virgil, West Creek and Walnut Creek are 31, 10 and 5 ppm, respectively. Therefore, at the end of five years, the SLT should expect to see approximately half of that number.
2. The SLT will request from KDHE a report on the milestone achievements in **phosphorus** load reductions. The 2015 milestone for phosphorus should be based on the phosphorus concentration in the watershed. In 2020, the milestones for phosphorus reductions for the Verdigris River at Virgil, West Creek and Walnut Creek are 26, 13 and 24 ppb, respectively. Therefore, at the end of five years, the SLT should expect to see approximately half of that number.
3. The SLT will request a report from KDHE concerning the revisions of the TMDLs from 2013.
4. The SLT will request a report from KDHE, USCOE Kansas Department of Wildlife and Parks on trends in water quality in Toronto Reservoir.
5. The SLT will report on progress towards achieving the adoption rates listed in Section 9.1 of this report.
6. The SLT will report on progress towards achieving the benchmarks listed in Section 9.2 of this report.
7. The SLT will report on progress towards achieving the BMP implementations in Section 9.3 of this report.
8. The SLT will discuss the impairments on the 303d list and the possibility of addressing these impairments prior to listing as TMDLs.
9. The SLT will discuss the effect of implementing BMPs aimed at specific TMDLs on the impairments listed on the 303d list.
10. The SLT will discuss necessary adjustments and revisions needed in the targets listed in this plan.

# 12.0 Appendix

## 12.1 Service Providers

**Table 52 Potential Service Provider Listing.**

| Organization | Programs | Purpose | Technical or Financial Assistance | Phone | Website address |
|---|---|---|---|---|---|
| **Environmental Protection Agency** | Clean Water State Revolving Fund Program<br><br>Watershed Protection | Provides low cost loans to communities for water pollution control activities.<br><br>To conduct holistic strategies for restoring and protecting aquatic resources based on hydrology rather than political boundaries. | Financial | 913-551-7003<br><br>913-551-7003 | www.epa.gov |
| **Kansas Alliance for Wetlands and Streams** | Streambank Stabilization<br>Wetland Restoration<br>Cost share programs | The Kansas Alliance for Wetlands and Streams (KAWS) organized in 1996 to promote the protection, enhancement, restoration and establishment wetlands and streams in Kansas. | Technical | 620-241-3636 | www.kaws.org |
| **Kansas Dept. of Agriculture** | Watershed structures permitting. | Available for watershed districts and multipurpose small lakes development. | Technical and Financial | 785-296-2933 | www.accesskansas.org/kda |

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

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

| Organization | Programs and Technical Assistance | Purpose | Technical or Financial Assistance | Phone | Website address |
|---|---|---|---|---|---|
| **Kansas Forest Service** | Conservation Tree Planting Program<br><br>Riparian and Wetland Protection Program | Provides low cost trees and shrubs for conservation plantings.<br><br>Work closely with other agencies to promote and assist with establishment of riparian forestland and manage existing stands. | Technical | 785-532-3312<br><br>785-532-3310 | www.kansasforests.org |
| **Kansas Rural Center** | The Heartland Network<br>Clean Water Farms-River Friendly Farms<br>Sustainable Food Systems Project<br>Cost share programs | The Center is committed to economically viable, environmentally sound and socially sustainable rural culture. | Technical and Financial | 913-873-3431 | http://www.kansasruralcenter.org |
| **Kansas Rural Water Association** | Technical assistance for Water Systems with Source Water Protection Planning. | Provide education, technical assistance and leadership to public water and wastewater utilities to enhance the public health and to sustain Kansas' communities | Technical | 785-336-3760 | http://www.krwa.net |

| | | | | | |
|---|---|---|---|---|---|
| **Kansas State Research and Extension** | 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. | | | www.ksre.ksu.edu/kelp |
| | Kansas Local Government Water Quality Planning and Management | Provide guidance to local governments on water protection programs. | | 785-532-2643 | www.ksre.ksu.edu/olg |
| | Rangeland and Natural Area Services (RNAS) | Reduce non-point source pollution emanating from Kansas grasslands. | Technical | 785-532-0416 | |
| | WaterLINK | Service-learning projects available to college and university faculty and community watersheds in Kansas. | | | 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. | | 785-532-5640 | www.kansasprideprogram.ksu.edu/healthyecosystems/ |
| | Citizen Science | Education combined with volunteer soil and water testing for enhanced natural resource stewardship. | | | www.ksre.ksu.edu/kswater/ |

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

| | | | | | |
|---|---|---|---|---|---|
| **State Conservation Commission and Conservation Districts** | Water Resources Cost Share<br><br>Nonpoint Source Pollution Control Fund<br><br>Riparian and Wetland Protection Program<br><br>Stream Rehabilitation Program<br><br>Kansas Water Quality Buffer Initiative<br><br>Watershed district and multipurpose lakes | Provide cost share assistance to landowners for establishment of water conservation practices.<br><br>Provides financial assistance for nonpoint pollution control projects which help restore water quality.<br><br>Funds to assist with wetland and riparian development and enhancement.<br><br>Assist with streams that have been adversely altered by channel modifications.<br><br>Compliments Conservation Reserve Program by offering additional financial incentives for grass filters and riparian forest buffers.<br><br>Programs are available for watershed district and multipurpose small lakes. | Technical and Financial | Greenwood Co 620-583-5544<br><br>Lyon Co 620-343-2812<br><br>Chase Co 620-273-6462 | www.accesskansas.org/kscc<br><br>http://www.kacdnet.org/ |

| Organization | Programs and Technical Assistance | Purpose | Technical or Financial Assistance | Phone | Website address |
|---|---|---|---|---|---|
| **U.S. Army Corps of Engineers (USACE)** | Planning Assistance to States<br><br>Environmental Restoration | Assistance in development of plans for development, utilization and conservation of water and related land resources of drainage<br><br>Funding assistance for aquatic ecosystem restoration. | Technical | 816-983-3157<br><br>816-983-3157 | www.usace.army.mil |
| **US Fish and Wildlife Service** | Fish and Wildlife Enhancement Program<br><br>Private Lands Program | Supports field operations which include technical assistance on wetland design.<br><br>Contracts to restore, enhance, or create wetlands. | Technical | 785-539-3474<br><br>785-539-3474 | www.fws.gov |
| **US Geological Survey** | National Streamflow Information Program<br><br>Water Cooperative Program | Provide streamflow data<br><br>Provide cooperative studies and water-quality information | Technical | 785-832-3539 | http://ks.water.usgs.gov<br>http://nrtwq.usgs.gov |

| Organization | Programs and Technical Assistance | Purpose | Technical or Financial Assistance | Phone | Website address |
|---|---|---|---|---|---|
| **USDA-Natural Resources Conservation Service and Farm Service Agency** | Conservation Compliance<br><br>Conservation Operations<br><br>Watershed Planning and Operations<br><br>Wetland Reserve Program<br><br>Wildlife Habitat Incentives Program<br><br>Grassland Reserve Program, EQIP, and Conservation Reserve Program | Primarily for the technical assistance to develop conservation plans on cropland.<br><br>To provide technical assistance on private land for development and application of Resource Management Plans.<br><br>Primarily focused on high priority areas where agricultural improvements will meet water quality objectives.<br><br>Cost share and easements to restore wetlands.<br><br>Cost share to establish wildlife habitat which includes wetlands and riparian areas.<br><br>Improve and protect rangeland resources with cost-sharing practices, rental agreements, and easement purchases. | Technical and Financial | Greenwood Co 620-583-5544<br><br>Lyon Co 620-343-2812<br><br>Chase Co 620-273-6462 | www.ks.nrcs.usda.gov |

## 12.2 BMP Definitions

### 12.2.1 Cropland

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

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

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

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

Terraces
-Earth embankment and/or channel constructed across the slope to intercept runoff water and trap soil.
-One of the oldest/most common BMPs.

-30 percent Erosion Reduction Efficiency, 30 percent phosphorous reduction efficiency.
-$1.02 per linear foot, 50 percent cost-share available from NRCS.

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

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

### 12.2.2 Livestock

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

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

Alternative (Off-Stream) Watering System
-Watering system so that livestock do not enter stream or body of water.
-Studies show cattle will drink from tank over a stream or pond 80 percent of the time.

-10-25 year lifespan, average P reduction: 30-98 percent with greater efficiencies for limited stream access.
-$3,795 installed for solar system, including present value of maintenance costs.

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

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

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

## 12.3 Appendix Tables

The tables below are for subbasins in the cropland targeted area only. The targeted areas for livestock and rangeland BMPs are within a relatively small and well defined area. With the restrictions of only spending WRAPS funds within these areas on BMP implementation the SLT required the freedom to be able to implement BMPs wherever there are willing land owners within this area. Hence, we have not broken down specific BMP implementation goals by sub-watershed, only goals for the entire targeted area to give the SLT more freedom. When this plan is reviewed in five years the SLT will inventory BMPs implemented and will then determine if they need to focus on a single targeted area with more intensity.

### 12.3.1 Adoption Rates for Cropland Sub Watersheds

**Table 53 Adoption Rates for Cropland Sub Watersheds.**

| Sub Watershed #3 Annual Adoption (acres), Cropland BMPs | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Year | Buffer | No-Till | Terraces | Cons Rotation | Waterways | Total Acreage |
| Short Term | 1 | 43 | 32 | 11 | 5 | 11 | 101 |
| | 2 | 43 | 32 | 11 | 5 | 11 | 101 |
| | 3 | 43 | 32 | 11 | 5 | 11 | 101 |
| ***Total*** | | *128* | *96* | *32* | *16* | *32* | *304* |

| Adoption Rates for Cropland Sub Watersheds, Cont. | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Medium Term** | 4 | 43 | 32 | 11 | 5 | 11 | 101 |
| | 5 | 43 | 32 | 11 | 5 | 11 | 101 |
| | 6 | 43 | 32 | 11 | 5 | 11 | 101 |
| ***Total*** | | *256* | *192* | *64* | *32* | *64* | *608* |
| **Long Term** | 7 | 43 | 32 | 11 | 5 | 11 | 101 |
| | 8 | 43 | 32 | 11 | 5 | 11 | 101 |
| | 9 | 43 | 32 | 11 | 5 | 11 | 101 |
| | 10 | 43 | 32 | 11 | 5 | 11 | 101 |
| | 11 | 43 | 32 | 11 | 0 | 11 | 96 |
| | 12 | 43 | 32 | 11 | 0 | 11 | 96 |
| | 13 | 43 | 32 | 11 | 0 | 11 | 96 |
| | 14 | 43 | 32 | 11 | 0 | 11 | 96 |
| | 15 | 43 | 32 | 11 | 0 | 11 | 96 |
| | 16 | 43 | 32 | 11 | 0 | 11 | 96 |
| | 17 | 43 | 32 | 11 | 0 | 11 | 96 |
| | 18 | 43 | 32 | 11 | 0 | 11 | 96 |
| | 19 | 43 | 32 | 11 | 0 | 11 | 96 |
| | 20 | 43 | 32 | 11 | 0 | 11 | 96 |
| ***Total*** | | *853* | *640* | *213* | *53* | *213* | *1,973* |

**Sub Watershed #5 Annual Adoption (acres), Cropland BMPs**

| | Year | Buffer | No-Till | Terraces | Cons Rotation | Waterways | Total Acreage |
|---|---|---|---|---|---|---|---|
| **Short Term** | 1 | 83 | 62 | 21 | 10 | 21 | 197 |
| | 2 | 83 | 62 | 21 | 10 | 21 | 197 |
| | 3 | 83 | 62 | 21 | 10 | 21 | 197 |
| ***Total*** | | *248* | *186* | *62* | *31* | *62* | *590* |
| **Medium Term** | 4 | 83 | 62 | 21 | 10 | 21 | 197 |
| | 5 | 83 | 62 | 21 | 10 | 21 | 197 |
| | 6 | 83 | 62 | 21 | 10 | 21 | 197 |
| ***Total*** | | *497* | *373* | *124* | *62* | *124* | *1,180* |
| **Long Term** | 7 | 83 | 62 | 21 | 10 | 21 | 197 |
| | 8 | 83 | 62 | 21 | 10 | 21 | 197 |
| | 9 | 83 | 62 | 21 | 10 | 21 | 197 |
| | 10 | 83 | 62 | 21 | 10 | 21 | 197 |
| | 11 | 83 | 62 | 21 | 0 | 21 | 186 |
| | 12 | 83 | 62 | 21 | 0 | 21 | 186 |
| | 13 | 83 | 62 | 21 | 0 | 21 | 186 |
| | 14 | 83 | 62 | 21 | 0 | 21 | 186 |
| | 15 | 83 | 62 | 21 | 0 | 21 | 186 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Adoption Rates for Cropland Sub Watersheds, Cont.** | | | | | | |
| | 16 | 83 | 62 | 21 | 0 | 21 | 186 |
| | 17 | 83 | 62 | 21 | 0 | 21 | 186 |
| | 18 | 83 | 62 | 21 | 0 | 21 | 186 |
| | 19 | 83 | 62 | 21 | 0 | 21 | 186 |
| | 20 | 83 | 62 | 21 | 0 | 21 | 186 |
| ***Total*** | | *1,656* | *1,242* | *414* | *103* | *414* | *3,829* |

### 12.3.2 Annual Costs for Cropland Sub Watersheds

**Table 54 Costs for Cropland Sub Watersheds.**

**Sub-Watershed #3 Annual Cost Before Cost-Share, Cropland BMPs**

| Year | Buffer | No-Till | Terraces | Cons Rotation | Waterways | Total Cost |
|---|---|---|---|---|---|---|
| 1 | $2,843 | $2,485 | $1,088 | $207 | $853 | $7,476 |
| 2 | $2,929 | $2,560 | $1,120 | $213 | $879 | $7,700 |
| 3 | $3,016 | $2,636 | $1,154 | $220 | $905 | $7,931 |
| 4 | $3,107 | $2,716 | $1,188 | $226 | $932 | $8,169 |
| 5 | $3,200 | $2,797 | $1,224 | $233 | $960 | $8,414 |
| 6 | $3,296 | $2,881 | $1,261 | $240 | $989 | $8,667 |
| 7 | $3,395 | $2,967 | $1,299 | $247 | $1,019 | $8,927 |
| 8 | $3,497 | $3,056 | $1,338 | $255 | $1,049 | $9,195 |
| 9 | $3,602 | $3,148 | $1,378 | $262 | $1,081 | $9,470 |
| 10 | $3,710 | $3,242 | $1,419 | $270 | $1,113 | $9,755 |
| 11 | $3,821 | $3,340 | $1,462 | $0 | $1,146 | $9,769 |
| 12 | $3,936 | $3,440 | $1,505 | $0 | $1,181 | $10,062 |
| 13 | $4,054 | $3,543 | $1,551 | $0 | $1,216 | $10,364 |
| 14 | $4,175 | $3,649 | $1,597 | $0 | $1,253 | $10,675 |
| 15 | $4,301 | $3,759 | $1,645 | $0 | $1,290 | $10,995 |
| 16 | $4,430 | $3,872 | $1,694 | $0 | $1,329 | $11,325 |
| 17 | $4,563 | $3,988 | $1,745 | $0 | $1,369 | $11,665 |
| 18 | $4,700 | $4,107 | $1,798 | $0 | $1,410 | $12,014 |
| 19 | $4,841 | $4,231 | $1,852 | $0 | $1,452 | $12,375 |
| 20 | $4,986 | $4,358 | $1,907 | $0 | $1,496 | $12,746 |

**Sub-Watershed #5 Annual Cost Before Cost-Share, Cropland BMPs**

| Year | Buffer | No-Till | Terraces | Cons Rotation | Waterways | Total Cost |
|---|---|---|---|---|---|---|
| 1 | $5,519 | $4,824 | $2,111 | $402 | $1,656 | $14,512 |
| 2 | $5,685 | $4,969 | $2,174 | $414 | $1,705 | $14,948 |
| 3 | $5,855 | $5,118 | $2,240 | $426 | $1,757 | $15,396 |
| 4 | $6,031 | $5,271 | $2,307 | $439 | $1,809 | $15,858 |

**Costs for Cropland Sub Watersheds, Cont.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 5 | $6,212 | $5,429 | $2,376 | $452 | $1,864 | $16,334 |
| 6 | $6,398 | $5,592 | $2,447 | $466 | $1,920 | $16,824 |
| 7 | $6,590 | $5,760 | $2,521 | $480 | $1,977 | $17,328 |
| 8 | $6,788 | $5,933 | $2,596 | $494 | $2,036 | $17,848 |
| 9 | $6,992 | $6,111 | $2,674 | $509 | $2,098 | $18,384 |
| 10 | $7,202 | $6,294 | $2,755 | $524 | $2,160 | $18,935 |
| 11 | $7,418 | $6,483 | $2,837 | $0 | $2,225 | $18,963 |
| 12 | $7,640 | $6,678 | $2,922 | $0 | $2,292 | $19,532 |
| 13 | $7,869 | $6,878 | $3,010 | $0 | $2,361 | $20,118 |
| 14 | $8,105 | $7,084 | $3,100 | $0 | $2,432 | $20,721 |
| 15 | $8,349 | $7,297 | $3,193 | $0 | $2,505 | $21,343 |
| 16 | $8,599 | $7,516 | $3,289 | $0 | $2,580 | $21,983 |
| 17 | $8,857 | $7,741 | $3,388 | $0 | $2,657 | $22,643 |
| 18 | $9,123 | $7,973 | $3,489 | $0 | $2,737 | $23,322 |
| 19 | $9,396 | $8,213 | $3,594 | $0 | $2,819 | $24,022 |
| 20 | $9,678 | $8,459 | $3,702 | $0 | $2,903 | $24,743 |

**Sub-Watershed #3 Annual Cost After Cost-Share, Cropland BMPs**

| Year | Buffer | No-Till | Terraces | Cons Rotation | Waterways | Total Cost |
|---|---|---|---|---|---|---|
| 1 | $284 | $1,516 | $544 | $207 | $426 | $2,978 |
| 2 | $293 | $1,561 | $560 | $213 | $439 | $3,067 |
| 3 | $302 | $1,608 | $577 | $220 | $452 | $3,159 |
| 4 | $311 | $1,656 | $594 | $226 | $466 | $3,254 |
| 5 | $320 | $1,706 | $612 | $233 | $480 | $3,351 |
| 6 | $330 | $1,757 | $630 | $240 | $494 | $3,452 |
| 7 | $340 | $1,810 | $649 | $247 | $509 | $3,555 |
| 8 | $350 | $1,864 | $669 | $255 | $525 | $3,662 |
| 9 | $360 | $1,920 | $689 | $262 | $540 | $3,772 |
| 10 | $371 | $1,978 | $710 | $270 | $556 | $3,885 |
| 11 | $382 | $2,037 | $731 | $0 | $573 | $3,723 |
| 12 | $394 | $2,098 | $753 | $0 | $590 | $3,835 |
| 13 | $405 | $2,161 | $775 | $0 | $608 | $3,950 |
| 14 | $418 | $2,226 | $799 | $0 | $626 | $4,069 |
| 15 | $430 | $2,293 | $823 | $0 | $645 | $4,191 |
| 16 | $443 | $2,362 | $847 | $0 | $664 | $4,316 |
| 17 | $456 | $2,433 | $873 | $0 | $684 | $4,446 |
| 18 | $470 | $2,506 | $899 | $0 | $705 | $4,579 |
| 19 | $484 | $2,581 | $926 | $0 | $726 | $4,717 |
| 20 | $499 | $2,658 | $954 | $0 | $748 | $4,858 |

**Adoption Rates for Cropland Sub Watersheds, Cont.**

**Sub-Watershed #5 Annual Cost After Cost-Share, Cropland BMPs**

| Year | Buffer | No-Till | Terraces | Cons Rotation | Waterways | Total Cost |
|---|---|---|---|---|---|---|
| 1 | $552 | $2,943 | $1,056 | $402 | $828 | $5,780 |
| 2 | $568 | $3,031 | $1,087 | $414 | $853 | $5,953 |
| 3 | $586 | $3,122 | $1,120 | $426 | $878 | $6,132 |
| 4 | $603 | $3,215 | $1,153 | $439 | $905 | $6,316 |
| 5 | $621 | $3,312 | $1,188 | $452 | $932 | $6,505 |
| 6 | $640 | $3,411 | $1,224 | $466 | $960 | $6,701 |
| 7 | $659 | $3,514 | $1,260 | $480 | $989 | $6,902 |
| 8 | $679 | $3,619 | $1,298 | $494 | $1,018 | $7,109 |
| 9 | $699 | $3,728 | $1,337 | $509 | $1,049 | $7,322 |
| 10 | $720 | $3,839 | $1,377 | $524 | $1,080 | $7,542 |
| 11 | $742 | $3,955 | $1,419 | $0 | $1,113 | $7,228 |
| 12 | $764 | $4,073 | $1,461 | $0 | $1,146 | $7,444 |
| 13 | $787 | $4,195 | $1,505 | $0 | $1,180 | $7,668 |
| 14 | $811 | $4,321 | $1,550 | $0 | $1,216 | $7,898 |
| 15 | $835 | $4,451 | $1,597 | $0 | $1,252 | $8,135 |
| 16 | $860 | $4,585 | $1,645 | $0 | $1,290 | $8,379 |
| 17 | $886 | $4,722 | $1,694 | $0 | $1,329 | $8,630 |
| 18 | $912 | $4,864 | $1,745 | $0 | $1,368 | $8,889 |
| 19 | $940 | $5,010 | $1,797 | $0 | $1,409 | $9,156 |
| 20 | $968 | $5,160 | $1,851 | $0 | $1,452 | $9,430 |

# 13.0 Bibliography


[1] Kansas Water Office. Reservoir Fact Sheets. http://www.kwu.org

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

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

[4] Calculated from Kansas Applied Remote Sensing Program, 2001. Kansas Geospatial Community Commons.

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

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

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

[8] Kansas Water Office. December, 2009.

[9] Internet source. http://www.pollutionissues.com/

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

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

[12] Kansas Geospatial Community Commons. Kansas Department of Health and Environment. Rural Water Districts, 2006, Public Water Supply, 1994. NPDES Treatment Facilities, 1994. http://www.kansasgis.org/catalog/catalog.cfm

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

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

[15] Kansas Department of Health and Environment. The Basics of TMDLs. http://www.kdheks.gov/tmdl/

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

[17] Kansas Department of Health and Environment, 2002. http://www.kdheks.gov/tmdl/

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

[19] Kansas Department of Health and Environment. 2010. http://www.kdheks.gov/tmdl/index.htm

[20] Kansas Department of Health and Environment, 2008. http://www.kdheks.gov/tmdl/

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

[22] Calculated from National Land Cover Database, 2001.

[23] Kansas Geospatial Commons. US Department of Agriculture Natural Resources Conservation Service. Calculated from Riparian Inventory, 1991. http://www.kansasgis.org/catalog/catalog.cfm

[24] Available at: http://www.ksre.ksu.edu/library/

[25] Available at: http://www.mwps.org/index.cfm

[26] MF-2737 Available at: http://www.ksre.ksu.edu/library/
MF-2454 Available at: http://www.ksre.ksu.edu/library/

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

[28]

[29] NRCS T factor. http://www.nrcs.usda.gov/technical/NRI/ and http://www.umbsn.org/watershed_programs/

[30] Geospatial Commons. US Department of Agriculture Natural Resources Conservation Service. SSURGO. http://www.kansasgis.org/catalog/catalog.cfm

[31] Geospatial Commons. US Department of Agriculture Natural Resources Conservation Service. SSURGO. http://www.kansasgis.org/catalog/catalog.cfm

[32] Kansas Geological Society, Kansas Corporation Commission, 2009. http://www.kgs.ku.edu/PRS/petroDB.html

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

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

[35] CAFO data provided by Kansas Department of Health and Environment, 2003. Data may be dated and subject to change. Grazing density obtained from US Department of Agriculture National Agricultural Statistics Service, 2002. http://nationalatlas.gov/atlasftp.html

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

[37] US Census Bureau, 2008. http://quickfacts.census.gov/qfd/states/2008.html
[38] Kansas Geospatial Commons. US Census Bureau. Tiger 2000 Census Blocks. http://www.kansasgis.org/catalog/catalog.cfm

[39] USDA/NRCS National Water and Climactic Center.

[40] Kansas Department of Health and Environment. 2010. http://www.kdheks.gov/tmdl/2010_tmdls.htm

[41] Kansas Geospatial Commons. Kansas Department of Health and Environment, 2006.

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

[43] Total farm use in the counties of the watershed by percentage. 2007 Census of Agriculture National Agricultural Statistic Service. (www.agcensus.usda.gov)

[44] Environmental Protection Agency. Ecoregions Level 3 in Texas and Oklahoma and Level 4 in Kansas. http://www.epa.gov/wed/pages/ecoregions.htm

[45] Conservation Tree/Shrub Plantings Suitability Groups, Windbreak Suitability Groups, and Plantings for Kansas. Kansas Forestry Technical Note KS-10. http://www.ks.nrcs.usda.gov/technical/

[46] Geyer W., K. Brooks, and T. Neppl. Streambank Stability of Two Kansas River Systems during the 1993 Flood in Kansas, USA. 2003. Transactions of the Kansas Academy of Science 106(1/2): p 48-53

[47] Riparian Forest Buffer Best Management Practices. http://www.kansasforests.org/

[48] Kansas Geospatial Commons. Environmental Stream Monitoring Sites 1997. Environmental Lake Monitoring Sites 1994. http://www.kansasgis.org/catalog/catalog.cfm