Upper Wakarusa Watershed Restoration and Protection Strategies (WRAPS) Plan

2023

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KCARE
Kansas Center for Agricultural Resources and the Environment

Kansas Department of Health and Environment

UPPER WAKARUSA WRAPS

K-STATE Research and Extension

Upper Wakarusa Watershed
Project Leadership Team

Upper Wakarusa WRAPS
Andrew Rutter, WRAPS Coordinator

Stakeholder Leadership Team
As of March 2023, there are 23 members of the Upper Wakarusa SLT.
SLT membership includes: local producers, landowners, and representatives from Douglas, Osage, Shawnee and Wabaunsee Conservation Districts.

Kansas State University
Will Boyer, Northeast Kansas Watershed Specialist
Daniel Skucius, Northeast Kansas Watershed Specialist
Amanda Schielke, Kansas Center for Agricultural Resources and the Environment (KCARE)
Melissa Harvey, KCARE

Kansas Department of Health and Environment
Riley VandeVen, Project Officer, Watershed Management Section
Mike Beezhold, Chief of the Watershed Management Section

Additional Technical Assistance
County Conservation Districts in the Upper Wakarusa Watershed
Kansas Department of Health and Environment
Kansas Department of Wildlife and Parks
Natural Resources Conservation Service

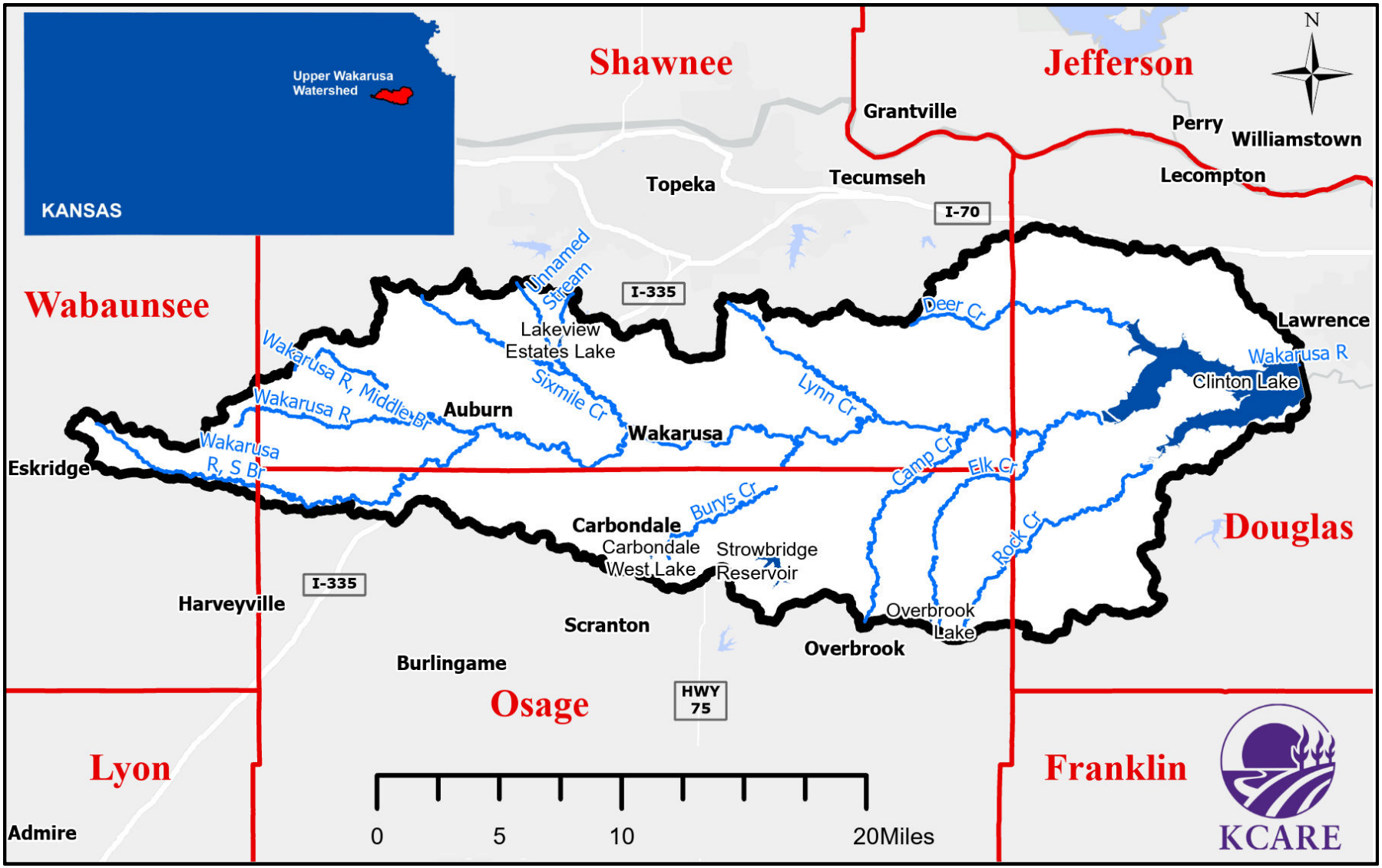

KANSAS
Upper Wakarusa Watershed
Shawnee
Jefferson
Wabaunsee
Osage
Lyon
Franklin
Douglas
Grantville
Perry
Williamstown
Lecompton
Topeka
Tecumseh
I-70
I-335
Unnamed Stream
Lakeview Estates Lake
Deer Cr
Lawrence
Wakarusa R
Clinton Lake
Wakarusa R, Middle Br
Wakarusa R
Sixmile Cr
Lynn Cr
Auburn
Wakarusa
Eskridge
Wakarusa R, S Br
Camp Cr
Elk Cr
Burys Cr
Carbondale
Carbondale West Lake
Strowbridge Reservoir
Rock Cr
Harveyville
I-335
Scranton
Overbrook Lake
Overbrook
Burlingame
HWY 75
Admire
0
5
10
20Miles
N
KCARE

Table of Contents

List of Figures

List of Tables

Glossary of Terms and Acronyms

Best Management Practices (BMPs): 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 used in photosynthesis, found in algae and other aquatic plants. Can be used for measurement of eutrophication in a water body.

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

***E. coli* bacteria (ECB):** Bacteria normally found in gastrointestinal tracts of animals. Some strains cause diarrheal diseases and are pathogenic to humans.

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

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

Hydrologic Unit Code (HUC): An identification system using numerical digits for watersheds. The smaller the watershed, the more digits a HUC will have.

KDHE: Kansas Department of Health and Environment.

KSRE: Kansas State University Research and Extension.

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

Nitrates: Final product of ammonia's biochemical oxidation, originating from manure and fertilizers. Primary source of nitrogen for plants.

Nitrogen (N): Element essential for plants and animals.

Nonpoint sources (NPS): Any activity not required to have a NPDES permit and results in the release of pollutants to waters of the state. This release may result from precipitation runoff, aerial drift and deposition from the air, or the release of subsurface brine or other contaminated groundwaters to surface waters of the state.

Nutrients: Nitrogen and/or phosphorus in a water source.

Phosphorus (P): Element in water that, in excess, can lead to increased biological activity which may cause eutrophication.

Point sources (PS): Any discernible, confined, and discrete conveyance from which pollutants are or could be discharged.

Riparian zone: Areas of interchange between land and water alongside bodies of water.

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

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

Stakeholder Leadership Team (SLT): Organization of watershed residents, landowners, farmers, ranchers, agency personnel, and any other 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 surface water-quality standards which results in failure to support their designated uses.

Total Nitrogen (TN): A chemical measurement of all nitrogen forms in a water sample.

Total Phosphorus (TP): A chemical measurement of all phosphorus forms in a water sample.

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

WRAPS: Watershed Restoration and Protection Strategy.

1. Preface and Plan Update

The purpose of this Watershed Restoration and Protection Strategy (WRAPS) report for the **Upper Wakarusa Watershed** is to outline a plan of restoration and protection goals and actions for this watershed's surface waters. Watershed goals can be characterized as either "restoration" or "protection." Watershed *restoration* refers to surface waters that fail to meet water quality standards and for areas of the watershed that need improvement in habitat, land management, or other attributes. Watershed *protection* refers to surface waters currently meeting water quality standards but require protection from future degradation.

In the WRAPS process, local communities and government agencies work together toward the common goal of a healthy environment. By working as a WRAPS team, communities can take several steps toward watershed restoration and protection. Local participants, or stakeholders, provide valuable grass-roots leadership, responsibility, and resource management throughout. These community members work together to ensure that their lands' water quality is protected because they have the most at stake. Agencies bring to the table science-based information, communication, and technical and financial assistance. The team works within the watershed to build awareness and education, to engage local leadership, and to monitor and evaluate watershed conditions; they also assess, plan, and implement the WRAPS process at the local level. By working as a WRAPS team, communities can take several steps toward watershed restoration and protection.

Other crucial objectives for the WRAPS process are to maintain recreational opportunities and biodiversity while protecting the environment from flooding and the negative effects of urbanization and industrial production. Final watershed goals are to provide a sustainable water source for drinking and domestic use while preserving food, fiber, and timber production. The ultimate WRAPS goal is a **restored and protected watershed**: "local hands caring for local lands" in partnership with government agencies to improve the environment for everyone.

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

Plan Update: The Kaw Valley Heritage Alliance (KVHA) was formed in 1995 in response to increased public awareness regarding the value of the Kansas River and its environs. The KVHA aimed to address a broad range of attributes of the Kansas River Valley and it was determined that water quality issues were one of the group's highest priorities. The Upper Wakarusa WRAPS group was established when the KVHA formed a sub-committee known as the "Core Group" in 2002. The group was made up of representatives from the Kansas Department of Health and Environment (KDHE), Kansas Biological Survey (KBS), Natural Resources Conservation Service (NRCS), City of Lawrence, Kansas State University, and the State Conservation Commission, which is now referred to as the Division of Conservation (DOC). This "Core Group" is now known as the stakeholder leadership team (SLT). The original WRAPS plan was written in 2003.

The Kansas Alliance for Wetlands and Streams (KAWS) had been providing limited financial and technical support for restoration activities. In 2006, KAWS was awarded a grant from KDHE to coordinate Upper Wakarusa WRAPS efforts. An updated plan was written, submitted, and approved in 2011.

Outdated WRAPS plan implementation goals became apparent after targeting and TMDL revisions from KDHE were made available. Therefore, the Upper Wakarusa WRAPS plan was updated and revised in 2023 by Kansas State University staff and KDHE, with the guidance of the Upper Wakarusa WRAPS Coordinator, KAWS, and the SLT.

***Note**: Tables throughout this plan use rounded figures.*

2. Upper Wakarusa WRAPS Introduction

This section discusses the importance of a WRAPS plan and describes the key collaborators who strive to make it effective, with a special focus on the Upper Wakarusa Watershed's location and stakeholders.

A. What is a Watershed?

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

B. What is a Watershed Restoration and Protection Strategy (WRAPS)?

WRAPS is a planning and management framework built to engage local citizen-stakeholders within a particular watershed. It is a process used to **identify** restoration and protection needs, to **establish** management goals for the watershed community, to **create** an action plan to achieve those goals, and to **implement** the action plan.

The acronym "WRAPS" originated from KDHE in response to the 1998 Clean Water Action Plan issued by the Clinton Administration. The Clean Water Action Plan directed the state environmental agency and the state conservationist of every state to complete a "unified watershed assessment." Upon completion of the assessment, states were directed to develop "watershed restoration action strategies" (WRAS).

The state of Kansas contends that restoring damage to a watershed is insufficient because it addresses only part of the need; action to protect water is a necessity, hence the new term WRAPS. "WRAPS" refers to the development of action plans that address nonpoint source pollution on a watershed basis. WRAPS projects are initiated by watershed stakeholders and receive financial support from KDHE to address Total Maximum Daily Loads (TMDLs) and related water quality concerns.

The WRAPS initiative is intended to address priority issues identified in the basin sections of the Kansas Water Plan through the development and implementation of WRAPS in priority watersheds.

C. Watershed Location

There are 12 major river basins in Kansas. The scope of this WRAPS plan will focus on the Upper Wakarusa Watershed. This watershed is in the northeastern part of the state of Kansas. The Upper Wakarusa WRAPS area is in the Kansas-Lower Republican River Basin (**Figure**

1). The Kansas-Lower Republican River basin is part of the larger Missouri River Basin, which is a sub-watershed of the Mississippi River Basin, the largest watershed in North America.

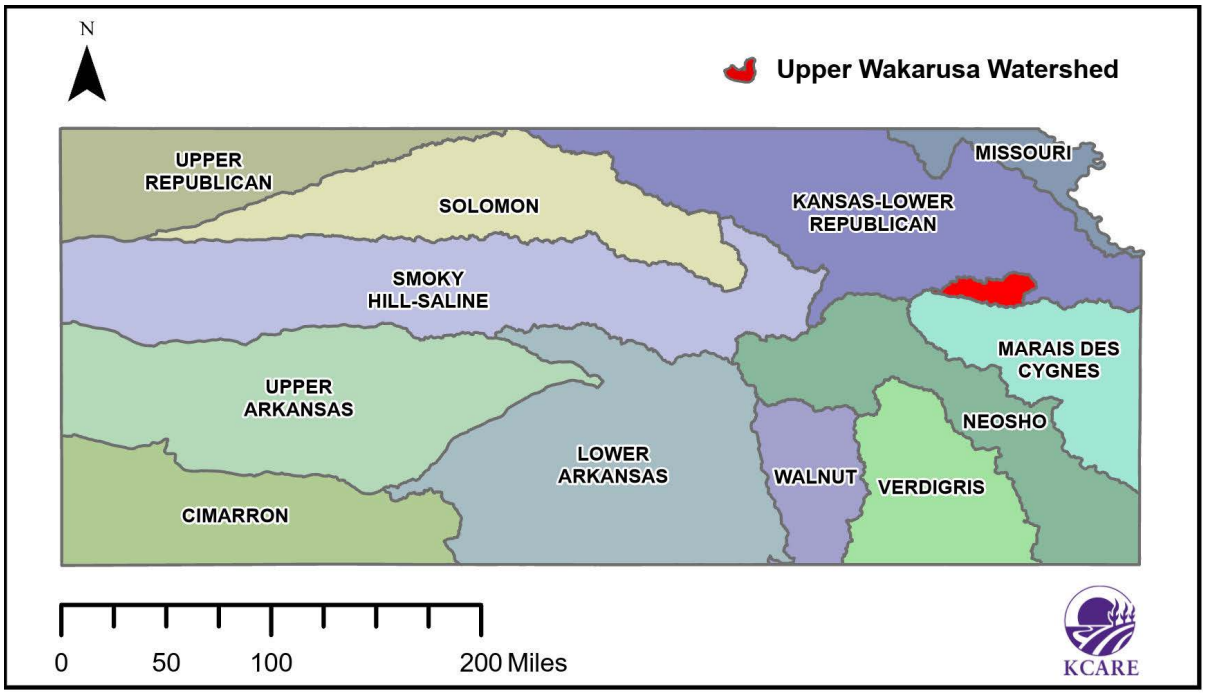


Figure 1. The 12 River Basins of Kansas, featuring the Upper Wakarusa Watershed

The Upper Wakarusa Watershed overlays portions of four counties, including Douglas, Osage, Shawnee, and Wabaunsee counties (**Figure 2**).

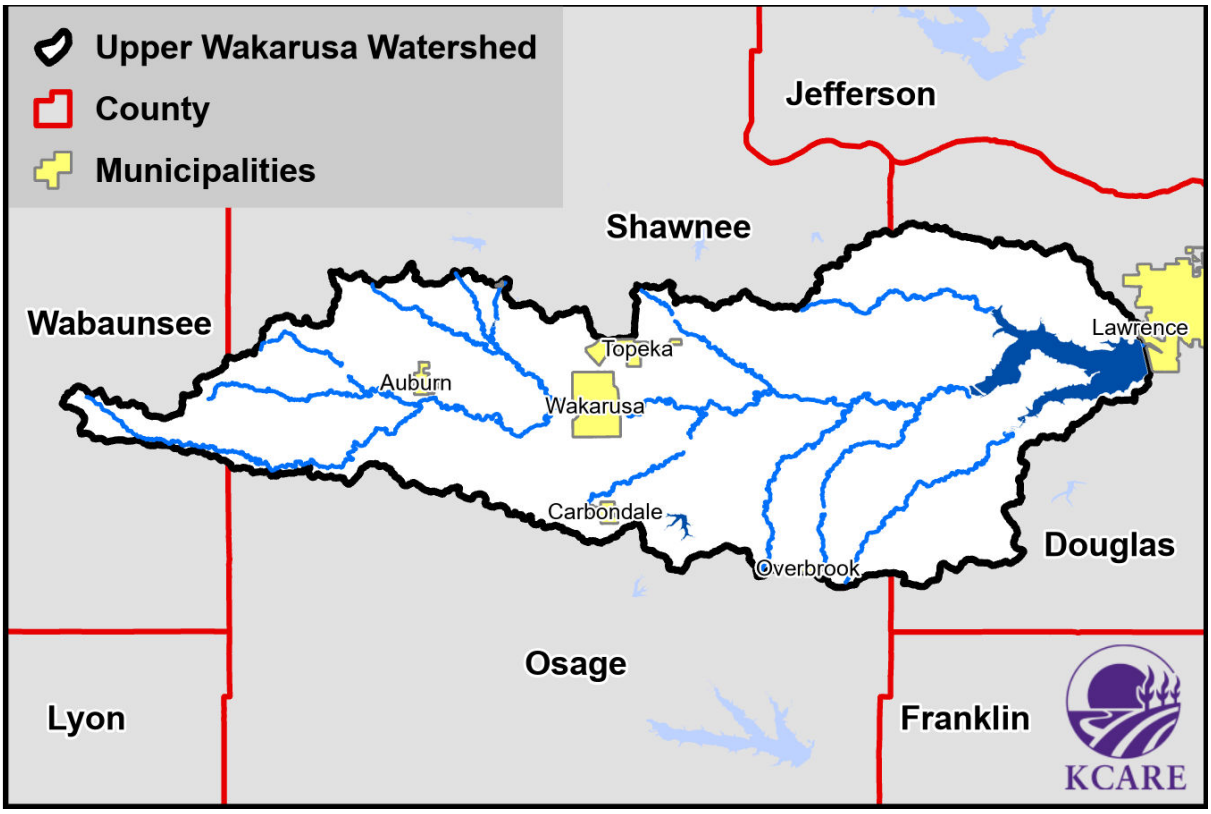


Figure 2. The Upper Wakarusa Watershed

D. Overview of the Upper Wakarusa Watershed

The Upper Wakarusa Watershed is considered to be the land area in northeast Kansas that drains into Clinton Lake. The Wakarusa River drains 71% of the watershed area while Deer Creek drains 10% and Rock Creek drains 14% of the watershed area. The remaining 5% is accounted for by the land area immediately surrounding Clinton Lake. The watershed covers 364 square miles and is made up of 232,695 total acres.

Clinton Lake is located in northeast Kansas, approximately four miles southwest of the City of Lawrence. Clinton Lake is a multipurpose U.S. Army Corps of Engineers (COE) reservoir that was authorized by congress in 1962. Funds for the lake were first appropriated for construction in 1971. Slow filling of the lake began in 1977 and lasted for three years to improve fishing potential, and the multipurpose pool level was reached in 1980. Today, it has 85 miles of perimeter shoreline. There is a 1.75 mile long rolled earth fill dam at river mile 22.2 of the Wakarusa River, a tributary of the Kansas River. This dam rises 85 feet above the valley and protects 156 square miles of the Wakarusa Valley below the dam from flooding.

Clinton Lake provides flood control, drinking water supply, low flow augmentation, water quality, primary contact recreation, food procurement, special aquatic life support, and wildlife habitat. While its primary function is flood control, Clinton Lake is the primary drinking water source for almost all residents in Douglas County. The lake also provides drinking water to the cities of Wellsville (Franklin County) and Edgerton (Johnson County), as well as to six rural water districts serving Osage, Shawnee, and Franklin counties.

The Wakarusa River runs west to east through the watershed, draining into Clinton Lake and exiting the lake on the east side through the spillway. This watershed is called "Upper" Wakarusa, as the segment of the Wakarusa River located to the west of the lake and draining into the lake is considered to be the "Upper" segment/portion of the Wakarusa River. The "Lower" Wakarusa River is the segment running out of the lake and continuing east/northeast through Douglas County, eventually flowing into the Kansas River near Eudora.

For the purpose of simplification in this plan, ***the Upper segment of the Wakarusa River will be referred to as the Wakarusa River.*** *However, the watershed will continue to be regarded as the Upper Wakarusa Watershed.*

E. Elevation of the Upper Wakarusa Watershed

Elevation determines watershed boundaries. As shown in **Figure 3**, the highest point of the Upper Wakarusa Watershed has an elevation of 2,223 feet, and the lowest point of the watershed has an elevation of 657 feet.

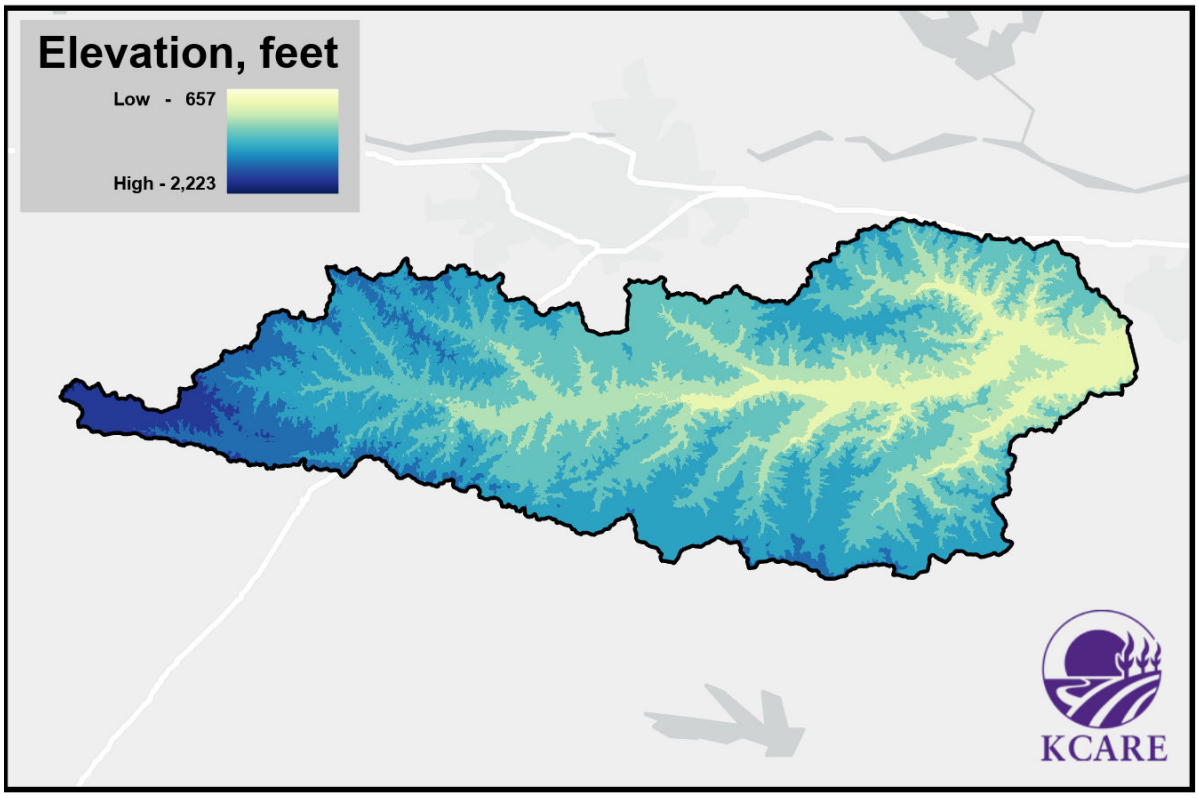


Figure 3. Elevation Relief Map of the Upper Wakarusa Watershed

F. What is a Hydrologic Unit Code (HUC)?

HUC is an acronym for **H**ydrologic **U**nit **C**ode; HUCs act as an identification system for watersheds. Each watershed is assigned a unique HUC number, in addition to a common name.

As previously mentioned, the Upper Wakarusa Watershed is in the Kansas-Lower Republican River Basin which is home to seven HUC 8 (meaning an 8-digit identifier code) classifications. The Upper Wakarusa Watershed is part of the HUC 8, identified as **10270104**.

The first two numbers in the HUC code refer to the drainage region, the second two digits refer to the drainage sub-region, the third two digits refer to the accounting unit, and the fourth pair of digits is the cataloging unit. For example:

- **10**270104: Region 10, Missouri Region – The drainage within the United States of: (a) the Missouri River Basin, (b) the Saskatchewan River Basin, and (c) several small, closed basins. This includes all of Nebraska and parts of Colorado, Iowa, Kansas, Minnesota, Missouri, Montana, North Dakota, South Dakota, and Wyoming (area = 509,547 sq. miles).
- 10**27**0104: Sub-region drainage of the Kansas River Basin, excluding the Republican and Smoky Hill River Basins. This includes Kansas, Missouri, and Nebraska (area = 15,000 sq. miles).
- 1027**01**04: Accounting unit drainage of the Kansas River Basin, excluding the Big Blue, Republican, and Smoky Hill River Basins in Kansas and Missouri (area = 5,500 sq. miles).
- 102701**04**: Cataloging unit drainage of the section of the Lower Kansas River Basin in Kansas (area = 1,640 sq. miles).

As watersheds become smaller, the HUC number becomes larger. HUC 8s can be split into smaller watersheds that are given HUC 10 numbers. The Upper Wakarusa Watershed consists of one HUC 10 delineation, **102701401**.

This HUC 10 watershed can be divided further, into 8 smaller HUC 12 watersheds which are listed below with emphasis on the last 3 digits of the HUC 12. For BMP implementation, this WRAPS plan will target those shown in **bold**, however riparian corridor and floodplain areas throughout the entire watershed will also be a priority for BMP implementation.

Upper Wakarusa HUC 12s:

- 102701040101
- 102701040102
- 102701040103
- **102701040104**
- **102701040105**
- **102701040106**
- **102701040107**
- **102701040108**

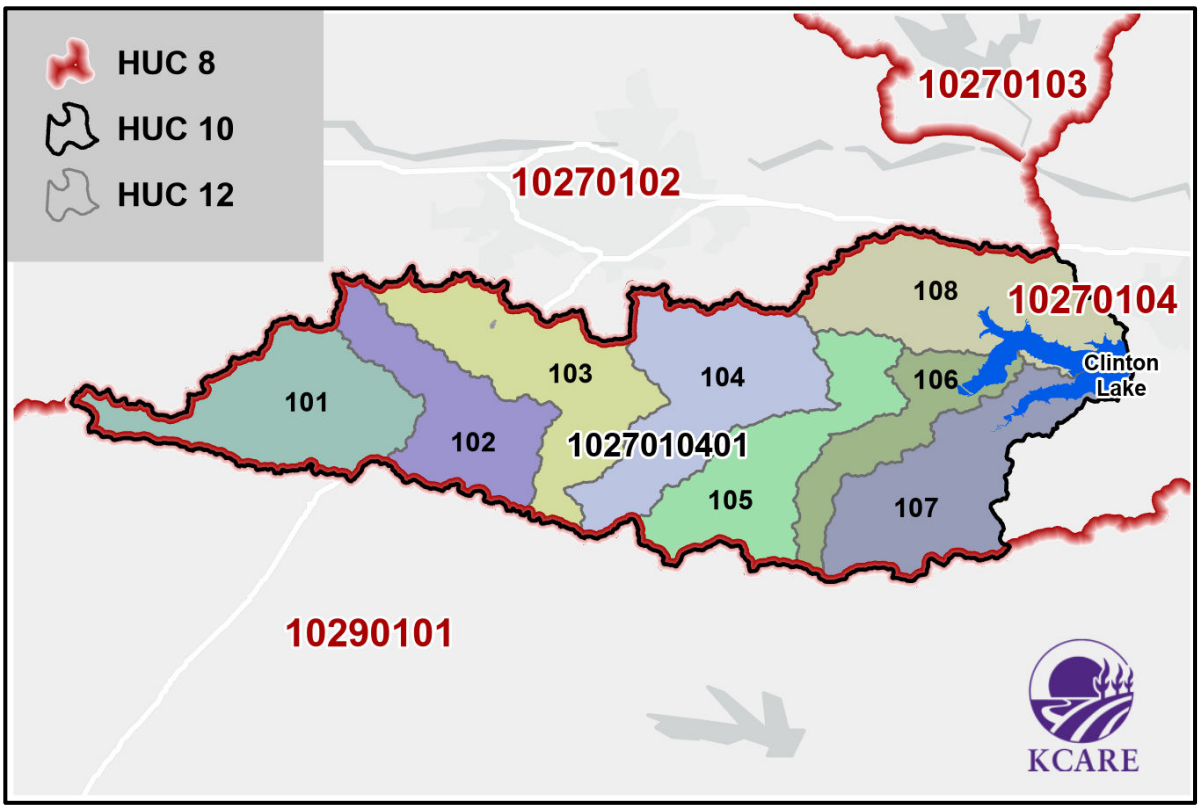


Figure 4. HUC 8, 10 and 12 Delineations in the Upper Wakarusa Watershed

G. Upper Wakarusa Watershed WRAPS History

According to the Kansas Unified Watershed Assessment prepared in 1999 by KDHE and the Natural Resources Conservation Service (NRCS), the Upper Wakarusa Watershed is rated as a Category I watershed. This means that the watershed needs restoration and protection to sustain water quality. A Category I watershed either does not meet state water quality standards or fails to achieve aquatic system goals related to habitat and ecosystem health. Category I watersheds also are assigned a priority for restoration. The Upper Wakarusa Watershed was ranked 1st out of 71 watersheds in the state for restoration priority, as it is part of the Lower Kansas HUC 8 Watershed, 10270104.

H. Who Are the Stakeholders?

The Upper Wakarusa WRAPS group was established when the Kaw Valley Heritage Alliance formed a sub-committee known as the "Core Group" in 2002. This "Core Group," now known as the stakeholder leadership team (SLT), was made up of representatives from the Kansas Department of Health and Environment (KDHE), Kansas Biological Survey (KBS), Natural Resources Conservation Service (NRCS), the City of Lawrence, Kansas State University, and the State Conservation Commission, which is now referred to as the Division of Conservation (DOC).

The SLT evolved from a core group of meeting attendees and now serves as a board providing guidance to the WRAPS Coordinator. The SLT serves to advise the WRAPS Coordinator when determining priorities and direction for watershed projects. The SLT currently has 23 members who represent producers and landowners, public water supplies, watershed districts, and conservation districts. They also represent entities from outreach/education, environmental/health, fish, forestry, wildlife, and local government, as well as livestock and crop production. The Kansas Alliance for Wetlands and Streams (KAWS) had been providing limited financial and technical support for restoration activities. In 2006, KAWS was awarded a grant from KDHE to coordinate Upper Wakarusa WRAPS efforts. As a result, the Upper Wakarusa WRAPS Coordinator is a KAWS affiliate.

The Upper Wakarusa WRAPS has completed three of the four basic stages in the WRAPS process. The **development** stage included recruiting stakeholders, affirming an interest in continuing the project, and documenting stakeholder decisions. The **assessment** stage reviewed watershed conditions and identified watershed restoration and protection needs. The **planning** phase established goals and action items, developed cost estimates, and identified stakeholder implementation strategies. The Upper Wakarusa WRAPS is now in the **implementation** stage, which includes securing the resources needed to execute the plan, monitoring and documenting progress, and revising the plan as needed. This includes adjustments in plan execution as area priorities may change.

I. Goals of the Stakeholder Leadership Team (SLT)

Responsibility for restoration and protection of the watershed rests primarily in the hands of local stakeholders. In cooperation with these local stakeholders, federal and state agencies provide technical and financial assistance for education activities and Best Management Practice (BMP) implementation. The SLT assistd in identifying specific goals to achieve watershed improvement; it is believed that implementation of BMPs as well as financial incentives and cost-share programs will, over time, lead to decreases in surface and groundwater impairments.

The **watershed goals** of the Upper Wakarusa Watershed SLT are to:

- prevent taste and odor issues in Clinton Lake, as it is a drinking water source, by:
  - reducing the amount of bacteria from livestock sources entering the Wakarusa River, Deer Creek, Rock Creek, and ultimately Clinton Lake;
  - reducing the amount of nutrients and sediment from cropland sources entering the Wakarusa River, Deer Creek, Rock Creek, and ultimately Clinton Lake;
- protect and restore water quality throughout the watershed; and
- educate the watershed community about water quality practices and benefits.

Secondary watershed priorities, many of which will be positively impacted by the implementation of this plan, include:

- eutrophication,
- degraded streams and rivers,
- sediment/biology,
- flooding,

- livestock management,
- source water protection, and
- grazing lands.

Making positive strides toward these goals and priorities will involve both an educational component and the implementation of BMPs in livestock areas. Efforts will focus on targeted areas in the Upper Wakarusa Watershed to achieve the greatest water quality improvement at a minimal cost. Targeted areas will be discussed in **Section 6** of this plan. The SLT hopes these efforts will protect water quality throughout the Upper Wakarusa Watershed.

The **main pollutants** for the Upper Wakarusa Watershed are *bacteria* and *nutrients*. This plan will focus primarily on bacteria from livestock source areas and nutrients from cropland sources.

J. Regional Advisory Committee (RAC)

In 2013, the governor of Kansas issued a call to action to develop a 50-Year Vision for incorporation into the Kansas Water Plan. Regional Advisory Committees (RACs) were developed in 2015 to work in concert with the 50-Year Vision. The Upper Wakarusa Watershed is part of the **Kansas RAC**.[1] The Kansas RAC has developed five priority goals for the future of the Kansas-Lower Republican River Basin; these goals are aligned closely with the WRAPS process and are detailed below.

Kansas RAC goals:

Priority Goal #1: Increase water storage capacity and availability in federal reservoirs to secure an adequate water supply and to maintain water quality in the region.

Action Plans:

1. Increase water storage availability in federal reservoirs to supplement instream flow needs of the Kansas River.
   - Complete necessary background work to support a request to reallocate storage from water supply to water quality in Milford and Perry reservoirs. Move a sufficient amount of storage from water supply to water quality in support of Kansas River quality flow targets.
   - Determine amount of additional annual costs for calling into service the remaining water supply storage not needed to meet instream purposes and request full funding When funding is secured, call into service storage not to be included within reallocation request.

2. By 2025, evaluate the ability to raise the conservation pool in each federal reservoir.

[1] Kansas Water Vision, Regional Goal Action Plans Section. https://kwo.ks.gov/docs/default-source/water-vision-water-plan/water-plan/complete-kwp-2022.pdf?sfvrsn=57338e14_2, Appendix A, page 9.

3. The Kansas RAC recommends the KWO pursue Forecast Informed Reservoir Operation and, as articulated in the "Basin Restoration Approach: Kansas Lower Republican," the Kansas RAC advises the KWO to improve coordination with the United States Army Corps of Engineers (USACE) on reservoir releases, management plans, and future actions to address resiliency to flood and drought conditions, water quality, and quantity issues.

4. The Kansas Water Office shall gather data to determine steps to maintain consistent storage levels at specific reservoirs. As a long-term goal, KWO should incorporate existing studies and information to study the possibility of future dredging and other measures by the State of Kansas on a more consistent basis to maintain storage.

Priority Goal #2: In order to ensure water supply needs are met throughout the entire region, review regional demands for water and evaluate water supply options for areas of need.

Action Plans:

1. The KWO will compile existing information and complete additional evaluation necessary to determine areas of water supply need.

2. Explore additional storage possibilities for construction of multipurpose small lakes so that new water sources can be brought online to alleviate specific regional issues.

3. Working with Kansas Department of Agriculture-Department of Conservation (KDA-DOC), Natural Resources Conservation Service (NRCS) and local watershed districts, identify existing watershed structures that are in need of restoration and have potential to be made larger and provide supplemental water supply.

4. Working with KDA-DOC, NRCS and local watershed districts, identify watershed dam and multipurpose small lake sites that have not been constructed but could be built to provide supplemental water supply.

5. KWO shall develop criteria to determine whether these sites should be expanded or built based on a broad range of issues including demonstrated need, return on investment, suitability of site for long-term use, taking into account potential for harmful algal blooms (HABs) and sedimentation, and other legal and logistical issues.

6. Seek partnership and funding opportunities for proposed projects that meet the established criteria.

7. Support the KWO and Kansas Department of Agriculture-Division of Water Resources (KDA-DWR) in their efforts to ensure all municipalities and rural water districts have updated water conservation plans that meet the 2007 Municipal Water Conservation Plan Guidelines.

Priority Goal #3: Reduce the cumulative sediment rate of federal reservoirs and other water supply lakes in the Kansas region to ensure adequate water supply for the region for the next 40 years.

Action Plans:

1. Establish a complete list of major reservoirs and water supply lakes in the Kansas RAC Region. This List is referred to as Appendix A and will be attached to Priority Goal #3.

2. The KWO shall set individual sediment reduction goals for each major reservoir and water supply lake. These goals will be included in Appendix A and updated as new information becomes available.

3. The sediment reduction goals for reservoirs and lakes will be achieved using best management practices (BMPs) implemented in the watersheds of these reservoirs and lakes in the Region. It is estimated that BMP implementation funding of a minimum of $5M annually will be required to achieve the targeted watershed goals within 40 years.

4. Reduce sediment load from out-of-state sources by working with neighboring states and supporting their efforts to implement BMPs.

5. By 2024, all state and federal lands surrounding each federal reservoir and water supply lake in the Kansas RAC Region must implement BMPs such as no-till, soil health practices, or buffers at levels to support achievement of sediment reduction at each reservoir or lake.

6. The KWO, in coordination with other state agencies, shall ensure individual WRAPS plans and Conservation Districts' goals for the Kansas RAC Region include the concept of reservoir sustainability with the goal of maintaining storage capacity in Kansas Region reservoirs.

7. Pursue innovative sediment management alternatives, such as water injection dredging technology.

8. The Kansas RAC will have representation on the NRCS Kansas Technical Committee to help ensure that reservoir sustainability and Kansas water supply issues are addressed in NRCS goal setting and programs.

9. Establish programs with local universities to leverage relevant expertise and student resources that will address the sedimentation reduction goal.

10. Obtain technical assistance and advisors (TA) at a level sufficient to meet the BMP implementation goals in the Region. It is estimated that additional TA funding of at least $350,000 annually would be necessary.

11. NRCS and local conservation districts, in coordination with other state agencies, should prioritize the completion of voluntary Comprehensive Conservation Plans for all land in

the Kansas RAC Region and encourage landowners to develop such plans. These Plans will be designed to address natural resource concerns on cropland, in riparian zones, on pastureland, livestock feeding area and others on a whole land or farm unit basis rather than on an individual crop field or a single resource concern basis. Information generated from these comprehensive plans will be used to aid in identifying BMP needs and prioritization of sub-watersheds in the basin, as well as assist with funding and implementation decisions. Eligibility for BMP cost share programs should be prioritized for lands that have Comprehensive Conservation Plans.

12. The KWO shall take the lead to create a partnership list of all BMP implementation programs available to the public from federal and state agencies, natural resource organizations and other groups. This list will be created and shared via a website hosted by KWO as well as in a 1-page flyer (or multiple page booklet as needed) that will be made available to the public. This information will be updated in real time on the KWO website and quarterly on the flyer by KWO staff and distributed widely to all agencies and partners for use and distribution. This document will be a key means to inform the public about all available cost share and technical assistance available for BMP implementation.

Priority Goal #4: Improve water quality throughout the Kansas Region through the utilization of natural solutions with a goal of sustainably meeting the needs of natural and human communities in the watershed.

Action Plans:

1. KWO will provide an annual report to the RAC regarding natural solutions that have been implemented, which will include an assessment of their effectiveness to date.

2. Identify and request natural solutions be incorporated for all appropriate applications. Examples of natural solutions include:
   - Prescribed burns (reduces atmospheric carbon output by preventing larger fires later with smaller fires now, and encourages climate-adapted native vegetation);
   - Hardwood reforestation in riparian areas (reduces erosion, reduces surface runoff; lowers water temperature);
   - Reduced impact logging (leave hollow trees standing, minimize clear cutting, maintain age diversity in forest stand, preserve highest quality trees);
   - Using soil health/regenerative agriculture practices on cropland (no soil disturbance, diversity of species, living root in the soil at all times, keeping soil covered, allow livestock impact) and rangeland (short periods of intense grazing, leaving more than 50% of plant biomass ungrazed, long periods of rest);
   - Wetlands and floodplains (pollution and erosion filtering, mitigation of pollutants, flood damage buffering);
   - For all of the above, see Proceedings of the Natural Academy of Sciences of the United States of America, "Natural Climate Solutions," October 31, 2017,114 (44) 11645-11650.

3. Pursue pilot projects for identified natural solutions.

4. Request that each funded project within the Kansas Region have stated objectives to further this goal, such as maintaining and restoring stream flows and water quality for healthy aquatic and riparian communities, protecting receiving waters from pollution, protecting the quality of water supplies to meet human needs within the watershed, reducing flood risk to human communities and encouraging natural flood processes, and increasing resilience to climate change.

Priority Goal #5: Continue to reduce the duration and frequency of Harmful Algal Blooms (HABs) in the watershed.

The reduction of HABs in the Milford Lake watershed is a top priority for the Kansas Regional Planning Area.

Action Plans:

1. The Kansas RAC shall recommend to the Kansas Water Authority that a minimum of $3 million per year shall be allocated towards HAB mitigation in the Kansas Regional Planning Area with a minimum of $1.5 million to be directed to BMP implementation in the Milford Lake Watershed.

2. By 2024, all state and federal lands surrounding each federal reservoir and water supply lake in the Kansas RAC Region must implement BMPs such as no-till, soil health practices, or buffers at levels to support achievement of HAB reduction at each reservoir or lake.

3. The KWO, in coordination with other state agencies, shall ensure individual WRAPS plans and Conservation Districts' goals for the Kansas RAC Region include the concept of minimizing nutrient inflow to lakes to reduce the potential for HABs with a focus on best management practices such as no-till, soil health and nutrient management practices, or buffer.

4. Encourage stakeholders to engage in collaborative efforts that result in the reduction of nutrient loading in federal reservoirs (example, Milford RCPP).

5. The Kansas RAC recommends that the KWO include management for HABs as part of the lake level management plan to mitigate HABs in reservoirs, as well as downstream impacts.

6. Support ongoing research for identification and remediation of the causes, prevention and treatment of HABs, including potential in-lake technologies.

7. Establish programs with local universities to leverage relevant expertise and student resources that will address the HAB reduction goal.

8. NRCS and local conservation districts, in coordination with other state agencies, should prioritize the completion of voluntary Comprehensive Conservation Plans for all land in

the Kansas RAC Region and encourage landowners to develop such plans. These Plans will be designed to address natural resource concerns on cropland, in riparian zones, on pastureland, livestock feeding area and others on a whole land or farm unit basis rather than on an individual crop field or a single resource concern basis. Information generated from these comprehensive plans will be used to aid in identifying BMP needs and prioritization of sub-watersheds in the basin, as well as assist with funding and implementation decisions. Eligibility for BMP cost share programs should be prioritized for lands that have Comprehensive Conservation Plans.

9. Encourage KDHE to continue providing funding to support rough fish removal.

10. Obtain technical assistance and advisors (TA) at a level sufficient to meet the HAB reduction goals in the Region.

3. Watershed Review

This watershed review is an in-depth description of the Upper Wakarusa Watershed. This section includes descriptions and data about the watershed's land cover and use, special water designations, annual rainfall, aquifers, population, public water supplies and permitted wastewater facilities.

A. Land Cover and Land Uses

Land use activities have a significant impact on the types and quantity of nutrient, sediment, and bacteria pollutants in the Upper Wakarusa Watershed. As shown in **Figure 5**, the four major land uses in this watershed are pasture/hay (41.7%), cropland (18.2%), deciduous forest (15.4%) and grassland (12.1%).

Pasture/hay and grassland land uses often can contribute livestock manure to streams and ponds that result in nutrient and bacteria runoff, in addition to sediment runoff from cattle trails and gullies in pastures.

Cropland is the main source of sediment and nutrient runoff from overland flow. Nutrients leach into sediment during runoff events and are deposited in nearby streams. Agricultural cropland under conventional tillage practices as well as a lack of maintenance of agricultural BMP structures can have cumulative effects on land transformation through sheet and rill erosion.

Properly managed forest/woodland with a good understory does not contribute a significant amount of sediment or nutrients to this watershed. In fact, forest/woodlands located along rivers and streams provide a good buffer to prevent streambank erosion. In addition, soil found in the temperate deciduous forest biome is rich in nutrients due to the presence of decaying material such as fallen leaves that is broken down into rich organic material called humus. This humus-rich soil is also great at holding water, making it available for plant use and reducing soil erosion.

Table 1 lists the remaining land uses in the watershed, including: open water (4.2%), mixed forest (2.8%), developed, open space (2.6%), and developed, low intensity (2%), developed medium intensity (0.3%), wetlands (0.2%), evergreen forest (0.1%), barren land (0.1%), shrubland (0.1%), developed, high intensity (0.1%) and woody wetlands (0.1%).

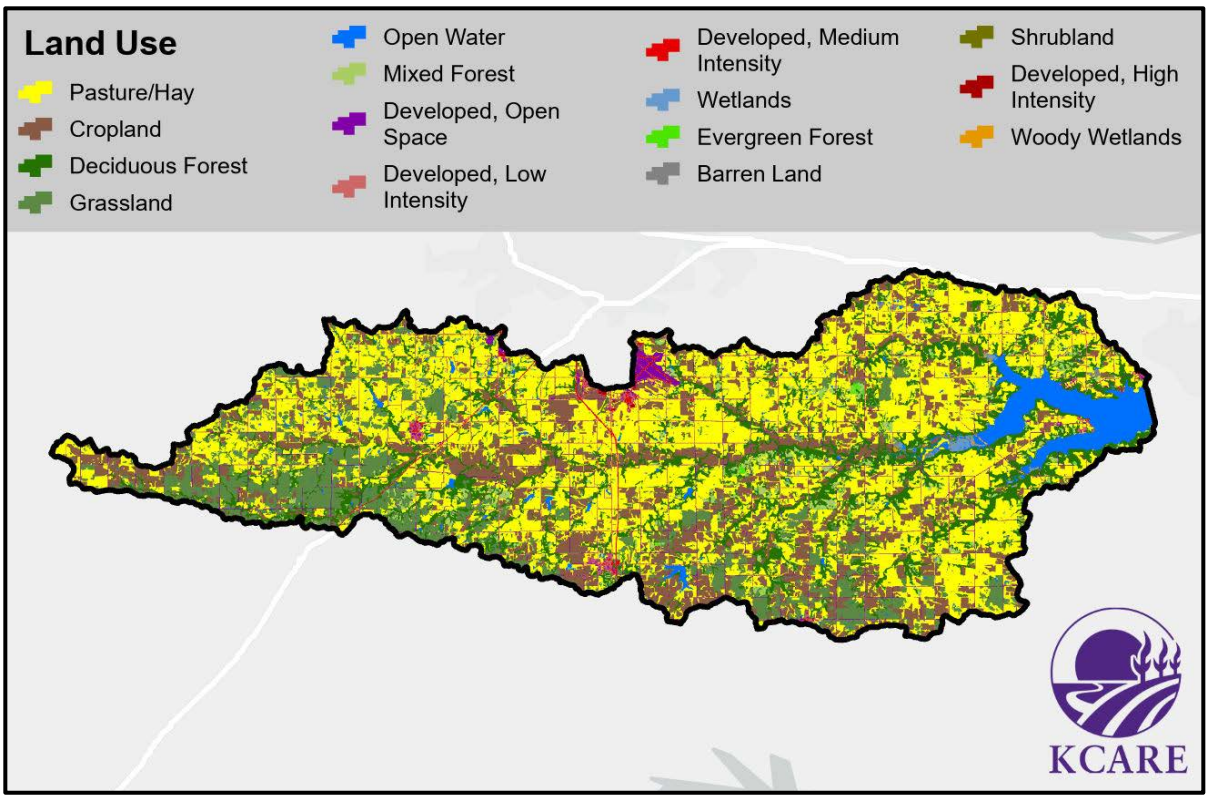


Figure 5. Land Cover and Land Use in the Upper Wakarusa Watershed

Table 1. Land Use in the Upper Wakarusa Watershed

Land Use in the Upper Wakarusa Watershed		
Land Use	**Acres**	**Percent of Watershed**
Pasture/Hay	97,033	41.7%
Cropland	42,399	18.2%
Deciduous Forest	35,827	15.4%
Grassland	28,113	12.1%
Open Water	9,721	4.2%
Mixed Forest	6,505	2.8%
Developed, Open Space	6,117	2.6%
Developed, Low Intensity	4,552	2.0%
Developed, Medium Intensity	770	0.3%
Wetlands	515	0.2%
Evergreen Forest	324	0.1%
Barren Land	243	0.1%
Shrubland	225	0.1%
Developed, High Intensity	194	0.1%
Woody Wetlands	157	0.1%
Total	**232,695**	**100%**

B. Designated Uses

The stream segments and lakes in the Upper Wakarusa Watershed have many designated uses according to the Kansas Surface Water Register, which is prepared and maintained by KDHE's Division of Environment, Bureau of Water. Designated uses for the Upper Wakarusa Watershed include aquatic life, contact recreational, domestic water supply, food procurement, groundwater recharge, industrial water supply, irrigation, and livestock water (**Table 2**). These "designated uses" are defined and assigned to specific water segments in the Kansas Surface Water Register, 2021, issued by KDHE (**Table 3**).

Table 2. Designated Water Uses Abbreviation Key

Designated Uses Abbreviation Key			
AL	Aquatic Life	GR	Groundwater Recharge
CR	Contact Recreational	IW	Industrial Water Supply
DS	Domestic Water Supply	IR	Irrigation
FP	Food Procurement	LW	Livestock Water
A	Primary contact recreation stream segment is a designated 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 or accessible by the public under Kansas law	C	Primary contact recreation stream segment is not open to or accessible by the public under Kansas law
E	Expected aquatic life use water	S	Special aquatic life use water
O	Referenced stream segment does not support the indicated designated use	X	Referenced stream segment is assigned the indicated designated use

Table 3. Designated Water Uses in the Upper Wakarusa Watershed[2]

Designated Water Uses: Upper Wakarusa Watershed - 10270104								
Water Segment/Stream Name:	**AL**	**CR**	**DS**	**FP**	**GR**	**IW**	**IR**	**LW**
Burys Creek*, Camp Creek, Deer Creek, Elk Creek, Lynn Creek, Sixmile Creek*, **Wakarusa River***	E	C	X	X	X	X	X	X
Rock Creek	E	B	X	X	X	X	X	X
Unnamed Streams, Segment 11* and 583*	E	b	O	O	O	O	X	X
Wakarusa River - Middle Branch*	E	b	X	X	X	X	X	X
Wakarusa River - South Branch*	E	b	X	O	X	X	X	X
Lake Name:	**AL**	**CR**	**DS**	**FP**	**GR**	**IW**	**IR**	**LW**
Carbondale West Lake	E	A	X	X	X	X	X	X
Clinton Lake/Reservoir*	S	A	X	X	X	X	X	X
Lakeview Estates Lake*	E	B	X	X	O	X	X	X
Overbrook Lake	E	B	X	X	O	X	X	X
Strowbridge Reservoir	E	B	X	X	O	X	X	X

[2] Kansas Surface Water Register, 2021. Kansas Department of Health and Environment. https://www.kdhe.ks.gov/DocumentCenter/View/13293/Kansas-Surface-Water-Register-PDF?bidId=, pages 11-13.

Waterbodies in bold are priority segments needing improvement and will be positively impacted by the implementation of this 9-Element WRAPS plan. Asterisks refer to a violation of designated use, and a TMDL has been written.

C. Special Aquatic Life Use Waters

Special Aquatic Life Use Waters[3] (SALU) 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." Clinton Lake is the only waterbody in the Upper Wakarusa Watershed to be designated as a SALU water. (**Figure 6**)

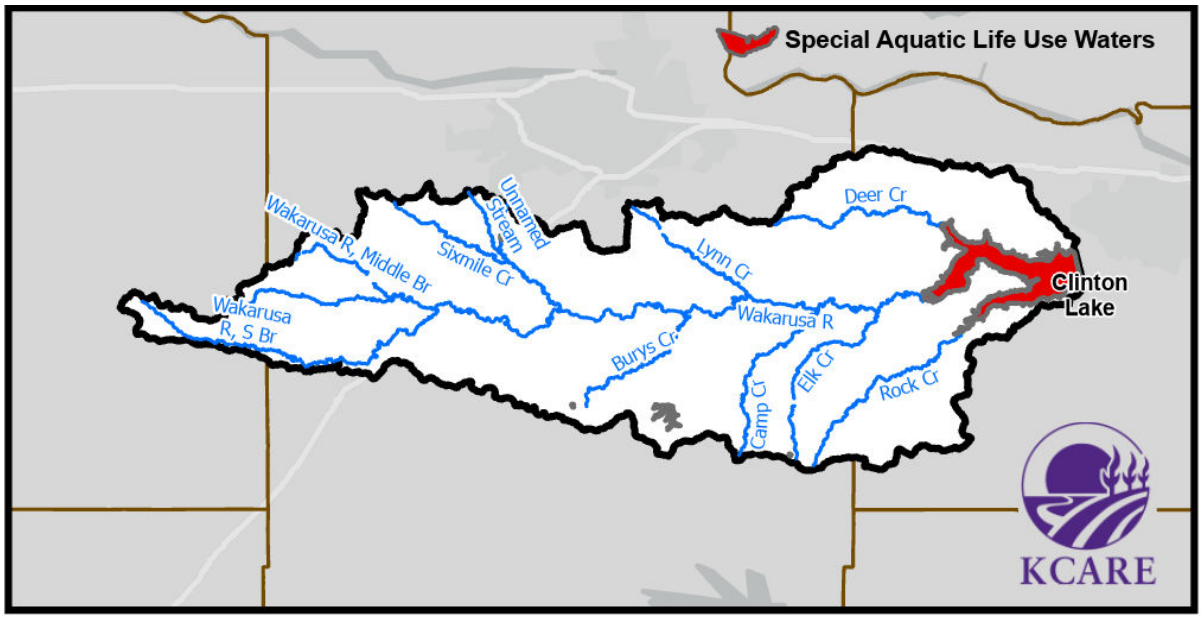


Figure 6. SALU Waters in the Upper Wakarusa Watershed

D. Exceptional State Waters

Exceptional State Waters[4] (ESW) are defined as "any of the surface waters or surface water segments that are of remarkable quality or of significant recreational or ecological value." There are no ESW-listed waters in the Upper Wakarusa Watershed.

[3] KS Surface Water Quality Standards. K.A.R. 28-16-28d(1)(b)(2)(A) For Exceptional State Waters, K.A.R. 28-16-28b(dd). For Outstanding National Resource Waters, K.A.R. 28-16-28b(aaa). https://www.kdhe.ks.gov/DocumentCenter/View/13290/Kansas-Surface-Water-Quality-Standards-2018-PDF

[4] KS Surface Water Quality Standards. K.A.R. 28-16-28d(1)(b)(2)(A) For Exceptional State Waters, K.A.R. 28-16-28b(dd). For Outstanding National Resource Waters, K.A.R. 28-16-28b(aaa). https://www.kdhe.ks.gov/DocumentCenter/View/13290/Kansas-Surface-Water-Quality-Standards-2018-PDF

E. Outstanding National Resource Waters

Outstanding National Resource Waters[4] (ONRW) are defined as "any of the surface waters or surface water segments of extraordinary recreational or ecological significance." The Upper Wakarusa Watershed does not house any ONRW-listed waters.

F. Rainfall and Runoff

Rainfall amounts and duration affect sediment and nutrient runoff during high-intensity rainfall events, most of which occur in late spring and early summer. This is the time frame when cropland is either bare, or crop biomass is small; likewise, grasses are short and do not catch runoff. Both situations can lead to pollutants and bacteria entering the waterways. The Upper Wakarusa Watershed averages 38.18 inches of rainfall annually (**Figure 7**). Precipitation data from the cities of Lawrence (located west of the watershed) and Topeka (located north of the watershed) were used to calculate the watershed's average annual rainfall. As shown in **Figure 8**, the highest levels of precipitation are found in the far-eastern section of the watershed, and the lowest levels of precipitation are found in the far western corner.

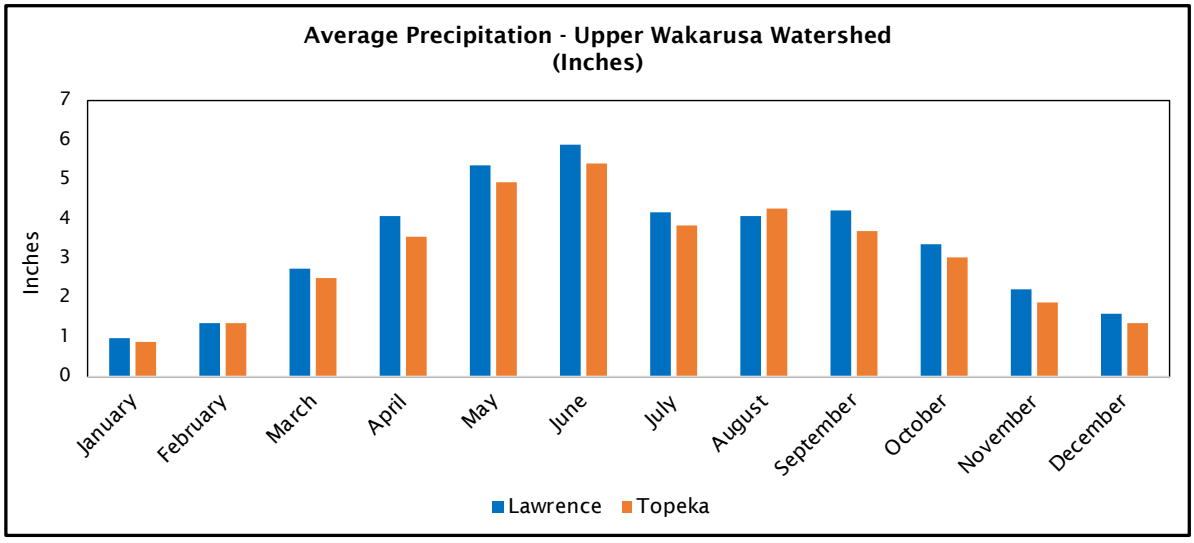


Figure 7. Upper Wakarusa Watershed Monthly Average Precipitation[5]

[5] U.S. Climate Data. https://USClimatedata.com

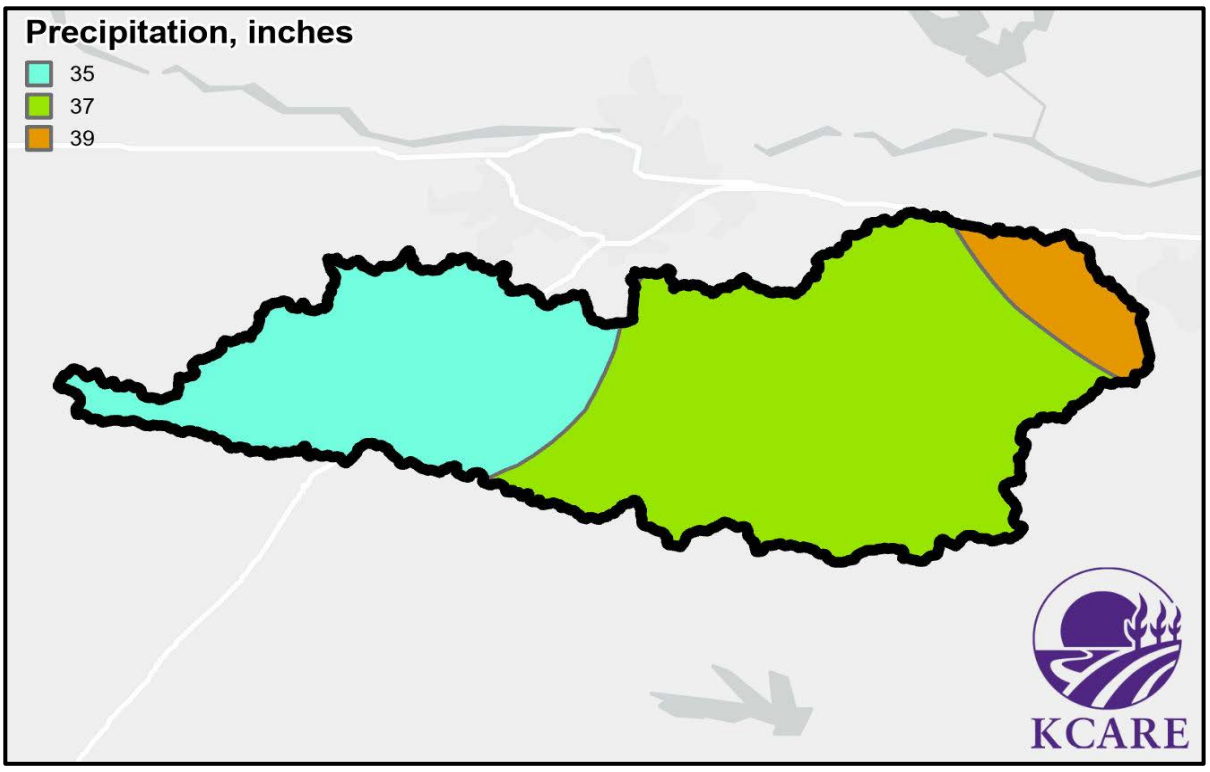


Figure 8. Annual Precipitation in the Upper Wakarusa Watershed

G. Population and Wastewater Systems

The Upper Wakarusa Watershed is made up of about 2% urban areas, with an above-average population density, and 98% rural areas with a below-average population density (**Figure 9**).

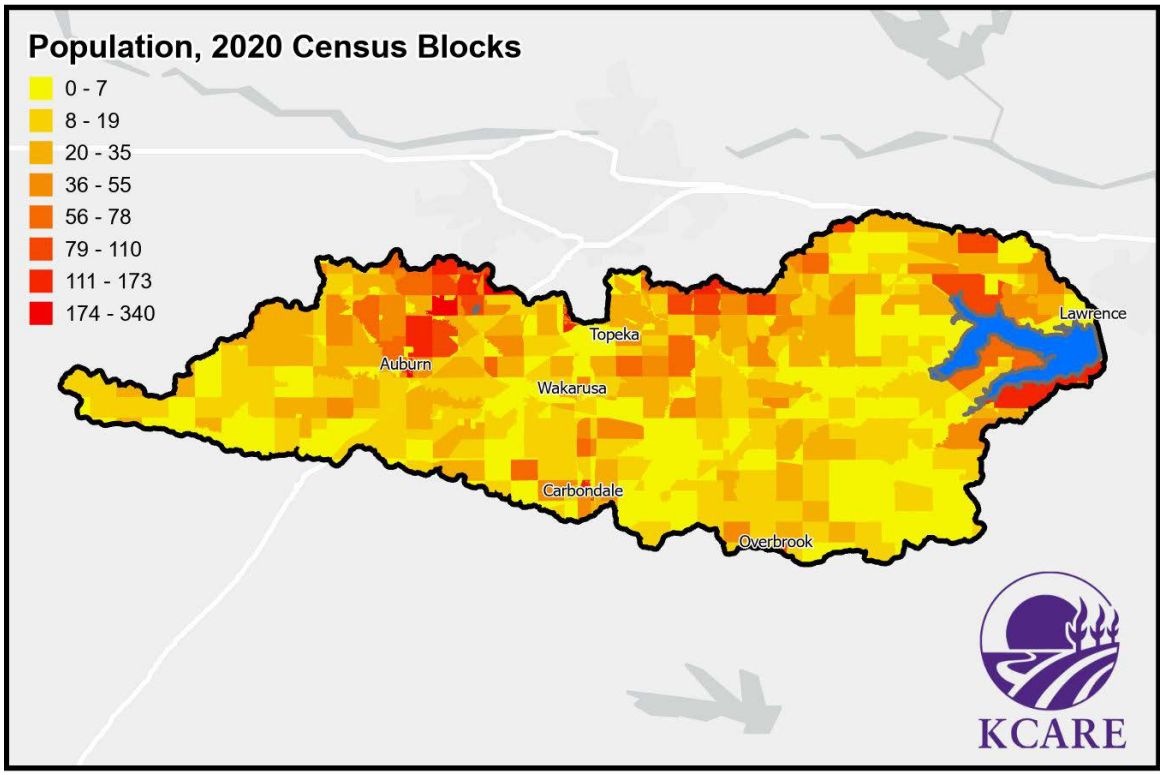


Figure 9. Upper Wakarusa Watershed Population Map

Table 4. Population in the Counties of the Upper Wakarusa

Estimating the Upper Wakarusa Watershed Population					
County	**Square Miles***	**Population: 2020 Census**	**Minus Major City Populations**	**Rural Population**	**Persons Per Square Rural Mile**
Douglas	475	118,785	94,934	23,851	50
Osage	720	15,766	n/a	15,766	22
Shawnee	556	178,909	126,587	52,322	94
Wabaunsee	800	6,877	n/a	6,877	9
TOTAL	**2,551**	**320,337**	**221,521**	**98,816**	**39**
****These totals represent each county, they do not take into account watershed boundary lines.***					

Table 4 uses county population averages to determine how many persons reside in the area per square mile. To calculate rural area populations more accurately, the populations of larger cities were subtracted from county totals. For instance, in the Upper Wakarusa Watershed, Topeka (Shawnee County), and Lawrence (Douglas County) populations were subtracted from the county totals. This is done for two reasons: both of these cities are technically outside the watershed, and these large urban areas skew the per square mile populations seen in Kansas rural areas.

Using an Upper Wakarusa Watershed area of 364 square miles, minus 7 square miles of municipal/urban area, and 35 square miles of Clinton Lake and the surrounding park, a total of 322 square miles can be determined to be rural area. Using the average of 39 persons per square

mile as determined in **Table 4**, the estimated total population in the rural areas of the Upper Wakarusa Watershed is 12,558; the addition of a municipal/urban population of 3,872, according to the 2020 U.S. Census, makes the total population in the Upper Wakarusa Watershed 16,430 (**Table 5**). Since the average population density for Kansas, represented as persons per square mile, is 32.9, the Upper Wakarusa Watershed has an above-average population.

Table 5. Rural and Urban Populations Used to Determine Wastewater Systems[6]

Upper Wakarusa Watershed Municipal and Rural Population		
Township	**2020 Population**	**Square Miles**
Auburn	1,273	0.64
Carbondale	1,352	0.76
Overbrook	1,005	0.55
Wakarusa	242	5.00
Municipal/Urban Totals	3,872	7
Rural Totals	12,558	322
Clinton Lake	0	35
Upper Wakarusa Watershed: TOTALS	**16,430**	**364**

The number of wastewater treatment systems is tied directly to population, particularly in rural areas without access to municipal wastewater treatment facilities. The lack of onsite wastewater systems, or systems that are either failing or improperly installed, can lead to bacteria and/or other nutrients from untreated sewage leaking or draining into the watershed. Even though all the counties in the watershed have county sanitary codes, there is no way of knowing how many failing or improperly constructed systems exist in the Upper Wakarusa Watershed. Using a rural population of roughly 12,675 and an estimated 2.29 persons per rural Kansas household, it can be determined that there are approximately 5,483 onsite wastewater treatment systems installed in the watershed with an expected failure rate of roughly 20%, or 1,096 systems.[7]

H. Aquifers

Portions of three aquifers underlie the Upper Wakarusa Watershed: the alluvial aquifer, as well as the Glacial Drift and Flint Hills Aquifer (**Figure 10**).

- The **alluvial** aquifer is part of and connected to a river system, consisting of sediment deposited by rivers in the stream valleys. A sign of a healthy and sustainable alluvial system is adequate stream flow. The alluvial aquifer in the Upper Wakarusa Watershed lies below Clinton Lake and along the Wakarusa River, including small portions of Burys, Elk, Camp, Deer, Lynn, Rock, and Sixmile Creeks.
- The **Glacial Drift Aquifer** was formed by deposits of rock left by the glacier that covered northeast Kansas 700,000 years ago. These rock deposits of sand and gravel created a

[6] U.S. Census – 2020 https://www.census.gov/en.html

[7] Cooperative Extension Service, University of Kentucky, College of Agriculture. http://www2.ca.uky.edu/agcomm/pubs/HENV/HENV502/HENV502.pdf

porous area that traps and holds water deposits. Small segments of this aquifer are found in the northern and eastern parts of the Upper Wakarusa Watershed.

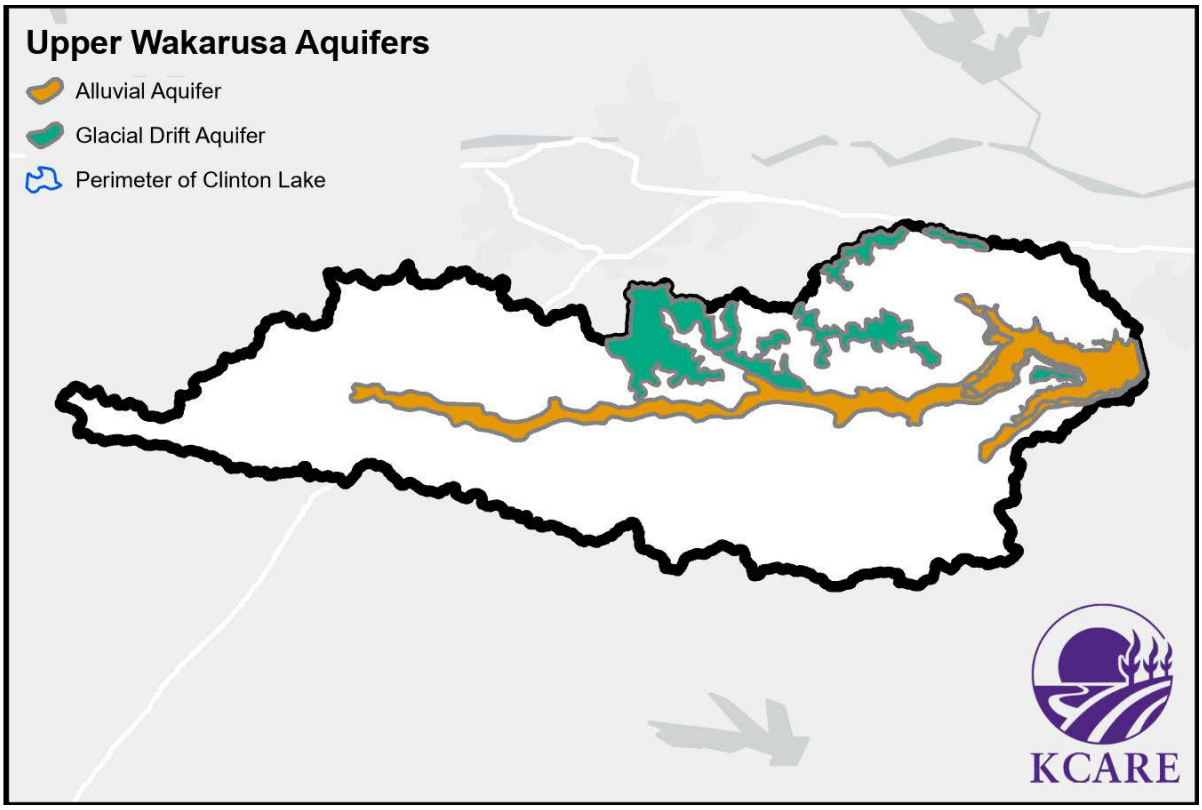


Figure 10. Aquifers in the Upper Wakarusa Watershed[8]

I. Public Water Supplies

A Public Water Supply (PWS) is defined as any system that supplies piped water to the public for human consumption, given that the system has at least 10 service connections, or regularly serves an average of 25 or more individuals for at least 60 days out of the year. Municipal water supplies and rural water districts are considered public water supplies.

A PWS uses water from either surface water or groundwater sources, or a combination of both. Generally, groundwater sources are less prone to man-made contamination than surface water sources since soil overlying aquifers acts as a protective barrier and filter. However, contaminants able to leach through the soil (or where aquifers are shallow) can have a negative impact on groundwater quality.

Sediment can affect a PWS that derives its water from a surface water supply by making it difficult to access the water at the intake or to treat the water prior to consumption. Nutrients and bacteria also will affect surface water supplies causing excess treatment costs prior to public consumption.

[8] US Geological Survey, Kansas Geological Survey.

There are 12 public water suppliers within the Upper Wakarusa Watershed, as shown in **Table 6**. Most people in the watershed receive their water from a PWS, while the rest of the watershed's population depend on private wells.

Table 6. Upper Wakarusa Watershed Public Water Suppliers[9]

Public Water Suppliers in the Upper Wakarusa Watershed		
Supplier	**Population Served**	**County**
Carbondale, City of	1,352	Osage
Clinton Lake/Reservoir	151,906	Douglas
Douglas County RWD 1	1,400	Douglas
Douglas County RWD 3	4,663	Douglas
Douglas County RWD 5	2,500	Douglas
Lawrence, City of	95,256	Douglas
Osage County RWD 5	3,186	Shawnee
Osage County RWD 8	2,240	Shawnee
Overbrook, City of	999	Osage
Shawnee County RWD 1C	4,160	Shawnee
Shawnee County RWD 3C	2,675	Shawnee
Shawnee County RWD 8	6,073	Shawnee
Topeka, City of	125,963	Shawnee
Total Population Served	**402,373**	

Source water protection

The 1996 amendments to the Safe Drinking Water Act required each state to develop a Source Water Assessment Program (SWAP)[10]. Additionally, each state was required to develop a Source Water Assessment (SWA) for each PWS that treats and distributes raw source water and to make the assessment available to the public. In Kansas, there are approximately 761 PWS requiring SWAs. SWAs include the following: delineation of the source water assessment area, inventory of potential contaminant sources, and susceptibility analysis. KDHE's Watershed Management Section has implemented the Kansas SWAP plan, and all SWAs are complete. Nearly all public water suppliers within the Upper Wakarusa Watershed were required to develop a SWAP in 2003.

[9] Kansas Department of Health and Environment, April 13, 2023.
[10] Kansas Department of Health and Environment, Source Water Assessment Reports. https://www.kdhe.ks.gov/997/Drinking-Water-Protection-Program

J. National Pollutant Discharge Elimination System (NPDES)

National Pollutant Discharge Elimination System (NPDES) permits specify the maximum amount of pollutants allowed to be discharged to surface waters. KDHE permits and regulates wastewater treatment facilities, and these facilities are considered point sources (PS) for pollutants. Municipal wastewater can contain suspended solids, biological pollutants that reduce oxygen in the water column, inorganic compounds, or bacteria. Having these PS located on streams or rivers may impact water quality in the waterways. Methods for treating municipal wastewater are similar across the country; wastewater treatment facilities remove solids and organic materials, disinfect water to kill bacteria and viruses, and discharge water to surface waterways.

Industrial point sources also can contribute toxic chemicals or heavy metals to waterways. Treatment of industrial wastewater is specific to the industry and to the pollutant discharged. Any pollutant discharge from PS allowed by the state is considered wasteload allocation. There are currently 14 permitted NPDES facilities in the Upper Wakarusa Watershed (**Table 7**).

Table 7. NPDES Permitted Facilities in the Upper Wakarusa Watershed[11]

NPDES Permitted Facilities in the Middle Kansas River Watershed				
Facility Name	**Facility Type**	**Description**	**City**	**County**
Auburn, City of	Municipal	Waste Stabilization Pond; Overflowing	Auburn	Shawnee
Carbondale (Water Treatment Plant)	Industrial	Waste Stabilization Pond; Overflowing	Carbondale	Osage
Carbondale, City of	Municipal	Waste Stabilization Pond; Overflowing	Carbondale	Osage
Hamm - Buchheim #69	Industrial	Mine Pit Dewatering (No Wash)	Lawrence	Douglas
Hamm - Harrell #53	Industrial	Mine Pit Dewatering (No Wash)	Lawrence	Douglas
Heartland Park	Commercial	Waste Stabilization Pond; Non-Overflowing	Topeka	Shawnee
ICI Manufacturing - Auburn Warehouse	Pre-Treatment	Primary Treatment Only	Auburn	Shawnee
Clinton State Park, KDWP	Municipal	Waste Stabilization Pond; Non-Overflowing with irrigation	Lawrence	Douglas
Martin Marietta Materials	Industrial	Mine Pit Dewatering (With Wash)	Lawrence	Douglas
Mid-States Materials - Big Springs Quarry	Industrial	Mine Pit Dewatering (With Wash)	Lawrence	Douglas
Mineral Springs Mobile Home Park	Commercial	Waste Stabilization Pond; Overflowing	Carbondale	Osage
Randy Long Trucking Inc.	Commercial	Waste Stabilization Pond; Non-Overflowing	Wakarusa	Shawnee
Tri-District Water Treatment Facility	Industrial	Waste Stabilization Pond; Overflowing	Berryton	Douglas
USD #450 Berryton Elementary School	Municipal	Waste Stabilization Pond; Non-Overflowing	Berryton	Shawnee

K. Livestock Operations in the Upper Wakarusa Watershed

1. Confined livestock

Any livestock facility with an animal unit capacity of 300 or more or a facility with a daily discharge, regardless of size, must register with KDHE. Any facility, no matter what animal capacity, is required to register if KDHE investigates them due to a complaint, and the facility is found to have significant pollution potential. Facilities that register with KDHE will be site-inspected for significant pollution potential. If KDHE does not find significant pollution potential at a facility, that facility can be certified if it follows management

[11] NPDES Facilities Provided by KDHE, April 2023.

practices recommended and approved by KDHE. These include, but are not limited to, regular cleaning of stalls, managing manure storage areas, etc.

Facilities having between 300 and 999 animal units are known as Confined Feeding Facilities (CFFs). Any CFFs identified with significant pollution potential must obtain a State of Kansas Livestock Waste Management Permit. Facilities of 1,000 animal units or more, known as Confined Animal Feeding Operations (CAFOs), must obtain an NPDES Livestock Waste Management Permit (Federal). Operations with a daily discharge, such as a dairy operation that generates an outflow from the milking barn daily, are required to have a permit. See **www.kdheks.gov/feedlots** for more information.

Table 8. Permitted Livestock Facilities in the Upper Wakarusa Watershed

Permitted Livestock Facilities	
Type	**Number of Facilities**
Cattle	14
Hog	2
Total	**16**

As shown in **Table 8**, there are 16 active permitted livestock facilities the Upper Wakarusa Watershed[12]. Permitted facilities are required to have a management plan for containing and using manure and for lot runoff. Livestock waste facilities can be useful tools for managing livestock waste, but waste material must be land-applied from the containment facilities in a manner that does not jeopardize water resources. Within the Upper Wakarusa Watershed, producers should apply livestock waste by matching the phosphorus content of the waste with soil test recommendations to avoid over-application of phosphorus in areas prone to runoff.

2. Unconfined livestock

Unconfined areas of animal concentration such as watering areas, loafing areas, or feeding areas also can have pollution potential for nutrients, sediment, and bacteria if the areas are not managed properly. Management practices for these areas can include alternative water sources, rotational grazing, proper mineral and feed placement, and proper manure application to cropland.

[12] Kansas Department of Health and Environment, February 2023.

4. Impaired Waters

Water quality in the Upper Wakarusa Watershed is monitored at one KDHE stream segment site, and five lake monitoring sites throughout the watershed (**Figure 11**).

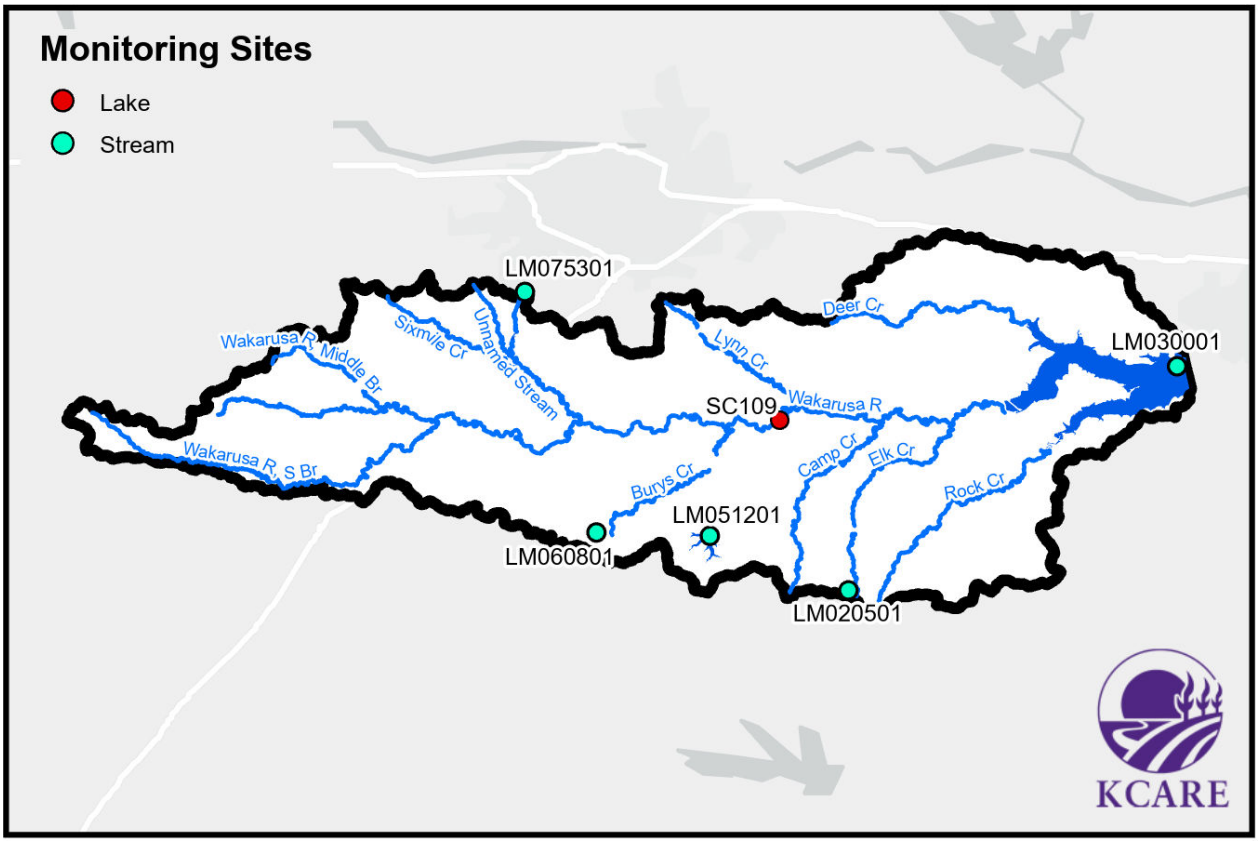


Figure 11. Upper Wakarusa Watershed Lake and Stream Monitoring Sites

KDHE stream monitoring stations are either permanent or rotational sampling sites. Permanent monitoring sites are sampled continuously, while rotational sites typically are sampled every four years. SC109 is a permanent sampling site. All sites are sampled for nutrients (nitrogen and phosphorus), metals, ammonia, solid fractions, turbidity, alkalinity, chlorophyll, pH, dissolved oxygen, *E. coli* bacteria, and chemicals. Sample analysis determines if the water contains an unacceptable level of these pollutants.

If analysis determines that any one pollutant exceeds acceptable limits, the water segment then becomes "impaired" by that pollutant and is reported as a 303d-listed impairment. The affected water segment is listed as a Total Maximum Daily Load (TMDL) if it is in dire need of pollutant reduction and is considered "high priority."

A. 303d List of Impaired Waters in the Upper Wakarusa Watershed

KDHE develops a 303d list (**Table 9**) of impaired waters biennially and submits it to EPA. To be included on this list, samples taken by the KDHE monitoring program must show that water quality standards are not met, which also means that the water's designated uses are not met. Each water segment is assigned a category number to describe and report the condition of the segment. These categories include:

- Category 2: Water was previously listed as impaired but now has water quality sufficient to support its designated uses.
- Category 3: There is insufficient data and/or information to make a use support designation.
- Category 4a: A Total Maximum Daily Load (TMDL) has been developed for the waterbody/combination.
- Category 4b: NPDES permits are addressing the impairment, or a watershed plan is addressing an atrazine impairment. This is an alternative to a TMDL.
- Category 5: Data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed. These waterbodies are 303d-listed.

KDHE has identified three lakes as *303d-listed* waters in the Upper Wakarusa Watershed **(Table 9)**. *All category 4a (TMDL) listings are described in the following "TMDL" section.*

Table 9. 303d-Listed Waters in the Upper Wakarusa River Watershed[13]

303d List of Impaired Waters, HUC 10270104				
Water Segment	**Category**	**Impairment**	**Priority**	**Monitoring Site**
Carbondale West Lake	5	Eutrophication	2024	LM060801
Overbrook Lake	5	Eutrophication	2025	LM020501
Strowbridge Reservoir	5	Eutrophication	2024	LM051201

[13] Kansas Department of Health and Environment, 2022.
https://www.kdhe.ks.gov/1219/303d-Methodology-List-of-Impaired-Waters
https://www.kdhe.ks.gov/DocumentCenter/View/22777/2022-303d-List-PDF?bidId=

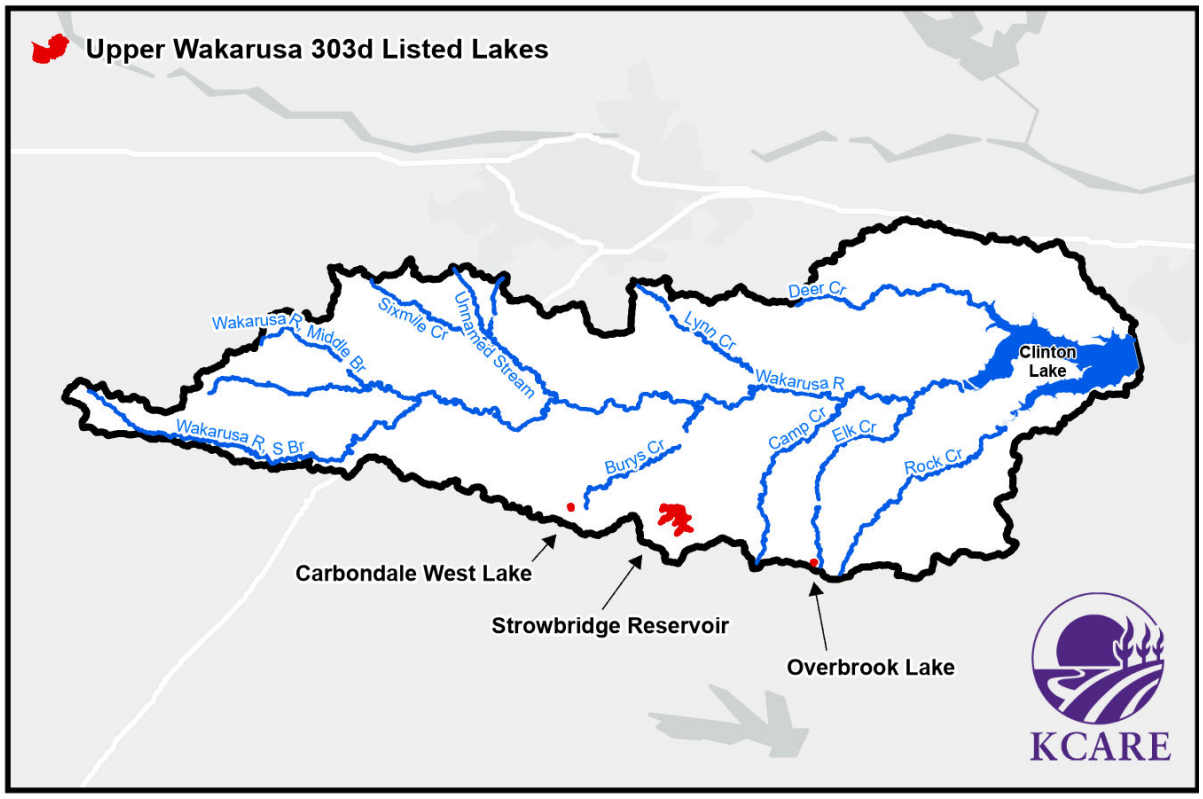


Figure 12. 303d-Listed Lakes in the Upper Wakarusa Watershed

B. Total Maximum Daily Loads (TMDL)

1. What is a TMDL?

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 its designated uses. TMDLs in Kansas may be established on a watershed basis and may use a pollutant-by-pollutant approach, a biomonitoring approach, or both as appropriate. TMDL establishment means that a draft TMDL has been completed, there has been public notice and comment on the TMDL, public comments have been considered, necessary revisions to the TMDL have been made, and the TMDL has been submitted to EPA for approval. In a TMDL, the desired outcome of the process is indicated, using the current situation as the baseline. Deviations from the water quality standards are documented, and the TMDL states its objective to meet the appropriate water quality standard by quantifying the degree of pollution reduction expected over time.

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 12 Kansas basins every five years on a rotational schedule. The Upper Wakarusa Watershed is part of the Kansas-Lower Republican River Basin and was reviewed in 2020; it is scheduled for review again in 2025.

2. Upper Wakarusa Watershed TMDLs

To be issued a TMDL, water samples taken during the KDHE monitoring program indicate that water quality standards have not been met. This in turn means that designated uses have not been met.

The Upper Wakarusa Watershed has five TMDLs (**Table 10**) to include:

- Clinton Lake (monitoring site LM03001): Eutrophication
- Lakeview Estates Lake (monitoring site LM075301): Aquatic Plants
- Lakeview Estates Lake (monitoring site LM075301: Eutrophication
- Wakarusa River near Topeka (monitoring site SC109): Biology/Sediment
- Wakarusa River near Topeka (monitoring site SC109): *E. coli*

For this Upper Wakarusa Watershed plan, focus and priority will be given to the highlighted TMDLs as listed below. However, the remaining TMDLs will be impacted positively by BMP implementation targeted to reduce livestock bacteria and nutrients (primarily phosphorus) from entering the water along all riparian corridors in the watershed.

Table 10. TMDLs in the Upper Wakarusa Watershed[14]

TMDLs in the Upper Wakarusa Watershed: HUC 10270104					
Water Segment	**Category**	**Impairment**	**Priority**	**Goal(s) of TMDL**	**Monitoring Site**
Clinton Lake	4a	Eutrophication	High	· Maintain chlorophyll *a* concentrations at 12 ppb, allowing a slightly eutrophic condition (TSI = 53-54). · Reduce proportion of blue green algae in lake to under 10% of phytoplankton. · Reduce phosphorus loads from Wakarusa drainage by 50-60%. · Reduce sedimentation within arms of the lake.	LM03001
Lakeview Estates Lake	4a	Aquatic Plants	Low	-	LM075301
		Eutrophication		-	
Wakarusa River near Topeka (Main, Middle and South Branches) * *Sixmile Creek and the Unnamed stream near Lakeview Estates, as well as Burys Creek, are all included in the 3 Wakarusa River TMDLs.*		Biology/Sediment		· Average MBI values of 4.5 or less. · Average composition of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), also known as EPT taxa, of 25% of more. · Average total suspended solids (TSS) concertation are below 100 mg/L in stream the majority of the time.	
		E. coli		· Less than 10 % of samples taken in Spring exceed primary criterion at flows under 630 cfs with no samples exceeding the criterion at flows under 110 cfs. · Less than 10% of samples taken in Summer or Fall exceed the primary criterion at flows under 630 cfs with no samples exceeding the criterion at flows under 14 cfs. · Less than 10% of samples taken in Winter exceed secondary criterion at flows under 630 cfs.	

Please note that the *E. coli* TMDLs were originally written as fecal coliform impairments. This was changed in 2003; however, some TMDLs found online have not been updated.

[14] Kansas Department of Health and Environment, 2022. https://www.kdhe.ks.gov/DocumentCenter/View/22777/2022-303d-List-PDF?bidId=

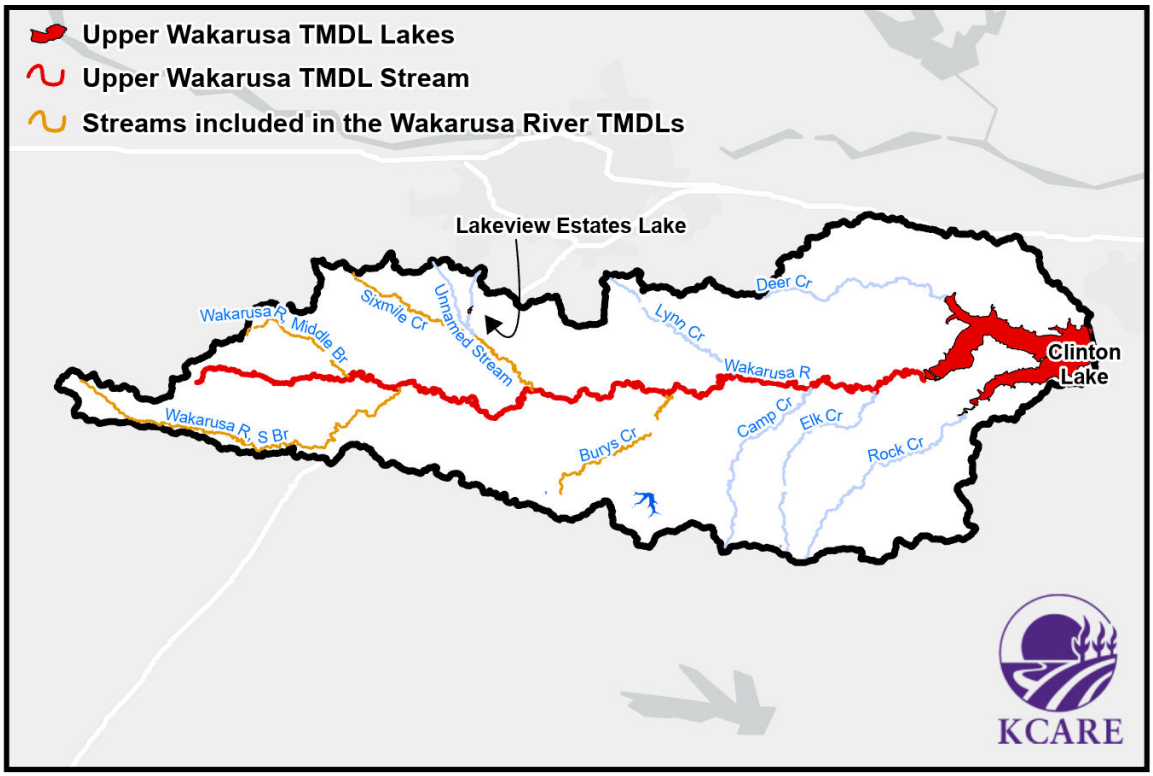


Figure 13. Lake and Stream TMDLs in the Upper Wakarusa Watershed

Note: Some of the implemented strategies for addressing the current priority TMDLs will have additional benefits by proactively addressing the 303d-listed impairments. The goal is to eliminate the need to develop a TMDL for current 303d-listed impairments.

5. Watershed Impairments to be Addressed

The Upper Wakarusa Watershed SLT acknowledges all TMDL and 303d-listed water segments in the watershed. This WRAPS plan will focus on three TMDL-listed impairments (**Figure 14**):

1. Biology/Sediment in the Wakarusa River near Topeka
2. *E. coli* in the Wakarusa River near Topeka
3. Eutrophication in Clinton Lake

*As seen in **Figure 14**, Burys Creek, Sixmile Creek, the Wakarusa River (Middle Branch), and the Wakarusa River (South Branch) are each included in the two Wakarusa River TMDLs mentioned above. Therefore, for the purpose of simplification throughout this WRAPS plan, these smaller water segments, and the Wakarusa River near Topeka, will be referenced as the "Wakarusa River" when referring to these TMDLs.*

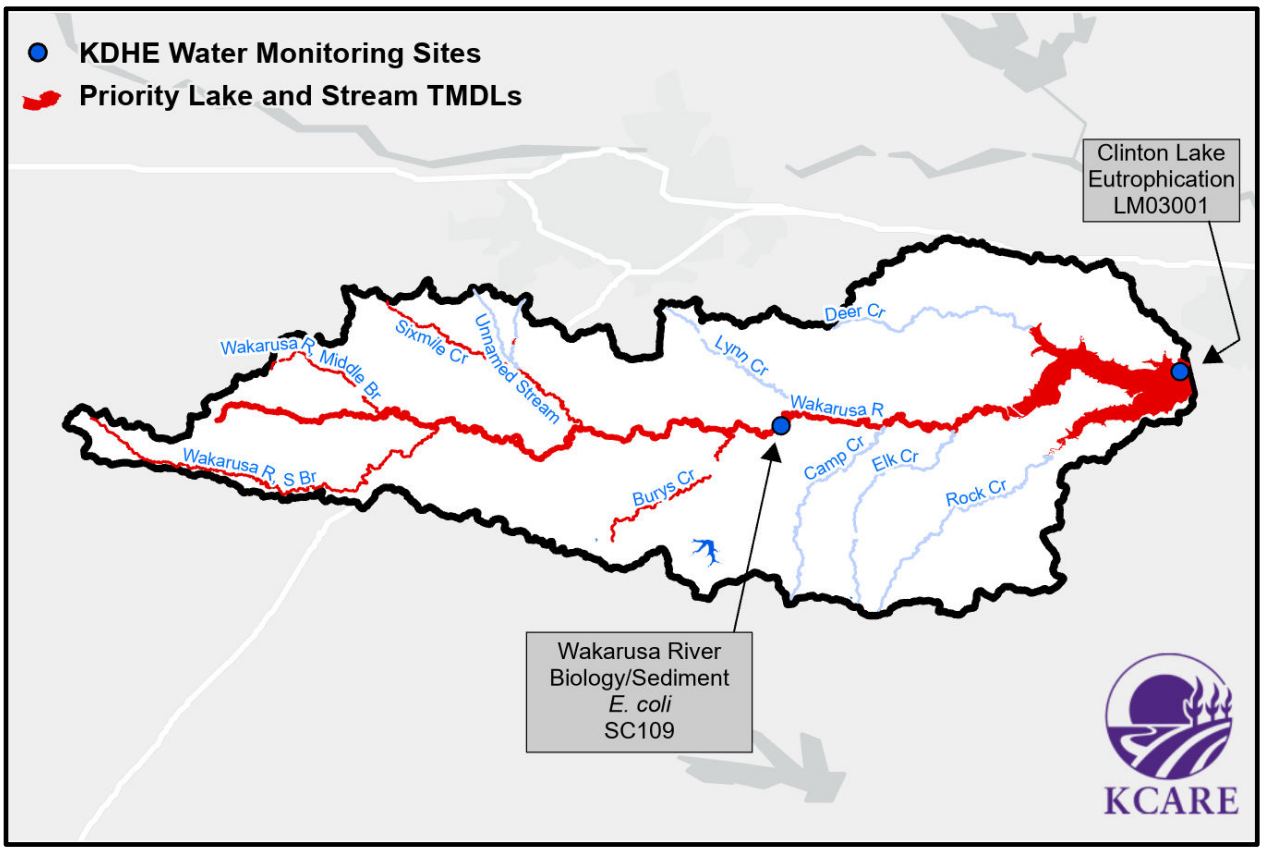


Figure 14. TMDL-Impaired Waters to be Addressed by this WRAPS Plan

Table 11. Upper Wakarusa Watershed TMDL Impairment Loads and Goals

Load Allocations for the Upper Wakarusa Watershed				
Impairment/TMDL	**Current Load**		**Allowed Load**	**Required Reduction**
Biology/Sediment: Wakarusa River	Sediment	289,325 tons per year	175,917 tons per year	113,408 tons per year
Eutrophication: Clinton Lake	Phosphorus	340,000 pounds per year	220,000 pounds per year	120,000 pounds per year
***E. coli*: Wakarusa River near Topeka**	Less than 10% exceedances of the nominal *E. coli* Bacteria (ECB) criterion at flows under 630 cfs. *Load Reduction will be assumed by reductions made in Total Phosphorus as indicated below.*			

All goals and BMPs will be aimed at protecting the Upper Wakarusa Watershed from further degradation. The Lakeview Estates Lake TMDLs, as well as the Carbondale West Lake, Strowbridge Lake, and Overbrook Lake 303d-listed eutrophication impairments will be positively impacted by BMP implementation addressing the TMDLs shown below in **Table 11**. This WRAPS plan addresses the Biology, Biology/Sediment, Eutrophication, and *E. coli* TMDLs listed above.

A. Biology/Sediment TMDL

The Upper Wakarusa River near Topeka has been listed for having a high-priority TMDL for the impairment of **Biology/Sediment**[15]. This plan will focus implementation and load reduction goals on priority cropland, livestock, and riparian areas, addressing both sediment and nutrients.

1. Sources of the impairments

KDHE has determined that the high-priority Biology TMDL in the Wakarusa River is due to excessive sediment and nutrient loading. There is a direct relation between levels of nutrient loading and biological integrity. Nutrients can attach to suspended soil particles in the water column and make their way into stream segments during runoff events. Physical components of the terrain, such as slope, propensity to generate runoff and soil type are important to sediment movement. Sediment transfer also can originate from alteration of stream channels, streambank erosion and river- and streambank sloughing. A lack of riparian cover can cause washing on the banks of streams or rivers and enhance erosion.

Nutrient loading, specifically phosphorus and nitrogen, can originate in both rural and urban areas and can be caused by both point and nonpoint sources. This plan focuses primarily on agricultural nonpoint source contributions, even though other possible sources will be included as part of the discussion. Decreased sediment loss and nutrient loads should result in improved aquatic communities and biological metrics indicative of

[15] Upper Wakarusa Biology TMDL: https://www.kdhe.ks.gov/DocumentCenter/View/14091/Upper-Wakarusa-River-Bio-PDF

improved water quality. Waters with adequate biology levels tend to sustain a Macroinvertebrate Biotic Index score below 4.5 while maintaining healthy total phosphorus and total nitrogen levels.

There are many sediment and nutrient pollutant sources that may contribute to the Biology impairment including: land use, soil erosion by wind and/or water, riparian quality, wastewater treatment facilities, population, confined animal feeding operations, grazing density, rainfall, and runoff. These sources are detailed below.

Land use

Land use activities have a significant impact on sediment and nutrient transfer in the watershed. Sediment can originate from streambank erosion and streambank sloughing caused by a lack of riparian cover. Sheet and rill erosion from cropping and pasture systems also contribute sediment into the ecosystem. Construction projects can leave disturbed areas of soil and unvegetated roadside ditches that can erode during a rainfall event. In addition, agricultural cropland using conventional tillage practices and lacking maintenance from agricultural BMP structures can have cumulative effects on land transformation through sheet and rill erosion. Fertilizer or manure applied to frozen ground or cropland prior to a rainfall event can be transported easily downstream. Livestock allowed stream access to drink or loaf will contribute manure/phosphorus directly into the stream. Overgrazed pastures do not provide adequate biomass to trap manure runoff.

Agricultural BMPs designed to help reduce nutrient runoff may include: implementing cover crops, no-till, minimum tillage, vegetative buffers and riparian areas; creating grassed waterways and grassed terraces; establishing permanent vegetative cover and grazing management plans; providing off-stream watering sites by fencing streams and ponds; relocating pasture feeding sites and feeding pens away from streams; implementing rotational grazing; and placing vegetative filter strips along waterways.

Soil erosion by wind and/or water

NRCS has established a "T-factor" in evaluating soil erosion, where T represents the soil loss tolerance factor. It is defined as the maximum amount of erosion at which soil quality as a medium for plant growth can be maintained. It is assigned to soils without respect to land use or cover and ranges from one ton per acre for shallow soils, to five tons per acre for deep soils that are not as affected by loss of productivity by erosion. T-factors represent the goal for maximum annual soil loss in sustaining the productivity of land use.[16]

Riparian quality

An adequately functioning and healthy riparian area will reduce sediment flow from cropland and rangeland. Riparian areas can be vulnerable to runoff and erosion from livestock-induced activities in pastureland and overland flow from bare soil on cropland. Buffers and filter strips, along with additional vegetated riparian areas, can be used to

[16] NRCS T factor. https://www.nrcs.usda.gov/nri and https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/soils/soil-health/manage-for-soil-carbon

impede erosion and streambank sloughing. Livestock restriction along the stream will prevent livestock from entering streams and degrading the streambanks. Cropland requires permanent vegetation adjacent to streams to impede the sediment flow from fields.

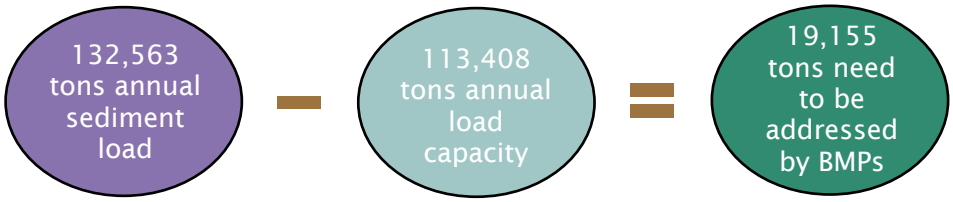
Wastewater treatment facilities
KDHE permits and regulates wastewater treatment facilities. National Pollutant Discharge Elimination System (NPDES) permits specify the maximum amount of pollutants allowed to be discharged to surface waters. There are 14 NPDES facilities in the Upper Wakarusa Watershed at the time of this document's publication.

Population
Watershed population can affect nutrient (phosphorus) runoff. There are an estimated 12,675 domestic onsite wastewater systems in the Upper Wakarusa Watershed, located mainly in rural areas. Although the functional condition of these systems is generally unknown, it is projected that nearly 20% (~ 2,535) may be failing; onsite wastewater could be an area of possible pollution contribution for evaluation.

Rainfall and runoff
Rainfall amounts and subsequent runoff affect nutrient and bacteria runoff from agricultural and urban areas into stream segments. The amount and timing of rainfall events affect manure runoff from livestock allowed access to streams, or manure applied before a rainfall or on frozen ground. Therefore, it is important to maintain adequate grass density to slow the runoff of manure over pastures.

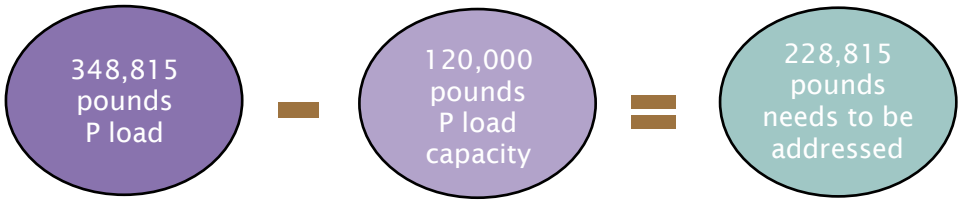
2. Pollutant loads

The current estimated sediment load in the Upper Wakarusa Watershed is 132,563 tons per year, according to the TMDL section of KDHE. The total sediment load reduction needed to meet the Biology/Sediment TMDL is 19,155 tons of sediment, a reduction of roughly 15%.



If all cropland BMPs have been implemented by the end of this 30-year WRAPS plan, a reduction of 33,341 per year of sediment will have been saved. This exceeds the load reduction required to meet the TMDL by 74%.

In addition to sediment, it has been determined that roughly a 66% reduction in P is necessary to meet the Upper Wakarusa Watershed's Biology, *E. coli,* and Eutrophication TMDLs, which equates to a reduction of 228,815 pounds per year.



If all cropland BMPs have been implemented, 206,405 pounds of P will have been reduced from the watershed at the end of this 30-year plan. This is less than the required amount needed to meet the TMDL. However, when the livestock BMPs (24,510 pounds of P reduced) are incorporated into the plan, the reduction goal will be met.

Nitrogen (N) loads in the watershed measure 1,902,572 pounds per year. Nitrogen (N) is not a nutrient targeted for reduction by this plan; however, it will be positively impacted by cropland BMP implementation. **If all cropland BMPs have been implemented during this 30-year plan, 817,353 pounds of N will have been reduced from the watershed.**

3. Which BMPs will be implemented to meet the TMDL?

The WRAPS Coordinator and SLT identified specific cropland BMPs that are acceptable to watershed residents and will result in significant sediment and, subsequently, nutrient and pollutant load reductions. The cropland BMPs designed to reduce sediment loading include: buffers, cover crops, no-till, nutrient management plans, permanent vegetation, terraces, waterways, and wetlands. Specific projects needing annual implementation have been determined through modeling and economic analysis (**Table 12**).

Table 12. BMPs to Prevent and/or Reduce Sediment Loss

BMPs to Reduce Sediment Loading in the Upper Wakarusa Watershed		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of sediment contribution from **cropland**	Buffers	854 acres
	Cover Crops	854 acres
	No-Till	854 acres
	Nutrient Management Plans	1,068 acres
	Permanent Vegetation	481 acres
	Terraces	854 acres
	Waterways	854 acres
	Wetlands	320 acres

The implementation of these cropland BMPs will serve to address sediment loading, but will result in reduced nutrient (namely, phosphorus and nitrogen) loading as well. This will simultaneously have a positive impact on the aquatic plants, E. coli *and eutrophication impairments in the watershed.*

B. *E. coli*

The Upper Wakarusa River near Topeka has been listed for having one high-priority TMDL for the impairment of ***E. coli***[17]. This plan will focus implementation and load reduction goals in priority livestock areas, including all riparian areas.

E. coli is present in human and animal waste and 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. *E. coli* is not harmful to humans, but its presence indicates that disease-causing organisms, or pathogens, also may be present. Presence of *E. coli* in waterways can originate from failing septic systems, runoff from livestock production areas, proximity of animals to water sources, and manure application to land if it is applied before a rainfall event or on frozen ground. TMDLs for *E. coli* have an upper limit of 200cfu/100ml of water for primary contact recreation (such as swimming), and an upper limit of 2,000cfu/ml of water for secondary, non-contact recreation (such as boating and fishing).

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

The critical measure of improving the sanitary conditions in any of the watershed's streams is not only to reduce the magnitude of bacteria samples collected, but also to reduce the frequency and duration of high bacteria levels. To measure these reductions, the bacteria count values of individual samples are transformed using logarithms and normalized by dividing by the logarithm of the applicable bacteria criterion. For most streams, the primary contact recreation criterion is either 262 or 427 counts, depending upon the accessibility of the stream. Note there is still allowance for occasional spikes of high bacteria, provided they do not occur frequently.

1. Impairment sources

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

[17] Upper Wakarusa *E. coli* TMDL: https://www.kdhe.ks.gov/DocumentCenter/View/14093/Upper-Wakarusa-River-FCB-PDF

There are many bacteria pollutant sources that may contribute to the *E. coli* impairment including: land use, wastewater treatment facilities, population, confined animal feeding operations, grazing density, rainfall, and runoff. These sources are detailed below.

Land use
Livestock production areas are a source of bacteria in streams within the Upper Wakarusa Watershed, as manure generated by any mammal can contain *E. coli*. Livestock housed in proximity to a stream or allowed to loaf in a water source can shed *E. coli*. Wild animals also contribute *E. coli* in streams and lakes, but limiting the wild animal population from water sources is not as easy as limiting livestock.

Wastewater treatment facilities
KDHE permits and regulates wastewater treatment facilities. National Pollutant Discharge Elimination System (NPDES) permits specify the maximum amount of pollutants allowed to be discharged to surface waters. There are 14 NPDES facilities in the Upper Wakarusa Watershed at the time of this document's publication.

Population
Watershed population can affect nutrient (phosphorus) runoff. There are an estimated 12,675 domestic onsite wastewater systems in the Upper Wakarusa Watershed, located mainly in rural areas. Although the functional condition of these systems is generally unknown, it is projected that nearly 20% (~ 2,535) may be failing; onsite wastewater could be an area of possible pollution contribution for evaluation.

Confined animal feeding operations (CAFOs)
In Kansas, animal feeding operations (AFOs) with more than 300 animal units (AUs) and fewer than 1,000 AUs must register with KDHE. An AU is an equal standard for all animals based on size and manure production. For example, one AU equals one animal weighing 1,000 pounds. Confined animal feeding operations (CAFOs) are those with more than 999 AUs, and they must be federally permitted. There are 16 certified or permitted AFOs and CAFOs in the Upper Wakarusa Watershed **(Table 13)**. There are also numerous small livestock farms (below 300 AUs) that contribute to the nutrient loads. In addition to livestock-contributed waste, improperly disposed of pet waste also can be a contributor to the phosphorus loads, although at a much smaller quantity.

Table 13. Permitted Facilities in the Upper Wakarusa Watershed

Permitted Livestock Facilities	
Type	**Number of Facilities**
Cattle	14
Hog	2
Total	**16**

Grazing density

Approximately 54% of the Upper Wakarusa Watershed is grassland/pasture/hay land. Grassland in this area of Kansas is a highly productive forage source for beef cattle. Grazing density affects grass cover and potential manure runoff because an overgrazed pasture will not have the needed forage biomass to trap and hold manure in a high rainfall event. Also, allowing cattle to drink or loaf in streams increases the occurrence of nutrients, namely phosphorus, and *E. coli* bacteria in the waterway. Grazing density ranges from 10.5 to 12.8, with an average of 11.7 cattle per 100 acres across the watershed.[18] This is considered low density when compared with statewide density numbers.

Rainfall and runoff

Rainfall amounts and subsequent runoff affect nutrient and bacteria runoff from agricultural and urban areas into stream segments. The amount and timing of rainfall events affect manure runoff from livestock allowed access to streams, or manure applied before a rainfall or on frozen ground. Therefore, it is important to maintain adequate grass density to slow the runoff of manure over pastures.

2. Pollutant loads

The current pollutant load for *E. coli* cannot be estimated. *E. coli* concentrations are difficult to model, and the scope of this WRAPS project does not include modeling. The lifespan 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.

There are no quantitative numbers for current load, load allocation and required load reductions for *E. coli*. Since there is not a traditional load allocation made for *E. coli* bacteria, the margin of safety will be framed around the desired endpoints of applicable water quality standards:

- Less than 10% of samples taken in spring exceed primary criterion at flows under 630 cfs with no samples exceeding the criterion at flows under 110 cfs.
- Less than 10% of samples taken in summer or fall exceed the primary criterion at flows under 630 cfs with no samples exceeding the criterion at flows under 14 cfs.
- Less than 10% of samples taken in winter exceed secondary criterion at flows under 630 cfs.

Since there is no bacteria load reduction calculation at this time, the SLT, with guidance from KDHE, will assume sufficient *E. coli* bacteria load reductions are made through the livestock BMP implementation schedule provided in this plan. Phosphorus load reductions from livestock implemented practices will be used to measure success in bacteria reductions. **If all livestock BMPs are implemented as planned, 24,510 pounds of P will be prevented from entering Upper Wakarusa water segments at the end of this 30-year plan.**

[18] https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/Kansas/index.php

In addition, livestock BMP implementation will result in nitrogen load reductions as well. **If all livestock BMPs are implemented as planned, 46,152 pounds of N will be reduced at the end of the is 30-year plan.**

3. Which BMPs will be implemented to meet the TMDL?

The WRAPS Coordinator and SLT identified specific BMPs acceptable to watershed residents, related to livestock management practices and the prevention of *E. coli* from entering the waterways. The livestock BMPs designed to reduce bacteria loading include: alternative watering systems, cover crop grazing, grazing management plan (riparian exclusion/fencing), relocate pasture feeding sites, rotational grazing, and vegetative filter strips. Specific projects that need annual implementation have been determined through modeling and economic analysis (**Tables 14**).

Table 14. BMPs to Prevent* E. coli *Bacteria Loading

Livestock BMPs to Reduce *E. coli* in the Upper Wakarusa Watershed		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of *E. coli* bacteria and nutrient contribution from **livestock**	Alternative Watering System	1 project every 2 years of the plan, beginning in year 1. 15 projects during the life of the plan.
	Cover Crop Grazing	1 project every 2 years of the plan, beginning in year 2. 15 projects during the life of the plan.
	Grazing Management Plan	1 project every 2 years of the plan, beginning in year 1. 15 projects during the life of the plan.
	Relocate Pasture Feeding Sites	1 project every 2 years of the plan, beginning in year 2. 15 projects during the life of the plan.
	Rotational Grazing	1 project every 2 years of the plan, beginning in year 1. 15 projects during the life of the plan.
	Vegetative Filter Strips	1 project every year for the first 10 years of the plan. Then, 1 project every 2 years of the plan, beginning in year 12. 20 projects during the life of the plan.

The implementation of these livestock BMPs in the watershed will address bacteria and nutrient (phosphorus and nitrogen) loading and will subsequently improve all aquatic plants, biology/sediment, and eutrophication impairments in the watershed.

C. Eutrophication

The Upper Wakarusa Watershed has a high-priority TMDL for the impairment of **eutrophication** in Clinton Lake.[19] In addition to the high-priority Eutrophication TMDL in Clinton Lake, the Upper Wakarusa Watershed has one TMDL and three 303d-listed water bodies for eutrophication. Although these areas will not be targeted specifically with BMP implementation and load reduction goals, they will be positively impacted by BMP implementation throughout the watershed. These areas include:

- Carbondale West Lake - 303d listed
- Lakeview Estates Lake - TMDL listed (low priority)
- Overbrook Lake - 303d listed
- Strowbridge Reservoir - 303d listed

[19] Upper Wakarusa Eutrophication TMDL: https://www.kdhe.ks.gov/DocumentCenter/View/14015/Clinton-Lake-EU-PDF

Clinton Lake has been on the TMDL 303d list since 1993 for eutrophication, caused by excess nutrient loading (primarily phosphorus). All uses in Clinton Lake are impaired to a degree by eutrophication. Clinton Lake is considered to be in a fully eutrophic state.

Phosphorus levels tend to be elevated in the lake, ranging between 30 - 100 ug/L, typical of eutrophic conditions while concentrations average 64 ug/L in the Wakarusa River. This creates conditions favorable for algae blooms and aquatic plant growth, negatively impacting aquatic life.

Algal blooms and aquatic plant growth may increase oxygen levels temporarily, but the bloom will die off eventually after nutrients become scarce. During this die-off, there are reduced dissolved oxygen (DO) levels in the water because algal decomposition uses the oxygen. This results in an unfavorable habitat for aquatic life. Desirable criteria for healthy water dictate DO rates more than 5 mg/L and biological oxygen demand (BOD) fewer than 3 mg/L.

Clinton Lake consistently has elevated chlorophyll *a* concentrations during summer months, average concentration is 18.1 ppb, related to a Trophic State Index of 59 which is on the border of very eutrophic conditions. Best conditions were seen in 1996 and 1997 when chlorophyll *a* levels were 10-11 ppb with a TSI of 54, indicative of slightly eutrophic conditions. This was followed by large chlorophyll *a* concentrations in 1998 of 26 and 37 ppb and a TSI of 64, indicating hyper-eutrophic conditions.

Additionally, elevated levels of geosmin, a decomposition product from decaying algae, has affected the taste and odor of the water supply from the lake, occasionally rendering the water unacceptable for use. Total phosphorus data are varied but tend to be elevated in the lake, averaging 64 ppb. Thirty three percent of the samples taken from the lake were over 100 ppb and 55% of the samples taken from the river were over 100 ppb. The lake tends to be nitrogen limited, allowing dominance of blue-green algae in summer and fall. Data collected by the Kansas Biological Survey confirm the phosphorus and algae data, noting that the arms of the lake are primary areas of production. Frequency analysis of the pool level at Clinton indicates that water is in the flood pool 60% of the time. A portion of that incursion is management plans to protect fishery spawn. Drawdowns are not very extensive, typically less than three feet.

The impairments in this watershed mainly stem from non-point pollution sources (NPS), meaning that there is not one specific outlet where contaminants enter the water course, but rather multiple sites contributing to the overall pollutant loads. Excess nutrients can originate from manure and fertilizer runoff in rural and urban areas. In the Upper Wakarusa Watershed, urbanization, agricultural land use, and small livestock operations all contribute excess nutrients to the watershed system.

1. Sources of the impairment

Nutrient loading can originate in both rural and urban areas and can be caused by both point and nonpoint sources. This plan focuses primarily on agricultural nonpoint source contributions, even though other possible sources will be included as part of the discussion.

There are many nutrient pollutant sources that may contribute to the Eutrophication impairment including: land use, wastewater treatment facilities, population, confined animal feeding operations, grazing density, rainfall, and runoff. These sources are detailed below.

Land Use

Land use activities can affect nutrient runoff into streams. For example, fertilizer or manure applied to frozen ground or cropland prior to a rainfall event can be transported easily downstream. Livestock allowed access to streams to drink or loaf will contribute manure directly into the stream. Overgrazed pastures do not provide adequate biomass to trap manure runoff.

Agricultural BMPs designed to help reduce nutrient runoff include the following: implementing cover crops, no-till, minimum tillage, vegetative buffers and riparian areas; creating grassed waterways and grassed terraces; establishing permanent vegetative cover and grazing management plans; providing off-stream watering sites by fencing streams and ponds; relocating pasture feeding sites and feeding pens away from streams; implementing rotational grazing; and placing vegetative filter strips along waterways.

Wastewater treatment facilities

KDHE permits and regulates wastewater treatment facilities. National Pollutant Discharge Elimination System (NPDES) permits specify the maximum amount of pollutants allowed to be discharged to surface waters. There are 14 NPDES facilities in the Upper Wakarusa Watershed at the time of this document's publication.

Population

Watershed population can affect nutrient (phosphorus) runoff. There are an estimated 12,675 domestic onsite wastewater systems in the Upper Wakarusa Watershed, located mainly in rural areas. Although the functional condition of these systems is generally unknown, it is projected that nearly 20% (~ 2,535) may be failing; onsite wastewater could be an area of possible pollution contribution for evaluation.

Confined animal feeding operations (CAFOs)

In Kansas, animal feeding operations (AFOs) with more than 300 animal units (AUs) and fewer than 1,000 AUs must register with KDHE. An AU is an equal standard for all animals based on size and manure production. For example, one AU equals one animal weighing 1,000 pounds. Confined animal feeding operations (CAFOs) are those with more than 999 AUs, and they must be federally permitted. There are 16 certified or permitted AFOs and CAFOs in the Upper Wakarusa Watershed **(Table 15)**. There are also numerous small

livestock farms (below 300 AUs) that contribute to the nutrient loads. In addition to livestock-contributed waste, improperly disposed of pet waste also can be a contributor to the phosphorus loads, although at a much smaller quantity.

Table 15. Permitted Facilities in the Upper Wakarusa Watershed

Permitted Livestock Facilities	
Type	**Number of Facilities**
Cattle	14
Hog	2
Total	**16**

Grazing density

Approximately 54% of the Upper Wakarusa Watershed is grass/pasture/hay land. Grassland in this area of Kansas is a highly productive forage source for beef cattle. Grazing density affects grass cover and potential manure runoff: an overgrazed pasture will not have the needed forage biomass to trap and hold manure in a high rainfall event. Also, allowing cattle to drink or loaf in streams increases the occurrence of nutrients, namely phosphorus, and *E. coli* bacteria in the waterway. Grazing density ranges from 10.5 to 12.8, with an average of 11.7 cattle per 100 acres across the watershed.[20] This is considered low density when compared with statewide density numbers.

Rainfall and runoff

Rainfall amounts and subsequent runoff affect nutrient and bacteria runoff from agricultural and urban areas into stream segments. The amount and timing of rainfall events affect manure runoff from livestock allowed access to streams, or manure applied before a rainfall or on frozen ground. Therefore, it is important to maintain adequate grass density to slow the runoff of manure over pastures.

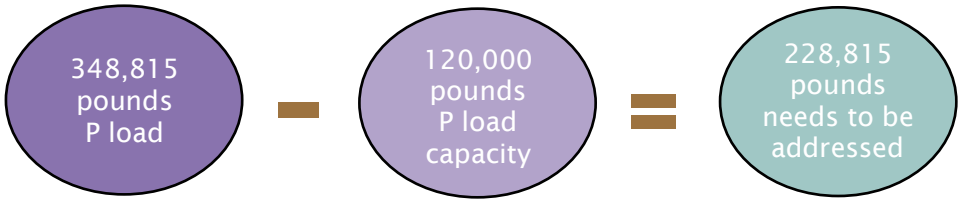
2. Pollutant loads

Phosphorus

The current estimated phosphorus (P) load in the Upper Wakarusa Watershed is 348,815 pounds per year, according to the TMDL section of KDHE.[21] The amount of P in the watershed contributes to the Eutrophication TMDLs in Clinton Lake and Lakeview Estates Lake and the 303d-listed Carbondale West, Overbrook, and Strowbridge lakes.

It has been determined that roughly a 66% reduction in P is necessary to meet the Upper Wakarusa Watershed's Eutrophication TMDL, which equates to a reduction of 228,815 pounds per year.

[20] https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/Kansas/index.php
[21] Kansas Department of Health and Environment. March 2023.



As previously mentioned, this plan will implement cropland BMPs to address the Biology/Sediment TMDL. These same cropland BMPs will reduce P in the watershed, thereby positively affecting the Eutrophication TMDL. Similarly, livestock BMPs will be implemented to address the *E. coli* bacteria TMDL. **If all cropland BMPs (206,405 pounds of P reduced) and livestock BMPs (24,510 pounds of P reduced) have been implemented at the end of this 30-year plan, a total of 230,915 pounds of P will have been reduced from the watershed.** This exceeds the load reduction required to meet the TMDL by roughly 1%.

Nitrogen

Current N loading is 1,902,572 pounds per year. While N is not a nutrient targeted for reduction by this plan, it will be impacted positively by cropland and livestock BMP implementation as well. Similar to P, **if all cropland (817,353 pounds of N reduced) and livestock (46,152 pounds of N reduced) BMPs have been implemented during this 30-year plan, a total of 863,505 pounds of N will have been reduced from the watershed.** This is a load reduction of 45%.

3. What BMPs will be implemented to meet the TMDL?

The Upper Wakarusa WRAPS plan will focus simultaneously on the Biology/Sediment and *E. coli* TMDLs found in the Wakarusa River as well as the Eutrophication TMDL in Clinton Lake.

The WRAPS Coordinator and SLT identified specific cropland and livestock BMPs that are acceptable to watershed residents and will result in significant sediment and nutrient load reductions. The cropland BMPs designed to reduce sediment and nutrient loading include: buffers, cover crops, no-till, nutrient management plan, permanent vegetation, terraces, waterways, and wetlands. The livestock BMPs designed to reduce phosphorus loading include: alternative watering systems, cover crop grazing, grazing management plans (riparian exclusion/fencing), relocate pasture feeding sites, rotational grazing, and vegetative filter strips. Specific projects that need annual implementation have been determined through modeling and economic analysis (**Table 16**).

Table 16. BMPs to Prevent and/or Reduce Nutrient Loss

BMPs to Reduce Nutrient Loading in the Upper Wakarusa Watershed		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of sediment and nutrient contribution from **cropland**	Buffers	854 acres
	Cover Crops	854 acres
	No-Till	854 acres
	Nutrient Management Plans	1,068 acres
	Permanent Vegetation	481 acres
	Terraces	854 acres
	Waterways	854 acres
	Wetlands	320 acres
Prevention of *E. coli* bacteria and nutrient contribution from **livestock**	Alternative Watering System	1 project every 2 years of the plan, beginning in year 1. 15 projects during the life of the plan.
	Cover Crop Grazing	1 project every 2 years of the plan, beginning in year 2. 15 projects during the life of the plan.
	Grazing Management Plan	1 project every 2 years of the plan, beginning in year 1. 15 projects during the life of the plan.
	Relocate Pasture Feeding Sites	1 project every 2 years of the plan, beginning in year 2. 15 projects during the life of the plan.
	Rotational Grazing	1 project every 2 years of the plan, beginning in year 1. 15 projects during the life of the plan.
	Vegetative Filter Strips	1 project every year for the first 10 years of the plan. Then, 1 project every 2 years of the plan, beginning in year 12. 20 projects during the life of the plan.

The implementation of cropland and livestock BMPs to address nutrient loading subsequently will improve all aquatic plants, biology/sediment, E. coli *and all eutrophication impairments in the watershed.*

D. Other Impairment Concern: Aquatic Plants

The Upper Wakarusa Watershed has one low-priority TMDL listing for **aquatic plants** in the Lakeview Estates Lake. The impaired use of this TMDL is listed as recreation. While aquatic plants will benefit from BMP implementation in the targeted areas, it is not a goal of this WRAPS plan.

Aquatic plants provide sufficient oxygen, food, and shelter to aquatic life. An excessive amount of nutrients from livestock and cropland areas can cause the plants to over-grow and supply too much oxygen to aquatic life, known as eutrophication. This results in an imbalance

of dissolved oxygen available to aquatic life and can often create a deadly environment. Insufficient light due to turbidity, often caused by total suspended solids (TSS), can cause aquatic plants to die, which subsequently can negatively impact aquatic life by not creating the oxygen and nutrients required to sustain life. Plants provide habitat from predators as well, so the death of aquatic plants certainly can cause the death of smaller aquatic life forms.

6. Targeted Areas

Implementing BMPs is necessary to improve a watershed's water quality. All crop fields, pastures, and feed lots are susceptible to runoff waters to some degree; these can contribute sediment and nutrients to nearby water segments. However, some crop fields, pastures, and feed lots are more susceptible than others, including areas with proximity to streams, soils prone to erosion and nutrient leaching, high water flow areas along streams, etc. Areas such as these are considered *high priority* and are targeted for BMP implementation. It has been determined that focusing BMP implementation in high-priority areas offers a greater improvement in water quality since these areas are generally major contributors to non-point source pollution and, ultimately, 303d and TMDL listings.

A. Studies Conducted to Determine Targeted Areas

1. Agricultural Non-Point Source Pollution Model (AGNPS)

AGNPS is a joint USDA–Agricultural Research Service and Natural Resources Conservation Service (NRCS) system of computer models developed to predict non-point source pollutant loadings within agricultural watersheds. It contains a continuous simulation, surface runoff model which is designed to assist with determining BMPs, the setting of TMDLs, and for risk and cost/benefit analyses.

Outputs related to soluble and attached nutrients (nitrogen, phosphorus, and organic carbon) and any number of pesticides are provided. Water and sediment yield by particle size class and source can also be calculated.

AGNPS results were used in the Upper Wakarusa Watershed for the 2011 plan to determine the contribution from each major Clinton Lake sub-watershed. It was found that nearly 50% of the phosphorus loading and 55% of sediment in Clinton Lake came from the Wakarusa River.

2. Soil and Water Assessment Tool (SWAT)

Cropland BMP targeted areas were identified through SWAT (Soil and Water Assessment Tool) modeling to determine areas of high overland runoff contributing sediment and nutrients to the watershed and Clinton Lake. The load reduction requirements figured in the 2011 Upper Wakarusa WRAPS plan were derived from the SWAT model. However, this WRAPS plan update uses the STEP-L model to determine load reduction requirements.

3. Spreadsheet Tool for Estimating Pollutant Loads (STEPL)

STEPL is a simple watershed model that provides both agricultural and urban annual average sediment and nutrient simulations and an evaluation of how various BMPs are implemented. The STEPL model calculates nutrient loading based on the runoff volume

and pollutant concentrations in the runoff water, as it is influenced by factors such as the land use distribution and management practices.

In 2023, KDHE ran the Upper Wakarusa Watershed through the STEPL modeling program to determine current load, allocated load, and load reductions required to meet the TMDLs addressed in this plan.

4. Ground-truthing

Land use assessments were conducted in Deer Creek, Lynn Creek, Burys Creek and Rock Creek. These assessments were used to write the 2011 Upper Wakarusa WRAPS Plan. While not updated for the 2023 plan, these assessments have been documented and may be used as resources in this 2023 plan.

Specific items identified are typically associated with cropland or pasture management. Examples include the following list.

- Winter feeding sites in or very near streams and waterways
- Ephemeral gullies
- No terraces on lands with slopes exceeding 3%
- Stream reaches of more than 500 feet where crops are planted up to the stream bank
- Evidence of substantial stream bank erosion

Wetland features or flat areas that appear to retain runoff were also identified as potential areas for enhancing runoff retention.

5. Streambank assessments[22]

The Watershed Institute conducted a bank stability study of Deer Creek that included field level assessments of two Deer Creek tributaries. Both tributaries, labeled sub-watersheds B and G, flow into Deer Creek within the normal pool elevation of Clinton Lake and directly discharge into Clinton Lake. Analysis of stream bank characteristics that contribute to instability indicated these were most likely to transport the most sediment to the lake.

Field assessments were conducted at selected sites within these sub-watersheds. (Some potential sites were not accessible as owners were reluctant to allow field observations.) The sites were given a stability evaluation that considered bank slope, vegetation health, and soils. Three areas of particular vulnerability in sub-watershed B and three in sub-watershed G were found. Even though sub-watershed D was not an area of focus, a particularly unstable site was found by observation from a road crossing. Study results are fully described in the project publication (The Water Institute, 2005).

A streambank erosion assessment of stream channels in the Upper Wakarusa Watershed was conducted by the Kansas Water Office to identify reaches with the most severe instability problems. Reaches were determined by comparing aerial photos taken in 1991

[22] Streambank Stability Studies and Assessment, 2011 WRAPS Plan.

to those from 2008. A total of 28 streambank erosion sites were found covering 11,217 feet of unstable streambank. The reaches identified were those that covered a reach of 1500 feet or more. Other sites with shorter reaches were not documented in the assessment.

Streambank gulley erosion sites also were identified. Gulley erosion sites had substantial head cuts into adjacent croplands or pastures from the stream channel and are major sources of sediment into the stream. Assessment results are fully described in the project report (Kansas Water Office, April 2011). It is likely many stream reaches identified by this approach would include those identified by the land use assessments as unstable reaches with no stream buffer.

The streambank erosion assessment is a more rigorous approach than the land use assessment and would provide more reliable results. Four sites were selected for detailed geomorphological analysis and recommendations for BMPs. One location was on Lynn Creek, one on Rock Creek, and two locations were on the main stem of the Wakarusa River. Results of the detailed geomorphological analysis are found in the U.S. Army Corps of Engineers, Kansas City District and Kansas Water Office, August 2011 report.

While streambank assessments were completed, streambanks will not be a priority area for this WRAPS plan.

6. **Water monitoring**

The KDHE water quality monitoring sites have determined which water segments and areas of the watershed have water impairment and pollutant issues. Water monitoring was used to help determine which HUC 12 sub-watersheds would be targeted for BMP implementation. In this plan, cropland and livestock areas were chosen to receive BMP implementation in order to address the impaired water segment by reducing the pollutant.

7. **Priority revisions in 2023**

In 2021, KDHE determined that BMP efforts should be focused on stream proximity, because stream segments are the route by which pollutants travel into larger water systems and, ultimately, lakes. By narrowing the focus of the western portion of the watershed to **riparian corridors, which is one-half mile on both sides of water segments**, and the Wakarusa River floodplain, the Upper Wakarusa WRAPS can implement BMPs in cropland and livestock areas that will most effectively reduce sediment, nutrient, and bacteria loading. The eastern portion of the watershed will implement BMPs throughout the HUC 12s that drain into Clinton Lake, reducing the amount of nutrients that enter the lake.

B. Targeted Areas for BMP Implementation

It is more economical for watersheds to use specific BMP placement, rather than randomly applying BMPs throughout the watershed. Every watershed has specific locations that

contribute a greater pollutant load due to soil type, proximity to streams, and land-use practices. By using BMPs in these specific areas, pollutants can be reduced at a more efficient rate.

As previously mentioned, the STEPL model, water monitoring, and stream proximity were all used to determine the targeted areas for this Upper Wakarusa WRAPS plan. Targeting assessment data were presented to, considered, and approved by the Upper Wakarusa WRAPS group and KDHE.

The Upper Wakarusa WRAPS group, in conjunction with KDHE's Watershed Management Section, decided to target 166,603 acres for BMP implementation in the Upper Wakarusa Watershed. This represents 71% of the total acres in the watershed (**Table 17**). It has been determined that the most efficient sediment, nutrient, and *E.coli* bacteria load reductions will be made in **cropland** and **livestock** areas.

As shown in **Figure 15**, cropland and livestock BMP implementation will take place in areas along the riparian corridors and in the floodplain of the Wakarusa River and its major tributaries, as well as in five complete HUC 12s.

The targeted riparian corridor and floodplain areas will collectively be referred to as the "riparian" area and are located in three HUC 12s. In total, these represent 22,308 acres, with 15,586 cropland and livestock acres. The HUC 12s include:

- HUC 102701040**101**
- HUC 102701040**102**
- HUC 102701040**103**

Cropland and livestock BMP implementation will also take place in these five HUC 12s:

- HUC 102701040**104** (33,875 total acres, 24,029 cropland and livestock acres)
- HUC 102701040**105** (27,617 total acres, 19,767 cropland and livestock acres)
- HUC 102701040**106** (16,395 total acres, 10,212 cropland and livestock acres)
- HUC 102701040**107** (31,921 total acres, 22,383 cropland and livestock acres)
- HUC 102701040**108** (34,487 total acres, 21,719 cropland and livestock acres)

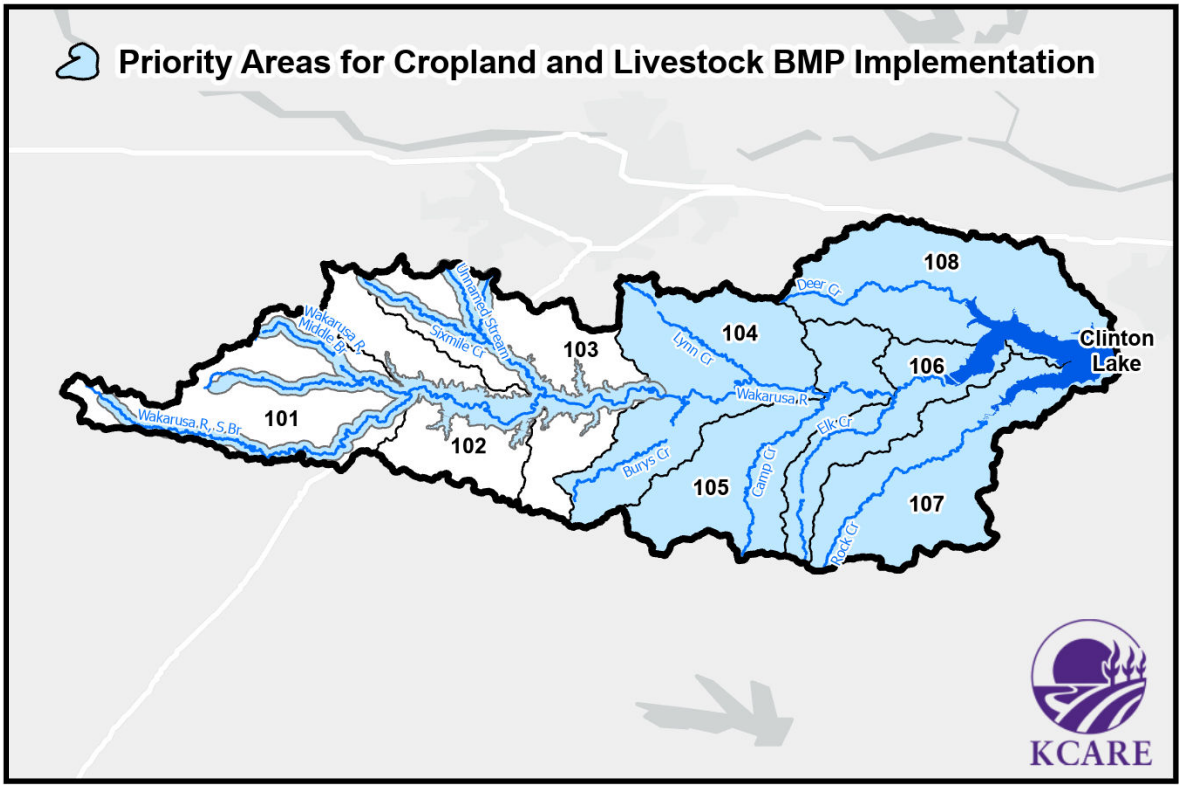


Figure 15. BMP Implementation Areas in the Upper Wakarusa Watershed

Table 17. Land Use in the Targeted Areas

Land Use in the Upper Wakarusa Targeted Area				
Land Use	**HUCs 104, 105, 106, 107, and 108 Targeted Acres**	**Riparian Corridor/ Floodplain Targeted Acres**	**Total Targeted Acres**	**Percent of Watershed Targeted for BMP Implementation**
Pasture/Hay	60,555	7,638	68,193	29%
Cropland	26,751	5,292	32,043	14%
Deciduous Forest	24,750	5,069	29,819	13%
Grassland	10,804	2,656	13,460	6%
Open Water	8,700	254	8,954	4%
Mixed Forest	4,515	312	4,827	2%
Developed, Open Space	3,866	595	4,461	2%
Developed, Low Intensity	2,618	360	2,978	1%
Wetlands	503	2	505	<1%
Developed, Medium Intensity	309	61	370	<1%
Evergreen Forest	294	6	300	<1%
Barren Land	225	0	225	<1%
Shrubland	172	26	198	<1%
Woody Wetlands	117	34	151	<1%
Developed, High Intensity	116	3	119	<1%
Total	**144,295**	**22,308**	**166,603**	**71%**
There are 232,695 acres in the Upper Wakarusa Watershed. 71% of those acres will be targeted for BMP implementation.				

C. Load Reduction Estimate Methodology

Load reductions will be estimated for each pollutant addressed in each area to measure success meeting TMDL goals.

1. Cropland

Baseline loadings are calculated using the AnnAGNPS model delineated to the HUC 12 watershed scale. AnnAGNPS is a continuous-simulation, multi-event modification of the single-event model, AGNPS. It offers improved technology and the addition of new features. BMP load reduction efficiencies are derived from Kansas State University Research and Extension Publication MF-2572.[23] Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies.

2. Livestock

Baseline nutrient loadings per animal unit are calculated using the Livestock Waste Facilities Handbook[24] and these three publications: *Decreasing Nitrogen and Phosphorus Excretion by Dairy Cattle*[25], *Fertilizing Cropland with Beef Manure*[26], and *Estimating Manure Nutrient Excretion*[27]. Livestock management practice load reduction efficiencies are derived from numerous sources, including Kansas State University Research and Extension Publication MF-2737[28] and MF-2454[29].

Load reduction estimates are the product of baseline loading and the applicable BMP load reduction efficiencies. According to the 2019 Ag Census, stocking rates in the Upper Wakarusa Watershed range from 10.5 to 12.8, with an average of 11.7 cattle per 100 acres. Therefore, a stocking rate of 1 animal unit per 8.5 acres is used to determine the livestock practice load reduction calculations.

[23] https://www.bookstore.ksre.ksu.edu/pubs/MF2572.pdf
[24] https://www-mwps.sws.iastate.edu/catalog/manure-management/livestock-waste-facilities-handbook
[25] Sudduth, T.Q. and M.J. Loveless. *Decreasing Nitrogen and Phosphorus Excretion by Dairy Cattle*. https://www.clemson.edu/extension/camm/manuals/dairy/dch3b_04.pdf
[26] Schmitt, Michael and George Rehm. *Fertilizing Cropland with Beef Manure*. 2002. University of Minnesota Extension Bulletin.
[27] Koelsch, Rick. *Estimating Manure Nutrient Excretion.* 2007. University of Nebraska Extension Bulletin.
[28] MF-2737 Available at: https://www.bookstore.ksre.ksu.edu/pubs/MF2737.pdf
[29] MF-2454 Available at: https://www.bookstore.ksre.ksu.edu/pubs/MF2454.pdf

7. Implementation

As mentioned in the previous section, BMP implementation in the Upper Wakarusa Watershed will take place in eight HUC 12 sub-watersheds, five in their entirety and only the riparian corridors and floodplain areas in the remaining three. Cropland and livestock areas will be targeted to effectively improve the following TMDL impairments:

- **Biology/Sediment:** cropland priority areas
- ***E. coli*:** livestock priority areas
- **Eutrophication:** cropland and livestock priority areas

Cropland BMPs will reduce sediment and nutrient (phosphorus and nitrogen) loading, thereby improving the Biology/Sediment TMDL in the Wakarusa River and Eutrophication TMDL in Clinton Lake. In addition, these reductions will subsequently work to improve the Upper Wakarusa Watershed's aquatic plants and other eutrophication impairments.

Livestock BMPs will reduce nutrient loading, particularly phosphorus, by moving cattle away from water segments. This will directly address the Wakarusa River *E. coli* TMDL and the Eutrophication TMDL in Clinton Lake. These reductions will also work to improve the Upper Wakarusa Watershed's aquatic plants and other eutrophication impairments.

A. Addressing the Biology/Sediment TMDL in the Upper Wakarusa Watershed

The Upper Wakarusa Watershed has a high-priority TMDL for biology/sediment in the Wakarusa River. This WRAPS plan will address this Biology/Sediment TMDL by reducing the amount of sediment loss in targeted **cropland** areas. It is expected that adoption and implementation of sediment BMPs will result in total sediment load reductions of **33,341 tons of sediment** at the conclusion of this 30-year WRAPS plan.

There are 32,043 cropland acres in the areas targeted for sediment load reduction in the Upper Wakarusa Watershed (**Table 18**). Land use in the sediment-targeted area does make an impact as cropland is known to be highly susceptible to runoff and erosion during rainfall events. Cropland BMP implementation will take place throughout the targeted portions of the watershed, which is roughly 14% of the entire watershed.

Table 18. Land Use in the Cropland Targeted Areas

Land Use in the Upper Wakarusa Targeted Area				
Land Use	**HUCs 104, 105, 106, 107, and 108 Targeted Acres**	**Riparian Corridor/ Floodplain Targeted Acres**	**Total Targeted Acres**	**Percent of Watershed Targeted for BMP Implementation**
Pasture/Hay	60,555	7,638	68,193	29%
Cropland	26,751	5,292	32,043	14%
Deciduous Forest	24,750	5,069	29,819	13%
Grassland	10,804	2,656	13,460	6%
Open Water	8,700	254	8,954	4%
Mixed Forest	4,515	312	4,827	2%
Developed, Open Space	3,866	595	4,461	2%
Developed, Low Intensity	2,618	360	2,978	1%
Wetlands	503	2	505	<1%
Developed, Medium Intensity	309	61	370	<1%
Evergreen Forest	294	6	300	<1%
Barren Land	225	0	225	<1%
Shrubland	172	26	198	<1%
Woody Wetlands	117	34	151	<1%
Developed, High Intensity	116	3	119	<1%
Total	**144,295**	**22,308**	**166,603**	**71%**
There are 232,695 acres in the Upper Wakarusa Watershed.				

Any BMPs implemented in the targeted areas simultaneously will reduce both sediment and nutrient loading.

1. Cropland targeted for sediment reductions in the Upper Wakarusa Watershed

Cropland BMPs will be implemented to reduce sediment loading in the Upper Wakarusa Watershed to protect local streams and to improve the Biology/Sediment TMDL in the Upper Wakarusa River. *Any cropland BMPs implemented in the targeted areas will reduce sediment loss, thereby simultaneously reducing nutrient loading.*

As shown in **Figure 16**, cropland BMP implementation will take place in areas along the riparian corridors and in the floodplain of the Wakarusa River and its major tributaries. These areas will collectively be considered the "riparian" area and are located in the following three HUC 12s, totaling 5,292 cropland acres:

- HUC 102701040**101**
- HUC 102701040**102**
- HUC 102701040**103**

Cropland BMP implementation will also take place throughout these five HUC 12s:

- HUC 102701040**104** (6,528 cropland acres)
- HUC 102701040**105** (7,324 cropland acres)
- HUC 102701040**106** (2,265 cropland acres)
- HUC 102701040**107** (5,956 cropland acres)
- HUC 102701040**108** (4,678 cropland acres)

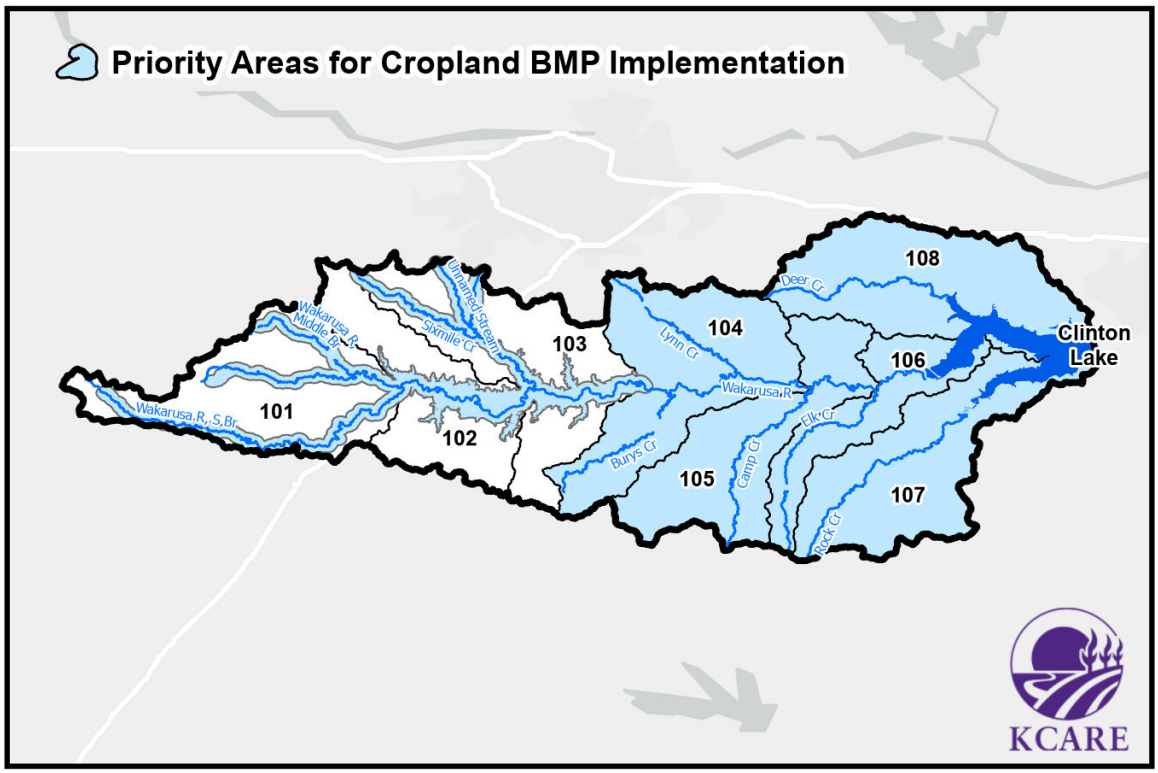


Figure 16. Cropland Targeted Area in the Upper Wakarusa Watershed

2. Cropland BMPs for sediment reductions

The following BMPs will be implemented to reduce sediment (and nutrient) loading from crop fields in the Upper Wakarusa Watershed's targeted areas:

- Buffers
- Cover Crops
- No-Till
- Nutrient Management Plans
- Permanent Vegetation
- Terraces
- Waterways
- Wetlands

Table 19. Cropland BMPs Needed to Reduce Sediment Loading

BMPs to Reduce Sediment Loading in the Upper Wakarusa Watershed		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of sediment contribution from **cropland**	Buffers	854 acres
	Cover Crops	854 acres
	No-Till	854 acres
	Nutrient Management Plans	1,068 acres
	Permanent Vegetation	481 acres
	Terraces	854 acres
	Waterways	854 acres
	Wetlands	320 acres

Table 20. Adoption Rates for Cropland BMPs to Address Sediment

Annual Adoption (treated acres), Cropland BMPs									
Year	**Buffers**	**Cover Crop**	**No-Till**	**Nutrient Management Plans**	**Permanent Vegetation**	**Terraces**	**Waterways**	**Wetlands**	**Total Adoption**
1	854	854	854	1,068	481	854	854	320	6,142
2	854	854	854	1,068	481	854	854	320	6,142
3	854	854	854	1,068	481	854	854	320	6,142
4	854	854	854	1,068	481	854	854	320	6,142
5	854	854	854	1,068	481	854	854	320	6,142
6	854	854	854	1,068	481	854	854	320	6,142
7	854	854	854	1,068	481	854	854	320	6,142
8	854	854	854	1,068	481	854	854	320	6,142
9	854	854	854	1,068	481	854	854	320	6,142
10	854	854	854	1,068	481	854	854	320	6,142
11	854	854	854	1,068	481	854	854	320	6,142
12	854	854	854	1,068	481	854	854	320	6,142
13	854	854	854	1,068	481	854	854	320	6,142
14	854	854	854	1,068	481	854	854	320	6,142
15	854	854	854	1,068	481	854	854	320	6,142
16	854	854	854	1,068	481	854	854	320	6,142
17	854	854	854	1,068	481	854	854	320	6,142
18	854	854	854	1,068	481	854	854	320	6,142
19	854	854	854	1,068	481	854	854	320	6,142
20	854	854	854	1,068	481	854	854	320	6,142
21	854	854	854	1,068	481	854	854	320	6,142
22	854	854	854	1,068	481	854	854	320	6,142
23	854	854	854	1,068	481	854	854	320	6,142
24	854	854	854	1,068	481	854	854	320	6,142
25	854	854	854	1,068	481	854	854	320	6,142
26	854	854	854	1,068	481	854	854	320	6,142
27	854	854	854	1,068	481	854	854	320	6,142
28	854	854	854	1,068	481	854	854	320	6,142
29	854	854	854	1,068	481	854	854	320	6,142
30	854	854	854	1,068	481	854	854	320	6,142
Total	**25,634**	**25,634**	**25,634**	**32,043**	**14,419**	**25,634**	**25,634**	**9,613**	**184,247**

As previously stated, there are 32,040 cropland acres in the targeted areas of the watershed, therefore it is assumed that multiple BMPs will need to take place on the available targeted acres to meet the goal of 184,247 acres of sediment BMP implementation at the end of this 30-year plan. For example, it would be ideal for a nutrient management plan to be set in place for every cropland acre, no-till and cover crops are often used simultaneously, waterways and terraces are not mutually exclusive, etc.

3. Sediment load reductions from cropland BMP implementation

The implementation of cropland BMPs on 6,142 acres per year in the Upper Wakarusa Watershed's targeted areas will result in a load reduction of 1,111 tons of sediment per year. At the end of this 30-year plan, a cumulative sediment load reduction of 33,341 tons will have taken place (**Table 21**).

Table 21. Sediment Load Reductions from Cropland BMP Implementation

Annual Soil Erosion Reduction (tons), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	185	148	148	116	198	111	148	56	1,111
2	371	297	297	232	396	223	297	111	2,223
3	556	445	445	348	595	334	445	167	3,334
4	742	593	593	464	793	445	593	223	4,445
5	927	742	742	579	991	556	742	278	5,557
6	1,113	890	890	695	1,189	668	890	334	6,668
7	1,298	1,038	1,038	811	1,387	779	1,038	389	7,780
8	1,483	1,187	1,187	927	1,585	890	1,187	445	8,891
9	1,669	1,335	1,335	1,043	1,784	1,001	1,335	501	10,002
10	1,854	1,483	1,483	1,159	1,982	1,113	1,483	556	11,114
11	2,040	1,632	1,632	1,275	2,180	1,224	1,632	612	12,225
12	2,225	1,780	1,780	1,391	2,378	1,335	1,780	668	13,336
13	2,410	1,928	1,928	1,507	2,576	1,446	1,928	723	14,448
14	2,596	2,077	2,077	1,622	2,774	1,558	2,077	779	15,559
15	2,781	2,225	2,225	1,738	2,973	1,669	2,225	834	16,671
16	2,967	2,373	2,373	1,854	3,171	1,780	2,373	890	17,782
17	3,152	2,522	2,522	1,970	3,369	1,891	2,522	946	18,893
18	3,338	2,670	2,670	2,086	3,567	2,003	2,670	1,001	20,005
19	3,523	2,818	2,818	2,202	3,765	2,114	2,818	1,057	21,116
20	3,708	2,967	2,967	2,318	3,963	2,225	2,967	1,113	22,227
21	3,894	3,115	3,115	2,434	4,162	2,336	3,115	1,168	23,339
22	4,079	3,263	3,263	2,550	4,360	2,448	3,263	1,224	24,450
23	4,265	3,412	3,412	2,665	4,558	2,559	3,412	1,279	25,562
24	4,450	3,560	3,560	2,781	4,756	2,670	3,560	1,335	26,673
25	4,636	3,708	3,708	2,897	4,954	2,781	3,708	1,391	27,784
26	4,821	3,857	3,857	3,013	5,152	2,893	3,857	1,446	28,896
27	5,006	4,005	4,005	3,129	5,351	3,004	4,005	1,502	30,007
28	5,192	4,153	4,153	3,245	5,549	3,115	4,153	1,558	31,118
29	5,377	4,302	4,302	3,361	5,747	3,226	4,302	1,613	32,230
30	5,563	4,450	4,450	3,477	5,945	3,338	4,450	1,669	33,341

4. Meeting the sediment goals in the Upper Wakarusa Watershed

Adoption and implementation of sediment BMPs in cropland will result in a total sediment load reduction of 33,341 tons at the conclusion of this 30-year WRAPS plan. The sediment load reduction goal in this plan was 19,155 tons; therefore, the implementation of all sediment BMPs will meet the load reduction goal in year 18 of this plan and will exceed the load reduction goal by 74% after 30 years. (**Table 22**).

Table 22. Meeting the Sediment Goal: Cumulative Sediment Reductions

Meeting the Sediment Goal for the Biology/Sediment TMDL		
Year	**Total Cropland Load Reduction (tons)**	**% of Sediment Goal**
1	1,111	6%
2	2,223	12%
3	3,334	17%
4	4,445	23%
5	5,557	29%
6	6,668	35%
7	7,780	41%
8	8,891	46%
9	10,002	52%
10	11,114	58%
11	12,225	64%
12	13,336	70%
13	14,448	75%
14	15,559	81%
15	16,671	87%
16	17,782	93%
17	18,893	99%
18	20,005	104%
19	21,116	110%
20	22,227	116%
21	23,339	122%
22	24,450	128%
23	25,562	133%
24	26,673	139%
25	27,784	145%
26	28,896	151%
27	30,007	157%
28	31,118	162%
29	32,230	168%
30	33,341	174%
Sediment Reduction Goal: 19,155 tons		

BMPs implemented in cropland areas will reduce both sediment and nutrients, thereby positively affecting the aquatic plants, biology, eutrophication, and E. coli *impairments in the Upper Wakarusa Watershed.*

B. Addressing the *E. coli* Bacteria TMDL in the Upper Wakarusa Watershed

The Upper Wakarusa has a high-priority TMDL for *E. coli* in the Wakarusa River. The watershed will target **livestock** areas for *E. coli* bacteria reductions. Unfortunately, there are no quantitative figures for *E. coli* reductions without intensive water monitoring. Nutrient reductions, namely phosphorus, will certainly be made with BMP implementation and will serve as an indicator that *E. coli* reductions were also achieved.

It is expected that adoption and implementation of livestock BMPs will result in total nutrient load reductions of **24,510 pounds of P** and **46,152 pounds of N** at the conclusion of this 30-year WRAPS plan.

There are 81,653 acres of pasture/hay and grassland (**Table 23**) in the targeted areas of the Upper Wakarusa River Watershed. Livestock BMP implementation will take place throughout the targeted portions of the watershed, which is roughly 35% of the entire watershed.

Table 23. Land Use in the Livestock Targeted Areas

Land Use in the Upper Wakarusa Targeted Area				
Land Use	**HUCs 104, 105, 106, 107, and 108 Targeted Acres**	**Riparian Corridor/ Floodplain Targeted Acres**	**Total Targeted Acres**	**Percent of Watershed Targeted for BMP Implementation**
Pasture/Hay	60,555	7,638	68,193	29%
Cropland	26,751	5,292	32,043	14%
Deciduous Forest	24,750	5,069	29,819	13%
Grassland	10,804	2,656	13,460	6%
Open Water	8,700	254	8,954	4%
Mixed Forest	4,515	312	4,827	2%
Developed, Open Space	3,866	595	4,461	2%
Developed, Low Intensity	2,618	360	2,978	1%
Wetlands	503	2	505	<1%
Developed, Medium Intensity	309	61	370	<1%
Evergreen Forest	294	6	300	<1%
Barren Land	225	0	225	<1%
Shrubland	172	26	198	<1%
Woody Wetlands	117	34	151	<1%
Developed, High Intensity	116	3	119	<1%
Total	**144,295**	**22,308**	166,603	**71%**
There are 232,695 acres in the Upper Wakarusa Watershed.				

1. Targeted livestock areas for *E. coli* reductions

Livestock area BMPs will be implemented to reduce *E. coli* bacteria loading and will simultaneously serve to reduce nutrients in the Upper Wakarusa Watershed. Livestock areas are considered pasture/hay acres and/or grassland acres.

As shown in **Figure 17**, livestock BMP implementation will take place in areas along the riparian corridors and in the floodplain of the Wakarusa River and its major tributaries. These areas will collectively be considered the "riparian" area and are located in the following three HUC 12s, totaling 10, 294 acres:

- HUC 102701040**101**
- HUC 102701040**102**
- HUC 102701040**103**

Livestock BMP implementation will also take place throughout these five HUC 12s:

- HUC 102701040**104** (17,501 livestock acres)
- HUC 102701040**105** (12,443 livestock acres)
- HUC 102701040**106** (7,947 livestock acres)
- HUC 102701040**107** (16,427 livestock acres)
- HUC 102701040**108** (17,041 livestock acres)

It should be noted that livestock BMPs are implemented by project, not by acre. One BMP project can make a significant difference on a livestock operation. Also worth noting, animal units are not a measurement for success at this time. Load reductions achieved are based on local county average and are specific to each BMP. The reasoning behind this is that livestock projects are costly, and few livestock producers are interested in implementing BMPs. Therefore, instead of concentrating on the number of animal units within an operation, Upper Wakarusa WRAPS will focus on implementing quality BMPs in priority areas with willing producers.

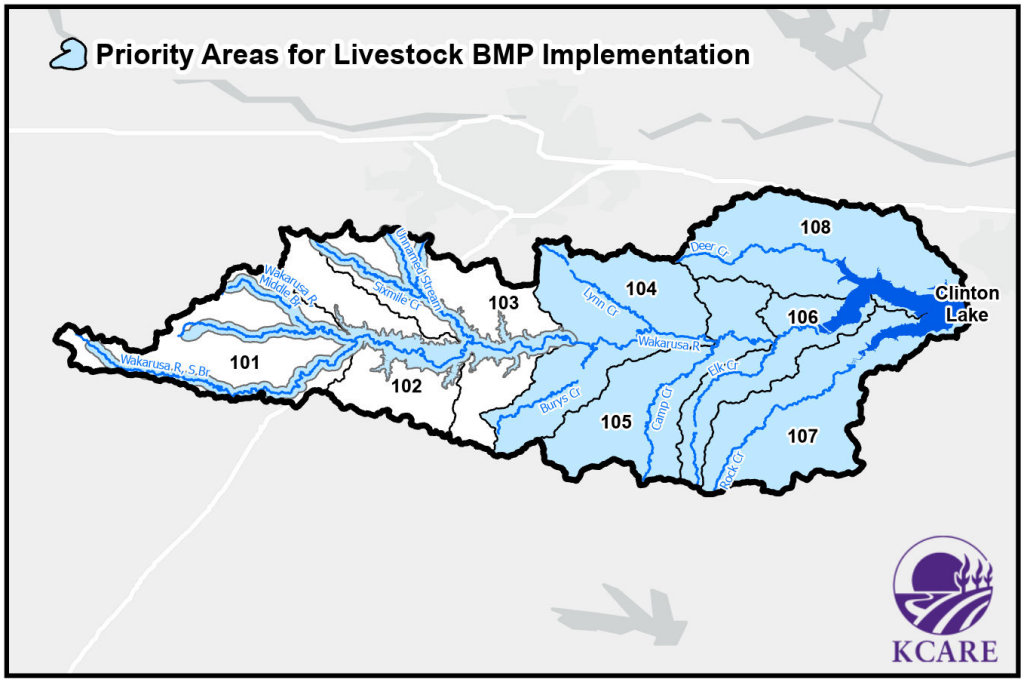


Figure 17. Livestock-Targeted Areas in the Upper Wakarusa Watershed

2. Livestock area BMPs for *E. coli* reductions in the Upper Wakarusa Watershed

The following BMPs will be implemented to reduce *E. coli* bacteria by way of nutrient loading from livestock targeted areas:

- Alternative Watering Systems
- Cover Crop Grazing
- Grazing Management Plans (including riparian exclusion/fencing)
- Relocate Pasture Feeding Sites
- Rotational Grazing
- Vegetative Filter Strips

Table 24. **E. coli** ***BMP Adoption Rates in Livestock Areas***

Livestock BMPs to Reduce *E. coli* in the Upper Wakarusa Watershed		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of *E. coli* bacteria and nutrient contribution from **livestock**	Alternative Watering System	1 project every 2 years of the plan, beginning in year 1. 15 projects during the life of the plan.
	Cover Crop Grazing	1 project every 2 years of the plan, beginning in year 2. 15 projects during the life of the plan.
	Grazing Management Plan	1 project every 2 years of the plan, beginning in year 1. 15 projects during the life of the plan.
	Relocate Pasture Feeding Sites	1 project every 2 years of the plan, beginning in year 2. 15 projects during the life of the plan.
	Rotational Grazing	1 project every 2 years of the plan, beginning in year 1. 15 projects during the life of the plan.
	Vegetative Filter Strips	1 project every year for the first 10 years of the plan. Then, 1 project every 2 years of the plan, beginning in year 12. 20 projects during the life of the plan.

Table 25. Adoption Rates for Livestock BMPs to address E. coli

Annual Livestock BMP Adoption							
Year	Alternative Watering System	Cover Crop Grazing	Grazing Management Plan	Relocate Pasture Feeding Sites	Rotational Grazing	Vegetative Filter Strips	Projects Per Year
1	1	1	0	0	1	1	4
2	0	0	1	1	0	1	3
3	1	1	0	0	1	1	4
4	0	0	1	1	0	1	3
5	1	1	0	0	1	1	4
6	0	0	1	1	0	1	3
7	1	1	0	0	1	1	4
8	0	0	1	1	0	1	3
9	1	1	0	0	1	1	4
10	0	0	1	1	0	1	3
11	1	1	0	0	1	0	3
12	0	0	1	1	0	1	3
13	1	1	0	0	1	0	3
14	0	0	1	1	0	1	3
15	1	1	0	0	1	0	3
16	0	0	1	1	0	1	3
17	1	1	0	0	1	0	3
18	0	0	1	1	0	1	3
19	1	1	0	0	1	0	3
20	0	0	1	1	0	1	3
21	1	1	0	0	1	0	3
22	0	0	1	1	0	1	3
23	1	1	0	0	1	0	3
24	0	0	1	1	0	1	3
25	1	1	0	0	1	0	3
26	0	0	1	1	0	1	3
27	1	1	0	0	1	0	3
28	0	0	1	1	0	1	3
29	1	1	0	0	1	0	3
30	0	0	1	1	0	1	3
Total	**15**	**15**	**15**	**15**	**15**	**20**	**95**

3. *E. coli* load reductions from livestock BMP implementation

It is not possible to estimate the current pollutant load for *E. coli* bacteria in the watershed due to several factors. First, environmental factors affect the viability of *E. coli* since it is a living organism. Next, the viability 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. In addition, *E. coli* concentrations are difficult to model, and the scope of this WRAPS project does not include modeling for *E. coli*. Therefore, it is assumed that the specific livestock BMPs identified for implementation in priority riparian areas will result in reduced *E. coli* contamination. The implementation of 3-4 livestock BMP projects per year will no doubt result in less *E. coli* bacteria in the Upper Wakarusa Watershed's streams and rivers.

E. coli load reductions will be assumed and measured by the achievement of nutrient (phosphorus and nitrogen) load reductions in livestock areas that have implemented BMPs laid out by this plan.

The reduction of nutrients due to livestock BMP implementation will also serve to positively impact the aquatic plants, biology, and eutrophication impairments in the Upper Wakarusa Watershed.

C. Addressing the Eutrophication TMDL in the Upper Wakarusa Watershed

The high-priority Eutrophication TMDL found in several Upper Wakarusa Watershed lakes will be positively impacted by the cropland and livestock BMP implementation schedule presented in this plan.

- The implementation of cropland BMPs to address the high-priority Biology/Sediment TMDL will subsequently result in nutrient (phosphorus and nitrogen) load reductions.
- Focusing BMPs in livestock areas to improve the high-priority *E. Coli* bacteria TMDL will also result in nutrient (phosphorus and nitrogen) load reductions.

1. Phosphorus load reductions

a. Phosphorus load reductions from cropland BMP implementation

The cropland sediment BMP implementation that takes place in the Upper Wakarusa Watershed will also result in a reduction in phosphorus loading. BMP implementation as structured in this plan will result in a phosphorus load reduction of 6,880 pounds per year and a total load reduction of 206,405 pounds over the course of this 30-year WRAPS plan (**Table 26**).

Table 26. Phosphorus Load Reductions from Cropland BMPs

Annual Phosphorous Reduction (lbs), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	1,111	1,111	889	694	1,187	666	889	333	6,880
2	2,222	2,222	1,777	1,389	2,374	1,333	1,777	666	13,760
3	3,332	3,332	2,666	2,083	3,562	1,999	2,666	1,000	20,640
4	4,443	4,443	3,555	2,777	4,749	2,666	3,555	1,333	27,521
5	5,554	5,554	4,443	3,471	5,936	3,332	4,443	1,666	34,401
6	6,665	6,665	5,332	4,166	7,123	3,999	5,332	1,999	41,281
7	7,776	7,776	6,221	4,860	8,310	4,665	6,221	2,333	48,161
8	8,887	8,887	7,109	5,554	9,498	5,332	7,109	2,666	55,041
9	9,997	9,997	7,998	6,248	10,685	5,998	7,998	2,999	61,921
10	11,108	11,108	8,887	6,943	11,872	6,665	8,887	3,332	68,802
11	12,219	12,219	9,775	7,637	13,059	7,331	9,775	3,666	75,682
12	13,330	13,330	10,664	8,331	14,246	7,998	10,664	3,999	82,562
13	14,441	14,441	11,553	9,025	15,434	8,664	11,553	4,332	89,442
14	15,552	15,552	12,441	9,720	16,621	9,331	12,441	4,665	96,322
15	16,662	16,662	13,330	10,414	17,808	9,997	13,330	4,999	103,202
16	17,773	17,773	14,219	11,108	18,995	10,664	14,219	5,332	110,083
17	18,884	18,884	15,107	11,803	20,182	11,330	15,107	5,665	116,963
18	19,995	19,995	15,996	12,497	21,369	11,997	15,996	5,998	123,843
19	21,106	21,106	16,885	13,191	22,557	12,663	16,885	6,332	130,723
20	22,216	22,216	17,773	13,885	23,744	13,330	17,773	6,665	137,603
21	23,327	23,327	18,662	14,580	24,931	13,996	18,662	6,998	144,483
22	24,438	24,438	19,551	15,274	26,118	14,663	19,551	7,331	151,364
23	25,549	25,549	20,439	15,968	27,305	15,329	20,439	7,665	158,244
24	26,660	26,660	21,328	16,662	28,493	15,996	21,328	7,998	165,124
25	27,771	27,771	22,216	17,357	29,680	16,662	22,216	8,331	172,004
26	28,881	28,881	23,105	18,051	30,867	17,329	23,105	8,664	178,884
27	29,992	29,992	23,994	18,745	32,054	17,995	23,994	8,998	185,764
28	31,103	31,103	24,882	19,439	33,241	18,662	24,882	9,331	192,645
29	32,214	32,214	25,771	20,134	34,429	19,328	25,771	9,664	199,525
30	33,325	33,325	26,660	20,828	35,616	19,995	26,660	9,997	206,405

b. Phosphorus load reductions from livestock BMP implementation

The livestock BMP implementation that takes place in the Upper Wakarusa Watershed reduce phosphorus loading. BMP implementation as structured in this plan will result in a phosphorus load reduction of 24,510 pounds at the conclusion of this 30-year WRAPS plan **(Table 27)**.

Load reductions from livestock sources are derived from the animal units involved in a "project" as described in Section 6, C-2.

Table 27. Phosphorus Load Reductions from Livestock BMPs

Annual Phosphorous Reduction (lbs), Livestock BMPs								
Year	Alternative Watering System	Cover Crop Grazing	Grazing Management Plan	Relocate Pasture Feeding Sites	Rotational Grazing	Vegetative Filter Strips	Annual Total	Cumulative Load Reduction
1	23	204	0	0	102	888	1,217	1,217
2	0	0	102	19	0	888	1,009	2,226
3	23	204	0	0	102	888	1,217	3,443
4	0	0	102	19	0	888	1,009	4,452
5	23	204	0	0	102	888	1,217	5,669
6	0	0	102	19	0	888	1,009	6,678
7	23	204	0	0	102	888	1,217	7,895
8	0	0	102	19	0	888	1,009	8,904
9	23	204	0	0	102	888	1,217	10,121
10	0	0	102	19	0	888	1,009	11,130
11	23	204	0	0	102	0	329	11,459
12	0	0	102	19	0	888	1,009	12,468
13	23	204			102	0	329	12,797
14	0	0	102	19	0	888	1,009	13,806
15	23	204			102	0	329	14,135
16	0	0	102	19	0	888	1,009	15,144
17	23	204			102	0	329	15,473
18	0	0	102	19	0	888	1,009	16,482
19	23	204			102	0	329	16,811
20	0	0	102	19	0	888	1,009	17,820
21	23	204			102	0	329	18,149
22	0	0	102	19	0	888	1,009	19,158
23	23	204			102	0	329	19,487
24	0	0	102	19	0	888	1,009	20,496
25	23	204			102	0	329	20,825
26	0	0	102	19	0	888	1,009	21,834
27	23	204			102	0	329	22,163
28	0	0	102	19	0	888	1,009	23,172
29	23	204			102	0	329	23,501
30	0	0	102	19	0	888	1,009	24,510

2. *Meeting the phosphorus goals in the Upper Wakarusa Watershed*

Over the course of this 30-year WRAPS plan, a total phosphorus load reduction of 230,915 pounds will be accomplished by following the cropland and livestock BMP implementation schedules outlined in this plan. This exceeds the load reduction goal of 228,815 pounds by roughly 1% in the final year of this WRAPS plan (**Table 28**).

Table 28. Cumulative Phosphorus Load Reductions in the Upper Wakarusa Watershed

Phosphorus Reduction from Cropland and Livestock BMPs				
Year	**Cropland Reduction (pounds/year)**	**Livestock Reduction (pounds/year)**	**Total Reduction (pounds/year)**	**% of TMDL**
1	6,880	1,217	8,097	4%
2	13,760	2,226	15,986	7%
3	20,640	3,443	24,083	11%
4	27,521	4,452	31,973	14%
5	34,401	5,669	40,070	18%
6	41,281	6,678	47,959	21%
7	48,161	7,895	56,056	24%
8	55,041	8,904	63,945	28%
9	61,921	10,121	72,042	31%
10	68,802	11,130	79,932	35%
11	75,682	11,459	87,141	38%
12	82,562	12,468	95,030	42%
13	89,442	12,797	102,239	45%
14	96,322	13,806	110,128	48%
15	103,202	14,135	117,337	51%
16	110,083	15,144	125,227	55%
17	116,963	15,473	132,436	58%
18	123,843	16,482	140,325	61%
19	130,723	16,811	147,534	64%
20	137,603	17,820	155,423	68%
21	144,483	18,149	162,632	71%
22	151,364	19,158	170,522	75%
23	158,244	19,487	177,731	78%
24	165,124	20,496	185,620	81%
25	172,004	20,825	192,829	84%
26	178,884	21,834	200,718	88%
27	185,764	22,163	207,927	91%
28	192,645	23,172	215,817	94%
29	199,525	23,501	223,026	97%
30	206,405	24,510	230,915	101%
Phosphorus Reduction Goal: 228,815 tons				

3. Nitrogen load reductions

a. Nitrogen load reductions from cropland BMP implementation

The cropland sediment BMP implementation that takes place in the Upper Wakarusa Watershed also will result in a reduction in nitrogen loading. BMP implementation as structured in this plan will result in a nitrogen load reduction of 27,245 pounds per year and a total load reduction of 817,353 pounds over the course of this 30-year WRAPS plan (**Table 29**).

Table 29. Nitrogen Load Reductions from Cropland BMPs

Annual Nitrogen Reduction (lbs), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	4,785	2,393	3,828	2,991	5,114	2,871	3,828	1,436	27,245
2	9,570	4,785	7,656	5,981	10,228	5,742	7,656	2,871	54,490
3	14,355	7,178	11,484	8,972	15,342	8,613	11,484	4,307	81,735
4	19,140	9,570	15,312	11,963	20,456	11,484	15,312	5,742	108,980
5	23,925	11,963	19,140	14,953	25,570	14,355	19,140	7,178	136,225
6	28,711	14,355	22,968	17,944	30,684	17,226	22,968	8,613	163,471
7	33,496	16,748	26,796	20,935	35,798	20,097	26,796	10,049	190,716
8	38,281	19,140	30,625	23,925	40,913	22,968	30,625	11,484	217,961
9	43,066	21,533	34,453	26,916	46,027	25,839	34,453	12,920	245,206
10	47,851	23,925	38,281	29,907	51,141	28,711	38,281	14,355	272,451
11	52,636	26,318	42,109	32,897	56,255	31,582	42,109	15,791	299,696
12	57,421	28,711	45,937	35,888	61,369	34,453	45,937	17,226	326,941
13	62,206	31,103	49,765	38,879	66,483	37,324	49,765	18,662	354,186
14	66,991	33,496	53,593	41,870	71,597	40,195	53,593	20,099	381,433
15	71,776	35,888	57,421	44,860	76,711	43,066	57,421	21,533	408,676
16	76,561	38,281	61,249	47,851	81,825	45,937	61,249	22,968	435,922
17	81,346	40,673	65,077	50,842	86,939	48,808	65,077	24,404	463,167
18	86,132	43,066	68,905	53,832	92,053	51,679	68,905	25,839	490,412
19	90,917	45,458	72,733	56,823	97,167	54,550	72,733	27,275	517,657
20	95,702	47,851	76,561	59,814	102,281	57,421	76,561	28,711	544,902
21	100,487	50,243	80,389	62,804	107,395	60,292	80,389	30,146	572,147
22	105,272	52,636	84,218	65,795	112,509	63,163	84,218	31,582	599,392
23	110,057	55,029	88,046	68,786	117,623	66,034	88,046	33,017	626,637
24	114,842	57,421	91,874	71,776	122,738	68,905	91,874	34,453	653,882
25	119,627	59,814	95,702	74,767	127,852	71,776	95,702	35,888	681,127
26	124,412	62,206	99,530	77,758	132,966	74,647	99,530	37,324	708,372
27	129,197	64,599	103,358	80,748	138,080	77,518	103,358	38,759	735,618
28	133,982	66,991	107,186	83,739	143,194	80,389	107,186	40,195	762,863
29	138,768	69,384	111,014	86,730	148,308	83,261	111,014	41,630	790,108
30	143,553	71,776	114,842	89,720	153,422	86,132	114,842	43,066	817,353

b. Nitrogen load reductions from livestock BMP implementation

The livestock BMP implementation that takes place in the Upper Wakarusa Watershed reduce nitrogen loading. BMP implementation as structured in this plan will result in a

nitrogen load reduction of 2,292 pounds per year and a total of 46,152 pounds at the conclusion of this 30-year WRAPS plan **(Table 30)**.

Load reductions from livestock sources are derived from the animal units involved in a "project" as described in Section 6, C-2.

Table 30. Nitrogen Load Reductions from Livestock BMPs

Annual Nitrogen Reduction (lbs), Livestock BMPs								
Year	Alternative Watering System	Cover Crop Grazing	Grazing Management Plan	Relocate Pasture Feeding Sites	Rotational Grazing	Vegetative Filter Strips	Annual Total	Cumulative Load Reduction
1	43	384	0	0	192	1,673	2,292	2,292
2	0	0	192	36	0	1,673	1,900	4,192
3	43	384	0	0	192	1,673	2,292	6,483
4	0	0	192	36	0	1,673	1,900	8,384
5	43	384	0	0	192	1,673	2,292	10,675
6	0	0	192	36	0	1,673	1,900	12,575
7	43	384	0	0	192	1,673	2,292	14,867
8	0	0	192	36	0	1,673	1,900	16,767
9	43	384	0	0	192	1,673	2,292	19,059
10	0	0	192	36	0	1,673	1,900	20,959
11	43	384	0	0	192	0	619	21,578
12	0	0	192	36	0	1,673	1,900	23,478
13	43	384	0	0	192	0	619	24,097
14	0	0	192	36	0	1,673	1,900	25,998
15	43	384	0	0	192	0	619	26,617
16	0	0	192	36	0	1,673	1,900	28,517
17	43	384	0	0	192	0	619	29,136
18	0	0	192	36	0	1,673	1,900	31,036
19	43	384	0	0	192	0	619	31,655
20	0	0	192	36	0	1,673	1,900	33,556
21	43	384	0	0	192	0	619	34,175
22	0	0	192	36	0	1,673	1,900	36,075
23	43	384	0	0	192	0	619	36,694
24	0	0	192	36	0	1,673	1,900	38,594
25	43	384	0	0	192	0	619	39,213
26	0	0	192	36	0	1,673	1,900	41,113
27	43	384	0	0	192	0	619	41,732
28	0	0	192	36	0	1,673	1,900	43,633
29	43	384	0	0	192	0	619	44,252
30	0	0	192	36	0	1,673	1,900	46,152

c. Cumulative nitrogen load reductions

Over the course of this 30-year WRAPS plan, a total nitrogen load reduction of 863,505 pounds will be accomplished by following the cropland and livestock BMP implementation schedules outlined in this plan (**Table 31**). This is a reduction of 45%

in current nitrogen loading which was 1,902,572 pounds/year[30]. While there is no load reduction goal set specific to nitrogen, these load reductions will certainly improve the Biology and Eutrophication TMDL impairments in the Upper Wakarusa Watershed.

Table 31. Cumulative Nitrogen Load Reductions in the Upper Wakarusa Watershed

Nitrogen Reduction from Cropland and Livestock BMPs			
Year	**Cropland Reduction (pounds/year)**	**Livestock Reduction (pounds/year)**	**Total Reduction (pounds/year)**
1	27,245	2,292	29,537
2	54,490	4,192	58,682
3	81,735	6,483	88,219
4	108,980	8,384	117,364
5	136,225	10,675	146,901
6	163,471	12,575	176,046
7	190,716	14,867	205,583
8	217,961	16,767	234,728
9	245,206	19,059	264,265
10	272,451	20,959	293,410
11	299,696	21,578	321,274
12	326,941	23,478	350,419
13	354,186	24,097	378,284
14	381,433	25,998	407,431
15	408,676	26,617	435,293
16	435,922	28,517	464,438
17	463,167	29,136	492,303
18	490,412	31,036	521,448
19	517,657	31,655	549,312
20	544,902	33,556	578,457
21	572,147	34,175	606,321
22	599,392	36,075	635,467
23	626,637	36,694	663,331
24	653,882	38,594	692,476
25	681,127	39,213	720,340
26	708,372	41,113	749,486
27	735,618	41,732	777,350
28	762,863	43,633	806,495
29	790,108	44,252	834,359
30	817,353	46,152	863,505
Nitrogen Load Reduction Goal: No reduction goals are formalized, but significant load reductions will be realized through cropland and livestock BMPs.			

[30] Nitrogen current loading number was provided by the KDHE Watershed Management Section, April 2023.

8. Information and Education

The Upper Wakarusa WRAPS Coordinator, with insight from the SLT, has determined which Information and Education (I&E) activities are needed in the Upper Wakarusa Watershed. These important activities provide watershed residents with an improved awareness of local watershed issues which leads to increased adoption rates of BMPs. All I&E activities and events are evaluated based on productivity, attendance, and achievement of objectives.

A. I&E Activities and Events in the Upper Wakarusa Watershed

Listed below are the I&E activities and events along with their costs and possible sponsoring agencies. If all listed I&E events and activities take place, the total annual cost would be **$41,750**. *It is understood that funding from non-WRAPS sources will be required if all these activities are to take place.*

Table 32. I&E: Cropland BMP Education

Cropland BMP Implementation					
BMP	**Target Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
Buffers	Landowners/ Producers	Forestry Field Day	Annual	$3,000	Kansas Forest Service
		Cropland BMPs Workshop/Field Day	Annual	$2,000	Conservation Districts, Upper Wakarusa WRAPS/KAWS
		One-on-one technical assistance for producers to implement BMPs in the targeted area.	Annual	No Cost	Conservation Districts, KDWP, NRCS
		One-on-one technical assistance for riparian tree planting	Annual, on-going	Included in Foresty Field Day	Kansas Forest Service
Cover Crops	Landowners/ Producers	One-on-one technical assistance for producers to implement BMPs in the targeted area.	Annual	No Cost	Conservation Districts, NRCS
		Cropland BMPs Workshop/Field Day	Annual	$2,000	Conservation Districts, Upper Wakarusa WRAPS/KAWS
No-Till	Landowners/ Producers	One-on-one technical assistance for producers to implement BMPs in the targeted area.	Annual	No Cost	Conservation Districts, NRCS
		Scholarships for producers to attend No-till on the Plains Annual Conference	Annual	$750	No-till on the Plains,Upper Wakarusa WRAPS/KAWS
		Cropland BMPs Workshop/Field Day	Annual, Spring	Included Above	Conservation Districts, Upper Wakarusa WRAPS/KAWS
Nutrient Management Plans	Landowners/ Producers	One-on-one technical assistance for producers to implement BMPs in the targeted area.	Annual	No Cost	Conservation Districts, NRCS
		Cropland BMPs Workshop/Field Day	Annual	Included Above	Conservation Districts, Upper Wakarusa WRAPS/KAWS
Permanent Vegetation	Landowners/ Producers	Cropland BMPs Workshop/Field Day	Annual - Ongoing	Included Above	Conservation Districts, Upper Wakarusa WRAPS/KAWS
		Forestry Field Day	Annual	Included in Foresty Field Day under "Buffers"	Kansas Forest Service
Terraces	Landowners/ Producers	One-on-one technical assistance for producers to implement BMPs in the targeted area.	Annual	No Cost	Conservation Districts, NRCS
		Cropland BMPs Workshop/Field Day	Annual	Included Above	Conservation Districts, Upper Wakarusa WRAPS/KAWS
Waterways	Landowners/ Producers	Cropland BMPs Workshop/Field Day	Annual	Included Above	Conservation Districts, Upper Wakarusa WRAPS/KAWS
		One-on-one technical assistance for producers to implement BMPs in the targeted area.	Annual	No Cost	Conservation Districts, NRCS
Wetlands	Landowners/ Producers	One-on-one technical assistance for producers to implement BMPs in the targeted area.	Annual - Ongoing	No Cost	Conservation Districts, NRCS
		Sediment Basin and Wetland Field Day/Tour	Every other year	Included with Sediment Basin and Wetland Field Day/Tour	Conservation Districts, Upper Wakarusa WRAPS/KAWS

Table 33. I&E: Livestock BMP Education

Livestock BMP Implementation					
BMP	**Target Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
Alternative Watering System	Livestock Producers/ Landowners	One-on-one technical assistance for producers to implement BMPs in the targeted area.	Annual - Ongoing	$4,000	Division of Conservation (DOC), Conservation Districts, K-State Research and Extension (KSRE), Kansas Rural Center, Kansas Alliance for Wetlands and Streams (KAWS), NRCS, and WRAPS
		Tour/Field Day	Annual	$10,000	
Cover Crop Grazing	Livestock Producers/ Landowners	One-on-one technical assistance for producers to implement BMPs in the targeted area.	Annual - Ongoing	Included Above	
		Tour/Field Day	Annual - Ongoing	Included Above	
Grazing Management Plan	Livestock Producers/ Landowners	Scholarships to Grazing Schools and workshops	Annual - Ongoing	$500	
Relocate Pasture Feeding Sites	Livestock Producers/ Landowners	One-on-one technical assistance for producers to implement BMPs in the targeted area.	Annual - Ongoing	Included Above	
		Tour/Field Day	Annual - Ongoing	Included Above	
Rotational Grazing	Livestock Producers/ Landowners	One-on-one technical assistance for producers to implement BMPs in the targeted area.	Annual - Ongoing	Included Above	
Vegetative Filter Strips	Livestock Producers/ Landowners	Scholarships to Grazing Schools and workshops	Annual - Winter	Included Above	

Table 34. I&E: Upper Wakarusa Watershed Resident Education

General / Watershed-Wide Information and Education					
BMP	**Target Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
Education Activities Targeting Youth	K-12 Students and Educators	Water festivals/ Water Rally	Annual - Spring or Summer	$1,000	Conservation Districts
		Poster, essay, speech contests	Annual - Spring	$200	Conservation Districts
		Day on the Farm	Annual - Spring	$500	Conservation Districts, Kansas Farm Bureau, KSRE
		Range Youth Camp	Annual	$1,100	Conservation Dristricts, NRCS
		Topeka Water Festival	Annual	$3,000	Shawnee County Conservation District and KACEE
		Envirothon	Annual - Winter	$500	Conservation Districts, NRCS
Education Activities Targeting Adults	Watershed Residents	Maintain a Upper Wakarusa River WRAPS Website	Annual - Ongoing	$1,000	WRAPS and KAWS
		Watershed Announcements/ Advertisement (television, radio, newspaper, etc.)	Annual - Ongoing	$1,000	WRAPS
		Media campaign to promote forestry practices	Annual - Ongoing	$500	Kansas Forest Service
		Educational presentations to conservation districts and community groups	Annual - Ongoing	$100	WRAPS
		Watershed tour highlighting practices	Annual - Fall	$1,000	Watershed Specialists, K-State Research and Extension, Kansas Rural Center, Conservation Districts, NRCS, KAWS, and WRAPS
		Referral Program provides information and referral to technical assistance individuals	Annual - Ongoing	$100	NRCS, Conservation Districts, KCARE and WRAPS
		BMP Auction (in targeted watersheds only)	Annual	$9,000	KSRE and Conservation Districts in the targeted areas
		Upper Wakarusa River Watershed and BMP brochures	Annual	$500	WRAPS
Total Cost (per year) for All Information and Education Activities				**$41,750**	

B. Evaluation of Information and Education Activities

All service providers conducting I&E activities funded through the Upper Wakarusa WRAPS will be required to include an evaluation component in their project implementation proposals. Evaluation methods will vary based on the activity. All service providers will be required to submit a brief written evaluation of their I&E activity summarizing the activity's success in achieving the learning objectives, and how the activity contributed to achieving long-term WRAPS goals, and/or objectives for pollutant load reductions.

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 or activity, development of a basic logic model identifying long-, medium-, and short-term behavior changes or other expected outcomes may be required.

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

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

9. Cost of Implementing BMPs and Funding Sources

The Watershed Coordinator, under the advisement of the SLT has reviewed all the recommended BMPs listed in this WRAPS plan to address the Biology and *E. coli* TMDLs and has determined which BMPs will receive implementation funding in cropland, streambank, and livestock areas. An added benefit is that most of the targeted BMPs will have positive impacts on other impairments in the Upper Wakarusa Watershed, including the Dissolved Oxygen, Eutrophication, and Total Phosphorus TMDLs. Below are expenses before and after cost-share for implementing the scheduled BMPs. Costs can be shared with any potential funding sources (**Table 40**). Cost derivations are in the appendix.

A. Cropland BMP Implementation Costs

Table 35. Implementation Costs: Cropland BMPs Before Cost-Share

Annual Cost* Before Cost-Share, Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Cost
1	$150,388	$34,179	$34,179	$19,226	$84,594	$108,519	$106,810	$25,634	$563,530
2	$154,900	$35,205	$35,205	$19,803	$87,131	$111,775	$110,014	$26,403	$580,435
3	$159,547	$36,261	$36,261	$20,397	$89,745	$115,128	$113,315	$27,196	$597,849
4	$164,334	$37,349	$37,349	$21,009	$92,438	$118,582	$116,714	$28,011	$615,784
5	$169,264	$38,469	$38,469	$21,639	$95,211	$122,139	$120,216	$28,852	$634,257
6	$174,341	$39,623	$39,623	$22,288	$98,067	$125,803	$123,822	$29,717	$653,285
7	$179,572	$40,812	$40,812	$22,957	$101,009	$129,577	$127,537	$30,609	$672,884
8	$184,959	$42,036	$42,036	$23,645	$104,039	$133,465	$131,363	$31,527	$693,070
9	$190,508	$43,297	$43,297	$24,355	$107,161	$137,469	$135,304	$32,473	$713,862
10	$196,223	$44,596	$44,596	$25,085	$110,375	$141,593	$139,363	$33,447	$735,278
11	$202,110	$45,934	$45,934	$25,838	$113,687	$145,840	$143,544	$34,450	$757,337
12	$208,173	$47,312	$47,312	$26,613	$117,097	$150,216	$147,850	$35,484	$780,057
13	$214,418	$48,731	$48,731	$27,411	$120,610	$154,722	$152,286	$36,549	$803,458
14	$220,851	$50,193	$50,193	$28,234	$124,228	$159,364	$156,854	$37,645	$827,562
15	$227,476	$51,699	$51,699	$29,081	$127,955	$164,145	$161,560	$38,774	$852,389
16	$234,300	$53,250	$53,250	$29,953	$131,794	$169,069	$166,406	$39,938	$877,961
17	$241,329	$54,848	$54,848	$30,852	$135,748	$174,141	$171,399	$41,136	$904,300
18	$248,569	$56,493	$56,493	$31,777	$139,820	$179,365	$176,541	$42,370	$931,428
19	$256,026	$58,188	$58,188	$32,731	$144,015	$184,746	$181,837	$43,641	$959,371
20	$263,707	$59,933	$59,933	$33,713	$148,335	$190,289	$187,292	$44,950	$988,152
21	$271,618	$61,731	$61,731	$34,724	$152,785	$195,997	$192,911	$46,299	$1,017,797
22	$279,767	$63,583	$63,583	$35,766	$157,369	$201,877	$198,698	$47,688	$1,048,331
23	$288,160	$65,491	$65,491	$36,839	$162,090	$207,934	$204,659	$49,118	$1,079,781
24	$296,805	$67,456	$67,456	$37,944	$166,953	$214,172	$210,799	$50,592	$1,112,174
25	$305,709	$69,479	$69,479	$39,082	$171,961	$220,597	$217,123	$52,109	$1,145,540
26	$314,880	$71,564	$71,564	$40,255	$177,120	$227,215	$223,636	$53,673	$1,179,906
27	$324,326	$73,711	$73,711	$41,462	$182,434	$234,031	$230,346	$55,283	$1,215,303
28	$334,056	$75,922	$75,922	$42,706	$187,907	$241,052	$237,256	$56,941	$1,251,762
29	$344,078	$78,200	$78,200	$43,987	$193,544	$248,284	$244,374	$58,650	$1,289,315
30	$354,400	$80,546	$80,546	$45,307	$199,350	$255,732	$251,705	$60,409	$1,327,994
Total	**$7,154,794**	**$1,626,090**	**$1,626,090**	**$914,675**	**$4,024,572**	**$5,162,835**	**$5,081,530**	**$1,219,567**	**$26,810,153**
**3% Inflation*									

Table 36. Implementation Costs: Cropland BMPs After Cost-Share

Annual Cost* After Cost-Share, Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Cost
1	$45,117	$10,254	$10,254	$5,768	$25,378	$32,556	$32,043	$7,690	$169,059
2	$46,470	$10,561	$10,561	$5,941	$26,139	$33,532	$33,004	$7,921	$174,131
3	$47,864	$10,878	$10,878	$6,119	$26,924	$34,538	$33,994	$8,159	$179,355
4	$49,300	$11,205	$11,205	$6,303	$27,731	$35,574	$35,014	$8,403	$184,735
5	$50,779	$11,541	$11,541	$6,492	$28,563	$36,642	$36,065	$8,656	$190,277
6	$52,302	$11,887	$11,887	$6,686	$29,420	$37,741	$37,147	$8,915	$195,986
7	$53,872	$12,244	$12,244	$6,887	$30,303	$38,873	$38,261	$9,183	$201,865
8	$55,488	$12,611	$12,611	$7,094	$31,212	$40,039	$39,409	$9,458	$207,921
9	$57,152	$12,989	$12,989	$7,306	$32,148	$41,241	$40,591	$9,742	$214,159
10	$58,867	$13,379	$13,379	$7,526	$33,113	$42,478	$41,809	$10,034	$220,583
11	$60,633	$13,780	$13,780	$7,751	$34,106	$43,752	$43,063	$10,335	$227,201
12	$62,452	$14,194	$14,194	$7,984	$35,129	$45,065	$44,355	$10,645	$234,017
13	$64,325	$14,619	$14,619	$8,223	$36,183	$46,417	$45,686	$10,965	$241,038
14	$66,255	$15,058	$15,058	$8,470	$37,269	$47,809	$47,056	$11,293	$248,269
15	$68,243	$15,510	$15,510	$8,724	$38,387	$49,243	$48,468	$11,632	$255,717
16	$70,290	$15,975	$15,975	$8,986	$39,538	$50,721	$49,922	$11,981	$263,388
17	$72,399	$16,454	$16,454	$9,256	$40,724	$52,242	$51,420	$12,341	$271,290
18	$74,571	$16,948	$16,948	$9,533	$41,946	$53,810	$52,962	$12,711	$279,429
19	$76,808	$17,456	$17,456	$9,819	$43,204	$55,424	$54,551	$13,092	$287,811
20	$79,112	$17,980	$17,980	$10,114	$44,501	$57,087	$56,188	$13,485	$296,446
21	$81,485	$18,519	$18,519	$10,417	$45,836	$58,799	$57,873	$13,890	$305,339
22	$83,930	$19,075	$19,075	$10,730	$47,211	$60,563	$59,609	$14,306	$314,499
23	$86,448	$19,647	$19,647	$11,052	$48,627	$62,380	$61,398	$14,735	$323,934
24	$89,041	$20,237	$20,237	$11,383	$50,086	$64,251	$63,240	$15,178	$333,652
25	$91,713	$20,844	$20,844	$11,725	$51,588	$66,179	$65,137	$15,633	$343,662
26	$94,464	$21,469	$21,469	$12,076	$53,136	$68,164	$67,091	$16,102	$353,972
27	$97,298	$22,113	$22,113	$12,439	$54,730	$70,209	$69,104	$16,585	$364,591
28	$100,217	$22,777	$22,777	$12,812	$56,372	$72,316	$71,177	$17,082	$375,529
29	$103,223	$23,460	$23,460	$13,196	$58,063	$74,485	$73,312	$17,595	$386,794
30	$106,320	$24,164	$24,164	$13,592	$59,805	$76,720	$75,511	$18,123	$398,398
Total	**$2,146,438**	**$487,827**	**$487,827**	**$274,403**	**$1,207,372**	**$1,548,850**	**$1,524,459**	**$365,870**	**$8,043,046**
**3% Inflation*									

B. Livestock BMP Implementation Costs

Table 37. Implementation Costs: Livestock BMPs Before Cost-Share

Annual Cost* Before Cost-Share, Livestock BMPs							
Year	Alternative Watering Systems	Cover Crop Grazing	Grazing Management Plan	Relocate Pasture Feeding Sites	Rotational Grazing	Vegetative Filter Strip	Total Cost
1	$5,000	$40	$0	$0	$7,000	$800	$12,840
2	$0	$0	$1,071	$2,269	$0	$824	$4,164
3	$5,305	$42	$0	$0	$7,426	$849	$13,622
4	$0	$0	$1,136	$2,407	$0	$874	$4,418
5	$5,628	$45	$0	$0	$7,879	$900	$14,452
6	$0	$0	$1,206	$2,554	$0	$927	$4,687
7	$5,970	$48	$0	$0	$8,358	$955	$15,332
8	$0	$0	$1,279	$2,709	$0	$984	$4,972
9	$6,334	$51	$0	$0	$8,867	$1,013	$16,265
10	$0	$0	$1,357	$2,874	$0	$1,044	$5,275
11	$6,720	$54	$0	$0	$9,407	$0	$16,181
12	$0	$0	$1,440	$3,049	$0	$1,107	$5,596
13	$7,129	$57	$0	$0	$9,980	$0	$17,166
14	$0	$0	$1,527	$3,235	$0	$1,175	$5,937
15	$7,563	$61	$0	$0	$10,588	$0	$18,212
16	$0	$0	$1,620	$3,432	$0	$1,246	$6,299
17	$8,024	$64	$0	$0	$11,233	$0	$19,321
18	$0	$0	$1,719	$3,641	$0	$1,322	$6,682
19	$8,512	$68	$0	$0	$11,917	$0	$20,497
20	$0	$0	$1,824	$3,863	$0	$1,403	$7,089
21	$9,031	$72	$0	$0	$12,643	$0	$21,746
22	$0	$0	$1,935	$4,098	$0	$1,488	$7,521
23	$9,581	$77	$0	$0	$13,413	$0	$23,070
24	$0	$0	$2,053	$4,348	$0	$1,579	$7,979
25	$10,164	$81	$0	$0	$14,230	$0	$24,475
26	$0	$0	$2,178	$4,613	$0	$1,675	$8,465
27	$10,783	$86	$0	$0	$15,096	$0	$25,965
28	$0	$0	$2,310	$4,893	$0	$1,777	$8,981
29	$11,440	$92	$0	$0	$16,015	$0	$27,547
30	$0	$0	$2,451	$5,192	$0	$1,885	$9,528
Total							**$384,284**
**3% Inflation*							

Table 38. Implementation Costs: Livestock BMPs After Cost-Share

Annual Cost* After Cost-Share, Livestock BMPs							
Year	**Alternative Watering Systems**	**Cover Crop Grazing**	**Grazing Management Plan**	**Relocate Pasture Feeding Sites**	**Rotational Grazing**	**Vegetative Filter Strip**	**Total Cost**
1	$1,500	$12	$0	$0	$2,100	$240	$3,852
2	$0	$0	$321	$681	$0	$247	$1,249
3	$1,591	$13	$0	$0	$2,228	$255	$4,087
4	$0	$0	$341	$722	$0	$262	$1,325
5	$1,688	$14	$0	$0	$2,364	$270	$4,335
6	$0	$0	$362	$766	$0	$278	$1,406
7	$1,791	$14	$0	$0	$2,508	$287	$4,599
8	$0	$0	$384	$813	$0	$295	$1,492
9	$1,900	$15	$0	$0	$2,660	$304	$4,880
10	$0	$0	$407	$862	$0	$313	$1,583
11	$2,016	$16	$0	$0	$2,822	$0	$4,854
12	$0	$0	$432	$915	$0	$332	$1,679
13	$2,139	$17	$0	$0	$2,994	$0	$5,150
14	$0	$0	$458	$971	$0	$352	$1,781
15	$2,269	$18	$0	$0	$3,176	$0	$5,463
16	$0	$0	$486	$1,030	$0	$374	$1,890
17	$2,407	$19	$0	$0	$3,370	$0	$5,796
18	$0	$0	$516	$1,092	$0	$397	$2,005
19	$2,554	$20	$0	$0	$3,575	$0	$6,149
20	$0	$0	$547	$1,159	$0	$421	$2,127
21	$2,709	$22	$0	$0	$3,793	$0	$6,524
22	$0	$0	$580	$1,229	$0	$446	$2,256
23	$2,874	$23	$0	$0	$4,024	$0	$6,921
24	$0	$0	$616	$1,304	$0	$474	$2,394
25	$3,049	$24	$0	$0	$4,269	$0	$7,342
26	$0	$0	$653	$1,384	$0	$503	$2,540
27	$3,235	$26	$0	$0	$4,529	$0	$7,790
28	$0	$0	$693	$1,468	$0	$533	$2,694
29	$3,432	$27	$0	$0	$4,805	$0	$8,264
30	$0	$0	$735	$1,557	$0	$566	$2,858
Total							**$115,285**
**3% Inflation*							

C. Total Costs for BMP Implementation and Education Activities

Table 39. Total Costs for WRAPS Plan Implementation

Total Annual WRAPS Cost After Cost-Share by BMP Category				
Year	Cropland	Livestock	Information and Education	Total Annual Cost with Inflation*
1	$169,059	$3,852	$41,750	$214,661
2	$174,131	$1,249	$43,003	$218,382
3	$179,355	$4,087	$44,293	$227,734
4	$184,735	$1,325	$45,621	$231,682
5	$190,277	$4,335	$46,990	$241,603
6	$195,986	$1,406	$48,400	$245,791
7	$201,865	$4,599	$49,852	$256,316
8	$207,921	$1,492	$51,347	$260,760
9	$214,159	$4,880	$52,888	$271,926
10	$220,583	$1,583	$54,474	$276,640
11	$227,201	$4,854	$56,109	$288,164
12	$234,017	$1,679	$57,792	$293,488
13	$241,038	$5,150	$59,526	$305,713
14	$248,269	$1,781	$61,311	$311,361
15	$255,717	$5,463	$63,151	$324,331
16	$263,388	$1,890	$65,045	$330,323
17	$271,290	$5,796	$66,996	$344,083
18	$279,429	$2,005	$69,006	$350,440
19	$287,811	$6,149	$71,077	$365,037
20	$296,446	$2,127	$73,209	$371,781
21	$305,339	$6,524	$75,405	$387,268
22	$314,499	$2,256	$77,667	$394,423
23	$323,934	$6,921	$79,997	$410,853
24	$333,652	$2,394	$82,397	$418,443
25	$343,662	$7,342	$84,869	$435,873
26	$353,972	$2,540	$87,415	$443,926
27	$364,591	$7,790	$90,038	$462,418
28	$375,529	$2,694	$92,739	$470,962
29	$386,794	$8,264	$95,521	$490,579
30	$398,398	$2,858	$98,387	$499,643
Total				**$10,144,605**
**3% Inflation*				

10. Technical Assistance and Funding Sources

Technical assistance and various funding sources may be required to implement the BMPs and the watershed education programs listed in this WRAPS plan. Possible technical assistance providers and funding sources are presented in **Tables 40** and **41.**

Table 40. Potential Technical Assistance Providers for Plan Implementation

Technical Assistance to Aid in BMP Implementation		
BMPs To Be Implemented		**Technical Assistance**
Cropland	Buffers	Upper Wakarsua WRAPS Coordinator/KAWS, Division of Conservation: Douglas, Shawnee, Osage and Wabaunsee County Conservation Districts, USDA-Farm Service Agency, USDA-NRCS, Kansas Department of Wildlife and Parks, Kansas Forest Service, Kansas Rural Water Association, Ducks Unlimited, Pheasants/Quail Forever, K-State Research and Extension, and KSRE Watershed Specialists
	Cover Crops	
	No-Till	
	Nutrient Management Plans	
	Permanent Vegetation	
	Terraces	
	Waterways	
	Wetlands	
Livestock	Alternative Watering Systems	
	Cover Crop Grazing	
	Grazing Management Plans	
	Relocate Pasture Feeding Sites	
	Rotational Grazing	
	Vegetative Filter Strips	

Table 41. Potential Funding Sources for Plan Implementation

Potential BMP Funding Sources	
Potential Funding Sources	**Potential Funding Programs**
Division of Conservation (DOC)	State Water Resources Cost Share Program (SWRCSP)
	Streambank Restoration funds
	Riparian and Wetland Protection Program (RWPP)
	Landowner incentive funds for streambank restoration projects
	Conservation Districts Non-point Source Pollution Funds (NPS)
Environmental Protection Agency (EPA) and the Kansas Department of Health and Environment (KDHE)	Section 319 Clean Water Act funds
	State Revolving Fund (SRF)
	WRAPS Grants
Kansas Department of Wildlife and Parks (KDWP)	Partnering for Wildlife
	Wildlife Habitat Incentive Program (WHIP) Habitat First Program
Kansas Forest Service	Rural Forestry Program
	Forestland Enhancement Program (FLEP)
Kansas Rural Water Association	Kansas Public Water Supply Loan Fund
Kansas State University, Research & Extension	Varies
Pheasants Forever, Quail Forever and other private entities	Varies
United States Department of Agriculture (USDA): Natural Resources Conservation Service (NRCS) and Farm Service Agency (FSA)	Environmental Quality Incentives Program (EQIP)
	Conservation Reserve Program (CRP)
	Continuous Conservation Reserve Program (CCRP)
	Wetland Reserve Program (WRP)
	Wildlife Habitat Incentive Program (WHIP)
	Forestland Enhancement Program (FLEP)
	State Acres for Wildlife Enhancement (SAFE)
	Grassland Reserve Program (GRP)
	Farmable Wetlands Program (FWP)

11. Measurable Milestones

The interim timeframe for all BMP implementation is 30 years from the date of publication of this report. Targeting and BMP implementation may shift over time to achieve TMDLs.

The estimated timeframe for reaching the sediment load reduction goal to address the **Biology TMDL** in the Upper Wakarusa Watershed will be in year 18 of this WRAPS plan. It is assumed that the ***E. coli* TMDL** will have significantly improved by year 30 of this plan. Reductions in nutrients from implemented livestock BMPs serve as evidence that positive impacts have been made toward *E. coli* bacteria loading. The estimated timeframe for reaching the phosphorus load reduction goal to address the **Eutrophication TMDL** will be in year 30 of this plan. Nitrogen will be positively impacted from all P-related TMDLs. After these load reduction goals are achieved, the process will become one of protection rather than restoration.

Reductions in sediment, phosphorus, and nitrogen will improve water quality throughout the watershed by positively impacting the aquatic plants, biology, *E. coli,* and eutrophication impairments found throughout the Upper Wakarusa Watershed.

A. Measurable Milestones for BMP Implementation

Milestones will be determined at the end of the 30-year plan by number of acres treated, projects installed, contacts made to watershed residents, and water quality parameters. The Upper Wakarusa WRAPS group will examine these criteria to determine if adequate progress has been made on BMP implementations to date. If they determine that adequate progress has not been made, they will readjust the implementation projects to achieve the TMDL, given another 5- to 10-year timeframe (**Tables 42 and 43**).

Table 42. Cropland BMP Implementation Milestones

Upper Wakarusa Implementation Milestones (treated acres), Cropland BMPs										
	Year	Buffers	Cover Crops	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Adoption
Short-Term	1	854	854	854	1,068	481	854	854	320	6,142
	2	854	854	854	1,068	481	854	854	320	6,142
	3	854	854	854	1,068	481	854	854	320	6,142
	4	854	854	854	1,068	481	854	854	320	6,142
	5	854	854	854	1,068	481	854	854	320	6,142
Total		*4,272*	*4,272*	*4,272*	*5,341*	*2,403*	*4,272*	*4,272*	*1,602*	*30,708*
Medium-Term	6	854	854	854	1,068	481	854	854	320	6,142
	7	854	854	854	1,068	481	854	854	320	6,142
	8	854	854	854	1,068	481	854	854	320	6,142
	9	854	854	854	1,068	481	854	854	320	6,142
	10	854	854	854	1,068	481	854	854	320	6,142
Total		*8,545*	*8,545*	*8,545*	*10,681*	*4,806*	*8,545*	*8,545*	*3,204*	*61,416*
Long-Term	11	854	854	854	1,068	481	854	854	320	6,142
	12	854	854	854	1,068	481	854	854	320	6,142
	13	854	854	854	1,068	481	854	854	320	6,142
	14	854	854	854	1,068	481	854	854	320	6,142
	15	854	854	854	1,068	481	854	854	320	6,142
	16	854	854	854	1,068	481	854	854	320	6,142
	17	854	854	854	1,068	481	854	854	320	6,142
	18	854	854	854	1,068	481	854	854	320	6,142
	19	854	854	854	1,068	481	854	854	320	6,142
	20	854	854	854	1,068	481	854	854	320	6,142
	21	854	854	854	1,068	481	854	854	320	6,142
	22	854	854	854	1,068	481	854	854	320	6,142
	23	854	854	854	1,068	481	854	854	320	6,142
	24	854	854	854	1,068	481	854	854	320	6,142
	25	854	854	854	1,068	481	854	854	320	6,142
	26	854	854	854	1,068	481	854	854	320	6,142
	27	854	854	854	1,068	481	854	854	320	6,142
	28	854	854	854	1,068	481	854	854	320	6,142
	29	854	854	854	1,068	481	854	854	320	6,142
	30	854	854	854	1,068	481	854	854	320	6,142
Total		*25,634*	*25,634*	*25,634*	*32,043*	*14,419*	*25,634*	*25,634*	*9,613*	*184,247*

Table 43. Livestock BMP Implementation Milestones

Upper Wakarusa Implementation Milestones (projects), Livestock BMPs								
	Year	Alternative Watering System	Cover Crop Grazing	Grazing Management Plan	Relocate Pasture Feeding Sites	Rotational Grazing	Vegetative Filter Strips	Total Adoption
Short-Term	1	1	1	0	0	1	1	4
	2	0	0	1	1	0	1	3
	3	1	1	0	0	1	1	4
	4	0	0	1	1	0	1	3
	5	1	1	0	0	1	1	4
Total		***3***	***3***	***2***	***2***	***3***	***5***	***18***
Medium-Term	6	0	0	1	1	0	1	3
	7	1	1	0	0	1	1	4
	8	0	0	1	1	0	1	3
	9	1	1	0	0	1	1	4
	10	0	0	1	1	0	1	3
Total		***5***	***5***	***5***	***5***	***5***	***10***	***35***
Long-Term	11	1	1	0	0	1	0	3
	12	0	0	1	1	0	1	3
	13	1	1	0	0	1	0	3
	14	0	0	1	1	0	1	3
	15	1	1	0	0	1	0	3
	16	0	0	1	1	0	1	3
	17	1	1	0	0	1	0	3
	18	0	0	1	1	0	1	3
	19	1	1	0	0	1	0	3
	20	0	0	1	1	0	1	3
	21	1	1	0	0	1	0	3
	22	0	0	1	1	0	1	3
	23	1	1	0	0	1	0	3
	24	0	0	1	1	0	1	3
	25	1	1	0	0	1	0	3
	26	0	0	1	1	0	1	3
	27	1	1	0	0	1	0	3
	28	0	0	1	1	0	1	3
	29	1	1	0	0	1	0	3
	30	0	0	1	1	0	1	3
Total		***15***	***15***	***15***	***15***	***15***	***20***	***95***

B. Benchmarks to Measure Water Quality and Social Progress

The goal of this WRAPS plan is that in the next 30-year time frame, the Upper Wakarusa Watershed will see improved water quality throughout the watershed, specifically reduced sediment, nutrients (phosphorus and nitrogen), and *E. coli* bacteria.

After reviewing the criteria listed in **Table 44**, the WRAPS group will assess and revise the overall strategy for the watershed in five years. New goals will be set and new BMPs will be implemented to achieve improved water quality. KDHE TMDL staff, Water Plan staff, the WRAPS Coordinator, and the SLT, will coordinate every five years to discuss benchmarks and TMDL updates. Using data obtained by KDHE, the following indicator and parameter criteria shall be used to assess progress toward successful implementation to abate pollutant loads.

Table 44. Upper Wakarusa Watershed Benchmarks to Measure Progress

Benchmarks to Measure Water Quality Progress		
Impairment Addressed	**Criteria to Measure Water Quality Progress**	**Information Source**
Biology/Sediment	Average percent composition of EPT* taxa of 25% or more.	KDHE, TMDL (page 2)
E. Coli	1. Less than 10% of samples taken in Spring exceed primary criterion at flows under 630 cfs† with no samples exceeding the criterion at flows under 110 cfs. 2. Less than 10% of samples taken in Summer or Fall exceed primary criterion at flows under 630 cfs with no samples exceeding the criterion at flows under 14 cfs. 3. Less than 10% of samples taken in Winter exceed secondary criterion at flows under 630 cfs.	KDHE, TMDL (page 3)
Eutrophication	1. Maintain chlorophyll *a* concentrations at 12 ppb‡, allowing a slightly eutrophic condition (TSI§ = 53-54). 2. Reduce proportion of blue green algae in lake to under 10% of phytoplankton. 3. Reduce phosphorus loads from Upper Wakarusa drainage by 50-60%. 4. Reduce sedimentation within arms of lake.	KDHE, TMDL (page 2)
Impairment Addressed	**Social Indicators to Measure Water Quality Progress**	**Information Source**
Biology/Sediment, *E. coli*, and Eutrophication	Taste and odor issues in public water supply drawn from the Wakarusa River and Clinton Lake.	KDHE
	Survey of water quality issues to determine whether information and education programs are having an effect on public perception.	KSRE
	Number of attendees at field days and tours.	KSRE
	Number of BMP acres and projects implemented in the targeted areas.	WRAPS, DOC, NRCS

* EPT - Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)

† cfs - cubic feet per second

‡ ppb - parts per billion

§ TSI - Trophic State Index

C. Water Quality Milestones Used to Determine Improvements

The goal of the Upper Wakarusa WRAPS plan is to restore water quality for uses that support aquatic life, primary-contact recreation, and public water supply for the watershed. This restoration plan specifically addresses the high-priority Biology/Sediment, *E. coli*, and Eutrophication TMDLs. To reach load reduction goals, a BMP implementation schedule spanning 30 years has been developed. Water quality milestones are established to measure water quality improvements within the watershed due to plan implementation.

The BMPs included in this plan will be implemented in targeted areas as laid out in **Sections 6 and 7** of this WRAPS plan. With these targeted areas in place, BMP implementation will result in positive impacts on water quality and impairment listings throughout the watershed.

D. Water Quality Milestones for the Upper Wakarusa Watershed

The Upper Wakarusa Watershed has Biology/Sediment, *E. coli*, and Eutrophication TMDLs addressed by this WRAPS plan. Milestones[31] for each TMDL are determined by set parameters designed to exhibit long-term goals to indicate the success of this WRAPS plan.

1. Water quality milestones for biology/sediment

The high-priority biology/sediment impairment in the Upper Wakarusa Watershed is located in the Wakarusa River and its major tributaries. Cropland BMPs, when implemented, will reduce sediment and subsequently nutrients, specifically phosphorus and nitrogen. This will improve water quality in those water segments as well as those into which they flow. Reductions in sediment will improve the Ephemeroptera, Plecoptera, and Trichoptera (EPT) and Macroinvertebrate Biotic Index (MBI) conditions in the Wakarusa River as well, thereby addressing the TMDL.

The desired endpoint is to maintain an average percent composition of EPT taxa of 25% or more **(Table 45).** In addition, concurrent biological sampling should show improvements in the macroinvertebrates index scores over the same period. The MBI is a biological monitoring metric that can be used to assess compliance with water quality standards. The MBI values can be used to determine the extent to which the monitored water body can support aquatic life as follows:

MBI $\leq$ 4.5 fully supports aquatic life
MBI 4.5 to < 5.4 partially supports aquatic life
MBI $\geq$ 5.4 does not support aquatic life

Percent EPT taxa is the preferred indicator for water quality, but the the MBI index may also be examined.[32]

Table 45. Wakarusa River Water Quality Milestones: Biology/Sediment

Water Quality Milestones for the Wakarusa River					
Sampling Site	Current Condition (2009-2019) % EPT > 50	10-Year Goal		Long-Term Goal	
		Improved Condition % EPT > 50	Total Increase Needed in % EPT > 50	Improved Condition % EPT > 50	Total Increase Needed % in EPT > 50
SB109	20	22	2	25	5

[31] Milestones were provided by the KDHE Watershed Management Section, May 2023.
[32] Biology TMDL, page 1.

Table 46. Wakarusa River Water Quality Milestones: Biology/Sediment

Water Quality Milestones for the Wakarusa River					
Sampling Site	Current Condition (2002-2019) % MBI < 4.5	10-Year Goal		Long-Term Goal	
		Improved Condition % MBI < 4.5	Total Increase Needed in % MBI < 4.5	Improved Condition % MBI < 4.5	Total Increase Needed in % MBI < 4.5
SB109	35	57	22	100	65

2. Water quality milestones for *E. coli*

The Wakarusa River also has a high-priority *E. coli* impairment. Riparian corridor and floodplain areas targeted for livestock BMP implementation will result in nutrient load reductions and will aid in reducing *E. coli* bacteria in these water segments as well as the rivers into which they feed.

The *E. coli* values are expressed as a percentile meeting water quality standards (WQS). This is based on an index of the natural log of samples, divided by the natural log of 427, which represents the water quality standard (WQS). The desired WQS can be found in **Table 47**.

Table 47. Wakarusa River Water Quality Milestones: E. coli

Water Quality Milestones for the Wakarusa River					
Sampling Site	Current Condition (2002-2021) % *E. coli* Index Values < 1	10-Year Goal		Long-Term Goal	
		Improved Condition % *E. coli* Index Values < 1	Total Increase Needed in % *E. coli* Index Values < 1	Improved Condition % *E. coli* Index Values < 1	Total Increase Needed in % *E. coli* Index Values < 1
SB109	69	79	10	90	21

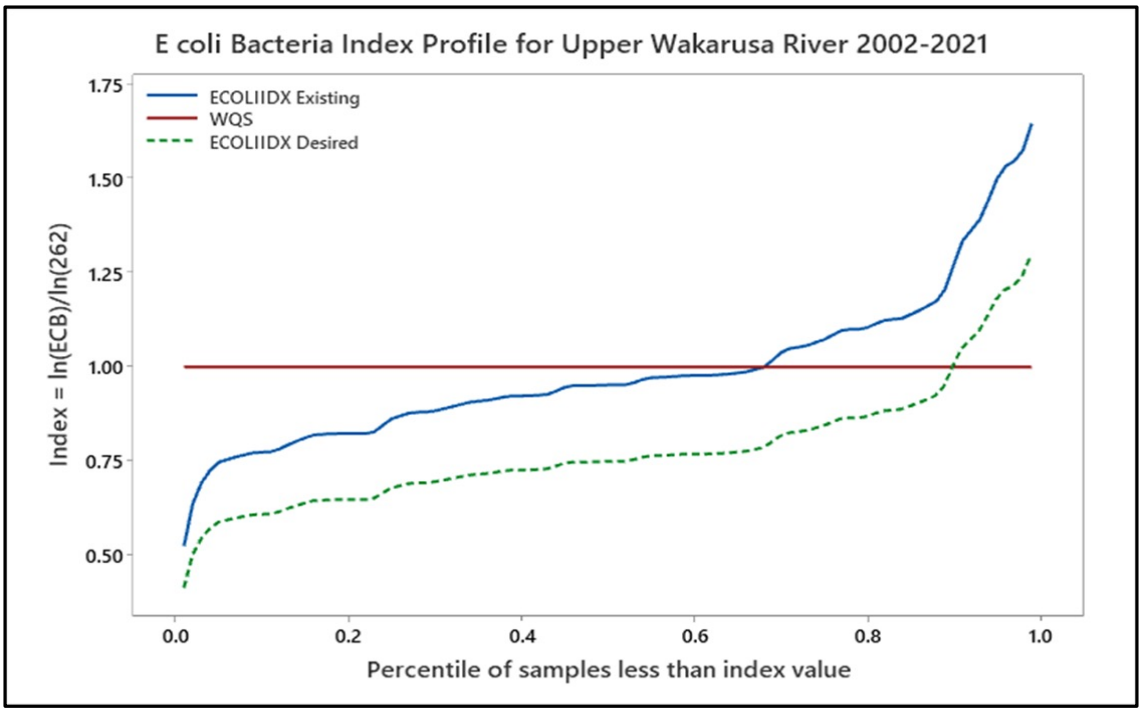


Figure 18. E. coli Index for the Wakarusa River[33]

3. Water quality milestones for eutrophication

The high-priority eutrophication impairment in Clinton Lake will be addressed by the implementation of cropland and livestock BMP implementation. BMP implementation will take place throughout the HUC 12s that drain directly into the lake as well as in the riparian and floodplain areas along the Wakarusa River, which flows directly into Clinton Lake. Reducing sediment runoff subsequently reduces nutrient loading, specifically phosphorus and nitrogen, and this will improve water quality in the lake as a whole. Reduced sediment and nutrients will result in an improved and sustainable chlorophyll *a* level (**Table 48**).

Table 48. Clinton Lake Milestones: Eutrophication, Chlorophyll a

Water Quality Milestones for Clinton Lake					
Sampling Site	Current Condition (2000-2021) Average Chlorophyll *a* (mg/L)	10-Year Goal		Long-Term Goal	
		Improved Condition Average Chlorophyll *a* (mg/L)	Total Reduction Needed in Average Chlorophyll *a* (mg/L)	Improved Condition Average Chlorophyll *a* (mg/L)	Total Reduction Needed in Average Chlorophyll *a* (mg/L)
LM030001	18.5	15.5	3	10	8.5

[33] Figure provided by KDHE, May 2023.

Table 49. Clinton Lake Milestones: Eutrophication, Total Phosphorus

Water Quality Milestones for the Upper Wakarusa Watershed					
Sampling Site	Current Condition (2012-2021) Median TP (mg/L)	10-Year Goal		Long-Term Goal	
		Improved Condition Median TP (mg/L)	Total Reduction Needed in Median TP (mg/L)	Improved Condition Median TP (mg/L) reduced 60%	Total Reduction Needed in Median TP (mg/L)
SC109	100	80	20	40	60

It should be noted that milestones met in ***Table 49*** *result from the BMP implementation in cropland and livestock areas as outlined in this plan. Therefore, achievement of these milestones will positively affect all three of the TMDLs, Biology/Sediment,* E. coli *and Eutrophication alike.*

12. Monitoring Water Quality

KDHE continues to monitor water quality in the Upper Wakarusa Watershed by maintaining the six (five lake and one stream) monitoring stations located within the watershed. **Figure 19** illustrates the locations of the monitoring sites within the watershed as well as the BMP-targeted areas identified and discussed in previous sections of this plan.

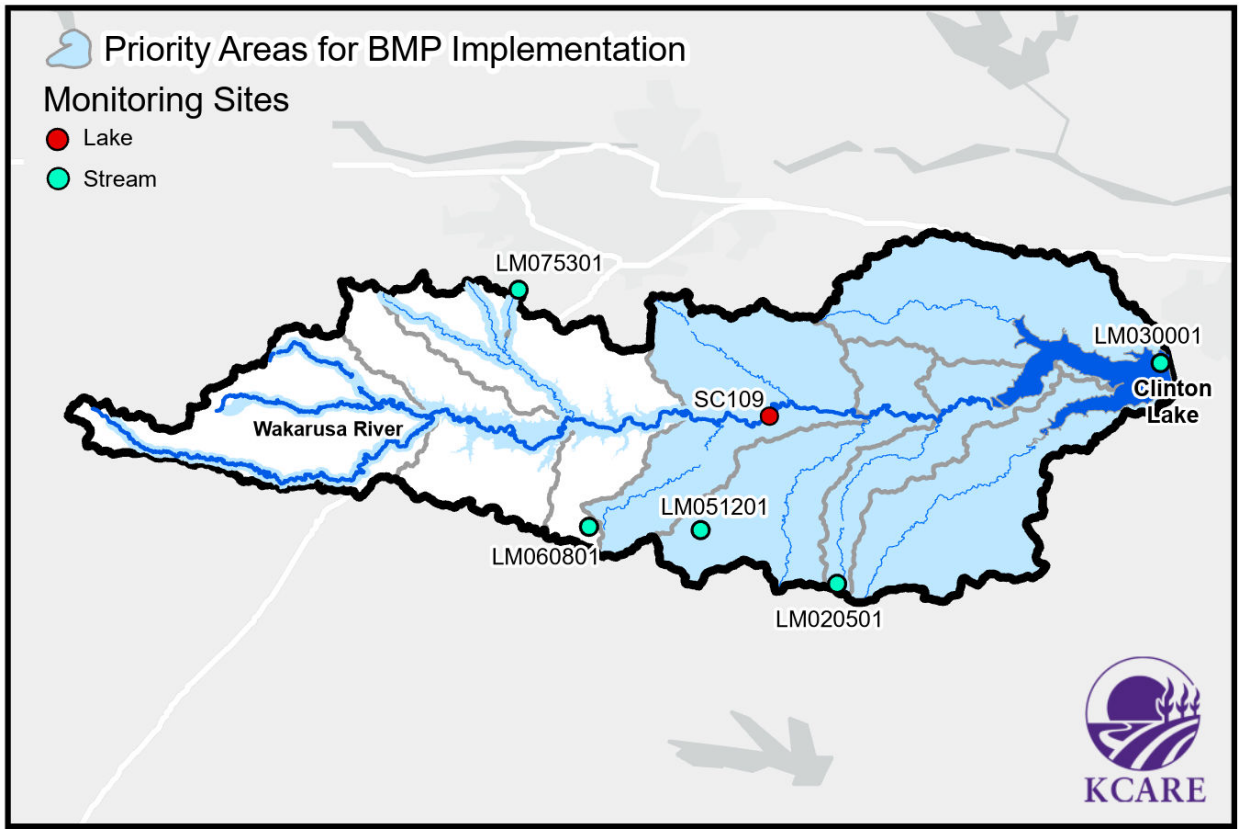


Figure 19. Monitoring Sites and Targeted Areas

Typically, monitoring takes place May through September. Monitoring sites are sampled for nutrients, bacteria, chemicals, turbidity, alkalinity, DO, pH, ammonia, and metals, with the addition of chlorophyll *a* measurements. The pollutant indicators tested for each site may vary depending on the season at collection time and other factors. Sampling data include temperature, conductivity, and Secchi disc depth. The Watershed Coordinator, advised by the SLT, will request that KDHE reviews analyzed data from all monitoring sources on an annual basis, with data collected in the targeted HUC 12s of special interest. Monitoring data will be used to direct the SLT in their evaluation of water quality progress.

Monitoring data in the Upper Wakarusa Watershed will be used to determine water quality progress, to track water quality milestones, and to determine the effectiveness of the BMP implementation outlined in this plan. The review schedule for the monitoring data will be tied to the water quality milestones developed in the Upper Wakarusa Watershed, as well as the frequency of the sampling data.

The BMP implementation schedule and water quality milestones for the Upper Wakarusa Watershed extend through a 30-year period from 2024-2054. During that period, KDHE will continue to analyze and to evaluate the collected monitoring data.

After the first five years of monitoring and BMP implementation, KDHE will evaluate the available water quality data to determine whether the water quality milestones have been achieved. KDHE and the Watershed Coordinator can address any necessary modifications or revisions to the plan based on data analysis. At the end of this plan in 2054, a determination will be made as to whether the water quality standards have been attained and if the plan needs to be extended.

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

13. Review of the WRAPS Plan

In the year 2029, this WRAPS plan will be reviewed and revised according to results from monitoring data. At this time, the SLT will review the criteria listed below, in addition to any other concerns that may occur at this plan's future review.

will request the following reports on the milestone achievements for biology/sediment, *E. coli,* and eutrophication load reductions and water quality improvements.

- KDHE will report on current and desired endpoints for water quality in the Upper Wakarusa Watershed regarding the **Biology/Sediment TMDL**. Measurable conditions expected in relation to the Biology/Sediment TMDL after scheduled cropland BMP implementation include:
    1. Maintain an average percent composition of EPT taxa of 25% or more as dictated in the TMDL.
    2. The sediment goal is a reduction of 19,155 tons, which is a 15% load reduction. If the cropland BMPs are implemented as structured, the sediment goal should be exceeded in year 18 of this WRAPS plan. By year 30 of the plan, 33,341 tons of sediment will have been prevented from entering the Wakarusa River and Clinton Lake. This exceeds the goal by 74%.
    3. Subsequent reductions in nutrients exemplify water quality improvements in the Wakarusa River. If cropland BMPs are implemented as planned, phosphorus loading will have been reduced by 206,405 pounds which will reduce nitrogen loading by 817,353 pounds.
- KDHE will report on current and desired endpoints for water quality in the Upper Wakarusa Watershed regarding the ***E. coli* TMDL.** The goal is to achieve Kansas Water Quality Standards and to support primary recreation by the end of this 30-year plan. Measurable conditions expected in relation to the *E. coli* TMDL after scheduled livestock BMP implementation include:
    1. Maintain chlorophyll *a* concentrations at 12 ppb, allowing a slightly eutrophic condition (TSI = 53-54) as dictated in the TMDL.
    2. Reduce proportion of blue green algae in lake to under 10% of phytoplankton as dictated in the TMDL.
    3. Reduce phosphorus loads from Upper Wakarusa drainage by 50-60% as dictated in the TMDL. The phosphorus load reduction goal provided by KDHE in April of 2023 is 228,815 tons, which is a 66% reduction. If the livestock BMPs are implemented as structured, a phosphorus load reduction of 24,510 pounds will take place.
    4. Subsequent reductions in nitrogen will take place if livestock BMPs are implemented as planned; nitrogen loading will be reduced by 46,152 pounds.
- KDHE will report on current and desired endpoints for water quality in the Upper Wakarusa Watershed regarding the **Eutrophication TMDL.** Measurable conditions expected in relation to the Eutrophication TMDL after scheduled cropland and livestock BMP implementation include:
    1. Maintain chlorophyll *a* concentrations at 12 ppb, allowing a slightly eutrophic condition (TSI = 53-54) as dictated by the TMDL.

2. Reduce proportion of blue green algae in lake to under 10% of phytoplankton as dictated by the TMDL.
3. Reduce phosphorus loads from Wakarusa drainage by 50-60% as dictated by the TMDL. The phosphorus load reduction goal provided by KDHE in April of 2023 is 228,815 tons, which is a 66% reduction. If the plan is implemented as structured (with both cropland and livestock BMP implementation), the phosphorus goal should be met in year 30 of this WRAPS plan, with a total phosphorus reduction of 230,915 pounds. In addition, nitrogen loading will also be positively impacted with a total load reduction of 863,505 pounds.
4. Reduce sedimentation within arms of lake as dictated by the TMDL. The sediment goal is a reduction of 19,155 tons, which is a 15% load reduction. If the cropland BMPs are implemented as structured, the sediment goal should be met, and exceeded, in year 18 of this WRAPS plan. By year 30 of the plan, 33,341 tons of sediment will have been prevented from entering the Wakarusa River and Clinton Lake, which exceeds the goal by 74%.
5. Subsequent reductions in nitrogen will take place if cropland and livestock BMPs are implemented as planned. Nitrogen loading will be positively impacted by a total load reduction of 863,505 pounds, which is a 45% reduction.

- KDHE will report on other TMDLs, including possible nutrient and sediment criteria, revised load allocations pertaining to the Biology and *E. coli* TMDLs, and new wasteload allocations defined for point sources.

- KDHE will report on trends in water quality in the Wakarusa River, Clinton Lake, and throughout the remainder of the Upper Wakarusa Watershed.

In turn, the Watershed Coordinator will provide various reports when necessary. These include:

- Progress toward achieving the benchmarks listed in this report;
- Progress toward achieving the BMP adoption rates in this report; and
- Discussion of necessary adjustments and revisions needed for the targets in this plan.

14. Appendix

A. Potential Service Providers

Table 50. Service Provider List

Organization	Programs	Purpose	Technical or Financial Assistance	Website Address
U.S. Environmental Protection Agency (EPA)	* Clean Water Act (CWA) Section 319 Funds * State Revolving Fund (SRF) Program	CWA provides grant funds for water protection activities. SRF and ARRA provide loans for water pollution control activities and green infrastructure.	Financial	www.epa.gov
Kansas Department of Health & Environment (KDHE)	* Watershed Restoration and Protection Strategy (WRAPS) * State Revolving Fund * Nonpoint Source Pollution Program * Watershed Management Programs * National Pollutant Discharge Elimination System (NPDES) Program * Livestock operation certification and permitting * Local Environmental Protection Program (LEPP)	Funding for programs to reduce nonpoint source pollution. Funding for local watershed projects and coordination (WRAPS). Low cost and "forgivable" loans for BMPs and green infrastructure projects. Compliance monitoring.	Technical and Financial	www.kdheks.gov
Kansas Alliance for Wetlands and Streams (KAWS)	*Streambank Stabilization *Wetland Restoration *Cost share programs *Riparian and streambank assessment	KAWS is a non-profit, non-governmental organization organized in 1996 to promote the protection, enhancement and restoration of wetlands and streams in Kansas.	Technical and Financial	www.kaws.org
Kansas Forest Service (KFS)	*Forest Stewardship Program * Rural Forestry Program * Riparian Forestry Programs	Assist private landowners with the management of woodlands and windbreaks through education, planning and on-site assistance from professional foresters.	Technical and Financial	www.kansasforests.org
Kansas Department of Wildlife & Parks (KDWP)	* Land and Water Conservation Funding * Conservation Easements * Wildlife Habitat Improvement Program * Walk-in Hunting Program * North American Waterfowl Conservation Act * Work with non-profits such as Ducks Unlimited, Pheasants Forever and other state and federal agencies to promote wildlife habitat	Supervises the fisheries, wildlife, law enforcement, and state parks in Kansas. Also works with nongame, threatened and endangered species programs. Educational programs and landowner assistance to promote enhanced wildlife habitat. Manage lands associated with state parks, wetlands and other conservation areas.	Technical and Financial	ksoutdoors.com
Kansas Department of Agriculture (KDA)	* Watershed Structures * Water Appropriation * Permitting	Deal with water resource management for the benefit of all Kansans, permitting, minimum desirable stream flow, dam safety and regulation.	Technical and Financial	www.ksda.gov
Kansas Rural Center (KRC)	* Clean Water Farms Project * Grazing Management	KRC is a non-profit, non-governmental organization organized in 1979 to promote long-term health of the land and its people through research, education, and advocacy; KRC promotes family farming and stewardship of soil and water.	Technical and Financial	www.kansasruralcenter.org
Kansas State Research & Extension (KSRE)	* Watershed Specialist Program * County Extension Offices * Kansas Public Healthy Ecosystems * Healthy Communities Program * Citizen Science Kansas Center for Ag Resources and Environment (KCARE)	Provide education, information and technical assistance to build awareness of water quality issues, identify sources of water quality, impairment and demonstrate, promote and implement BMPs for water quality improvement and protection.	Technical	www.ksre.ksu.edu
Kansas Association for Conservation and Environmental Education (KACEE)	* Facilitation and Educational Workshops related to Environmental Education.	KACEE is a non-profit, non-governmental organization that promotes and provides non-biased and science-based environmental education.	Technical	www.kacee.org

Service Provider List, Continued

Organization	Programs	Purpose	Technical or Financial Assistance	Website Address
Natural Resources Conservation Service (NRCS)	* Environmental Quality Incentive Program (EQIP) * Conservation Planning and Compliance Program * Multiple USDA Conservation Programs administered directly by NRCS or in partnership with the Farm Service Agency such as CRP, WRP and others.	NRCS is a Federal agency that works in partnership with the landowners to benefit the soil, water, air, plants, and animals for productive lands and healthy ecosystems through conservation planning and assistance. NRCS maintains field offices at USDA Service Centers in nearly every county in Kansas.	Technical and Financial	www.nrcs.usda.gov
County Conservation Districts (CCD)	* State Water Resources Cost Share Program * Nonpoint Source Pollution Programs * Works with local NRCS field office staff, FSA and other conservation agencies.	CDs are the primary local unit of government responsible for the conservation of soil, water, and related natural resources within a county's boundary; they are political subdivisions of state government utilizing funding from county and state allocations co-located with the local NRCS field office.	Technical and Financial * Douglas CCD: (785) 843-4260 * Osage CCD: (785) 457-3398 * Shawnee CCD: (785) 828-3458 * Wabaunsee CCD: (785) 765-3836	https://agriculture.ks.gov/divisions-programs/division-of-conservation/doc-home
Division of Conservation (DOC)	* Aid to CDs * Water Resources Cost Share Program * Non-Point Source Pollution Control Program * Riparian and Wetland Protection Program * Kansas Water Quality Buffer Initiative * Watershed Dam Program * Multipurpose Small Lakes Program * Other Water Supply/Rights Programs	The DOC works with 105 local conservation districts, 88 organized watershed districts, other special purpose districts, and state and federal agencies to administer programs to improve water quality, reduce soil erosion, conserve water, reduce flooding and provide local water supply. The SCC has responsibility to administer the Conservation Districts Law, the Watershed District Act and other statutes.	Technical and Financial	https://agriculture.ks.gov/divisions-programs/division-of-conservation/doc-home
Kansas Water Office (KWO)	*Water planning, policy, coordination and marketing for the state	KWO coordinates the Kansas water planning process in cooperation with the Kansas Water Authority (KWA). KWA's 24 members include representatives from diverse water use interest groups and leaders of the state's natural resource agencies. Advice on policy development comes from Basin Advisory Committees (BACs) in each of the state's 12 river basins and other local stakeholders. KWA in turn advises the Governor and Legislature on water issues to be considered for policy enactment.	Technical	www.kwo.org
Kansas Rural Water Association (KRWA)	*Assist public water supplies with Source Water Protection Planning *Educate system operators	Provide leadership, education, and technical assistance to public water and wastewater utilities.	Technical	www.krwa.net
No-till on the Plains	*Field days, workshops, technical consulting	A non-profit educational organization providing information to farmers on adopting no-till and other sustainable production methods	Technical	www.notill.org
U.S. Geological Survey (USGS)	* WaterWatch (streamflow conditions) * National Streamflow Information Program * Flood Inundation and mapping * Groundwater Resources Program * National Water Quality Assessment Program	Scientific organization that provides stream flow data and conducts research related to water resources	Technical	www.usgs.gov
U.S. Army Corps of Engineers (USACE)	* Water Quality Program * Reservoir Management	Manages federal reservoirs in Kansas and operates a water quality program	Technical	www.usace.army.mil

B. BMP Definitions

1. Cropland BMPs

a. Buffers

- Buffers are areas of a 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, a one-acre buffer treats 15 acres of cropland, and they have a 50% erosion, 50% nitrogen, and a 50% phosphorus reduction efficiency.

b. Cover crops

- A cover crop is a crop of a specific plant grown primarily for the benefit of the soil rather than the crop yield.
- Cover crops commonly are used to suppress weeds, manage soil erosion, help build and improve soil fertility and quality, and control diseases and pests.
- Cover crops are typically grasses or legumes but may be comprised of other green plants.
- Cover crops can reduce erosion from wind and water, sequester carbon in plant biomass and soils to increase soil organic matter content, capture and recycle excess nutrients in the soil profile, promote biological nitrogen fixation, increase biodiversity, promote weed suppression, provide supplemental forage, promote soil moisture management, and reduce particulate emissions into the atmosphere.[34]
- Cover crops have a 40% erosion, 25% nitrogen, and 50% phosphorus reduction efficiency.

c. No-till

- No-till is a management system in which chemicals may be used instead of tillage for weed control and seedbed preparation.
- In a 100% no-till system, the soil surface is never disturbed, except for planting or drilling operations; this maintains nutrient levels and aids in preventing nutrients from leaving the field due to runoff events.
- This system has a 40% erosion, 40% nitrogen, and 40% phosphorous reduction efficiency.

d. Nutrient management plans

- This is defined as managing the amount, source, placement, form and timing of the application of nutrients, and soil amendments.
- Nutrient management plans use intensive soil testing.
- They have a 25% erosion, 25% nitrogen, and a 25% phosphorus reduction efficiency.

[34] Kansas Department of Health and Environment. http://www.kdheks.gov/nps/downloads/AnnualReport2006.pdf

e. Permanent vegetation

- Establishing permanent vegetation on sites that have or are expected to have high erosion rates, and on sites that have physical, chemical, or biological conditions that prevent the establishment of vegetation using normal practices.
- Establishing permanent vegetation can stabilize areas with existing or expected high rates of soil erosion by water and wind.
- Establishing permanent vegetation can restore degraded sites that cannot be stabilized through normal methods.
- Has a reduction efficiency of 95% for erosion, 95% for nitrogen, and 95% for phosphorus.

f. Terraces

- Terraces are earth embankments and/or channels constructed across the slope to intercept runoff water and trap soil.
- They are one of the oldest and most common BMPs.
- Terraces have a 10-year lifespan, with 30% erosion, 30% nitrogen, and a 30% phosphorus reduction efficiency.

g. Waterways

- Grassed waterways are defined as a grassed strip used as an outlet to prevent silt and gully formation.
- They can also be used as outlets for water from terraces.
- On average for Kansas fields, a one-acre waterway will treat 10 acres of cropland.
- Grassed waterways have a 10-year lifespan, with 40% erosion, 40% nitrogen, and a 40% phosphorus reduction efficiency.

h. Wetlands

- Creating a wetland where water covers the soil or is present at the surface of the soil all year or for varying periods of the year, including the growing season.
- One acre of wetland will treat 15 acres of cropland, on average.
- According to NRCS, wetlands have a 20-year lifespan, with 40% erosion, 40% nitrogen, and a 40% phosphorus reduction efficiency.

2. Livestock BMPs

a. Alternative watering system

- These are watering systems designed so that livestock do not enter a stream or water body.
- Studies show cattle will drink from tank over a stream or pond 80% of the time.
- These systems have a 10- to 25-year lifespan.
- 85% phosphorus reduction efficiency and greater efficiencies for limited stream access.

b. Cover crop grazing

- Using cover crops for grazing is an excellent way to extend the grazing season into late fall/early winter and again in late winter/early spring.
- A cover crop is a crop of a specific plant grown primarily for the benefit of the soil rather than the crop yield.
- Cover crops prevent soil erosion, increase organic matter and microbial activity, improve soil water retention, recycle nutrients, and decrease soil compaction.
- Common choices for covers used for grazing include: cereal grains, wheat, oats, ryegrass, peas, vetch, sudangrass, and clovers.
- 35% phosphorus reduction efficiency.

c. Grazing management plan

- Grazing management plans are designed to avoid over-grazing of pastures and improved grazing distribution.
- 25% phosphorus reduction efficiency.
- Fencing off streams can be part of a grazing management plan.
  - Exclusion fencing prevents livestock from entering into and polluting stream waters. This prevents livestock from degrading the streambanks and causing sediment sloughing into the water.
  - An alternate watering system may be a necessary component with this BMP.
  - Stream, or exclusion, fencing has a 25-year lifespan in general.

d. Relocate pasture feeding sites

- Moving feeding sites in a pasture away from a stream, waterway, or body of water to increase the filtration and waste removal (e.g., move bale feeders away from the stream).
- Relocation can be outside of the targeted area and can incorporate cover crops. In the case of this plan, livestock will be removed away from streams and priority water segments.
- 70% phosphorus reduction efficiency.

e. Rotational grazing

- This is defined as a grazing system that rotates livestock within a pasture to spread manure more uniformly and to allow grass adequate rest to regenerate.
- Expenses may involve significant cross fencing and additional watering sites.
- Rotational grazing has an average of 25% phosphorus reduction efficiency.

f. Vegetative filter strips

- A vegetated area that receives runoff during rainfall from an animal feeding operation.
- This practice often requires a land area equal to or more than the drainage area (i.e., as large as the feedlot).
- Vegetative filter strips have a 10-year lifespan and require periodic mowing or haying.
- 50% phosphorus reduction efficiency.

C. BMP Budget Derivations[35]

Summarized derivation of cropland BMP cost estimates

- Buffers: $176 per treated acre with 70% cost share.
- Cover crops: $40 per treated acre with 70% cost share.
- No-till: $40 per treated acre with 70% cost share.
- Nutrient management plans: $18 per treated acre with 70% cost share.
- Permanent vegetation: $176 per treated acre with 70% cost share.
- Terraces: $127 per treated acre with 70% cost share.
- Waterways: $145 per treated acre with 70% cost share.
- Wetlands: $80 per treated acre with 70% cost share.

Summarized derivation of livestock BMP cost estimates

- Alternative watering system: $5,000 per unit with 70% cost-share.
- Cover crop grazing: $40 per treated acre with 70% cost share.
- Grazing management plan: $1,040 per plan with 70% cost-share.
- Relocate pasture feeding sites: $2,203 with 70% cost-share. Cost includes fencing, new watering system, concrete, and labor.
- Rotational grazing: $7,000 with 70% cost share. Cost includes fencing and labor.
- Vegetative filter strips: $800 with 70% cost-share. Cost includes building ¼ mile of fence, a permeable surface, and labor.

[35] All cost derivations were calculated using county average rates effective in May 2023 in combination with figures provided by the WRAPS coordinator.

D. 30-year Project Tables

Cropland areas will be targeted for sediment load reductions to address the high-priority Biology/Sediment TMDL in the Upper Wakarusa Watershed. While nutrients are not a targeted impairment of this plan, they will be impacted positively by sediment BMP implementation in cropland areas, also positively affecting the Eutrophication TMDL.

Cropland BMPs will take place in the following six areas:

1. HUC 102701040**104**
2. HUC 102701040**105**
3. HUC 102701040**106**
4. HUC 102701040**107**
5. HUC 102701040**108**
6. Riparian corridor and floodplain areas in HUCs 1027010**4101**, **102** and **103.** ***These areas will collectively be referred to as "riparian" throughout the following*** tables.

Below are the cropland adoption/implementation, load reduction, and costs tables for each of the six targeted areas listed above.

Livestock areas were targeted for BMP implementation to address the E. coli *TMDL. However, livestock implementation tables are not included below as there are not enough operations to set implementation goals by targeted area, HUC 12, or riparian. Livestock BMP implementation project numbers are figured as a whole, to include the entire targeted area as one area.*

*Therefore, there is only one livestock adoption/implementation table (**Table 25**, page 71), one phosphorus load reduction table (**Table 27**, page 74), one nitrogen load reduction table (**Table 30**, page 77) and one set of costs tables (**Tables 37** and **38** on pages 87 and 90, respectively).*

1. Cropland BMP implementation in the Upper Wakarusa Watershed

HUC 104 Annual Adoption (treated acres), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Adoption
1	174	174	174	218	98	174	174	65	1,251
2	174	174	174	218	98	174	174	65	1,251
3	174	174	174	218	98	174	174	65	1,251
4	174	174	174	218	98	174	174	65	1,251
5	174	174	174	218	98	174	174	65	1,251
6	174	174	174	218	98	174	174	65	1,251
7	174	174	174	218	98	174	174	65	1,251
8	174	174	174	218	98	174	174	65	1,251
9	174	174	174	218	98	174	174	65	1,251
10	174	174	174	218	98	174	174	65	1,251
11	174	174	174	218	98	174	174	65	1,251
12	174	174	174	218	98	174	174	65	1,251
13	174	174	174	218	98	174	174	65	1,251
14	174	174	174	218	98	174	174	65	1,251
15	174	174	174	218	98	174	174	65	1,251
16	174	174	174	218	98	174	174	65	1,251
17	174	174	174	218	98	174	174	65	1,251
18	174	174	174	218	98	174	174	65	1,251
19	174	174	174	218	98	174	174	65	1,251
20	174	174	174	218	98	174	174	65	1,251
21	174	174	174	218	98	174	174	65	1,251
22	174	174	174	218	98	174	174	65	1,251
23	174	174	174	218	98	174	174	65	1,251
24	174	174	174	218	98	174	174	65	1,251
25	174	174	174	218	98	174	174	65	1,251
26	174	174	174	218	98	174	174	65	1,251
27	174	174	174	218	98	174	174	65	1,251
28	174	174	174	218	98	174	174	65	1,251
29	174	174	174	218	98	174	174	65	1,251
30	174	174	174	218	98	174	174	65	1,251
Total	**5,222**	**5,222**	**5,222**	**6,528**	**2,938**	**5,222**	**5,222**	**1,958**	**37,536**

HUC 105 Annual Adoption (treated acres), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Adoption
1	195	195	195	244	110	195	195	73	1,404
2	195	195	195	244	110	195	195	73	1,404
3	195	195	195	244	110	195	195	73	1,404
4	195	195	195	244	110	195	195	73	1,404
5	195	195	195	244	110	195	195	73	1,404
6	195	195	195	244	110	195	195	73	1,404
7	195	195	195	244	110	195	195	73	1,404
8	195	195	195	244	110	195	195	73	1,404
9	195	195	195	244	110	195	195	73	1,404
10	195	195	195	244	110	195	195	73	1,404
11	195	195	195	244	110	195	195	73	1,404
12	195	195	195	244	110	195	195	73	1,404
13	195	195	195	244	110	195	195	73	1,404
14	195	195	195	244	110	195	195	73	1,404
15	195	195	195	244	110	195	195	73	1,404
16	195	195	195	244	110	195	195	73	1,404
17	195	195	195	244	110	195	195	73	1,404
18	195	195	195	244	110	195	195	73	1,404
19	195	195	195	244	110	195	195	73	1,404
20	195	195	195	244	110	195	195	73	1,404
21	195	195	195	244	110	195	195	73	1,404
22	195	195	195	244	110	195	195	73	1,404
23	195	195	195	244	110	195	195	73	1,404
24	195	195	195	244	110	195	195	73	1,404
25	195	195	195	244	110	195	195	73	1,404
26	195	195	195	244	110	195	195	73	1,404
27	195	195	195	244	110	195	195	73	1,404
28	195	195	195	244	110	195	195	73	1,404
29	195	195	195	244	110	195	195	73	1,404
30	195	195	195	244	110	195	195	73	1,404
Total	**5,859**	**5,859**	**5,859**	**7,324**	**3,296**	**5,859**	**5,859**	**2,197**	**42,113**

HUC 106 Annual Adoption (treated acres), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Adoption
1	60	60	60	76	34	60	60	23	434
2	60	60	60	76	34	60	60	23	434
3	60	60	60	76	34	60	60	23	434
4	60	60	60	76	34	60	60	23	434
5	60	60	60	76	34	60	60	23	434
6	60	60	60	76	34	60	60	23	434
7	60	60	60	76	34	60	60	23	434
8	60	60	60	76	34	60	60	23	434
9	60	60	60	76	34	60	60	23	434
10	60	60	60	76	34	60	60	23	434
11	60	60	60	76	34	60	60	23	434
12	60	60	60	76	34	60	60	23	434
13	60	60	60	76	34	60	60	23	434
14	60	60	60	76	34	60	60	23	434
15	60	60	60	76	34	60	60	23	434
16	60	60	60	76	34	60	60	23	434
17	60	60	60	76	34	60	60	23	434
18	60	60	60	76	34	60	60	23	434
19	60	60	60	76	34	60	60	23	434
20	60	60	60	76	34	60	60	23	434
21	60	60	60	76	34	60	60	23	434
22	60	60	60	76	34	60	60	23	434
23	60	60	60	76	34	60	60	23	434
24	60	60	60	76	34	60	60	23	434
25	60	60	60	76	34	60	60	23	434
26	60	60	60	76	34	60	60	23	434
27	60	60	60	76	34	60	60	23	434
28	60	60	60	76	34	60	60	23	434
29	60	60	60	76	34	60	60	23	434
30	60	60	60	76	34	60	60	23	434
Total	**1,812**	**1,812**	**1,812**	**2,265**	**1,019**	**1,812**	**1,812**	**680**	**13,024**

HUC 107 Annual Adoption (treated acres), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Adoption
1	159	159	159	199	89	159	159	60	1,142
2	159	159	159	199	89	159	159	60	1,142
3	159	159	159	199	89	159	159	60	1,142
4	159	159	159	199	89	159	159	60	1,142
5	159	159	159	199	89	159	159	60	1,142
6	159	159	159	199	89	159	159	60	1,142
7	159	159	159	199	89	159	159	60	1,142
8	159	159	159	199	89	159	159	60	1,142
9	159	159	159	199	89	159	159	60	1,142
10	159	159	159	199	89	159	159	60	1,142
11	159	159	159	199	89	159	159	60	1,142
12	159	159	159	199	89	159	159	60	1,142
13	159	159	159	199	89	159	159	60	1,142
14	159	159	159	199	89	159	159	60	1,142
15	159	159	159	199	89	159	159	60	1,142
16	159	159	159	199	89	159	159	60	1,142
17	159	159	159	199	89	159	159	60	1,142
18	159	159	159	199	89	159	159	60	1,142
19	159	159	159	199	89	159	159	60	1,142
20	159	159	159	199	89	159	159	60	1,142
21	159	159	159	199	89	159	159	60	1,142
22	159	159	159	199	89	159	159	60	1,142
23	159	159	159	199	89	159	159	60	1,142
24	159	159	159	199	89	159	159	60	1,142
25	159	159	159	199	89	159	159	60	1,142
26	159	159	159	199	89	159	159	60	1,142
27	159	159	159	199	89	159	159	60	1,142
28	159	159	159	199	89	159	159	60	1,142
29	159	159	159	199	89	159	159	60	1,142
30	159	159	159	199	89	159	159	60	1,142
Total	**4,765**	**4,765**	**4,765**	**5,956**	**2,680**	**4,765**	**4,765**	**1,787**	**34,247**

HUC 108 Annual Adoption (treated acres), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Adoption
1	125	125	125	156	70	125	125	47	897
2	125	125	125	156	70	125	125	47	897
3	125	125	125	156	70	125	125	47	897
4	125	125	125	156	70	125	125	47	897
5	125	125	125	156	70	125	125	47	897
6	125	125	125	156	70	125	125	47	897
7	125	125	125	156	70	125	125	47	897
8	125	125	125	156	70	125	125	47	897
9	125	125	125	156	70	125	125	47	897
10	125	125	125	156	70	125	125	47	897
11	125	125	125	156	70	125	125	47	897
12	125	125	125	156	70	125	125	47	897
13	125	125	125	156	70	125	125	47	897
14	125	125	125	156	70	125	125	47	897
15	125	125	125	156	70	125	125	47	897
16	125	125	125	156	70	125	125	47	897
17	125	125	125	156	70	125	125	47	897
18	125	125	125	156	70	125	125	47	897
19	125	125	125	156	70	125	125	47	897
20	125	125	125	156	70	125	125	47	897
21	125	125	125	156	70	125	125	47	897
22	125	125	125	156	70	125	125	47	897
23	125	125	125	156	70	125	125	47	897
24	125	125	125	156	70	125	125	47	897
25	125	125	125	156	70	125	125	47	897
26	125	125	125	156	70	125	125	47	897
27	125	125	125	156	70	125	125	47	897
28	125	125	125	156	70	125	125	47	897
29	125	125	125	156	70	125	125	47	897
30	125	125	125	156	70	125	125	47	897
Total	**3,742**	**3,742**	**3,742**	**4,678**	**2,105**	**3,742**	**3,742**	**1,403**	**26,899**

Riparian Annual Adoption (treated acres), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Adoption
1	141	141	141	176	79	141	141	53	1,014
2	141	141	141	176	79	141	141	53	1,014
3	141	141	141	176	79	141	141	53	1,014
4	141	141	141	176	79	141	141	53	1,014
5	141	141	141	176	79	141	141	53	1,014
6	141	141	141	176	79	141	141	53	1,014
7	141	141	141	176	79	141	141	53	1,014
8	141	141	141	176	79	141	141	53	1,014
9	141	141	141	176	79	141	141	53	1,014
10	141	141	141	176	79	141	141	53	1,014
11	141	141	141	176	79	141	141	53	1,014
12	141	141	141	176	79	141	141	53	1,014
13	141	141	141	176	79	141	141	53	1,014
14	141	141	141	176	79	141	141	53	1,014
15	141	141	141	176	79	141	141	53	1,014
16	141	141	141	176	79	141	141	53	1,014
17	141	141	141	176	79	141	141	53	1,014
18	141	141	141	176	79	141	141	53	1,014
19	141	141	141	176	79	141	141	53	1,014
20	141	141	141	176	79	141	141	53	1,014
21	141	141	141	176	79	141	141	53	1,014
22	141	141	141	176	79	141	141	53	1,014
23	141	141	141	176	79	141	141	53	1,014
24	141	141	141	176	79	141	141	53	1,014
25	141	141	141	176	79	141	141	53	1,014
26	141	141	141	176	79	141	141	53	1,014
27	141	141	141	176	79	141	141	53	1,014
28	141	141	141	176	79	141	141	53	1,014
29	141	141	141	176	79	141	141	53	1,014
30	141	141	141	176	79	141	141	53	1,014
Total	**4,234**	**4,234**	**4,234**	**5,292**	**2,381**	**4,234**	**4,234**	**1,588**	**30,429**

2. Cropland BMP implementation: Cumulative soil erosion load reductions

HUC 104 Annual Soil Erosion Reduction (tons), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	38	30	30	24	40	23	30	11	226
2	76	60	60	47	81	45	60	23	453
3	113	91	91	71	121	68	91	34	679
4	151	121	121	94	161	91	121	45	906
5	189	151	151	118	202	113	151	57	1,132
6	227	181	181	142	242	136	181	68	1,358
7	264	212	212	165	283	159	212	79	1,585
8	302	242	242	189	323	181	242	91	1,811
9	340	272	272	212	363	204	272	102	2,038
10	378	302	302	236	404	227	302	113	2,264
11	416	332	332	260	444	249	332	125	2,491
12	453	363	363	283	484	272	363	136	2,717
13	491	393	393	307	525	295	393	147	2,943
14	529	423	423	331	565	317	423	159	3,170
15	567	453	453	354	606	340	453	170	3,396
16	604	484	484	378	646	363	484	181	3,623
17	642	514	514	401	686	385	514	193	3,849
18	680	544	544	425	727	408	544	204	4,075
19	718	574	574	449	767	431	574	215	4,302
20	756	604	604	472	807	453	604	227	4,528
21	793	635	635	496	848	476	635	238	4,755
22	831	665	665	519	888	499	665	249	4,981
23	869	695	695	543	929	521	695	261	5,208
24	907	725	725	567	969	544	725	272	5,434
25	944	756	756	590	1,009	567	756	283	5,660
26	982	786	786	614	1,050	589	786	295	5,887
27	1,020	816	816	637	1,090	612	816	306	6,113
28	1,058	846	846	661	1,130	635	846	317	6,340
29	1,095	876	876	685	1,171	657	876	329	6,566
30	1,133	907	907	708	1,211	680	907	340	6,792

HUC 105 Annual Soil Erosion Reduction (tons), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	42	34	34	26	45	25	34	13	254
2	85	68	68	53	91	51	68	25	508
3	127	102	102	79	136	76	102	38	762
4	170	136	136	106	181	102	136	51	1,016
5	212	170	170	132	226	127	170	64	1,270
6	254	203	203	159	272	153	203	76	1,524
7	297	237	237	185	317	178	237	89	1,778
8	339	271	271	212	362	203	271	102	2,032
9	381	305	305	238	408	229	305	114	2,286
10	424	339	339	265	453	254	339	127	2,540
11	466	373	373	291	498	280	373	140	2,794
12	509	407	407	318	544	305	407	153	3,048
13	551	441	441	344	589	331	441	165	3,302
14	593	475	475	371	634	356	475	178	3,556
15	636	509	509	397	679	381	509	191	3,810
16	678	542	542	424	725	407	542	203	4,064
17	720	576	576	450	770	432	576	216	4,318
18	763	610	610	477	815	458	610	229	4,572
19	805	644	644	503	861	483	644	242	4,826
20	848	678	678	530	906	509	678	254	5,080
21	890	712	712	556	951	534	712	267	5,335
22	932	746	746	583	996	559	746	280	5,589
23	975	780	780	609	1,042	585	780	292	5,843
24	1,017	814	814	636	1,087	610	814	305	6,097
25	1,060	848	848	662	1,132	636	848	318	6,351
26	1,102	882	882	689	1,178	661	882	331	6,605
27	1,144	915	915	715	1,223	687	915	343	6,859
28	1,187	949	949	742	1,268	712	949	356	7,113
29	1,229	983	983	768	1,314	737	983	369	7,367
30	1,271	1,017	1,017	795	1,359	763	1,017	381	7,621

HUC 106 Annual Soil Erosion Reduction (tons), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	13	10	10	8	14	8	10	4	79
2	26	21	21	16	28	16	21	8	157
3	39	31	31	25	42	24	31	12	236
4	52	42	42	33	56	31	42	16	314
5	66	52	52	41	70	39	52	20	393
6	79	63	63	49	84	47	63	24	471
7	92	73	73	57	98	55	73	28	550
8	105	84	84	66	112	63	84	31	628
9	118	94	94	74	126	71	94	35	707
10	131	105	105	82	140	79	105	39	786
11	144	115	115	90	154	87	115	43	864
12	157	126	126	98	168	94	126	47	943
13	170	136	136	106	182	102	136	51	1,021
14	183	147	147	115	196	110	147	55	1,100
15	197	157	157	123	210	118	157	59	1,178
16	210	168	168	131	224	126	168	63	1,257
17	223	178	178	139	238	134	178	67	1,336
18	236	189	189	147	252	142	189	71	1,414
19	249	199	199	156	266	149	199	75	1,493
20	262	210	210	164	280	157	210	79	1,571
21	275	220	220	172	294	165	220	83	1,650
22	288	231	231	180	308	173	231	87	1,728
23	301	241	241	188	322	181	241	90	1,807
24	315	252	252	197	336	189	252	94	1,885
25	328	262	262	205	350	197	262	98	1,964
26	341	273	273	213	364	204	273	102	2,043
27	354	283	283	221	378	212	283	106	2,121
28	367	294	294	229	392	220	294	110	2,200
29	380	304	304	238	406	228	304	114	2,278
30	393	315	315	246	420	236	315	118	2,357

HUC 107 Annual Soil Erosion Reduction (tons), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	34	28	28	22	37	21	28	10	207
2	69	55	55	43	74	41	55	21	413
3	103	83	83	65	111	62	83	31	620
4	138	110	110	86	147	83	110	41	826
5	172	138	138	108	184	103	138	52	1,033
6	207	165	165	129	221	124	165	62	1,239
7	241	193	193	151	258	145	193	72	1,446
8	276	221	221	172	295	165	221	83	1,653
9	310	248	248	194	332	186	248	93	1,859
10	345	276	276	215	368	207	276	103	2,066
11	379	303	303	237	405	227	303	114	2,272
12	414	331	331	258	442	248	331	124	2,479
13	448	358	358	280	479	269	358	134	2,685
14	483	386	386	302	516	290	386	145	2,892
15	517	414	414	323	553	310	414	155	3,099
16	551	441	441	345	589	331	441	165	3,305
17	586	469	469	366	626	352	469	176	3,512
18	620	496	496	388	663	372	496	186	3,718
19	655	524	524	409	700	393	524	196	3,925
20	689	551	551	431	737	414	551	207	4,132
21	724	579	579	452	774	434	579	217	4,338
22	758	607	607	474	810	455	607	227	4,545
23	793	634	634	495	847	476	634	238	4,751
24	827	662	662	517	884	496	662	248	4,958
25	862	689	689	539	921	517	689	258	5,164
26	896	717	717	560	958	538	717	269	5,371
27	931	744	744	582	995	558	744	279	5,578
28	965	772	772	603	1,031	579	772	290	5,784
29	999	800	800	625	1,068	600	800	300	5,991
30	1,034	827	827	646	1,105	620	827	310	6,197

HUC 108 Annual Soil Erosion Reduction (tons), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	27	22	22	17	29	16	22	8	162
2	54	43	43	34	58	32	43	16	325
3	81	65	65	51	87	49	65	24	487
4	108	87	87	68	116	65	87	32	649
5	135	108	108	85	145	81	108	41	811
6	162	130	130	102	174	97	130	49	974
7	189	152	152	118	203	114	152	57	1,136
8	217	173	173	135	231	130	173	65	1,298
9	244	195	195	152	260	146	195	73	1,460
10	271	217	217	169	289	162	217	81	1,623
11	298	238	238	186	318	179	238	89	1,785
12	325	260	260	203	347	195	260	97	1,947
13	352	282	282	220	376	211	282	106	2,109
14	379	303	303	237	405	227	303	114	2,272
15	406	325	325	254	434	244	325	122	2,434
16	433	346	346	271	463	260	346	130	2,596
17	460	368	368	288	492	276	368	138	2,758
18	487	390	390	305	521	292	390	146	2,921
19	514	411	411	321	550	309	411	154	3,083
20	541	433	433	338	579	325	433	162	3,245
21	568	455	455	355	608	341	455	171	3,407
22	596	476	476	372	636	357	476	179	3,570
23	623	498	498	389	665	374	498	187	3,732
24	650	520	520	406	694	390	520	195	3,894
25	677	541	541	423	723	406	541	203	4,056
26	704	563	563	440	752	422	563	211	4,219
27	731	585	585	457	781	439	585	219	4,381
28	758	606	606	474	810	455	606	227	4,543
29	785	628	628	491	839	471	628	236	4,705
30	812	650	650	508	868	487	650	244	4,868

Riparian Annual Soil Erosion Reduction (tons), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	31	24	24	19	33	18	24	9	184
2	61	49	49	38	65	37	49	18	367
3	92	73	73	57	98	55	73	28	551
4	122	98	98	77	131	73	98	37	734
5	153	122	122	96	164	92	122	46	918
6	184	147	147	115	196	110	147	55	1,101
7	214	171	171	134	229	129	171	64	1,285
8	245	196	196	153	262	147	196	73	1,468
9	276	220	220	172	295	165	220	83	1,652
10	306	245	245	191	327	184	245	92	1,835
11	337	269	269	211	360	202	269	101	2,019
12	367	294	294	230	393	220	294	110	2,203
13	398	318	318	249	425	239	318	119	2,386
14	429	343	343	268	458	257	343	129	2,570
15	459	367	367	287	491	276	367	138	2,753
16	490	392	392	306	524	294	392	147	2,937
17	521	416	416	325	556	312	416	156	3,120
18	551	441	441	345	589	331	441	165	3,304
19	582	465	465	364	622	349	465	175	3,487
20	612	490	490	383	655	367	490	184	3,671
21	643	514	514	402	687	386	514	193	3,854
22	674	539	539	421	720	404	539	202	4,038
23	704	563	563	440	753	423	563	211	4,222
24	735	588	588	459	785	441	588	220	4,405
25	766	612	612	478	818	459	612	230	4,589
26	796	637	637	498	851	478	637	239	4,772
27	827	661	661	517	884	496	661	248	4,956
28	857	686	686	536	916	514	686	257	5,139
29	888	710	710	555	949	533	710	266	5,323
30	919	735	735	574	982	551	735	276	5,506

3. Cropland BMP implementation: Cumulative phosphorus load reductions

HUC 104 Annual Phosphorous Reduction (lbs), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	226	226	181	141	242	136	181	68	1,402
2	453	453	362	283	484	272	362	136	2,803
3	679	679	543	424	726	407	543	204	4,205
4	905	905	724	566	967	543	724	272	5,607
5	1,132	1,132	905	707	1,209	679	905	339	7,008
6	1,358	1,358	1,086	849	1,451	815	1,086	407	8,410
7	1,584	1,584	1,267	990	1,693	950	1,267	475	9,812
8	1,810	1,810	1,448	1,132	1,935	1,086	1,448	543	11,213
9	2,037	2,037	1,629	1,273	2,177	1,222	1,629	611	12,615
10	2,263	2,263	1,810	1,414	2,419	1,358	1,810	679	14,017
11	2,489	2,489	1,991	1,556	2,660	1,494	1,991	747	15,418
12	2,716	2,716	2,173	1,697	2,902	1,629	2,173	815	16,820
13	2,942	2,942	2,354	1,839	3,144	1,765	2,354	883	18,222
14	3,168	3,168	2,535	1,980	3,386	1,901	2,535	950	19,623
15	3,395	3,395	2,716	2,122	3,628	2,037	2,716	1,018	21,025
16	3,621	3,621	2,897	2,263	3,870	2,173	2,897	1,086	22,427
17	3,847	3,847	3,078	2,404	4,112	2,308	3,078	1,154	23,828
18	4,073	4,073	3,259	2,546	4,354	2,444	3,259	1,222	25,230
19	4,300	4,300	3,440	2,687	4,595	2,580	3,440	1,290	26,632
20	4,526	4,526	3,621	2,829	4,837	2,716	3,621	1,358	28,033
21	4,752	4,752	3,802	2,970	5,079	2,851	3,802	1,426	29,435
22	4,979	4,979	3,983	3,112	5,321	2,987	3,983	1,494	30,837
23	5,205	5,205	4,164	3,253	5,563	3,123	4,164	1,561	32,238
24	5,431	5,431	4,345	3,395	5,805	3,259	4,345	1,629	33,640
25	5,658	5,658	4,526	3,536	6,047	3,395	4,526	1,697	35,042
26	5,884	5,884	4,707	3,677	6,288	3,530	4,707	1,765	36,443
27	6,110	6,110	4,888	3,819	6,530	3,666	4,888	1,833	37,845
28	6,337	6,337	5,069	3,960	6,772	3,802	5,069	1,901	39,247
29	6,563	6,563	5,250	4,102	7,014	3,938	5,250	1,969	40,648
30	6,789	6,789	5,431	4,243	7,256	4,073	5,431	2,037	42,050

HUC 105 Annual Phosphorous Reduction (lbs), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	254	254	203	159	271	152	203	76	1,573
2	508	508	406	317	543	305	406	152	3,145
3	762	762	609	476	814	457	609	229	4,718
4	1,016	1,016	812	635	1,085	609	812	305	6,290
5	1,269	1,269	1,016	793	1,357	762	1,016	381	7,863
6	1,523	1,523	1,219	952	1,628	914	1,219	457	9,436
7	1,777	1,777	1,422	1,111	1,899	1,066	1,422	533	11,008
8	2,031	2,031	1,625	1,269	2,171	1,219	1,625	609	12,581
9	2,285	2,285	1,828	1,428	2,442	1,371	1,828	686	14,153
10	2,539	2,539	2,031	1,587	2,714	1,523	2,031	762	15,726
11	2,793	2,793	2,234	1,746	2,985	1,676	2,234	838	17,298
12	3,047	3,047	2,437	1,904	3,256	1,828	2,437	914	18,871
13	3,301	3,301	2,641	2,063	3,528	1,980	2,641	990	20,444
14	3,555	3,555	2,844	2,222	3,799	2,133	2,844	1,066	22,016
15	3,808	3,808	3,047	2,380	4,070	2,285	3,047	1,143	23,589
16	4,062	4,062	3,250	2,539	4,342	2,437	3,250	1,219	25,161
17	4,316	4,316	3,453	2,698	4,613	2,590	3,453	1,295	26,734
18	4,570	4,570	3,656	2,856	4,884	2,742	3,656	1,371	28,307
19	4,824	4,824	3,859	3,015	5,156	2,894	3,859	1,447	29,879
20	5,078	5,078	4,062	3,174	5,427	3,047	4,062	1,523	31,452
21	5,332	5,332	4,265	3,332	5,698	3,199	4,265	1,600	33,024
22	5,586	5,586	4,469	3,491	5,970	3,351	4,469	1,676	34,597
23	5,840	5,840	4,672	3,650	6,241	3,504	4,672	1,752	36,169
24	6,094	6,094	4,875	3,808	6,513	3,656	4,875	1,828	37,742
25	6,347	6,347	5,078	3,967	6,784	3,808	5,078	1,904	39,315
26	6,601	6,601	5,281	4,126	7,055	3,961	5,281	1,980	40,887
27	6,855	6,855	5,484	4,285	7,327	4,113	5,484	2,057	42,460
28	7,109	7,109	5,687	4,443	7,598	4,265	5,687	2,133	44,032
29	7,363	7,363	5,890	4,602	7,869	4,418	5,890	2,209	45,605
30	7,617	7,617	6,094	4,761	8,141	4,570	6,094	2,285	47,178

HUC 106 Annual Phosphorous Reduction (lbs), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	79	79	63	49	84	47	63	24	486
2	157	157	126	98	168	94	126	47	973
3	236	236	188	147	252	141	188	71	1,459
4	314	314	251	196	336	188	251	94	1,945
5	393	393	314	245	420	236	314	118	2,432
6	471	471	377	294	504	283	377	141	2,918
7	550	550	440	344	587	330	440	165	3,404
8	628	628	503	393	671	377	503	188	3,891
9	707	707	565	442	755	424	565	212	4,377
10	785	785	628	491	839	471	628	236	4,863
11	864	864	691	540	923	518	691	259	5,350
12	942	942	754	589	1,007	565	754	283	5,836
13	1,021	1,021	817	638	1,091	612	817	306	6,322
14	1,099	1,099	879	687	1,175	660	879	330	6,809
15	1,178	1,178	942	736	1,259	707	942	353	7,295
16	1,256	1,256	1,005	785	1,343	754	1,005	377	7,781
17	1,335	1,335	1,068	834	1,427	801	1,068	400	8,268
18	1,413	1,413	1,131	883	1,511	848	1,131	424	8,754
19	1,492	1,492	1,194	932	1,594	895	1,194	448	9,240
20	1,570	1,570	1,256	982	1,678	942	1,256	471	9,727
21	1,649	1,649	1,319	1,031	1,762	989	1,319	495	10,213
22	1,727	1,727	1,382	1,080	1,846	1,036	1,382	518	10,699
23	1,806	1,806	1,445	1,129	1,930	1,084	1,445	542	11,186
24	1,884	1,884	1,508	1,178	2,014	1,131	1,508	565	11,672
25	1,963	1,963	1,570	1,227	2,098	1,178	1,570	589	12,158
26	2,042	2,042	1,633	1,276	2,182	1,225	1,633	612	12,645
27	2,120	2,120	1,696	1,325	2,266	1,272	1,696	636	13,131
28	2,199	2,199	1,759	1,374	2,350	1,319	1,759	660	13,617
29	2,277	2,277	1,822	1,423	2,434	1,366	1,822	683	14,104
30	2,356	2,356	1,884	1,472	2,518	1,413	1,884	707	14,590

HUC 107 Annual Phosphorous Reduction (lbs), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	206	206	165	129	221	124	165	62	1,279
2	413	413	330	258	441	248	330	124	2,558
3	619	619	496	387	662	372	496	186	3,837
4	826	826	661	516	883	496	661	248	5,115
5	1,032	1,032	826	645	1,103	619	826	310	6,394
6	1,239	1,239	991	774	1,324	743	991	372	7,673
7	1,445	1,445	1,156	903	1,545	867	1,156	434	8,952
8	1,652	1,652	1,321	1,032	1,765	991	1,321	496	10,231
9	1,858	1,858	1,487	1,161	1,986	1,115	1,487	557	11,510
10	2,065	2,065	1,652	1,290	2,207	1,239	1,652	619	12,789
11	2,271	2,271	1,817	1,420	2,427	1,363	1,817	681	14,067
12	2,478	2,478	1,982	1,549	2,648	1,487	1,982	743	15,346
13	2,684	2,684	2,147	1,678	2,869	1,611	2,147	805	16,625
14	2,891	2,891	2,313	1,807	3,089	1,734	2,313	867	17,904
15	3,097	3,097	2,478	1,936	3,310	1,858	2,478	929	19,183
16	3,304	3,304	2,643	2,065	3,531	1,982	2,643	991	20,462
17	3,510	3,510	2,808	2,194	3,751	2,106	2,808	1,053	21,740
18	3,717	3,717	2,973	2,323	3,972	2,230	2,973	1,115	23,019
19	3,923	3,923	3,138	2,452	4,193	2,354	3,138	1,177	24,298
20	4,129	4,129	3,304	2,581	4,413	2,478	3,304	1,239	25,577
21	4,336	4,336	3,469	2,710	4,634	2,602	3,469	1,301	26,856
22	4,542	4,542	3,634	2,839	4,855	2,725	3,634	1,363	28,135
23	4,749	4,749	3,799	2,968	5,075	2,849	3,799	1,425	29,414
24	4,955	4,955	3,964	3,097	5,296	2,973	3,964	1,487	30,692
25	5,162	5,162	4,129	3,226	5,517	3,097	4,129	1,549	31,971
26	5,368	5,368	4,295	3,355	5,737	3,221	4,295	1,611	33,250
27	5,575	5,575	4,460	3,484	5,958	3,345	4,460	1,672	34,529
28	5,781	5,781	4,625	3,613	6,179	3,469	4,625	1,734	35,808
29	5,988	5,988	4,790	3,742	6,399	3,593	4,790	1,796	37,087
30	6,194	6,194	4,955	3,871	6,620	3,717	4,955	1,858	38,366

HUC 108 Annual Phosphorous Reduction (lbs), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	162	162	130	101	173	97	130	49	1,004
2	324	324	259	203	347	195	259	97	2,009
3	487	487	389	304	520	292	389	146	3,013
4	649	649	519	405	693	389	519	195	4,018
5	811	811	649	507	867	487	649	243	5,022
6	973	973	778	608	1,040	584	778	292	6,027
7	1,135	1,135	908	709	1,213	681	908	341	7,031
8	1,297	1,297	1,038	811	1,387	778	1,038	389	8,036
9	1,460	1,460	1,168	912	1,560	876	1,168	438	9,040
10	1,622	1,622	1,297	1,014	1,733	973	1,297	487	10,044
11	1,784	1,784	1,427	1,115	1,907	1,070	1,427	535	11,049
12	1,946	1,946	1,557	1,216	2,080	1,168	1,557	584	12,053
13	2,108	2,108	1,687	1,318	2,253	1,265	1,687	632	13,058
14	2,270	2,270	1,816	1,419	2,426	1,362	1,816	681	14,062
15	2,433	2,433	1,946	1,520	2,600	1,460	1,946	730	15,067
16	2,595	2,595	2,076	1,622	2,773	1,557	2,076	778	16,071
17	2,757	2,757	2,206	1,723	2,946	1,654	2,206	827	17,076
18	2,919	2,919	2,335	1,824	3,120	1,751	2,335	876	18,080
19	3,081	3,081	2,465	1,926	3,293	1,849	2,465	924	19,084
20	3,243	3,243	2,595	2,027	3,466	1,946	2,595	973	20,089
21	3,406	3,406	2,724	2,128	3,640	2,043	2,724	1,022	21,093
22	3,568	3,568	2,854	2,230	3,813	2,141	2,854	1,070	22,098
23	3,730	3,730	2,984	2,331	3,986	2,238	2,984	1,119	23,102
24	3,892	3,892	3,114	2,433	4,160	2,335	3,114	1,168	24,107
25	4,054	4,054	3,243	2,534	4,333	2,433	3,243	1,216	25,111
26	4,216	4,216	3,373	2,635	4,506	2,530	3,373	1,265	26,116
27	4,379	4,379	3,503	2,737	4,680	2,627	3,503	1,314	27,120
28	4,541	4,541	3,633	2,838	4,853	2,724	3,633	1,362	28,124
29	4,703	4,703	3,762	2,939	5,026	2,822	3,762	1,411	29,129
30	4,865	4,865	3,892	3,041	5,200	2,919	3,892	1,460	30,133

Riparian Annual Phosphorous Reduction (lbs), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	183	183	147	115	196	110	147	55	1,136
2	367	367	294	229	392	220	294	110	2,273
3	550	550	440	344	588	330	440	165	3,409
4	734	734	587	459	784	440	587	220	4,545
5	917	917	734	573	980	550	734	275	5,681
6	1,101	1,101	881	688	1,176	660	881	330	6,818
7	1,284	1,284	1,027	803	1,372	771	1,027	385	7,954
8	1,468	1,468	1,174	917	1,569	881	1,174	440	9,090
9	1,651	1,651	1,321	1,032	1,765	991	1,321	495	10,227
10	1,835	1,835	1,468	1,147	1,961	1,101	1,468	550	11,363
11	2,018	2,018	1,614	1,261	2,157	1,211	1,614	605	12,499
12	2,201	2,201	1,761	1,376	2,353	1,321	1,761	660	13,635
13	2,385	2,385	1,908	1,491	2,549	1,431	1,908	715	14,772
14	2,568	2,568	2,055	1,605	2,745	1,541	2,055	771	15,908
15	2,752	2,752	2,201	1,720	2,941	1,651	2,201	826	17,044
16	2,935	2,935	2,348	1,835	3,137	1,761	2,348	881	18,180
17	3,119	3,119	2,495	1,949	3,333	1,871	2,495	936	19,317
18	3,302	3,302	2,642	2,064	3,529	1,981	2,642	991	20,453
19	3,486	3,486	2,789	2,179	3,725	2,091	2,789	1,046	21,589
20	3,669	3,669	2,935	2,293	3,921	2,201	2,935	1,101	22,726
21	3,853	3,853	3,082	2,408	4,117	2,312	3,082	1,156	23,862
22	4,036	4,036	3,229	2,523	4,314	2,422	3,229	1,211	24,998
23	4,219	4,219	3,376	2,637	4,510	2,532	3,376	1,266	26,134
24	4,403	4,403	3,522	2,752	4,706	2,642	3,522	1,321	27,271
25	4,586	4,586	3,669	2,867	4,902	2,752	3,669	1,376	28,407
26	4,770	4,770	3,816	2,981	5,098	2,862	3,816	1,431	29,543
27	4,953	4,953	3,963	3,096	5,294	2,972	3,963	1,486	30,680
28	5,137	5,137	4,109	3,210	5,490	3,082	4,109	1,541	31,816
29	5,320	5,320	4,256	3,325	5,686	3,192	4,256	1,596	32,952
30	5,504	5,504	4,403	3,440	5,882	3,302	4,403	1,651	34,088

4. Cropland BMP implementation: Cumulative nitrogen load reductions

HUC 104 Annual Nitrogen Reduction (lbs), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	975	487	780	609	1,042	585	780	292	5,551
2	1,950	975	1,560	1,219	2,084	1,170	1,560	585	11,101
3	2,925	1,462	2,340	1,828	3,126	1,755	2,340	877	16,652
4	3,899	1,950	3,120	2,437	4,167	2,340	3,120	1,170	22,202
5	4,874	2,437	3,899	3,046	5,209	2,925	3,899	1,462	27,753
6	5,849	2,925	4,679	3,656	6,251	3,509	4,679	1,755	33,303
7	6,824	3,412	5,459	4,265	7,293	4,094	5,459	2,047	38,854
8	7,799	3,899	6,239	4,874	8,335	4,679	6,239	2,340	44,404
9	8,774	4,387	7,019	5,484	9,377	5,264	7,019	2,632	49,955
10	9,748	4,874	7,799	6,093	10,419	5,849	7,799	2,925	55,505
11	10,723	5,362	8,579	6,702	11,461	6,434	8,579	3,217	61,056
12	11,698	5,849	9,359	7,311	12,502	7,019	9,359	3,509	66,606
13	12,673	6,337	10,138	7,921	13,544	7,604	10,138	3,802	72,157
14	13,648	6,824	10,918	8,530	14,586	8,189	10,918	4,094	77,708
15	14,623	7,311	11,698	9,139	15,628	8,774	11,698	4,387	83,258
16	15,598	7,799	12,478	9,748	16,670	9,359	12,478	4,679	88,809
17	16,572	8,286	13,258	10,358	17,712	9,943	13,258	4,972	94,359
18	17,547	8,774	14,038	10,967	18,754	10,528	14,038	5,264	99,910
19	18,522	9,261	14,818	11,576	19,796	11,113	14,818	5,557	105,460
20	19,497	9,748	15,598	12,186	20,837	11,698	15,598	5,849	111,011
21	20,472	10,236	16,377	12,795	21,879	12,283	16,377	6,142	116,561
22	21,447	10,723	17,157	13,404	22,921	12,868	17,157	6,434	122,112
23	22,422	11,211	17,937	14,013	23,963	13,453	17,937	6,726	127,662
24	23,396	11,698	18,717	14,623	25,005	14,038	18,717	7,019	133,213
25	24,371	12,186	19,497	15,232	26,047	14,623	19,497	7,311	138,764
26	25,346	12,673	20,277	15,841	27,089	15,208	20,277	7,604	144,314
27	26,321	13,160	21,057	16,451	28,130	15,793	21,057	7,896	149,865
28	27,296	13,648	21,837	17,060	29,172	16,377	21,837	8,189	155,415
29	28,271	14,135	22,616	17,669	30,214	16,962	22,616	8,481	160,966
30	29,245	14,623	23,396	18,278	31,256	17,547	23,396	8,774	166,516

HUC 105 Annual Nitrogen Reduction (lbs), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	1,094	547	875	684	1,169	656	875	328	6,227
2	2,187	1,094	1,750	1,367	2,338	1,312	1,750	656	12,455
3	3,281	1,641	2,625	2,051	3,507	1,969	2,625	984	18,682
4	4,375	2,187	3,500	2,734	4,676	2,625	3,500	1,312	24,909
5	5,469	2,734	4,375	3,418	5,845	3,281	4,375	1,641	31,137
6	6,562	3,281	5,250	4,101	7,013	3,937	5,250	1,969	37,364
7	7,656	3,828	6,125	4,785	8,182	4,594	6,125	2,297	43,591
8	8,750	4,375	7,000	5,469	9,351	5,250	7,000	2,625	49,819
9	9,843	4,922	7,875	6,152	10,520	5,906	7,875	2,953	56,046
10	10,937	5,469	8,750	6,836	11,689	6,562	8,750	3,281	62,274
11	12,031	6,015	9,625	7,519	12,858	7,219	9,625	3,609	68,501
12	13,125	6,562	10,500	8,203	14,027	7,875	10,500	3,937	74,728
13	14,218	7,109	11,375	8,886	15,196	8,531	11,375	4,265	80,956
14	15,312	7,656	12,250	9,570	16,365	9,187	12,250	4,594	87,183
15	16,406	8,203	13,125	10,254	17,534	9,843	13,125	4,922	93,410
16	17,499	8,750	14,000	10,937	18,703	10,500	14,000	5,250	99,638
17	18,593	9,297	14,875	11,621	19,871	11,156	14,875	5,578	105,865
18	19,687	9,843	15,750	12,304	21,040	11,812	15,750	5,906	112,092
19	20,781	10,390	16,625	12,988	22,209	12,468	16,625	6,234	118,320
20	21,874	10,937	17,499	13,671	23,378	13,125	17,499	6,562	124,547
21	22,968	11,484	18,374	14,355	24,547	13,781	18,374	6,890	130,774
22	24,062	12,031	19,249	15,039	25,716	14,437	19,249	7,219	137,002
23	25,155	12,578	20,124	15,722	26,885	15,093	20,124	7,547	143,229
24	26,249	13,125	20,999	16,406	28,054	15,750	20,999	7,875	149,456
25	27,343	13,671	21,874	17,089	29,223	16,406	21,874	8,203	155,684
26	28,437	14,218	22,749	17,773	30,392	17,062	22,749	8,531	161,911
27	29,530	14,765	23,624	18,456	31,561	17,718	23,624	8,859	168,139
28	30,624	15,312	24,499	19,140	32,729	18,374	24,499	9,187	174,366
29	31,718	15,859	25,374	19,824	33,898	19,031	25,374	9,515	180,593
30	32,812	16,406	26,249	20,507	35,067	19,687	26,249	9,843	186,821

HUC 106 Annual Nitrogen Reduction (lbs), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	338	169	271	211	361	203	271	101	1,926
2	676	338	541	423	723	406	541	203	3,852
3	1,015	507	812	634	1,084	609	812	304	5,778
4	1,353	676	1,082	846	1,446	812	1,082	406	7,703
5	1,691	846	1,353	1,057	1,807	1,015	1,353	507	9,629
6	2,029	1,015	1,624	1,268	2,169	1,218	1,624	609	11,555
7	2,368	1,184	1,894	1,480	2,530	1,421	1,894	710	13,481
8	2,706	1,353	2,165	1,691	2,892	1,624	2,165	812	15,407
9	3,044	1,522	2,435	1,903	3,253	1,826	2,435	913	17,333
10	3,382	1,691	2,706	2,114	3,615	2,029	2,706	1,015	19,259
11	3,721	1,860	2,977	2,325	3,976	2,232	2,977	1,116	21,184
12	4,059	2,029	3,247	2,537	4,338	2,435	3,247	1,218	23,110
13	4,397	2,199	3,518	2,748	4,699	2,638	3,518	1,319	25,036
14	4,735	2,368	3,788	2,960	5,061	2,841	3,788	1,421	26,962
15	5,074	2,537	4,059	3,171	5,422	3,044	4,059	1,522	28,888
16	5,412	2,706	4,329	3,382	5,784	3,247	4,329	1,624	30,814
17	5,750	2,875	4,600	3,594	6,145	3,450	4,600	1,725	32,740
18	6,088	3,044	4,871	3,805	6,507	3,653	4,871	1,826	34,665
19	6,427	3,213	5,141	4,017	6,868	3,856	5,141	1,928	36,591
20	6,765	3,382	5,412	4,228	7,230	4,059	5,412	2,029	38,517
21	7,103	3,552	5,682	4,439	7,591	4,262	5,682	2,131	40,443
22	7,441	3,721	5,953	4,651	7,953	4,465	5,953	2,232	42,369
23	7,780	3,890	6,224	4,862	8,314	4,668	6,224	2,334	44,295
24	8,118	4,059	6,494	5,074	8,676	4,871	6,494	2,435	46,220
25	8,456	4,228	6,765	5,285	9,037	5,074	6,765	2,537	48,146
26	8,794	4,397	7,035	5,496	9,399	5,277	7,035	2,638	50,072
27	9,132	4,566	7,306	5,708	9,760	5,479	7,306	2,740	51,998
28	9,471	4,735	7,577	5,919	10,122	5,682	7,577	2,841	53,924
29	9,809	4,904	7,847	6,131	10,483	5,885	7,847	2,943	55,850
30	10,147	5,074	8,118	6,342	10,845	6,088	8,118	3,044	57,776

HUC 107 Annual Nitrogen Reduction (lbs), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	889	445	712	556	951	534	712	267	5,064
2	1,779	889	1,423	1,112	1,901	1,067	1,423	534	10,128
3	2,668	1,334	2,135	1,668	2,852	1,601	2,135	800	15,193
4	3,558	1,779	2,846	2,224	3,802	2,135	2,846	1,067	20,257
5	4,447	2,224	3,558	2,779	4,753	2,668	3,558	1,334	25,321
6	5,337	2,668	4,269	3,335	5,703	3,202	4,269	1,601	30,385
7	6,226	3,113	4,981	3,891	6,654	3,736	4,981	1,868	35,449
8	7,115	3,558	5,692	4,447	7,605	4,269	5,692	2,135	40,514
9	8,005	4,002	6,404	5,003	8,555	4,803	6,404	2,401	45,578
10	8,894	4,447	7,115	5,559	9,506	5,337	7,115	2,668	50,642
11	9,784	4,892	7,827	6,115	10,456	5,870	7,827	2,935	55,706
12	10,673	5,337	8,539	6,671	11,407	6,404	8,539	3,202	60,770
13	11,563	5,781	9,250	7,227	12,358	6,938	9,250	3,469	65,834
14	12,452	6,226	9,962	7,783	13,308	7,471	9,962	3,736	70,899
15	13,341	6,671	10,673	8,338	14,259	8,005	10,673	4,002	75,963
16	14,231	7,115	11,385	8,894	15,209	8,539	11,385	4,269	81,027
17	15,120	7,560	12,096	9,450	16,160	9,072	12,096	4,536	86,091
18	16,010	8,005	12,808	10,006	17,110	9,606	12,808	4,803	91,155
19	16,899	8,450	13,519	10,562	18,061	10,139	13,519	5,070	96,220
20	17,789	8,894	14,231	11,118	19,012	10,673	14,231	5,337	101,284
21	18,678	9,339	14,942	11,674	19,962	11,207	14,942	5,603	106,348
22	19,567	9,784	15,654	12,230	20,913	11,740	15,654	5,870	111,412
23	20,457	10,228	16,365	12,786	21,863	12,274	16,365	6,137	116,476
24	21,346	10,673	17,077	13,341	22,814	12,808	17,077	6,404	121,541
25	22,236	11,118	17,789	13,897	23,764	13,341	17,789	6,671	126,605
26	23,125	11,563	18,500	14,453	24,715	13,875	18,500	6,938	131,669
27	24,015	12,007	19,212	15,009	25,666	14,409	19,212	7,204	136,733
28	24,904	12,452	19,923	15,565	26,616	14,942	19,923	7,471	141,797
29	25,793	12,897	20,635	16,121	27,567	15,476	20,635	7,738	146,861
30	26,683	13,341	21,346	16,677	28,517	16,010	21,346	8,005	151,926

HUC 108 Annual Nitrogen Reduction (lbs), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	699	349	559	437	747	419	559	210	3,978
2	1,397	699	1,118	873	1,493	838	1,118	419	7,955
3	2,096	1,048	1,677	1,310	2,240	1,257	1,677	629	11,933
4	2,794	1,397	2,235	1,746	2,986	1,677	2,235	838	15,910
5	3,493	1,746	2,794	2,183	3,733	2,096	2,794	1,048	19,888
6	4,191	2,096	3,353	2,620	4,480	2,515	3,353	1,257	23,865
7	4,890	2,445	3,912	3,056	5,226	2,934	3,912	1,467	27,843
8	5,589	2,794	4,471	3,493	5,973	3,353	4,471	1,677	31,820
9	6,287	3,144	5,030	3,930	6,719	3,772	5,030	1,886	35,798
10	6,986	3,493	5,589	4,366	7,466	4,191	5,589	2,096	39,775
11	7,684	3,842	6,148	4,803	8,213	4,611	6,148	2,305	43,753
12	8,383	4,191	6,706	5,239	8,959	5,030	6,706	2,515	47,731
13	9,082	4,541	7,265	5,676	9,706	5,449	7,265	2,724	51,708
14	9,780	4,890	7,824	6,113	10,453	5,868	7,824	2,934	55,686
15	10,479	5,239	8,383	6,549	11,199	6,287	8,383	3,144	59,663
16	11,177	5,589	8,942	6,986	11,946	6,706	8,942	3,353	63,641
17	11,876	5,938	9,501	7,422	12,692	7,126	9,501	3,563	67,618
18	12,574	6,287	10,060	7,859	13,439	7,545	10,060	3,772	71,596
19	13,273	6,637	10,618	8,296	14,186	7,964	10,618	3,982	75,573
20	13,972	6,986	11,177	8,732	14,932	8,383	11,177	4,191	79,551
21	14,670	7,335	11,736	9,169	15,679	8,802	11,736	4,401	83,528
22	15,369	7,684	12,295	9,605	16,425	9,221	12,295	4,611	87,506
23	16,067	8,034	12,854	10,042	17,172	9,640	12,854	4,820	91,484
24	16,766	8,383	13,413	10,479	17,919	10,060	13,413	5,030	95,461
25	17,465	8,732	13,972	10,915	18,665	10,479	13,972	5,239	99,439
26	18,163	9,082	14,530	11,352	19,412	10,898	14,530	5,449	103,416
27	18,862	9,431	15,089	11,789	20,158	11,317	15,089	5,659	107,394
28	19,560	9,780	15,648	12,225	20,905	11,736	15,648	5,868	111,371
29	20,259	10,129	16,207	12,662	21,652	12,155	16,207	6,078	115,349
30	20,957	10,479	16,766	13,098	22,398	12,574	16,766	6,287	119,326

Riparian Annual Nitrogen Reduction (lbs), Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Load Reduction
1	790	395	632	494	845	474	632	237	4,500
2	1,581	790	1,264	988	1,689	948	1,264	474	8,999
3	2,371	1,185	1,897	1,482	2,534	1,422	1,897	711	13,499
4	3,161	1,581	2,529	1,976	3,378	1,897	2,529	948	17,998
5	3,951	1,976	3,161	2,470	4,223	2,371	3,161	1,185	22,498
6	4,742	2,371	3,793	2,964	5,068	2,845	3,793	1,422	26,998
7	5,532	2,766	4,426	3,457	5,912	3,319	4,426	1,660	31,497
8	6,322	3,161	5,058	3,951	6,757	3,793	5,058	1,897	35,997
9	7,112	3,556	5,690	4,445	7,601	4,267	5,690	2,134	40,497
10	7,903	3,951	6,322	4,939	8,446	4,742	6,322	2,371	44,996
11	8,693	4,346	6,954	5,433	9,291	5,216	6,954	2,608	49,496
12	9,483	4,742	7,587	5,927	10,135	5,690	7,587	2,845	53,995
13	10,274	5,137	8,219	6,421	10,980	6,164	8,219	3,082	58,495
14	11,064	5,532	8,851	6,915	11,824	6,638	8,851	3,319	62,995
15	11,854	5,927	9,483	7,409	12,669	7,112	9,483	3,556	67,494
16	12,644	6,322	10,115	7,903	13,514	7,587	10,115	3,793	71,994
17	13,435	6,717	10,748	8,397	14,358	8,061	10,748	4,030	76,493
18	14,225	7,112	11,380	8,891	15,203	8,535	11,380	4,267	80,993
19	15,015	7,508	12,012	9,384	16,047	9,009	12,012	4,505	85,493
20	15,805	7,903	12,644	9,878	16,892	9,483	12,644	4,742	89,992
21	16,596	8,298	13,277	10,372	17,737	9,957	13,277	4,979	94,492
22	17,386	8,693	13,909	10,866	18,581	10,432	13,909	5,216	98,991
23	18,176	9,088	14,541	11,360	19,426	10,906	14,541	5,453	103,491
24	18,967	9,483	15,173	11,854	20,270	11,380	15,173	5,690	107,991
25	19,757	9,878	15,805	12,348	21,115	11,854	15,805	5,927	112,490
26	20,547	10,274	16,438	12,842	21,960	12,328	16,438	6,164	116,990
27	21,337	10,669	17,070	13,336	22,804	12,802	17,070	6,401	121,490
28	22,128	11,064	17,702	13,830	23,649	13,277	17,702	6,638	125,989
29	22,918	11,459	18,334	14,324	24,493	13,751	18,334	6,875	130,489
30	23,708	11,854	18,967	14,818	25,338	14,225	18,967	7,112	134,988

5. Cropland BMP implementation: Costs before cost-share

HUC 104 Annual Cost* Before Cost-Share, Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Cost
1	$30,638	$6,963	$6,963	$3,917	$17,234	$22,108	$21,760	$5,222	$114,806
2	$31,557	$7,172	$7,172	$4,034	$17,751	$22,771	$22,413	$5,379	$118,250
3	$32,504	$7,387	$7,387	$4,155	$18,283	$23,455	$23,085	$5,540	$121,797
4	$33,479	$7,609	$7,609	$4,280	$18,832	$24,158	$23,778	$5,707	$125,451
5	$34,483	$7,837	$7,837	$4,408	$19,397	$24,883	$24,491	$5,878	$129,215
6	$35,518	$8,072	$8,072	$4,541	$19,979	$25,629	$25,226	$6,054	$133,091
7	$36,583	$8,314	$8,314	$4,677	$20,578	$26,398	$25,983	$6,236	$137,084
8	$37,681	$8,564	$8,564	$4,817	$21,196	$27,190	$26,762	$6,423	$141,197
9	$38,811	$8,821	$8,821	$4,962	$21,831	$28,006	$27,565	$6,616	$145,433
10	$39,976	$9,085	$9,085	$5,111	$22,486	$28,846	$28,392	$6,814	$149,795
11	$41,175	$9,358	$9,358	$5,264	$23,161	$29,712	$29,244	$7,018	$154,289
12	$42,410	$9,639	$9,639	$5,422	$23,856	$30,603	$30,121	$7,229	$158,918
13	$43,683	$9,928	$9,928	$5,584	$24,571	$31,521	$31,025	$7,446	$163,686
14	$44,993	$10,226	$10,226	$5,752	$25,309	$32,467	$31,955	$7,669	$168,596
15	$46,343	$10,532	$10,532	$5,925	$26,068	$33,441	$32,914	$7,899	$173,654
16	$47,733	$10,848	$10,848	$6,102	$26,850	$34,444	$33,901	$8,136	$178,864
17	$49,165	$11,174	$11,174	$6,285	$27,655	$35,477	$34,918	$8,380	$184,230
18	$50,640	$11,509	$11,509	$6,474	$28,485	$36,541	$35,966	$8,632	$189,756
19	$52,159	$11,854	$11,854	$6,668	$29,340	$37,638	$37,045	$8,891	$195,449
20	$53,724	$12,210	$12,210	$6,868	$30,220	$38,767	$38,156	$9,158	$201,313
21	$55,336	$12,576	$12,576	$7,074	$31,126	$39,930	$39,301	$9,432	$207,352
22	$56,996	$12,954	$12,954	$7,286	$32,060	$41,128	$40,480	$9,715	$213,573
23	$58,706	$13,342	$13,342	$7,505	$33,022	$42,362	$41,694	$10,007	$219,980
24	$60,467	$13,742	$13,742	$7,730	$34,013	$43,632	$42,945	$10,307	$226,579
25	$62,281	$14,155	$14,155	$7,962	$35,033	$44,941	$44,234	$10,616	$233,376
26	$64,149	$14,579	$14,579	$8,201	$36,084	$46,290	$45,561	$10,935	$240,378
27	$66,074	$15,017	$15,017	$8,447	$37,167	$47,678	$46,927	$11,263	$247,589
28	$68,056	$15,467	$15,467	$8,700	$38,282	$49,109	$48,335	$11,600	$255,017
29	$70,098	$15,931	$15,931	$8,961	$39,430	$50,582	$49,785	$11,948	$262,667
30	$72,201	$16,409	$16,409	$9,230	$40,613	$52,099	$51,279	$12,307	$270,547
Total	**$1,457,619**	**$331,277**	**$331,277**	**$186,343**	**$819,911**	**$1,051,805**	**$1,035,241**	**$248,458**	**$5,461,932**
**3% Inflation*									

HUC 105 Annual Cost* Before Cost-Share, Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Cost
1	$34,374	$7,812	$7,812	$4,394	$19,335	$24,804	$24,413	$5,859	$128,805
2	$35,405	$8,047	$8,047	$4,526	$19,915	$25,548	$25,146	$6,035	$132,669
3	$36,467	$8,288	$8,288	$4,662	$20,513	$26,315	$25,900	$6,216	$136,649
4	$37,561	$8,537	$8,537	$4,802	$21,128	$27,104	$26,677	$6,403	$140,748
5	$38,688	$8,793	$8,793	$4,946	$21,762	$27,917	$27,477	$6,595	$144,971
6	$39,849	$9,057	$9,057	$5,094	$22,415	$28,755	$28,302	$6,792	$149,320
7	$41,044	$9,328	$9,328	$5,247	$23,087	$29,617	$29,151	$6,996	$153,800
8	$42,276	$9,608	$9,608	$5,405	$23,780	$30,506	$30,025	$7,206	$158,414
9	$43,544	$9,896	$9,896	$5,567	$24,493	$31,421	$30,926	$7,422	$163,166
10	$44,850	$10,193	$10,193	$5,734	$25,228	$32,364	$31,854	$7,645	$168,061
11	$46,196	$10,499	$10,499	$5,906	$25,985	$33,334	$32,809	$7,874	$173,103
12	$47,582	$10,814	$10,814	$6,083	$26,765	$34,334	$33,794	$8,111	$178,296
13	$49,009	$11,138	$11,138	$6,265	$27,568	$35,364	$34,808	$8,354	$183,645
14	$50,479	$11,473	$11,473	$6,453	$28,395	$36,425	$35,852	$8,604	$189,154
15	$51,994	$11,817	$11,817	$6,647	$29,246	$37,518	$36,927	$8,863	$194,829
16	$53,554	$12,171	$12,171	$6,846	$30,124	$38,644	$38,035	$9,128	$200,674
17	$55,160	$12,536	$12,536	$7,052	$31,028	$39,803	$39,176	$9,402	$206,694
18	$56,815	$12,912	$12,912	$7,263	$31,958	$40,997	$40,352	$9,684	$212,895
19	$58,519	$13,300	$13,300	$7,481	$32,917	$42,227	$41,562	$9,975	$219,281
20	$60,275	$13,699	$13,699	$7,706	$33,905	$43,494	$42,809	$10,274	$225,860
21	$62,083	$14,110	$14,110	$7,937	$34,922	$44,799	$44,093	$10,582	$232,636
22	$63,946	$14,533	$14,533	$8,175	$35,969	$46,143	$45,416	$10,900	$239,615
23	$65,864	$14,969	$14,969	$8,420	$37,049	$47,527	$46,778	$11,227	$246,803
24	$67,840	$15,418	$15,418	$8,673	$38,160	$48,953	$48,182	$11,564	$254,207
25	$69,875	$15,881	$15,881	$8,933	$39,305	$50,421	$49,627	$11,911	$261,834
26	$71,971	$16,357	$16,357	$9,201	$40,484	$51,934	$51,116	$12,268	$269,689
27	$74,131	$16,848	$16,848	$9,477	$41,698	$53,492	$52,650	$12,636	$277,779
28	$76,355	$17,353	$17,353	$9,761	$42,949	$55,097	$54,229	$13,015	$286,113
29	$78,645	$17,874	$17,874	$10,054	$44,238	$56,750	$55,856	$13,405	$294,696
30	$81,005	$18,410	$18,410	$10,356	$45,565	$58,452	$57,532	$13,808	$303,537
Total	**$1,635,356**	**$371,672**	**$371,672**	**$209,065**	**$919,888**	**$1,180,058**	**$1,161,474**	**$278,754**	**$6,127,939**
**3% Inflation*									

HUC 106 Annual Cost* Before Cost-Share, Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Cost
1	$10,630	$2,416	$2,416	$1,359	$5,980	$7,671	$7,550	$1,812	$39,834
2	$10,949	$2,488	$2,488	$1,400	$6,159	$7,901	$7,777	$1,866	$41,029
3	$11,278	$2,563	$2,563	$1,442	$6,344	$8,138	$8,010	$1,922	$42,260
4	$11,616	$2,640	$2,640	$1,485	$6,534	$8,382	$8,250	$1,980	$43,527
5	$11,965	$2,719	$2,719	$1,530	$6,730	$8,634	$8,498	$2,039	$44,833
6	$12,324	$2,801	$2,801	$1,575	$6,932	$8,893	$8,753	$2,101	$46,178
7	$12,693	$2,885	$2,885	$1,623	$7,140	$9,159	$9,015	$2,164	$47,564
8	$13,074	$2,971	$2,971	$1,671	$7,354	$9,434	$9,286	$2,229	$48,991
9	$13,466	$3,061	$3,061	$1,722	$7,575	$9,717	$9,564	$2,295	$50,460
10	$13,870	$3,152	$3,152	$1,773	$7,802	$10,009	$9,851	$2,364	$51,974
11	$14,286	$3,247	$3,247	$1,826	$8,036	$10,309	$10,147	$2,435	$53,533
12	$14,715	$3,344	$3,344	$1,881	$8,277	$10,618	$10,451	$2,508	$55,139
13	$15,156	$3,445	$3,445	$1,938	$8,525	$10,937	$10,764	$2,583	$56,793
14	$15,611	$3,548	$3,548	$1,996	$8,781	$11,265	$11,087	$2,661	$58,497
15	$16,079	$3,654	$3,654	$2,056	$9,045	$11,603	$11,420	$2,741	$60,252
16	$16,562	$3,764	$3,764	$2,117	$9,316	$11,951	$11,763	$2,823	$62,060
17	$17,059	$3,877	$3,877	$2,181	$9,596	$12,309	$12,116	$2,908	$63,922
18	$17,570	$3,993	$3,993	$2,246	$9,883	$12,679	$12,479	$2,995	$65,839
19	$18,098	$4,113	$4,113	$2,314	$10,180	$13,059	$12,853	$3,085	$67,814
20	$18,640	$4,236	$4,236	$2,383	$10,485	$13,451	$13,239	$3,177	$69,849
21	$19,200	$4,364	$4,364	$2,455	$10,800	$13,854	$13,636	$3,273	$71,944
22	$19,776	$4,494	$4,494	$2,528	$11,124	$14,270	$14,045	$3,371	$74,103
23	$20,369	$4,629	$4,629	$2,604	$11,458	$14,698	$14,467	$3,472	$76,326
24	$20,980	$4,768	$4,768	$2,682	$11,801	$15,139	$14,901	$3,576	$78,615
25	$21,609	$4,911	$4,911	$2,763	$12,155	$15,593	$15,348	$3,683	$80,974
26	$22,258	$5,059	$5,059	$2,845	$12,520	$16,061	$15,808	$3,794	$83,403
27	$22,925	$5,210	$5,210	$2,931	$12,896	$16,543	$16,282	$3,908	$85,905
28	$23,613	$5,367	$5,367	$3,019	$13,282	$17,039	$16,771	$4,025	$88,482
29	$24,322	$5,528	$5,528	$3,109	$13,681	$17,550	$17,274	$4,146	$91,137
30	$25,051	$5,693	$5,693	$3,203	$14,091	$18,077	$17,792	$4,270	$93,871
Total	**$505,746**	**$114,942**	**$114,942**	**$64,655**	**$284,482**	**$364,941**	**$359,194**	**$86,207**	**$1,895,110**
**3% Inflation*									

HUC 107 Annual Cost* After Cost-Share, Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Cost
1	$8,386	$1,906	$1,906	$1,072	$4,717	$6,051	$5,956	$1,429	$31,424
2	$8,638	$1,963	$1,963	$1,104	$4,859	$6,233	$6,135	$1,472	$32,367
3	$8,897	$2,022	$2,022	$1,137	$5,004	$6,420	$6,319	$1,516	$33,338
4	$9,164	$2,083	$2,083	$1,171	$5,155	$6,612	$6,508	$1,562	$34,338
5	$9,439	$2,145	$2,145	$1,207	$5,309	$6,811	$6,704	$1,609	$35,368
6	$9,722	$2,209	$2,209	$1,243	$5,468	$7,015	$6,905	$1,657	$36,429
7	$10,013	$2,276	$2,276	$1,280	$5,633	$7,226	$7,112	$1,707	$37,522
8	$10,314	$2,344	$2,344	$1,319	$5,802	$7,442	$7,325	$1,758	$38,647
9	$10,623	$2,414	$2,414	$1,358	$5,976	$7,666	$7,545	$1,811	$39,807
10	$10,942	$2,487	$2,487	$1,399	$6,155	$7,896	$7,771	$1,865	$41,001
11	$11,270	$2,561	$2,561	$1,441	$6,339	$8,132	$8,004	$1,921	$42,231
12	$11,608	$2,638	$2,638	$1,484	$6,530	$8,376	$8,244	$1,979	$43,498
13	$11,956	$2,717	$2,717	$1,529	$6,726	$8,628	$8,492	$2,038	$44,803
14	$12,315	$2,799	$2,799	$1,574	$6,927	$8,887	$8,747	$2,099	$46,147
15	$12,685	$2,883	$2,883	$1,622	$7,135	$9,153	$9,009	$2,162	$47,531
16	$13,065	$2,969	$2,969	$1,670	$7,349	$9,428	$9,279	$2,227	$48,957
17	$13,457	$3,058	$3,058	$1,720	$7,570	$9,711	$9,558	$2,294	$50,426
18	$13,861	$3,150	$3,150	$1,772	$7,797	$10,002	$9,844	$2,363	$51,939
19	$14,277	$3,245	$3,245	$1,825	$8,031	$10,302	$10,140	$2,434	$53,497
20	$14,705	$3,342	$3,342	$1,880	$8,272	$10,611	$10,444	$2,507	$55,102
21	$15,146	$3,442	$3,442	$1,936	$8,520	$10,929	$10,757	$2,582	$56,755
22	$15,601	$3,546	$3,546	$1,994	$8,775	$11,257	$11,080	$2,659	$58,458
23	$16,069	$3,652	$3,652	$2,054	$9,039	$11,595	$11,412	$2,739	$60,211
24	$16,551	$3,761	$3,761	$2,116	$9,310	$11,943	$11,755	$2,821	$62,018
25	$17,047	$3,874	$3,874	$2,179	$9,589	$12,301	$12,107	$2,906	$63,878
26	$17,559	$3,991	$3,991	$2,245	$9,877	$12,670	$12,471	$2,993	$65,795
27	$18,085	$4,110	$4,110	$2,312	$10,173	$13,050	$12,845	$3,083	$67,768
28	$18,628	$4,234	$4,234	$2,381	$10,478	$13,442	$13,230	$3,175	$69,801
29	$19,187	$4,361	$4,361	$2,453	$10,793	$13,845	$13,627	$3,270	$71,896
30	$19,762	$4,491	$4,491	$2,526	$11,116	$14,260	$14,036	$3,369	$74,052
Total	**$398,970**	**$90,675**	**$90,675**	**$51,005**	**$224,420**	**$287,893**	**$283,359**	**$68,006**	**$1,495,003**
**3% Inflation*									

HUC 108 Annual Cost* Before Cost-Share, Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Cost
1	$21,955	$4,990	$4,990	$2,807	$12,350	$15,843	$15,593	$3,742	$82,270
2	$22,614	$5,140	$5,140	$2,891	$12,720	$16,318	$16,061	$3,855	$84,739
3	$23,292	$5,294	$5,294	$2,978	$13,102	$16,808	$16,543	$3,970	$87,281
4	$23,991	$5,453	$5,453	$3,067	$13,495	$17,312	$17,039	$4,089	$89,899
5	$24,711	$5,616	$5,616	$3,159	$13,900	$17,831	$17,550	$4,212	$92,596
6	$25,452	$5,785	$5,785	$3,254	$14,317	$18,366	$18,077	$4,338	$95,374
7	$26,216	$5,958	$5,958	$3,351	$14,746	$18,917	$18,619	$4,469	$98,235
8	$27,002	$6,137	$6,137	$3,452	$15,189	$19,485	$19,178	$4,603	$101,182
9	$27,812	$6,321	$6,321	$3,556	$15,645	$20,069	$19,753	$4,741	$104,218
10	$28,647	$6,511	$6,511	$3,662	$16,114	$20,671	$20,346	$4,883	$107,344
11	$29,506	$6,706	$6,706	$3,772	$16,597	$21,291	$20,956	$5,029	$110,565
12	$30,391	$6,907	$6,907	$3,885	$17,095	$21,930	$21,585	$5,180	$113,882
13	$31,303	$7,114	$7,114	$4,002	$17,608	$22,588	$22,232	$5,336	$117,298
14	$32,242	$7,328	$7,328	$4,122	$18,136	$23,266	$22,899	$5,496	$120,817
15	$33,210	$7,548	$7,548	$4,246	$18,680	$23,964	$23,586	$5,661	$124,441
16	$34,206	$7,774	$7,774	$4,373	$19,241	$24,683	$24,294	$5,831	$128,175
17	$35,232	$8,007	$8,007	$4,504	$19,818	$25,423	$25,023	$6,005	$132,020
18	$36,289	$8,247	$8,247	$4,639	$20,413	$26,186	$25,773	$6,186	$135,980
19	$37,378	$8,495	$8,495	$4,778	$21,025	$26,971	$26,547	$6,371	$140,060
20	$38,499	$8,750	$8,750	$4,922	$21,656	$27,780	$27,343	$6,562	$144,262
21	$39,654	$9,012	$9,012	$5,069	$22,305	$28,614	$28,163	$6,759	$148,590
22	$40,844	$9,283	$9,283	$5,221	$22,974	$29,472	$29,008	$6,962	$153,047
23	$42,069	$9,561	$9,561	$5,378	$23,664	$30,356	$29,878	$7,171	$157,639
24	$43,331	$9,848	$9,848	$5,539	$24,374	$31,267	$30,775	$7,386	$162,368
25	$44,631	$10,143	$10,143	$5,706	$25,105	$32,205	$31,698	$7,608	$167,239
26	$45,970	$10,448	$10,448	$5,877	$25,858	$33,171	$32,649	$7,836	$172,256
27	$47,349	$10,761	$10,761	$6,053	$26,634	$34,167	$33,628	$8,071	$177,424
28	$48,769	$11,084	$11,084	$6,235	$27,433	$35,191	$34,637	$8,313	$182,746
29	$50,232	$11,416	$11,416	$6,422	$28,256	$36,247	$35,676	$8,562	$188,229
30	$51,739	$11,759	$11,759	$6,614	$29,103	$37,335	$36,747	$8,819	$193,876
Total	**$1,044,538**	**$237,395**	**$237,395**	**$133,535**	**$587,553**	**$753,729**	**$741,859**	**$178,046**	**$3,914,050**
**3% Inflation*									

Riparian Annual Cost* Before Cost-Share, Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Cost
1	$24,837	$5,645	$5,645	$3,175	$13,971	$17,922	$17,640	$4,234	$93,069
2	$25,582	$5,814	$5,814	$3,270	$14,390	$18,460	$18,169	$4,361	$95,861
3	$26,350	$5,989	$5,989	$3,369	$14,822	$19,014	$18,714	$4,491	$98,737
4	$27,140	$6,168	$6,168	$3,470	$15,266	$19,584	$19,276	$4,626	$101,699
5	$27,954	$6,353	$6,353	$3,574	$15,724	$20,172	$19,854	$4,765	$104,750
6	$28,793	$6,544	$6,544	$3,681	$16,196	$20,777	$20,450	$4,908	$107,892
7	$29,657	$6,740	$6,740	$3,791	$16,682	$21,400	$21,063	$5,055	$111,129
8	$30,547	$6,942	$6,942	$3,905	$17,182	$22,042	$21,695	$5,207	$114,463
9	$31,463	$7,151	$7,151	$4,022	$17,698	$22,703	$22,346	$5,363	$117,897
10	$32,407	$7,365	$7,365	$4,143	$18,229	$23,384	$23,016	$5,524	$121,433
11	$33,379	$7,586	$7,586	$4,267	$18,776	$24,086	$23,707	$5,690	$125,076
12	$34,380	$7,814	$7,814	$4,395	$19,339	$24,809	$24,418	$5,860	$128,829
13	$35,412	$8,048	$8,048	$4,527	$19,919	$25,553	$25,150	$6,036	$132,694
14	$36,474	$8,290	$8,290	$4,663	$20,517	$26,319	$25,905	$6,217	$136,674
15	$37,568	$8,538	$8,538	$4,803	$21,132	$27,109	$26,682	$6,404	$140,775
16	$38,695	$8,794	$8,794	$4,947	$21,766	$27,922	$27,483	$6,596	$144,998
17	$39,856	$9,058	$9,058	$5,095	$22,419	$28,760	$28,307	$6,794	$149,348
18	$41,052	$9,330	$9,330	$5,248	$23,092	$29,623	$29,156	$6,997	$153,828
19	$42,284	$9,610	$9,610	$5,406	$23,784	$30,511	$30,031	$7,207	$158,443
20	$43,552	$9,898	$9,898	$5,568	$24,498	$31,427	$30,932	$7,424	$163,196
21	$44,859	$10,195	$10,195	$5,735	$25,233	$32,370	$31,860	$7,646	$168,092
22	$46,204	$10,501	$10,501	$5,907	$25,990	$33,341	$32,816	$7,876	$173,135
23	$47,590	$10,816	$10,816	$6,084	$26,770	$34,341	$33,800	$8,112	$178,329
24	$49,018	$11,141	$11,141	$6,267	$27,573	$35,371	$34,814	$8,355	$183,679
25	$50,489	$11,475	$11,475	$6,455	$28,400	$36,432	$35,858	$8,606	$189,189
26	$52,003	$11,819	$11,819	$6,648	$29,252	$37,525	$36,934	$8,864	$194,865
27	$53,564	$12,174	$12,174	$6,848	$30,129	$38,651	$38,042	$9,130	$200,711
28	$55,170	$12,539	$12,539	$7,053	$31,033	$39,810	$39,184	$9,404	$206,732
29	$56,826	$12,915	$12,915	$7,265	$31,964	$41,005	$40,359	$9,686	$212,934
30	$58,530	$13,302	$13,302	$7,483	$32,923	$42,235	$41,570	$9,977	$219,322
Total	**$1,181,636**	**$268,554**	**$268,554**	**$151,061**	**$664,670**	**$852,658**	**$839,230**	**$201,415**	**$4,427,779**
**3% Inflation*									

6. Cropland BMP implementation: Costs after cost-share

HUC 104 Annual Cost* After Cost-Share, Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Cost
1	$9,191	$2,089	$2,089	$1,175	$5,170	$6,632	$6,528	$1,567	$34,442
2	$9,467	$2,152	$2,152	$1,210	$5,325	$6,831	$6,724	$1,614	$35,475
3	$9,751	$2,216	$2,216	$1,247	$5,485	$7,036	$6,926	$1,662	$36,539
4	$10,044	$2,283	$2,283	$1,284	$5,650	$7,247	$7,133	$1,712	$37,635
5	$10,345	$2,351	$2,351	$1,323	$5,819	$7,465	$7,347	$1,763	$38,764
6	$10,655	$2,422	$2,422	$1,362	$5,994	$7,689	$7,568	$1,816	$39,927
7	$10,975	$2,494	$2,494	$1,403	$6,173	$7,919	$7,795	$1,871	$41,125
8	$11,304	$2,569	$2,569	$1,445	$6,359	$8,157	$8,029	$1,927	$42,359
9	$11,643	$2,646	$2,646	$1,489	$6,549	$8,402	$8,269	$1,985	$43,630
10	$11,993	$2,726	$2,726	$1,533	$6,746	$8,654	$8,518	$2,044	$44,939
11	$12,353	$2,807	$2,807	$1,579	$6,948	$8,913	$8,773	$2,106	$46,287
12	$12,723	$2,892	$2,892	$1,627	$7,157	$9,181	$9,036	$2,169	$47,675
13	$13,105	$2,978	$2,978	$1,675	$7,371	$9,456	$9,307	$2,234	$49,106
14	$13,498	$3,068	$3,068	$1,726	$7,593	$9,740	$9,587	$2,301	$50,579
15	$13,903	$3,160	$3,160	$1,777	$7,820	$10,032	$9,874	$2,370	$52,096
16	$14,320	$3,255	$3,255	$1,831	$8,055	$10,333	$10,170	$2,441	$53,659
17	$14,750	$3,352	$3,352	$1,886	$8,297	$10,643	$10,476	$2,514	$55,269
18	$15,192	$3,453	$3,453	$1,942	$8,546	$10,962	$10,790	$2,590	$56,927
19	$15,648	$3,556	$3,556	$2,000	$8,802	$11,291	$11,113	$2,667	$58,635
20	$16,117	$3,663	$3,663	$2,060	$9,066	$11,630	$11,447	$2,747	$60,394
21	$16,601	$3,773	$3,773	$2,122	$9,338	$11,979	$11,790	$2,830	$62,206
22	$17,099	$3,886	$3,886	$2,186	$9,618	$12,338	$12,144	$2,915	$64,072
23	$17,612	$4,003	$4,003	$2,251	$9,907	$12,708	$12,508	$3,002	$65,994
24	$18,140	$4,123	$4,123	$2,319	$10,204	$13,090	$12,884	$3,092	$67,974
25	$18,684	$4,246	$4,246	$2,389	$10,510	$13,482	$13,270	$3,185	$70,013
26	$19,245	$4,374	$4,374	$2,460	$10,825	$13,887	$13,668	$3,280	$72,113
27	$19,822	$4,505	$4,505	$2,534	$11,150	$14,303	$14,078	$3,379	$74,277
28	$20,417	$4,640	$4,640	$2,610	$11,484	$14,733	$14,501	$3,480	$76,505
29	$21,029	$4,779	$4,779	$2,688	$11,829	$15,175	$14,936	$3,585	$78,800
30	$21,660	$4,923	$4,923	$2,769	$12,184	$15,630	$15,384	$3,692	$81,164
Total	**$437,286**	**$99,383**	**$99,383**	**$55,903**	**$245,973**	**$315,541**	**$310,572**	**$74,537**	**$1,638,580**
**3% Inflation*									

HUC 105 Annual Cost* After Cost-Share, Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Cost
1	$10,312	$2,344	$2,344	$1,318	$5,801	$7,441	$7,324	$1,758	$38,641
2	$10,622	$2,414	$2,414	$1,358	$5,975	$7,664	$7,544	$1,810	$39,801
3	$10,940	$2,486	$2,486	$1,399	$6,154	$7,894	$7,770	$1,865	$40,995
4	$11,268	$2,561	$2,561	$1,441	$6,338	$8,131	$8,003	$1,921	$42,225
5	$11,606	$2,638	$2,638	$1,484	$6,529	$8,375	$8,243	$1,978	$43,491
6	$11,955	$2,717	$2,717	$1,528	$6,724	$8,626	$8,491	$2,038	$44,796
7	$12,313	$2,798	$2,798	$1,574	$6,926	$8,885	$8,745	$2,099	$46,140
8	$12,683	$2,882	$2,882	$1,621	$7,134	$9,152	$9,008	$2,162	$47,524
9	$13,063	$2,969	$2,969	$1,670	$7,348	$9,426	$9,278	$2,227	$48,950
10	$13,455	$3,058	$3,058	$1,720	$7,568	$9,709	$9,556	$2,293	$50,418
11	$13,859	$3,150	$3,150	$1,772	$7,796	$10,000	$9,843	$2,362	$51,931
12	$14,274	$3,244	$3,244	$1,825	$8,029	$10,300	$10,138	$2,433	$53,489
13	$14,703	$3,342	$3,342	$1,880	$8,270	$10,609	$10,442	$2,506	$55,093
14	$15,144	$3,442	$3,442	$1,936	$8,518	$10,928	$10,756	$2,581	$56,746
15	$15,598	$3,545	$3,545	$1,994	$8,774	$11,255	$11,078	$2,659	$58,449
16	$16,066	$3,651	$3,651	$2,054	$9,037	$11,593	$11,411	$2,739	$60,202
17	$16,548	$3,761	$3,761	$2,116	$9,308	$11,941	$11,753	$2,821	$62,008
18	$17,044	$3,874	$3,874	$2,179	$9,588	$12,299	$12,105	$2,905	$63,868
19	$17,556	$3,990	$3,990	$2,244	$9,875	$12,668	$12,469	$2,992	$65,784
20	$18,082	$4,110	$4,110	$2,312	$10,171	$13,048	$12,843	$3,082	$67,758
21	$18,625	$4,233	$4,233	$2,381	$10,477	$13,440	$13,228	$3,175	$69,791
22	$19,184	$4,360	$4,360	$2,452	$10,791	$13,843	$13,625	$3,270	$71,884
23	$19,759	$4,491	$4,491	$2,526	$11,115	$14,258	$14,034	$3,368	$74,041
24	$20,352	$4,625	$4,625	$2,602	$11,448	$14,686	$14,455	$3,469	$76,262
25	$20,963	$4,764	$4,764	$2,680	$11,791	$15,126	$14,888	$3,573	$78,550
26	$21,591	$4,907	$4,907	$2,760	$12,145	$15,580	$15,335	$3,680	$80,907
27	$22,239	$5,054	$5,054	$2,843	$12,510	$16,048	$15,795	$3,791	$83,334
28	$22,906	$5,206	$5,206	$2,928	$12,885	$16,529	$16,269	$3,904	$85,834
29	$23,594	$5,362	$5,362	$3,016	$13,271	$17,025	$16,757	$4,022	$88,409
30	$24,301	$5,523	$5,523	$3,107	$13,670	$17,536	$17,259	$4,142	$91,061
Total	**$490,607**	**$111,502**	**$111,502**	**$62,720**	**$275,966**	**$354,017**	**$348,442**	**$83,626**	**$1,838,382**
**3% Inflation*									

HUC 106 Annual Cost* After Cost-Share, Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Cost
1	$3,189	$725	$725	$408	$1,794	$2,301	$2,265	$544	$11,950
2	$3,285	$747	$747	$420	$1,848	$2,370	$2,333	$560	$12,309
3	$3,383	$769	$769	$433	$1,903	$2,441	$2,403	$577	$12,678
4	$3,485	$792	$792	$446	$1,960	$2,515	$2,475	$594	$13,058
5	$3,589	$816	$816	$459	$2,019	$2,590	$2,549	$612	$13,450
6	$3,697	$840	$840	$473	$2,080	$2,668	$2,626	$630	$13,853
7	$3,808	$865	$865	$487	$2,142	$2,748	$2,705	$649	$14,269
8	$3,922	$891	$891	$501	$2,206	$2,830	$2,786	$669	$14,697
9	$4,040	$918	$918	$516	$2,272	$2,915	$2,869	$689	$15,138
10	$4,161	$946	$946	$532	$2,341	$3,003	$2,955	$709	$15,592
11	$4,286	$974	$974	$548	$2,411	$3,093	$3,044	$731	$16,060
12	$4,414	$1,003	$1,003	$564	$2,483	$3,185	$3,135	$752	$16,542
13	$4,547	$1,033	$1,033	$581	$2,558	$3,281	$3,229	$775	$17,038
14	$4,683	$1,064	$1,064	$599	$2,634	$3,379	$3,326	$798	$17,549
15	$4,824	$1,096	$1,096	$617	$2,713	$3,481	$3,426	$822	$18,076
16	$4,969	$1,129	$1,129	$635	$2,795	$3,585	$3,529	$847	$18,618
17	$5,118	$1,163	$1,163	$654	$2,879	$3,693	$3,635	$872	$19,176
18	$5,271	$1,198	$1,198	$674	$2,965	$3,804	$3,744	$898	$19,752
19	$5,429	$1,234	$1,234	$694	$3,054	$3,918	$3,856	$925	$20,344
20	$5,592	$1,271	$1,271	$715	$3,146	$4,035	$3,972	$953	$20,955
21	$5,760	$1,309	$1,309	$736	$3,240	$4,156	$4,091	$982	$21,583
22	$5,933	$1,348	$1,348	$758	$3,337	$4,281	$4,214	$1,011	$22,231
23	$6,111	$1,389	$1,389	$781	$3,437	$4,409	$4,340	$1,042	$22,898
24	$6,294	$1,430	$1,430	$805	$3,540	$4,542	$4,470	$1,073	$23,585
25	$6,483	$1,473	$1,473	$829	$3,647	$4,678	$4,604	$1,105	$24,292
26	$6,677	$1,518	$1,518	$854	$3,756	$4,818	$4,742	$1,138	$25,021
27	$6,878	$1,563	$1,563	$879	$3,869	$4,963	$4,885	$1,172	$25,772
28	$7,084	$1,610	$1,610	$906	$3,985	$5,112	$5,031	$1,207	$26,545
29	$7,296	$1,658	$1,658	$933	$4,104	$5,265	$5,182	$1,244	$27,341
30	$7,515	$1,708	$1,708	$961	$4,227	$5,423	$5,338	$1,281	$28,161
Total	**$151,724**	**$34,483**	**$34,483**	**$19,396**	**$85,345**	**$109,482**	**$107,758**	**$25,862**	**$568,533**
**3% Inflation*									

HUC 107 Annual Cost* After Cost-Share, Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Cost
1	$8,386	$1,906	$1,906	$1,072	$4,717	$6,051	$5,956	$1,429	$31,424
2	$8,638	$1,963	$1,963	$1,104	$4,859	$6,233	$6,135	$1,472	$32,367
3	$8,897	$2,022	$2,022	$1,137	$5,004	$6,420	$6,319	$1,516	$33,338
4	$9,164	$2,083	$2,083	$1,171	$5,155	$6,612	$6,508	$1,562	$34,338
5	$9,439	$2,145	$2,145	$1,207	$5,309	$6,811	$6,704	$1,609	$35,368
6	$9,722	$2,209	$2,209	$1,243	$5,468	$7,015	$6,905	$1,657	$36,429
7	$10,013	$2,276	$2,276	$1,280	$5,633	$7,226	$7,112	$1,707	$37,522
8	$10,314	$2,344	$2,344	$1,319	$5,802	$7,442	$7,325	$1,758	$38,647
9	$10,623	$2,414	$2,414	$1,358	$5,976	$7,666	$7,545	$1,811	$39,807
10	$10,942	$2,487	$2,487	$1,399	$6,155	$7,896	$7,771	$1,865	$41,001
11	$11,270	$2,561	$2,561	$1,441	$6,339	$8,132	$8,004	$1,921	$42,231
12	$11,608	$2,638	$2,638	$1,484	$6,530	$8,376	$8,244	$1,979	$43,498
13	$11,956	$2,717	$2,717	$1,529	$6,726	$8,628	$8,492	$2,038	$44,803
14	$12,315	$2,799	$2,799	$1,574	$6,927	$8,887	$8,747	$2,099	$46,147
15	$12,685	$2,883	$2,883	$1,622	$7,135	$9,153	$9,009	$2,162	$47,531
16	$13,065	$2,969	$2,969	$1,670	$7,349	$9,428	$9,279	$2,227	$48,957
17	$13,457	$3,058	$3,058	$1,720	$7,570	$9,711	$9,558	$2,294	$50,426
18	$13,861	$3,150	$3,150	$1,772	$7,797	$10,002	$9,844	$2,363	$51,939
19	$14,277	$3,245	$3,245	$1,825	$8,031	$10,302	$10,140	$2,434	$53,497
20	$14,705	$3,342	$3,342	$1,880	$8,272	$10,611	$10,444	$2,507	$55,102
21	$15,146	$3,442	$3,442	$1,936	$8,520	$10,929	$10,757	$2,582	$56,755
22	$15,601	$3,546	$3,546	$1,994	$8,775	$11,257	$11,080	$2,659	$58,458
23	$16,069	$3,652	$3,652	$2,054	$9,039	$11,595	$11,412	$2,739	$60,211
24	$16,551	$3,761	$3,761	$2,116	$9,310	$11,943	$11,755	$2,821	$62,018
25	$17,047	$3,874	$3,874	$2,179	$9,589	$12,301	$12,107	$2,906	$63,878
26	$17,559	$3,991	$3,991	$2,245	$9,877	$12,670	$12,471	$2,993	$65,795
27	$18,085	$4,110	$4,110	$2,312	$10,173	$13,050	$12,845	$3,083	$67,768
28	$18,628	$4,234	$4,234	$2,381	$10,478	$13,442	$13,230	$3,175	$69,801
29	$19,187	$4,361	$4,361	$2,453	$10,793	$13,845	$13,627	$3,270	$71,896
30	$19,762	$4,491	$4,491	$2,526	$11,116	$14,260	$14,036	$3,369	$74,052
Total	**$398,970**	**$90,675**	**$90,675**	**$51,005**	**$224,420**	**$287,893**	**$283,359**	**$68,006**	**$1,495,003**
**3% Inflation*									

HUC 108 Annual Cost* After Cost-Share, Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Cost
1	$6,587	$1,497	$1,497	$842	$3,705	$4,753	$4,678	$1,123	$24,681
2	$6,784	$1,542	$1,542	$867	$3,816	$4,895	$4,818	$1,156	$25,422
3	$6,988	$1,588	$1,588	$893	$3,931	$5,042	$4,963	$1,191	$26,184
4	$7,197	$1,636	$1,636	$920	$4,049	$5,194	$5,112	$1,227	$26,970
5	$7,413	$1,685	$1,685	$948	$4,170	$5,349	$5,265	$1,264	$27,779
6	$7,636	$1,735	$1,735	$976	$4,295	$5,510	$5,423	$1,302	$28,612
7	$7,865	$1,787	$1,787	$1,005	$4,424	$5,675	$5,586	$1,341	$29,471
8	$8,101	$1,841	$1,841	$1,036	$4,557	$5,845	$5,753	$1,381	$30,355
9	$8,344	$1,896	$1,896	$1,067	$4,693	$6,021	$5,926	$1,422	$31,265
10	$8,594	$1,953	$1,953	$1,099	$4,834	$6,201	$6,104	$1,465	$32,203
11	$8,852	$2,012	$2,012	$1,132	$4,979	$6,387	$6,287	$1,509	$33,169
12	$9,117	$2,072	$2,072	$1,166	$5,129	$6,579	$6,475	$1,554	$34,164
13	$9,391	$2,134	$2,134	$1,201	$5,282	$6,776	$6,670	$1,601	$35,189
14	$9,673	$2,198	$2,198	$1,237	$5,441	$6,980	$6,870	$1,649	$36,245
15	$9,963	$2,264	$2,264	$1,274	$5,604	$7,189	$7,076	$1,698	$37,332
16	$10,262	$2,332	$2,332	$1,312	$5,772	$7,405	$7,288	$1,749	$38,452
17	$10,570	$2,402	$2,402	$1,351	$5,945	$7,627	$7,507	$1,802	$39,606
18	$10,887	$2,474	$2,474	$1,392	$6,124	$7,856	$7,732	$1,856	$40,794
19	$11,213	$2,548	$2,548	$1,434	$6,307	$8,091	$7,964	$1,911	$42,018
20	$11,550	$2,625	$2,625	$1,477	$6,497	$8,334	$8,203	$1,969	$43,279
21	$11,896	$2,704	$2,704	$1,521	$6,692	$8,584	$8,449	$2,028	$44,577
22	$12,253	$2,785	$2,785	$1,566	$6,892	$8,842	$8,702	$2,089	$45,914
23	$12,621	$2,868	$2,868	$1,613	$7,099	$9,107	$8,964	$2,151	$47,292
24	$12,999	$2,954	$2,954	$1,662	$7,312	$9,380	$9,232	$2,216	$48,710
25	$13,389	$3,043	$3,043	$1,712	$7,531	$9,662	$9,509	$2,282	$50,172
26	$13,791	$3,134	$3,134	$1,763	$7,757	$9,951	$9,795	$2,351	$51,677
27	$14,205	$3,228	$3,228	$1,816	$7,990	$10,250	$10,089	$2,421	$53,227
28	$14,631	$3,325	$3,325	$1,870	$8,230	$10,557	$10,391	$2,494	$54,824
29	$15,070	$3,425	$3,425	$1,927	$8,477	$10,874	$10,703	$2,569	$56,469
30	$15,522	$3,528	$3,528	$1,984	$8,731	$11,200	$11,024	$2,646	$58,163
Total	**$313,361**	**$71,218**	**$71,218**	**$40,060**	**$176,266**	**$226,119**	**$222,558**	**$53,414**	**$1,174,215**

**3% Inflation*

Riparian Annual Cost* After Cost-Share, Cropland BMPs									
Year	Buffers	Cover Crop	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Wetlands	Total Cost
1	$7,451	$1,693	$1,693	$953	$4,191	$5,377	$5,292	$1,270	$27,921
2	$7,675	$1,744	$1,744	$981	$4,317	$5,538	$5,451	$1,308	$28,758
3	$7,905	$1,797	$1,797	$1,011	$4,447	$5,704	$5,614	$1,347	$29,621
4	$8,142	$1,850	$1,850	$1,041	$4,580	$5,875	$5,783	$1,388	$30,510
5	$8,386	$1,906	$1,906	$1,072	$4,717	$6,051	$5,956	$1,429	$31,425
6	$8,638	$1,963	$1,963	$1,104	$4,859	$6,233	$6,135	$1,472	$32,368
7	$8,897	$2,022	$2,022	$1,137	$5,005	$6,420	$6,319	$1,517	$33,339
8	$9,164	$2,083	$2,083	$1,172	$5,155	$6,613	$6,508	$1,562	$34,339
9	$9,439	$2,145	$2,145	$1,207	$5,309	$6,811	$6,704	$1,609	$35,369
10	$9,722	$2,210	$2,210	$1,243	$5,469	$7,015	$6,905	$1,657	$36,430
11	$10,014	$2,276	$2,276	$1,280	$5,633	$7,226	$7,112	$1,707	$37,523
12	$10,314	$2,344	$2,344	$1,319	$5,802	$7,443	$7,325	$1,758	$38,649
13	$10,624	$2,414	$2,414	$1,358	$5,976	$7,666	$7,545	$1,811	$39,808
14	$10,942	$2,487	$2,487	$1,399	$6,155	$7,896	$7,771	$1,865	$41,002
15	$11,271	$2,561	$2,561	$1,441	$6,340	$8,133	$8,005	$1,921	$42,232
16	$11,609	$2,638	$2,638	$1,484	$6,530	$8,377	$8,245	$1,979	$43,499
17	$11,957	$2,717	$2,717	$1,529	$6,726	$8,628	$8,492	$2,038	$44,804
18	$12,316	$2,799	$2,799	$1,574	$6,928	$8,887	$8,747	$2,099	$46,148
19	$12,685	$2,883	$2,883	$1,622	$7,135	$9,153	$9,009	$2,162	$47,533
20	$13,066	$2,969	$2,969	$1,670	$7,349	$9,428	$9,280	$2,227	$48,959
21	$13,458	$3,059	$3,059	$1,720	$7,570	$9,711	$9,558	$2,294	$50,428
22	$13,861	$3,150	$3,150	$1,772	$7,797	$10,002	$9,845	$2,363	$51,941
23	$14,277	$3,245	$3,245	$1,825	$8,031	$10,302	$10,140	$2,434	$53,499
24	$14,705	$3,342	$3,342	$1,880	$8,272	$10,611	$10,444	$2,507	$55,104
25	$15,147	$3,442	$3,442	$1,936	$8,520	$10,930	$10,758	$2,582	$56,757
26	$15,601	$3,546	$3,546	$1,994	$8,776	$11,258	$11,080	$2,659	$58,460
27	$16,069	$3,652	$3,652	$2,054	$9,039	$11,595	$11,413	$2,739	$60,213
28	$16,551	$3,762	$3,762	$2,116	$9,310	$11,943	$11,755	$2,821	$62,020
29	$17,048	$3,874	$3,874	$2,179	$9,589	$12,301	$12,108	$2,906	$63,880
30	$17,559	$3,991	$3,991	$2,245	$9,877	$12,670	$12,471	$2,993	$65,797
Total	**$354,491**	**$80,566**	**$80,566**	**$45,318**	**$199,401**	**$255,797**	**$251,769**	**$60,425**	**$1,328,334**
**3% Inflation*									