Twin Lakes Watershed Restoration and Protection Strategies (WRAPS) Plan

2019

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KCARE
Kansas Center for Agricultural Resources and the Environment

Kansas
Department of Health and Environment

Twin Lakes WRAPS Project

K-STATE
Research and Extension

Twin Lakes Watershed
Project Leadership Team

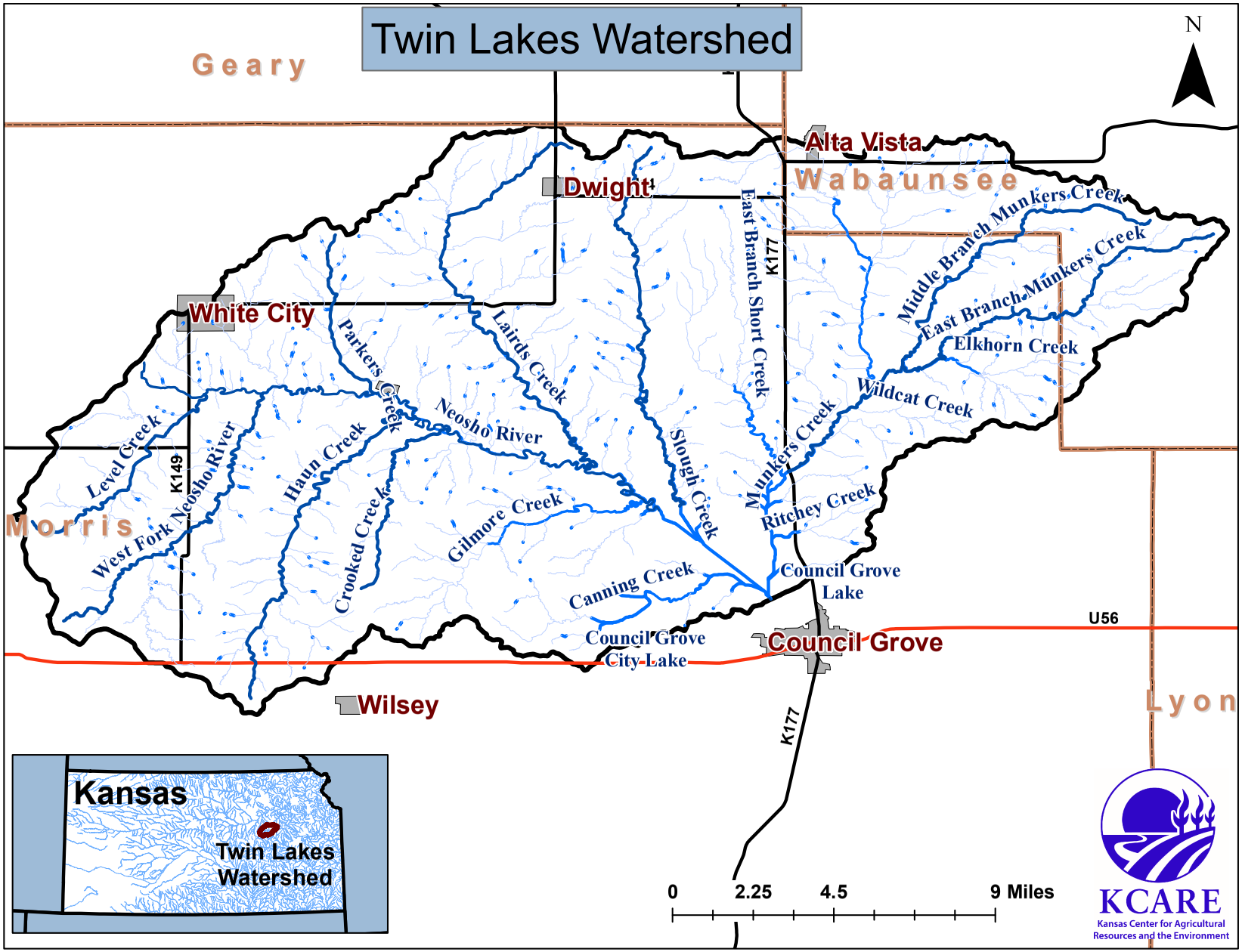
Twin Lakes Watershed WRAPS
Angela Anderson, Project Coordinator
Morris County Conservation District

Stakeholder Leadership Team
As of January 2020, there are 60 members on the Twin Lakes Watershed SLT.

Kansas State University
Jeff Davidson, Flint Hills Watershed Specialist
Susan Brown, Kansas Center for Agricultural Resources and the Environment (KCARE)
Amanda Schielke, KCARE
Melissa Harvey, KCARE

Kansas Department of Health and Environment
Katie Basiotis, Watershed Management Section, Project Officer

Additional Technical Assistance
County Conservation Districts in the Twin Lakes Watershed
Kansas Department of Health and Environment
Kansas Department of Wildlife, Parks and Tourism
Natural Resources Conservation Service


Twin Lakes Watershed
N
Geary
Alta Vista
Wabaunsee
Dwight
East Branch Short Creek
K177
Middle Branch Munkers Creek
East Branch Munkers Creek
Elkhorn Creek
Wildcat Creek
White City
Parkers Creek
Lairds Creek
Neosho River
Level Creek
K149
West Fork Neosho River
Haun Creek
Crooked Creek
Gilmore Creek
Slough Creek
Munkers Creek
Ritchey Creek
Morris
Canning Creek
Council Grove Lake
Council Grove City Lake
U56
Council Grove
Wilsey
K177
Lyon
Kansas
Twin Lakes Watershed
0
2.25
4.5
9 Miles
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Glossary of Terms and Acronyms

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

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

Biota: Plant and animal life of a particular region.

Chlorophyll *a*: Common pigment 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 Research and Extension

Municipal water system: A water system having at least 10 service connections or regularly serving an average of at least 25 individuals daily at least 60 days out of the year.

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

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 that, in excess, can lead to increased biological activity which may cause eutrophication.

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

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

Phosphorus (P): Element essential for plant growth. When found in excess in water, P 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.

RAC: Regional Advisory Committee. There are 14 RACs in Kansas, which establish priority goals for their region.

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 **Twin Lakes 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 requiring protection from future degradation.

In the WRAPS process, local communities and government agencies work together toward the common goal of a healthy environment. Local participants, or stakeholders, provide valuable grassroots leadership, responsibility, and resource management in this process. Because they have the most at stake, these community members work together to ensure that their lands' water quality is protected. Agencies bring to the table science-based information, communication, and technical and financial assistance. By working as a WRAPS team, communities can take several steps toward watershed restoration and protection. Within the watershed, the team works 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.

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 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 Twin Lakes Watershed.

Plan Update: The original Twin Lakes Watershed WRAPS plan was written and approved in 2012. However, a TMDL revision by the Kansas Department of Health and Environment (KDHE) resulted in outdated WRAPS plan implementation goals. Therefore, the Twin Lakes Watershed WRAPS plan was updated and revised in late 2019 by Kansas State University staff and KDHE, with the guidance of the Twin Lakes Watershed WRAPS Coordinator and SLT.

Note: Tables throughout this plan use rounded figures.

2. Twin Lakes Watershed 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 specifics of the Twin Lakes 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).

Kansas contends that restoring damage to a watershed is not enough because that addresses only part of the need; action to protect water is a necessity, hence the new term **WRAPS**. Historically, "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 and EPA Section 319 funds to address Total Maximum Daily Loads (TMDLs) and related water quality concerns.

The WRAPS initiative intends 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 river basins in Kansas. The scope of this WRAPS plan will focus on the Twin Lakes Watershed, located in the northernmost portion of the Neosho Basin (**Figure 1**). This basin drains the Neosho River and its tributaries into Oklahoma and eventually empties into the Gulf of Mexico.

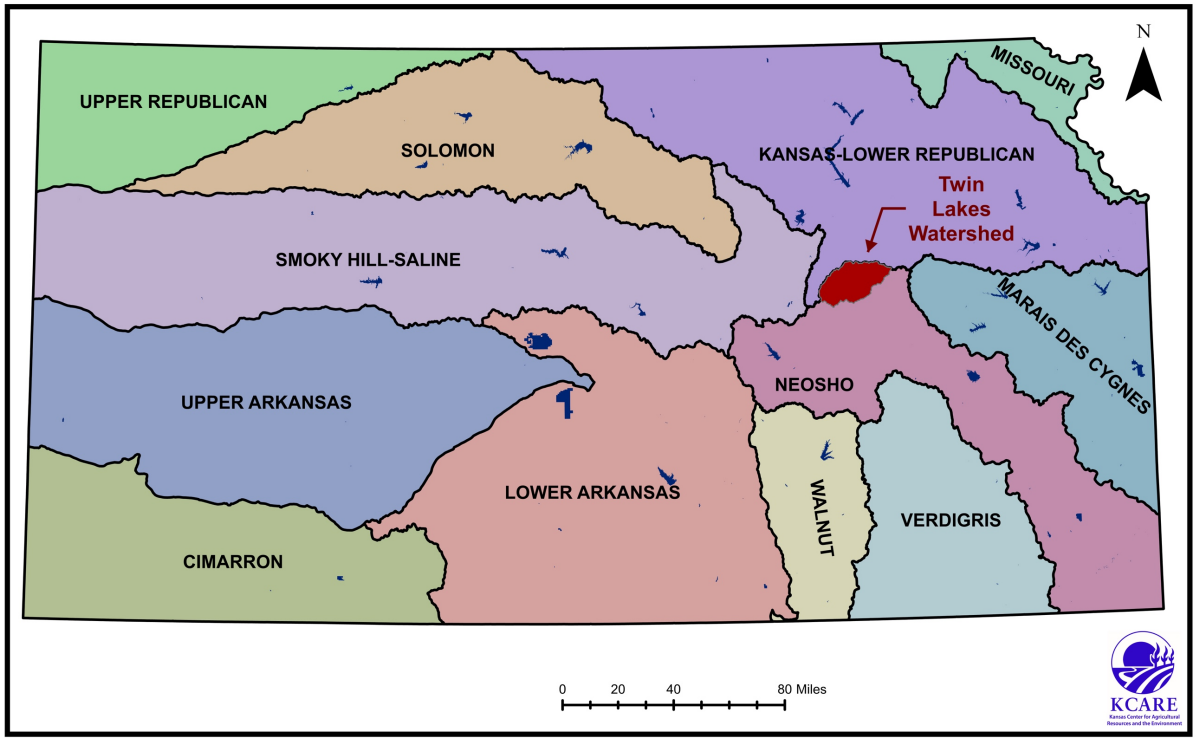


Figure 1. The 12 River Basins of Kansas, Highlighting the Twin Lakes Watershed

The Twin Lakes Watershed is located in northeastern Kansas and overlays portions of two counties. The majority of the Twin Lakes Watershed is in Morris County, with a small portion in southwestern Wabaunsee County. The Twin Lakes Watershed also has been referred to as the "Council Grove Watershed" due to its proximity to Council Grove and the fact that its drainage area is right above the city (**Figure 2**).

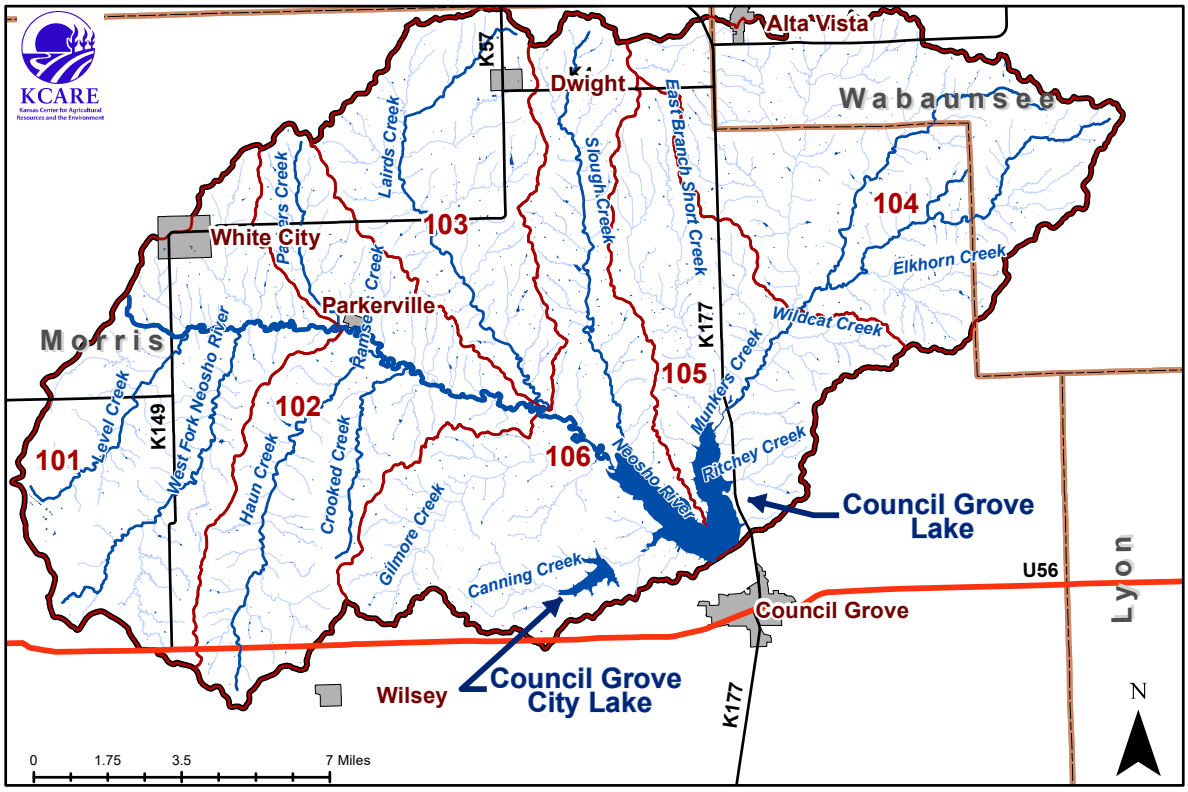


Figure 2. Twin Lakes Watershed

D. Overview of the Twin Lakes Watershed

The Twin Lakes Watershed covers 167,297 acres, which equates to 261 square miles. Twin Lakes is the name used to describe the watershed as it houses two reservoirs that lie in the headwater of the Neosho River: Council Grove *City* Lake and Council Grove Lake. For the purpose of this plan, we will refer to them as lakes even though they were built as reservoirs.

Council Grove City Lake was constructed in 1942 as the primary water supply for the City of Council Grove. This 434-acre, multi-use lake, is located 3.5 miles northwest of Council Grove and is surrounded by homes and cabins. Council Grove City Lake is not the focus of this WRAPS plan.

The construction of Council Grove Lake was authorized by the Flood Control Act of 1950 at a cost of $11.5 million. Construction began in 1962, and the lake was placed in full flood control operation in 1964. The lake is located 36 miles south of Manhattan and just a half mile north of Council Grove in Morris County. The size of Council Grove Lake is 2,589 acres.

The Kansas Department of Wildlife, Parks and Tourism (KDWPT) oversees approximately 2,000 acres of land around the northern end of Council Grove Lake, referred to as the Council Grove Wildlife Area. The U.S. Army Corps of Engineers (USACE), Tulsa District, manages the lake and its eight parks: on the southwest shore are Canning Creek Cove, Santa Fe Trail, Marina Cove, and Neosho Park. Custer Park, Kit Carson Cove, Richey Cove, and Kansa View are located on the eastern shore. All eight parks include campgrounds, and seven (excluding

Kansa View) include boat ramps. Canning Creek Cove, Neosho Park, and Richey Cove have hiking trails while the lake's one swimming beach is located at Richey Cove.

Although it began as a flood control project, Council Grove Lake is relied on heavily for many other reasons. A portion of the lake's storage is held in reserve as a water source for Council Grove, Emporia, and Iola; this storage can be obtained for use through releases to the Neosho River. The lake also is a popular recreation spot for visitors from all over the country. Council Grove Lake and its surrounding public and private lands have become important aquatic and terrestrial wildlife habitat which means that protecting and restoring this water body is significant both ecologically and economically.

Restoration of the water quality in Council Grove Lake and its tributaries will be the focus of this WRAPS plan.

E. Elevation of the Twin Lakes Watershed

Elevation determines watershed boundaries. As shown in **Figure 3**, the upper boundary of the Twin Lakes Watershed has an elevation of 1,446 feet, and the lowest point of the watershed has an elevation of 1,282 feet.

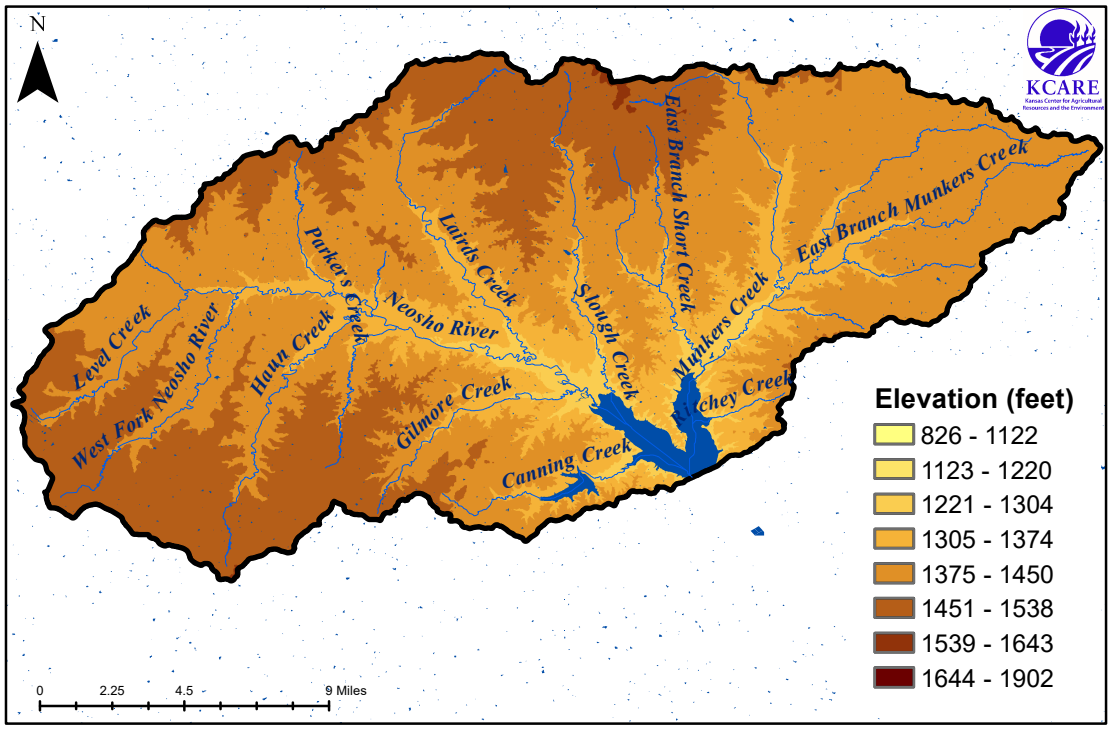


Figure 3. Elevation Relief Map of the Twin Lakes Watershed

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 Twin Lakes Watershed is located in the Neosho Basin which is home to seven HUC 8 (meaning an 8-digit identifier code) classifications. The Twin Lakes Watershed is part of the Neosho Headwaters HUC 8 (11070201). 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:

- **11**070201: Region drainage of the Arkansas, White, and Red River Basins above the points of highest backwater effect of the Mississippi River (Area = 226,630 sq. miles)
- 11**07**0201: Sub-region drainage of the Neosho and Verdigris River Basins in Arkansas, Kansas, Missouri and Oklahoma (Area = 20,500 sq. miles)
- 1107**02**01: Accounting unit drainage of the Neosho River Basin in Arkansas, Kansas Missouri and Oklahoma (Area = 12,400 sq. miles)
- 110702**01**: Cataloging unit drainage of the section of the Neosho River Headwaters in Kansas (Area = 1,110 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, and HUC 10 watersheds can be divided into smaller HUC 12 watersheds. The Twin Lakes Watershed consists of the HUC 10-numbered 1107020101, indicating the drainage area of Council Grove Lake. The Twin Lakes Watershed can be divided further into six HUC 12 delineations to include the following numbers: 110702010**101**, 110702010**102**, 110702010**103**, 110702010**104**, 110702010**105**, and 110702010**106** (**Figure 4**).

Targeting for BMP implementation within the Twin Lakes Watershed will be according to HUC 12 sub-watersheds. *Please note that maps throughout this plan will refer to these HUC 12s primarily by their last three digits.*

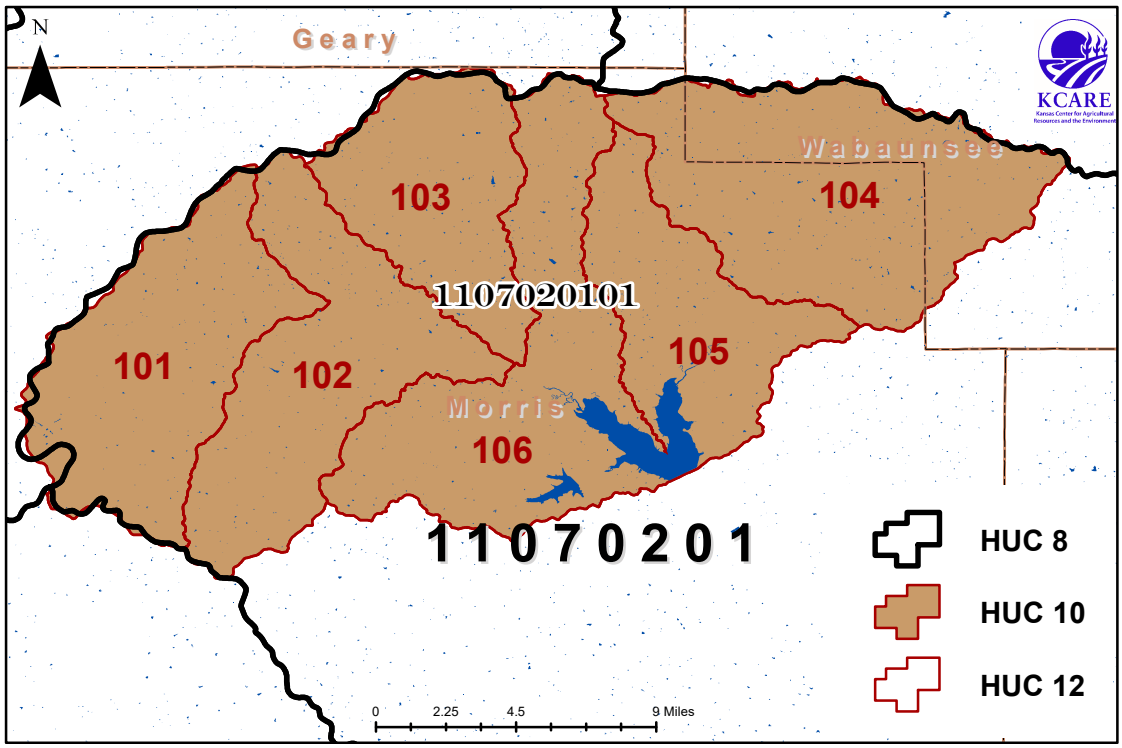


Figure 4. HUC 8, 10 and 12 Delineations in the Twin Lakes Watershed

G. Twin Lakes Watershed WRAPS History

According to the Kansas Unified Watershed Assessment prepared by KDHE and the NRCS (Natural Resources Conservation Service) in 1999, the Neosho Headwaters 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 Twin Lakes Watershed is part of the Neosho Headwaters, which ranked 38 out of 92 watersheds in Kansas for restoration priority.

H. Who Are the Stakeholders?

In 2005, the Flint Hills Resource Conservation and Development (RC&D) Council was contacted by the Morris County Conservation District and agreed to serve as the project sponsor for the Twin Lakes WRAPS program. The project sponsor hired a project manager and recruited a group of concerned citizens to establish a proactive and voluntary Stakeholder Leadership Team (SLT). This SLT includes landowners and agency personnel.

Although the SLT membership and the project manager have changed over the years, the goal of the Twin Lakes WRAPS group remains the same: to implement a 9-Element WRAPS plan and establishing concrete actions to improve and protect the water quality of Council Grove Lake and its tributaries. A 9-Element plan is a plan that contains the minimum elements that the EPA stipulates must be included in watershed plans that are developed and implemented

using section 319 funds. Those elements are: identifying sources of pollution, determining load reductions, developing management measures, identifying technical and financial assistance, developing information and education programs, developing an implementation schedule, developing milestones, creating criteria to measure progress, and developing a monitoring component. The Morris County Conservation District Board of Supervisors and staff members now serve as the project management team (PMT) and facilitate the SLT and the implementation of this plan.

The Twin Lakes WRAPS SLT membership includes representatives from the Morris County Conservation District, NRCS, Kansas State University Research and Extension, KDWPT, Army Corps of Engineers, Kansas Forest Service, Morris County Commissioners, KDHE, the Council Grove City Lake Association, local landowners, and members of the agricultural industry. Roughly half of the SLT members are local landowners and producers. Information about the current SLT is included at the beginning of this report.

The WRAPS Coordinator arranges a quarterly meeting with the SLT in order to assist the decision-making process. The current SLT keeps up-to-date on the issues within both the county and the watershed and seeks advice from landowners. Once a year, the coordinator and selected SLT members join the Morris County Conservation District board for an annual visit and presentation to the Morris County Commissioners. The Twin Lakes WRAPS has received funds from the County Commission in support of the Twin Lakes Water Festival as a result of these visits. The SLT and Coordinator update the county commissioners on projects in the watershed and funding amounts brought into the county through the WRAPS project.

The SLT submitted the original Twin Lakes WRAPS plan to KDHE in 2012.

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 Practices (BMP) implementation. The SLT has identified 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 ground water impairments.

The **watershed goals** of the Twin Lakes Watershed SLT are to:

- reduce the amount of nutrients flowing into Council Grove Lake;
- reduce the amount of sediment entering Council Grove Lake;
- reduce the amount of nutrients, specifically total phosphorus, sediment and copper in the Neosho River;
- protect and restore water quality throughout the watershed; and
- educate the watershed community about water quality practices and benefits.

Accomplishing these goals will involve both an educational component as well as the implementation of BMPs on both cropland and in livestock areas. Efforts will focus on targeted

areas in the Twin Lakes 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 the productivity of agricultural lands throughout the watershed, improve water quality in local streams and in Council Grove Lake, and help reduce other nonpoint source pollutants (such as nitrogen) from entering Council Grove Lake and degrading its water quality.

The **main pollutants** for the Twin Lakes Watershed are nutrients and sediment.

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 Twin Lakes Watershed is part of the **Neosho RAC**.[1] The Neosho RAC has developed five priority goals for the future of the Neosho River Basin, and these goals are aligned closely with the WRAPS process. Because only two of the five priority goals pertain to the Twin Lakes Watershed, they will be the only goals detailed in this plan.

Neosho RAC Goals:

1. Reduce vulnerability to drought by increasing the reservoir storage at Marion and Council Grove Lakes through a permanent raise in conservation pool elevation. By 2025, evaluate the feasibility of permanent conservation pool raise at Marion and Council Grove Lakes. Based on the outcome and findings of the feasibility study, stage increases in permanent pool elevation based on supply needs. Ensure water supply available from storage exceeds projected demand by at least 10% through the year 2050.

   To meet this goal, the Neosho RAC developed the following **Action Steps**:
   - The Kansas Water Office will continually work with the U.S. Army Corps of Engineers on refining reservoir operations and developing Drought Contingency Plans.
   - A working group will be created to provide input on the pool rises at Marion, Council Grove, and John Redmond Reservoirs. This group will include the KWO, KDWP&T, KDHE, NRCS, USACE, and USFW. The working group will look at costs associated with the pool raises and the benefits of increased supply.
   - Based on the input from the working group and the cost-benefit ratio analysis, the feasibility of the pool raises at Marion, Council Grove, and John Redmond Reservoirs will be determined by 2025. Based on that determination, a reallocation study may be implemented.

[1] Kansas Water Vision, Regional Goal Action Plans Section. http://kwo.ks.gov/docs/default-source/water-vision-water-plan/vision/rpt-vision-regional-goal-action-plans-section.pdf?sfvrsn=4, page 112.

2. Every five years assess the effectiveness of BMPs for effects on hydrology, reduction of sediment and nutrient, and provide that information and education to those implementing practices. Assessments may include off-stream storage for sediment and nutrient trapping, overland erosion and nutrient sequestration, in-reservoir sediment and nutrient movement and re-suspension, and a landscape-scale watershed modeling project.

   To meet this goal, the Neosho RAC developed the following **Action Step**:

   - This goal is met as the other goals' plans are implemented.

In summary, the Neosho RAC will work in cooperation and coordination with local WRAPS groups, conservation districts, producers and municipalities. Partnerships will implement goals by leveraging existing financial resources and finding new funding sources, implementing new conservation practices, and providing education and awareness of water quality and quantity issues in the watershed.

3. Watershed Review

This watershed review is an in-depth description of the Twin Lakes 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 waste water facilities.

A. Land Cover and Land Uses

Land use activities have a significant impact on the types and quantity of nutrient and sediment pollutants in the Twin Lakes Watershed. The three major land uses in this watershed are grassland (60%), cultivated crops (21%) and pasture/hay (8%). Grassland and pasture/hay land uses can often contribute livestock manure to streams and ponds, resulting in nutrient and bacteria runoff, in addition to sediment runoff from cattle trails and gullies in pastures. Cultivated crops (cropland) are the main source of sediment and nutrient runoff from overland flow. Nutrients leach into sediment during runoff events and are deposited in nearby streams and, eventually, the lake. In addition, 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. **Table 1** lists the remaining land uses in the watershed, including: deciduous forest (4%), developed/urban open space (4%), water (2%) and other (~ 1%). Properly managed forest/woodland with a good understory does not contribute much sediment or nutrients to the watershed. In fact, forest/woodlands located along rivers and streams provide a good buffer to prevent streambank erosion.

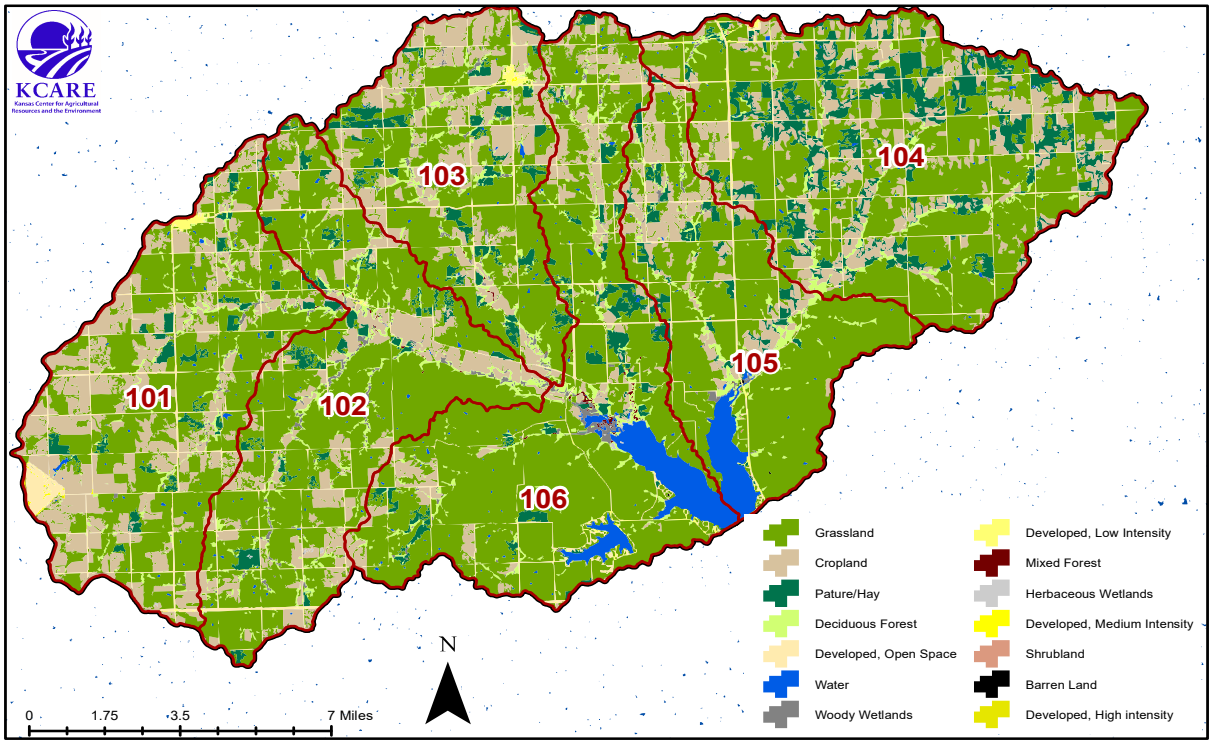


Figure 5. Land Cover and Land Use in the Twin Lakes Watershed

Table 1. Land Use in the Twin Lakes Watershed

Land Use in the Twin Lakes Watershed								
Land Use	Acres in HUC 12: 110702010...						Total Acres	% of Watershed
	101	102	103	104	105	106		
Grassland	14,820	18,522	10,263	20,275	13,446	22,724	100,050	59.8%
Cropland	9,368	5,401	5,752	7,875	3,083	3,611	35,090	21.0%
Pasture/Hay	1,151	1,203	1,667	5,831	1,081	1,723	12,656	7.6%
Dediduous Forest	812	1,447	987	946	969	1,471	6,632	4.0%
Developed, Open Space	1,461	889	735	1,474	597	1,064	6,220	3.7%
Water	135	116	80	91	1,286	2,379	4,087	2.4%
Woody Wetlands	175	418	243	48	172	388	1,444	0.9%
Developed, Low Intensity	233	37	119	153	83	137	762	0.5%
Mixed Forest	2	16	11	0	7	93	128	0.1%
Herbaceous Wetlands	11	20	12	6	8	36	93	0.1%
Developed, Medium Intensity	53	2	7	1	8	10	80	< 0.1%
Shrubland	1	4	1	12	22	2	42	< 0.1%
Barren Land	0	0	1	1	6	2	10	< 0.1%
Developed, High Intensity	3	0	0	0	0	0	4	< 0.1%
Total	**28,226**	**28,073**	**19,878**	**36,714**	**20,766**	**33,640**	**167,297**	**99.9%**

B. Designated Uses

The stream segments and lakes in the Twin Lakes 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 Twin Lakes Watershed include: aquatic life, contact recreational, domestic water supply use, food procurement, groundwater recharge, industrial water supply, irrigation, and livestock water. These "designated uses" are defined and assigned to specific water segments in the Kansas Surface Water Register, 2013, 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 Twin Lakes Watershed[2]

Designated Water Uses: Twin Lakes Watershed - 11070201								
Water Segment Name	**AL**	**CR**	**DS**	**FP**	**GR**	**IW**	**IR**	**LW**
Haun Creek, Munkers Creek, Munkers Creek - East Branch, Munkers Creek - Middle Branch	E	C	X	X	X	X	X	X
Lairds Creek, Level Creek, Neosho River - West Fork	E	b	X	X	X	X	X	X
Neosho River: above Council Grove Lake	E*	C*	X*	X*	X*	X*	X*	X*
Slough Creek	E	b	X	O	X	X	X	X
Council Grove Lake	E*	A*	X*	X*	X*	X*	X*	X*
Council Grove *City* Lake	E	A	X	X	X	X	X	X

*Waterbodies in bold will be directly affected by implementation of this 9-Element Watershed plan. *Asterisks refer to a violation of designated use and a TMDL has been written.*

C. Special Aquatic Life Use Waters[3]

Special Aquatic Life Use (SALU) waters are defined as "surface waters that contain combinations of habitat types and indigenous biota not found commonly in the state, or surface waters that contain representative populations of threatened or endangered species." The Twin Lakes Watershed does not have any SALU-listed waters.

D. Exceptional State Waters[3]

Exceptional State Waters (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 Twin Lakes Watershed.

E. Outstanding National Resource Waters[3]

Outstanding National Resource Waters (ONRW) are defined as "any of the surface waters or surface water segments of extraordinary recreational or ecological significance." The Twin Lakes Watershed does not contain 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

[2] Kansas Surface Water Register, 2013. Kansas Department of Health and Environment. https://www.epa.gov/sites/production/files/2014-12/documents/kswqs-register-2009.pdf, pages 28 and 61.
[3] KS Surface Water Quality Standards. For Special Aquatic Life Use Waters, K.A.R. 28-16-28d(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). http://www.kdheks.gov/tmdl/download/Unofficial_Copy_SURFACE_WATER_QUALITY_STANDARDS_04.11.18.pdf

cropland is either bare, or crop biomass is small; likewise, grasses are short and do not catch runoff. Both of these situations can lead to pollutants entering the waterways. The Twin Lakes Watershed averages 34.6 inches of rainfall annually (**Figure 7**). As shown in **Figure 6**, precipitation data from the city of Council Grove, which is just south of Council Grove Lake, were used to calculate the average annual rainfall in the watershed.

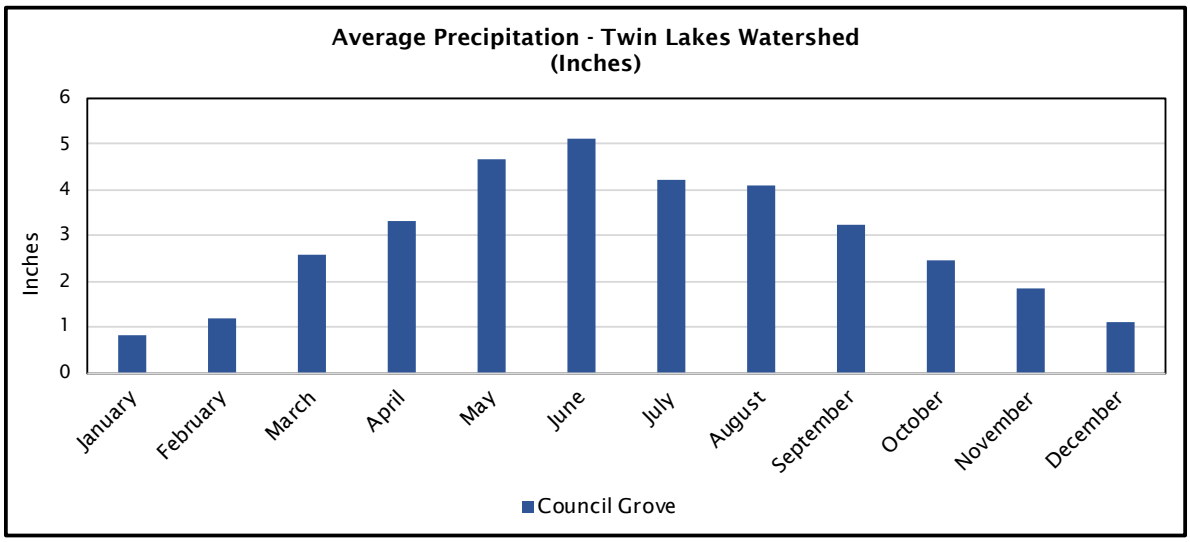


Figure 6. Twin Lakes Watershed Monthly Average Precipitation[4]

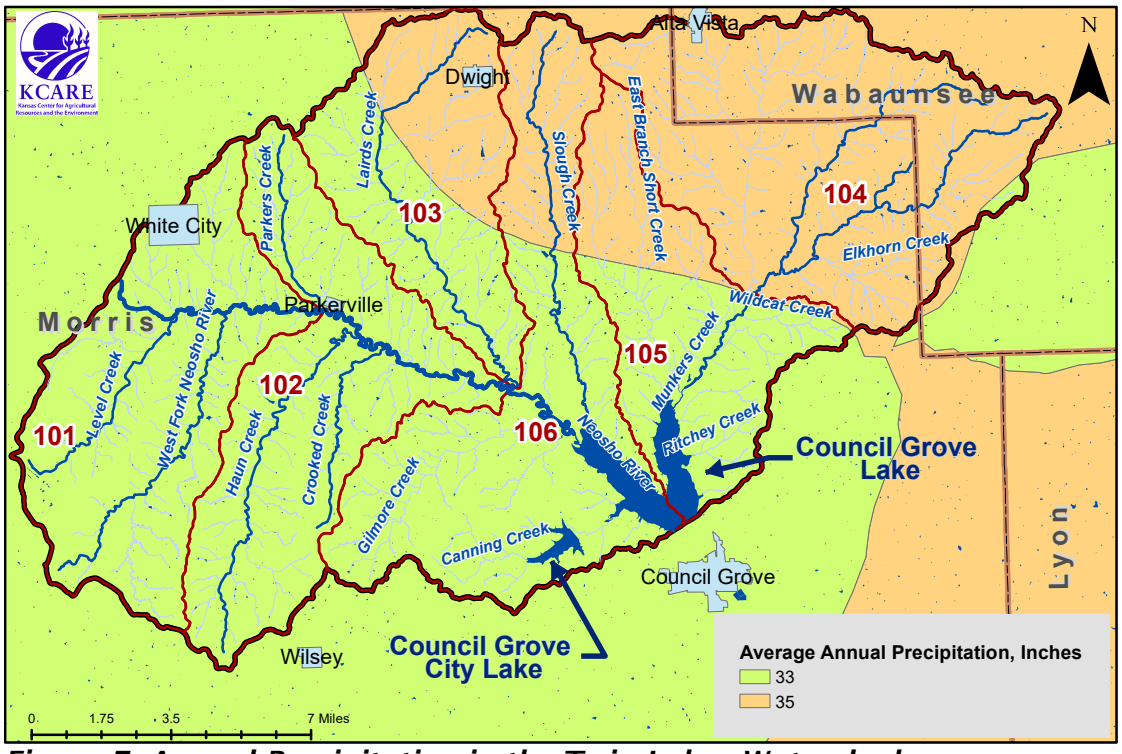


Figure 7. Annual Precipitation in the Twin Lakes Watershed

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

G. Population and Wastewater Systems

Most of the Twin Lakes Watershed is considered below-average population with no major urban areas located in the watershed (**Figure 8**).

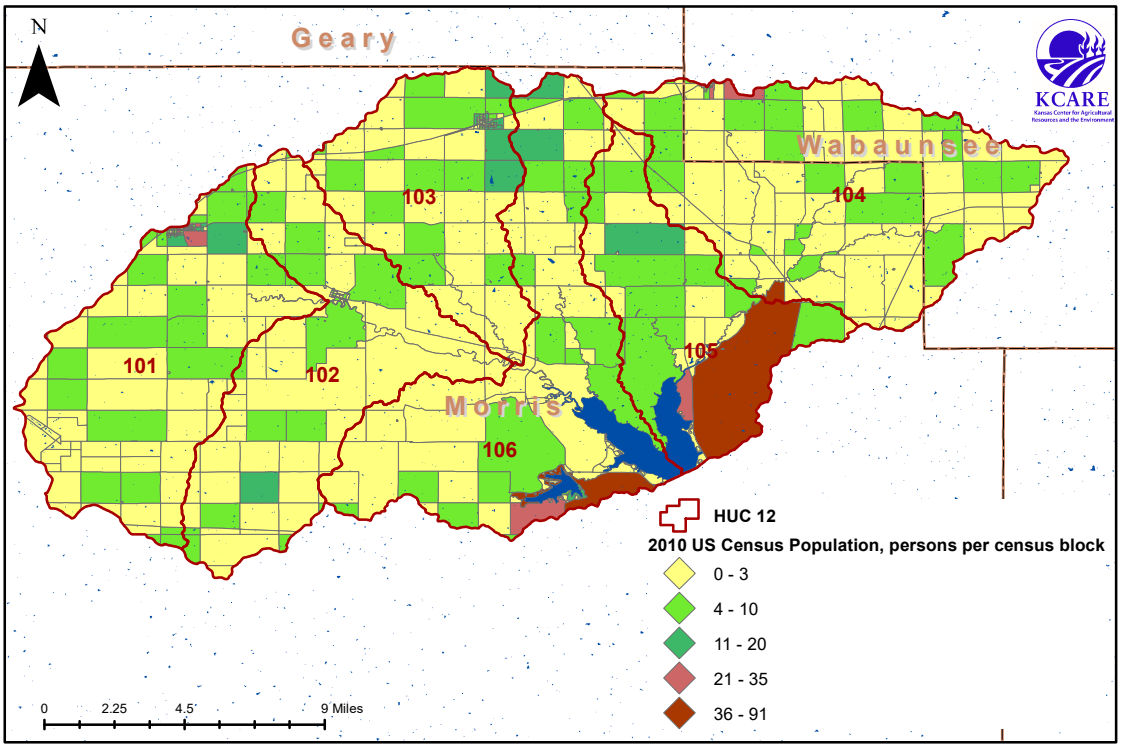


Figure 8. Twin Lakes Watershed Population Map

The average population density for Kansas, represented as persons per square mile, is 32.9; the average for the Twin Lakes Watershed is 8.6 persons per square mile (**Table 4**). Using a watershed area of 261 square miles (less the eight square miles of lakes and park areas), the total population for the Twin Lakes Watershed is estimated to be 2,176 (**Table 5**).

Numbers from 2019 listed in Tables 4 and 5 are estimates from The League of Kansas Municipalities organization, therefore calculations for current population and wastewater systems in the watershed will utilize 2010 U.S. Census data.

Table 4. Population in the Counties of the Twin Lakes Watershed

Estimating Twin Lakes Watershed Population			
County	**2010**	**2019**	**Persons per square mile**
Morris	5,923	5,521	8.4
Wabaunsee	7,053	6,899	8.8
TOTAL	**12,976**	**12,420**	**8.6**

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

Twin Lakes Watershed Municipal Population		
Township	**2010**	**2019**
Alta Vista	444	422
Dwight	272	255
Parkerville	59	59
White City	618	569
TOTAL URBAN POPULATION	1,393	1,305
TOTAL RURAL POPULATION	783	
Twin Lakes Watershed: TOTAL POPULATION	**2,176**	

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 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 Twin Lakes Watershed. Using a rural population of roughly 783 and an estimated 2.29 people per rural Kansas household, it can be determined that there are approximately 342 onsite wastewater treatment systems installed in the watershed with an expected failure rate of roughly 20%, or 68 systems.[5]

H. Aquifers

One **alluvial** aquifer underlies the Twin Lakes Watershed (**Figure 9**). The alluvial aquifer is part of and connected to a river system, consisting of sediment deposited by rivers in the stream valleys. Creeks in this watershed that have alluvial aquifers are the Neosho River, Canning Creek, East Branch Short Creek, Gilmore Creek, Lairds Creek, Munkers Creek, Ritchey Creek, and Slough Creek.

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

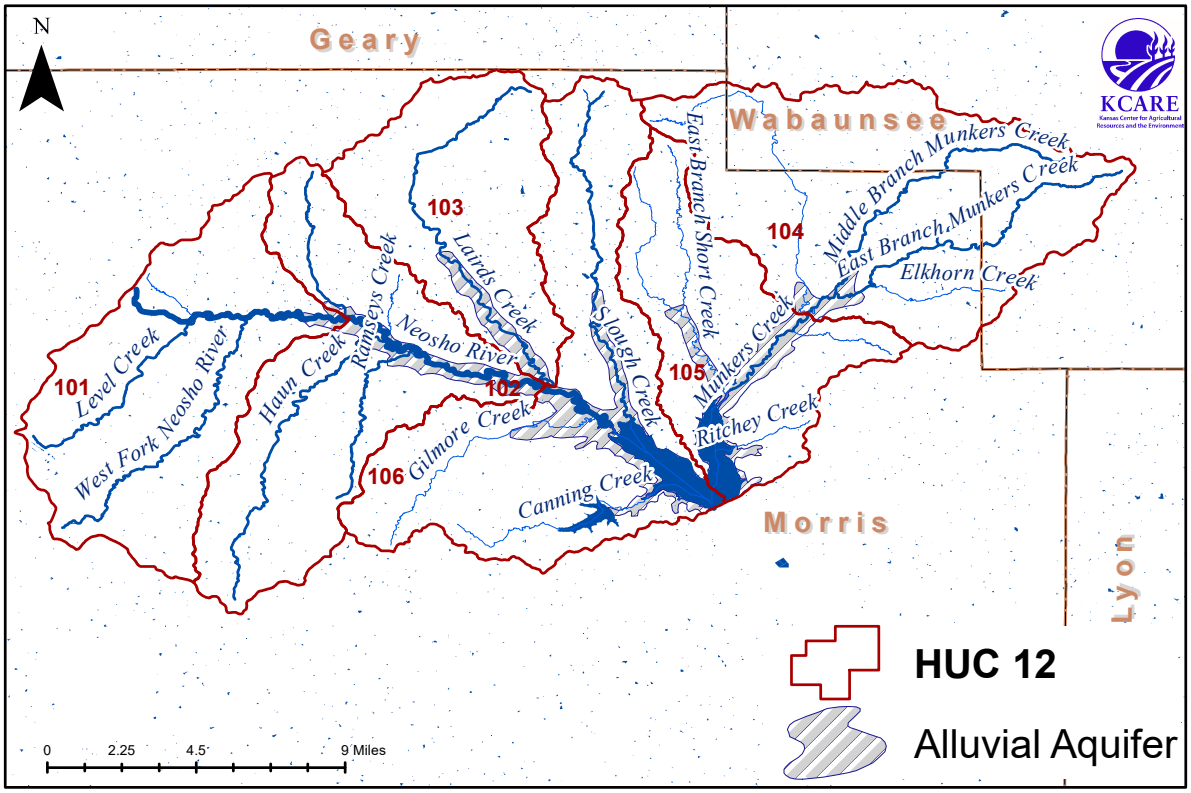


Figure 9. Alluvial Aquifer in the Twin Lakes Watershed

I. Public Water Supplies

Sediment can affect a Public Water Supply (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 costs in treatment prior to public consumption.

PWS within this watershed are shown in **Table 6**. Most of the rural population in the Twin Lakes Watershed obtain their water through private groundwater wells. Alta Vista, Dwight and White City use groundwater sources for their public water supply. Many of the groundwater wells in each of these municipalities is located within the Twin Lakes Watershed.

The watershed's largest public water supply source is the Council Grove City Lake which provides water for the City of Council Grove. Council Grove Lake, a federal reservoir, serves as a backup water supply for the cities of Council Grove and Emporia.[6] Most likely, these communities would access the water supply through releases from the lake into the Neosho River.

[6] From KDHE on November 4, 2019 - Kansas Water Office Cottonwood/Neosho River Basin Assurance District No. 3, https://kwo.ks.gov/reservoirs.

Table 6. Twin Lakes Watershed Public Water Suppliers[7]

Public Water Suppliers in the Twin Lakes Watershed		
Public Water Suppliers	**County**	**Population**
Alta Vista, City of	Wabaunsee	422
*Council Grove, City of	Morris	2,079
Dwight, City of	Morris	255
Morris County RWD 1	Morris	1,091
White City, City of	Morris	569
Total Population Served		**4,416**
** System lies outside the project area, however the intake is in the Twin Lakes Watershed.*		
RWD - Rural Water District		

Source water protection

The 1996 amendments to the Safe Drinking Water Act required each state to develop a Source Water Assessment Program (SWAP). Additionally, each state was required to develop a Source Water Assessment (SWA) for each public water supply that treats and distributes raw source water. In Kansas, there are approximately 763 public water supplies that required SWAs. A SWA includes the following: delineation of the source water assessment area; inventory of potential contaminant sources; and susceptibility analysis. The SWA must also be made available to the public. KDHE's Watershed Management Section has implemented the Kansas SWAP plan, and all SWAs are completed[8].

The Safe Drinking Water Act did not require protection planning to be part of the SWAP process. On a voluntary basis, KDHE encourages public water supplies and their surrounding communities to use SWA as the foundation for future protection planning efforts.

The Twin Lakes Watershed has five active PWS sites. Three public water suppliers within the Twin Lakes Watershed were required to develop a SWPP in 2003: Alta Vista, Dwight and White City. Alta Vista scored "low" Susceptibility Likelihood Scores (SLS) for each contaminants of concern category while Dwight scored "moderate" SLS for all contaminants with the exception of inorganic compounds, which scored a "low" SLS. White City scored "moderate" susceptibility SLS for all contaminants of concern. Knowing the susceptibility scores assists communities and the watershed SLT with their planning efforts for protecting water sources.

J. National Pollutant Discharge Elimination System (NPDES)

National Pollutant Discharge Elimination System (NPDES) permits specify the maximum amount of pollutants allowed to be discharged into surface waters. Wastewater treatment

[7] Kansas Department of Health and Environment, November 4, 2019.
[8] Kansas Department of Health and Environment, Source Water Assessment Reports. http://www.kdheks.gov/nps/swap/SWreports.html

facilities are permitted and regulated by KDHE, and the permit holder considers these facilities point sources for pollutants. Having these point sources (PS) located on streams or rivers may impact water quality in the waterways. Municipal wastewater can contain suspended solids, biological pollutants that reduce oxygen in the water column, inorganic compounds, or bacteria. Treatment of municipal wastewater is 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 the pollutant discharged. Any pollutant discharge from PS allowed by the state is considered to be wasteload allocation. There are currently four permitted NPDES facilities in the Twin Lakes Watershed (**Table 7**).

Table 7. NPDES Permitted Facilities in the Twin Lakes Watershed[9]

NPDES Permitted Facilities in the Twin Lakes Watershed				
Facility Name	**Facility Type**	**Description**	**City**	**County**
Alta Vista, City of	Discharging lagoon	Waste - stabilization pond (overflowing)	Alta Vista	Wabaunsee
Dwight, City of	Discharging lagoon	Waste - stabilization pond (overflowing)	Dwight	Morris
White City, City of	Discharging lagoon	Waste - stabilization pond (overflowing)	White City	Morris
White Memorial Camp WWTP	Non-discharging lagoon	Waste - stabilization pond (non-overflowing)	N/A	Morris

K. Livestock Operations in the Twin Lakes 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 practices recommended and approved by KDHE. These include, but are not limited to, regular cleaning of stalls, managing manure storage areas, etc. Facilities that have between 300 and 999 animal units are known as Confined Feeding Facilities (CFFs). Any CFFs identified with a 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

[9] NPDES Facilities Provided by KDHE on November 4, 2019.

that generates an outflow from the milking barn on a daily basis, are required to have a permit. See **www.kdheks.gov/feedlots** for more information.

Table 8. Permitted Livestock Facilities in the Twin Lakes Watershed

Permitted Livestock Facilities	
County	**Quantity of Facilities**
Morris	13
Wabaunsee	0
Total	13

As shown in **Table 8**, there are 13 active permitted livestock facilities in the two counties housing the Twin Lakes Watershed. Permitted facilities are required to have a management plan for containing and utilizing 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 Twin Lakes 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.

4. Impaired Waters in the Twin Lakes Watershed

Water quality in the Twin Lakes Watershed is monitored at four different sites (**Figure 10**). These sites include two KDHE stream sampling sites, one on the Neosho River (SC637), one on Lairds Creek near the Neosho River confluence (SC632). There are two additional lake monitoring sites, one on Council Grove *City* Lake (LM043001) and the other at the base of Council Grove Lake (LM22001).

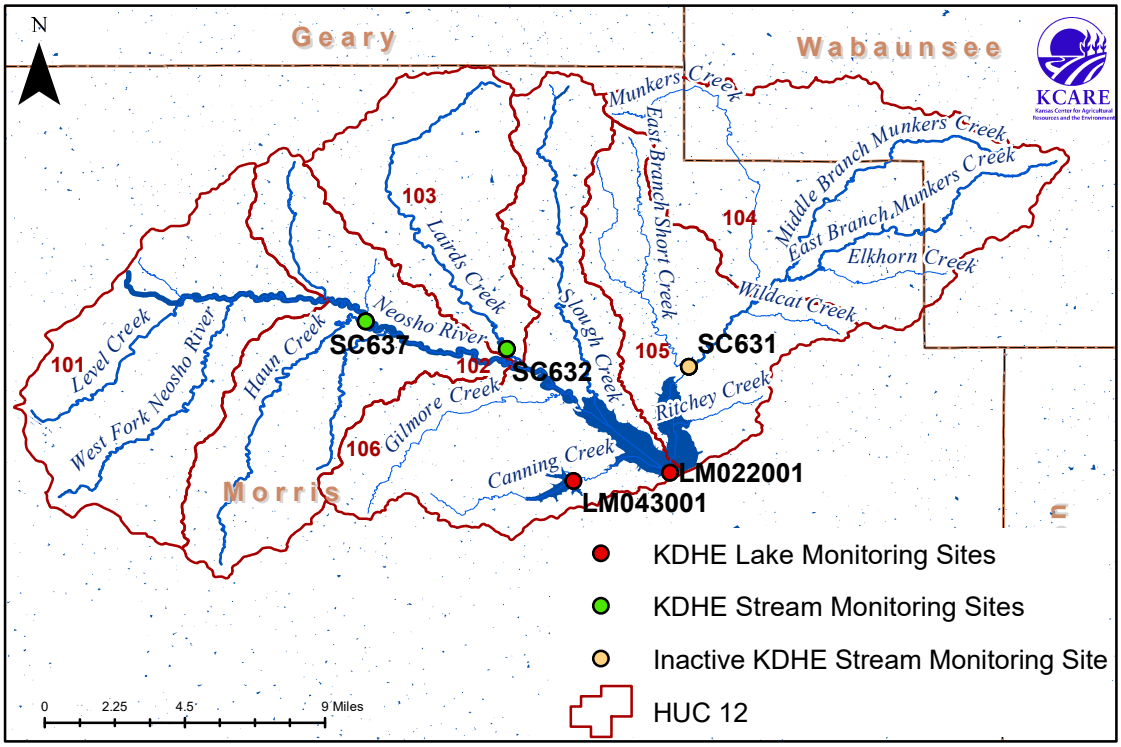


Figure 10. Twin Lakes Watershed Monitoring Sites

Water samples from these monitoring sites are analyzed for nutrients, metals, ammonia, total suspended solids, turbidity, alkalinity, chlorophyll, pH, dissolved oxygen, *E. coli* bacteria and chemicals. Sample analysis determines if the water contains an unacceptable level of the analyte (the substance whose chemical constituents are being measured). If analysis determines that any one pollutant exceeds acceptable limits, the water segment then becomes designated as "impaired" by that pollutant and is reported as a 303d-listed impairment. If the water segment affected by the pollutant is in dire need of reduction and is considered "high priority," it is then listed as a Total Maximum Daily Load (TMDL).

A. 303d List of Impaired Waters in the Twin Lakes Watershed

KDHE develops a "303d list" of impaired waters biennially and submits it to EPA. To be included on the 303d 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 for the time being.

Munkers Creek near Council Grove has been Category 5, 303d-listed for dissolved oxygen (DO). It is expected to receive a TMDL for DO in 2022. (**Table 9**). *All category 4a (TMDL) listings are described in the following "TMDL" section.*

Table 9. 303d-Listed Waters in the Twin Lakes Watershed[10]

303d List of Impaired Waters				
Water Segment	**Category**	**Impairment**	**Priority**	**Sampling Station**
Munkers Creek, near Council Grove	5	Dissolved Oxygen	2022	SC631

[10] Kansas Department of Health and Environment, 2018. http://www.kdheks.gov/tmdl/2018/Approved_2018_303_d)_List_of_All_Impaired_Waters.pdf

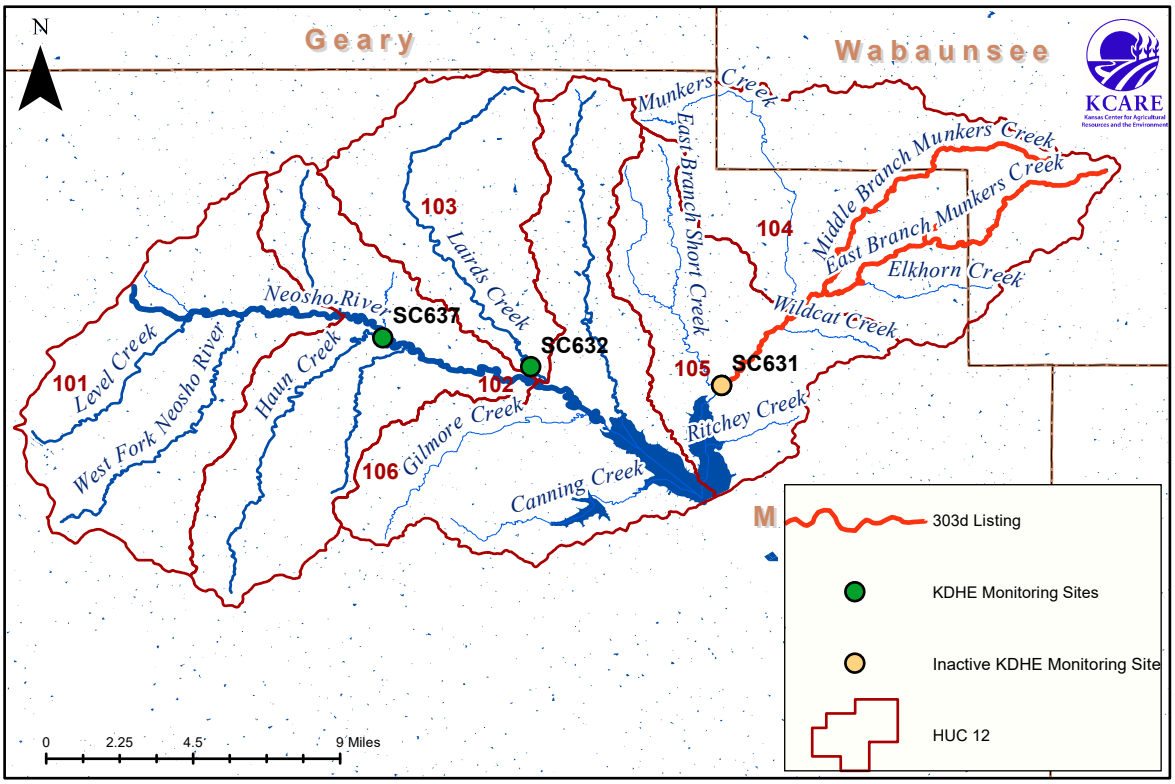


Figure 11. 303d-Listed Waters in the Twin Lakes Watershed

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 Twin Lakes Watershed is part of the Neosho Basin and was reviewed in 2012; it is scheduled for review again in 2022.

2. Twin Lakes Watershed TMDLs

The Twin Lakes Watershed has four TMDLs, identified by the KDHE monitoring program. Council Grove Lake has two TMDLs: eutrophication and siltation. The Neosho River, near Parkerville, has two TMDLs: total phosphorus (TP) and copper (Cu). (**Table 10)**.

Table 10. TMDLs in the Twin Lakes Watershed[11]

TMDLS in the Twin Lakes Watershed					
Water Segment	**Category**	**Impairment**	**Priority**	**Goal of TMDL**	**Sampling Station**
Council Grove Lake	4A	Eutrophication	High	Summer Chlorophyll a ≤ 10 µg/l	LM022001
	4A	Siltation	High	Secchi Disc Depth ≥ 1 m	LM022001
Neosho River, near Parkerville	4A	Total Phosphorus	High	ALUS Index ≥ 14, Sestonic Chlorophyll ≤ 5 µg/l	SC637
	4A	Copper	Low	3.718 lbs/day	SC637

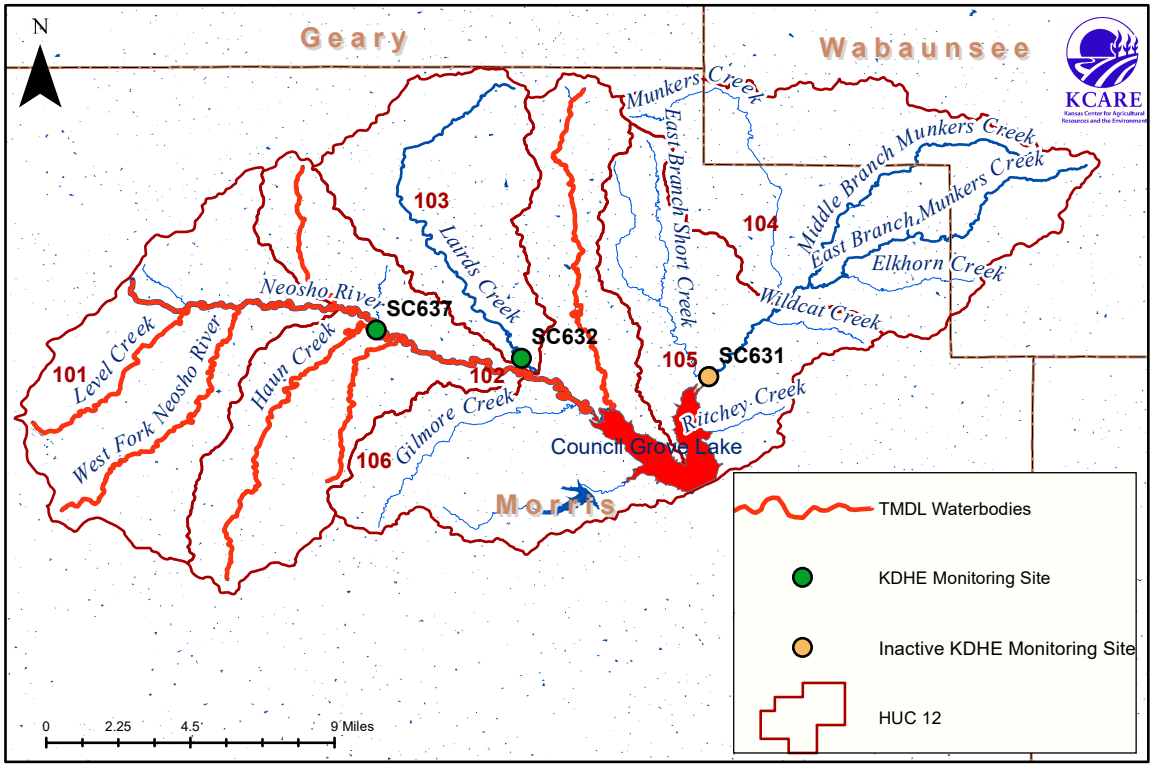


Figure 12. Waters with a TMDL in the Twin Lakes Watershed

[11] Kansas Department of Health and Environment, 2018. http://www.kdheks.gov/tmdl/2018/Approved_2018_303_d)_List_of_All_Impaired_Waters.pdf

Note: Some of the implemented strategies for addressing the current TMDLs as determined by the SLT and outlined in this plan will have additional benefits by proactively addressing the 303d-listed dissolved oxygen impairment. The ultimate goal will be to eliminate the need to develop a TMDL for the current 303d-listed impairment. For the purpose of this plan, focus and priority will be given to current TMDLs in the Twin Lakes Watershed.

3. Delisted TMDLs

There is no longer a fecal coliform bacteria (FCB) TMDL in the Neosho River near Parkerville. In 2012, the Neosho River's FCB TMDL was shifted from a Category 4a to a Category 2 listing for FCB, meaning that water quality improvements have been made.

5. Watershed Impairments to be Addressed

The Twin Lakes Watershed SLT acknowledges all TMDL and 303d-listed water segments in the watershed. All goals and BMPs will be aimed at protecting the Twin Lakes Watershed from further degradation (**Table 11**). **The SLT will focus this WRAPS plan on two key TMDL-listed impairments, the eutrophication of Council Grove Lake and total phosphorus in the Neosho River, near Parkerville.**

Table 11. Twin Lakes Watershed TMDL Impairment Loads and Goals

Load Allocations for the Twin Lakes Watershed				
Impairment/TMDL		Current Load (lbs/yr)	Allowed Load (lbs/yr)	Required Reduction (lbs/year)
Eutrophication Council Grove Lake	Nitrogen	1,257,384	1,014,949	242,435
	Phosphorus	217,436	148,669	68,767
Total Phosphorus Neosho River, near Parkerville		2,450	1,145	1,305

Although this WRAPS plan only specifically addresses the eutrophication TMDL in Council Grove Lake and total phosphrous TMDL in the Neosho River near Parkerville, it should be noted that the following impairments and waterbodies will be impacted positively by targeted BMP implementation:

- Siltation/Sediment TMDL (Council Grove Lake)
- Cu TMDL (Neosho River, near Parkerville)
- Dissolved Oxygen 303d (Munkers Creek, near Council Grove)

A. Eutrophication: Nitrogen and Phosphorus

The Twin Lakes Watershed has a "high" priority TMDL for the impairment of **eutrophication** in Council Grove Lake.[12] Council Grove Lake has been on the TMDL 303d list since 1998 for eutrophication, caused by excess nutrient loading (primarily nitrogen and phosphorus) that creates conditions favorable for algae blooms and aquatic plant growth. This lake is classified as argillotrophic, meaning that the lake produces low levels of phytoplankton because the water is clouded by high levels of suspended clay particles; therefore, Council Grove Lake could support the growth of potentially harmful blue-green algae if conducive environmental conditions are present.

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

[12] KDHE, E TMDL for Council Grove Lake, http://www.kdheks.gov/tmdl/ne/CouncilGroveTMDL.pdf

The impairments in this watershed mainly stem from nonpoint sources (NPS) of pollution, meaning that there are multiple sites contributing to the overall pollutant loads. Excess nutrients can originate from manure and fertilizer runoff in rural and urban areas. Urbanization, agricultural land use, and small livestock operations all contribute excess nutrients within the Twin Lakes Watershed.

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.

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 that are allowed access to streams to drink and/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: 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 four NPDES facilities, including three discharging lagoons, in the Twin Lakes Watershed at the time of this document's publication.

Population

Watershed population can affect nutrient runoff. There are roughly 342 domestic onsite wastewater systems estimated in the Twin Lakes Watershed, mainly in rural areas. Although the functional condition of these systems is generally unknown, it is projected that nearly 20% may be failing; onsite wastewater could be an area of possible pollution contribution for evaluation.

Confined Animal Feeding Operations

In Kansas, animal feeding operations (AFOs) with 300 or more animal units (AUs) but 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 certified or permitted AFOs and CAFOs spread throughout this watershed. 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 can also be a contributor to the nutrient loads, although at a much smaller quantity.

Grazing density

Approximately 60% of the Twin Lakes Watershed is grassland. 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 during a high rainfall event. Also, allowing cattle to drink and loaf in streams increases the occurrence of nutrients and *E. coli* bacteria in the waterway. Grazing density ranges from 8.1 to 8.6 cattle per 100 acres across the watershed.[13] This is considered to be medium density when compared with statewide density numbers.

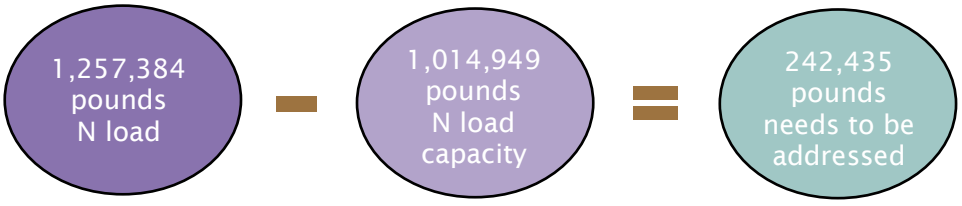
Rainfall and runoff

Rainfall amounts and subsequent runoff affect nutrient runoff from agricultural and urban areas into streams and Council Grove Lake. The amount and timing of rainfall events affects manure runoff from livestock that are allowed access to streams, or manure applied before a rainfall or on frozen ground. It also affects erosion from cropland. Therefore, it is important to maintain adequate grass density to slow the runoff of manure over pastures.

2. Pollutant loads

Nitrogen

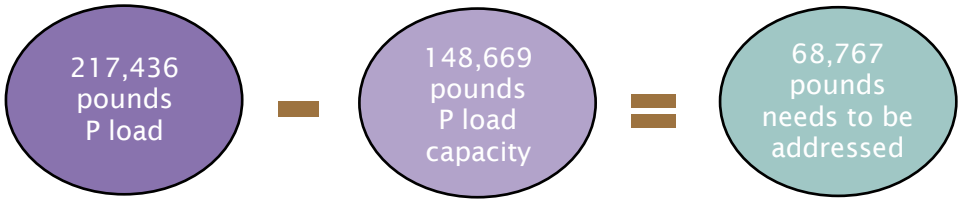
The current estimated nitrogen load in the Twin Lakes Watershed is 1,257,384 pounds per year, according to the TMDL section of KDHE.[14] The amount of nitrogen (N) in the watershed contributes to the eutrophication TMDL in Council Grove Lake and the 303d listing for dissolved oxygen in Munkers Creek near Council Grove. It has been determined that a 19% reduction in nitrogen is necessary to meet the Council Grove Lake TMDL, which equates to a reduction of 242,435 pounds per year. **If all BMPs have been implemented, 159,826 pounds of nitrogen will have been reduced from the watershed at the end of this 30-year 9-element plan.** This only meets 66% of the amount required to meet the TMDL.



[13] https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/Kansas/index.php
[14] Kansas Department of Health and Environment. October 2019.

Phosphorus

The current estimated phosphorus (P) load in the Twin Lakes Watershed is 217,436 pounds per year, according to the TMDL section of KDHE.[15] The amount of phosphorus in the watershed contributes to the eutrophication TMDL in Council Grove Lake, the total phosphorus TMDL in the Neosho River near Parkerville, and the 303d listing for dissolved oxygen in Munkers Creek near Council Grove. The total load reduction needed to meet the phosphorus TMDL in Council Grove Lake is 68,767 pounds of phosphorus per year, a reduction of 32%. **If all BMPs are implemented, 73,668 pounds of phosphorus will be reduced from the watershed at the end of this 30-year plan.** This exceeds the required reduction goal by 107%.



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

The SLT identified specific cropland and livestock BMPs which will result in significant nutrient pollutant reductions and are acceptable to watershed residents. Each agricultural BMP such as permanent vegetation, no-till with cover crops, terraces, waterways, vegetative buffers, nutrient management plans, and grade stabilization structures will improve water quality by reducing nutrient runoff and leaching. Implementing vegetative filter strips, relocating feeding pens and pasture feeding sites away from streams, providing alternate watering sites and grazing management plans will all help to reduce nutrient loading from livestock areas. Specific acreages or projects that need annual implementation have been determined through modeling and economic analysis and have been approved by the SLT (**Table 12**).

Table 12. BMPs to Prevent and/or Reduce Nutrient Runoff and Leaching

BMPs to Reduce Nutrient Loading		
Protection Measures	**Best Management Practices**	**Adoption Rate Goal**
Prevention of nutrient contribution from **cropland**	Permanent Vegetation	26 acres
	No-till with Cover Crops	155 acres
	Terraces	52 acres
	Waterways	52 acres
	Vegetative Buffers	52 acres
	Nutrient Management Plans	155 acres
	Grade Stabilization Structures	52 acres
Prevention of nutrient contribution from **livestock**	Vegetative Filter Strip	1 project per year
	Relocate Feeding Pens	1 project every 2 years
	Relocate Pasture Feeding Sites	1 project per year
	Off-Stream Watering System	3 projects per year
	Rotational Grazing	1 project every 2 years

[15] Kansas Department of Health and Environment. October 2019.

The implementation of cropland BMPs in support of the eutrophication TMDL also works to reduce sediment loading, thereby positively impacting the watershed's sediment and Cu TMDLs. The implementation of both cropland and livestock BMPs in the watershed subsequently improves the total phosphorus TMDL in the Neosho River, as well as the dissolved oxygen 303d listing in Munkers Creek, near Council Grove.

B. Total Phosphorus

The Twin Lakes Watershed has a "high" priority TMDL for the impairment of **total phosphorus (TP)** in the Neosho River near Parkerville.[16] The cropland and livestock BMPs implemented to reduce nutrient and sediment loading related to the eutrophication TMDL in Council Grove Lake will have positive impacts on the TP TMDL in the Neosho River and the watershed as a whole.

Water quality data collected from 2000 to 2007 reveals that Council Grove Lake ranks third for TP concentration out of 24 federal reservoirs in the state of Kansas. The average concentration is 198 µg/L (ppb), which is 10 times greater than the reference value (19 µg/L) suggested for the Flint Hills region and nearly twice that of the national average (100 µg/L) as indicated within the EPA's Survey of Nation's Lakes.

1. Sources of the impairment

Phosphorus loading can originate in rural and urban areas, and it can be caused by both point and nonpoint sources. While this WRAPS plan focuses primarily on agricultural nonpoint source contributions, other possible sources for phosphorus loading are included as part of the discussion. For more detail on this, refer to the section titled "Eutrophication Sources of Impairment" (pp 33-34), which includes information about how land use, wastewater treatment facilities, population, CAFOs, grazing density, rainfall and runoff can contribute to phosphorus impairment in the Twin Lakes Watershed.

2. Pollutant loads

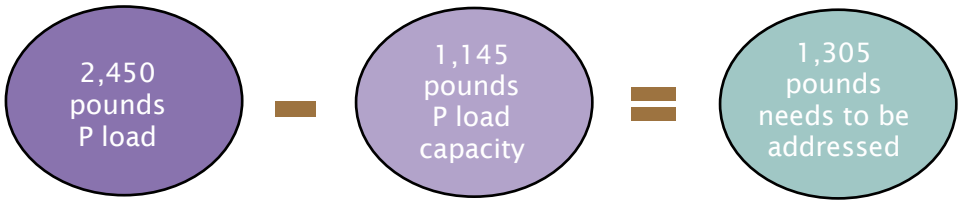
Neosho River's TP TMDL requires a phosphorus reduction of 1,305 pounds per year from the Neosho River near Parkerville at sampling site SC637. (**Table 13**)

Table 13. Reductions to Meet TP TMDL[17]

TP Concentration Reductions Necessary to Meet TMDL Endpoints								
	Current Condition TP (mg/L)	Current Condition TP Load (lbs/yr)	Phase I TMDL TP (mg/L)	Phase I TMDL (lbs/yr)	Phase I Nonpoint Load Reduction Needed (lbs/yr)	Phase II TMDL TP (mg/L)	Phase II TMDL (lbs/yr)	Phase II Nonpoint Load Reduction Neeeded (lbs/yr)
Neosho River, near Parkerville	0.259	2,450	0.164	1,552	899	0.121	1,145	1,305

[16] KDHE, TP TMDL for the Neosho River, http://www.kdheks.gov/tmdl/2014/NeoshoR_Parkerville_TPTMDL.pdf
[17] TMDL table provided by KDHE on April 6, 2020.

Neosho River, near Parkerville current phosphorus loading and required reductions:



This WRAPS plan will achieve this goal as nutrient BMPs are implemented throughout the targeted areas to address the eutrophication TMDL in the Council Grove Lake. The Council Grove Lake eutrophication TMDL requires a 68,767 pounds/year reduction in phosphorus. The 1,305 pounds/year required to meet the Neosho River TP TMDL is part of this 68,767 total pounds/year reduction as it is upstream of the lake and eventually enters the lake. As mentioned above, this plan actually accomplishes 73,668 pounds/year in TP reductions, exceeding the requirement of the Council Grove Lake eutrophication and the Neosho River (near Parkerville) TP TMDLs.

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

The implementation of BMPs across the Twin Lakes Watershed will work to reduce nutrient levels, including total phosphorus, throughout the watershed. This includes the Neosho River which flows into Council Grove Lake; therefore, implementing these cropland and livestock BMPs will address eutrophication in Council Grove Lake as well as the total phosphorus TMDL in the Neosho River near Parkerville.

The SLT identified specific cropland and livestock BMPs which will result in significant phosphorus pollutant reductions and are acceptable to watershed residents. Each agricultural BMP such as permanent vegetation, no-till with cover crops, terraces, waterways, vegetative buffers, nutrient management plans, and grade stabilization structures will improve water quality by reducing nutrient runoff and leaching. Implementing vegetative filter strips, relocating feeding pens and pasture feeding sites away from streams, and providing alternate watering sites and grazing management plans will all work to reduce nutrient loading from livestock areas. Specific acreages or projects that need annual implementation have been determined through modeling and economic analysis and have been approved by the SLT (**Table 14**).

Table 14. BMPs to Prevent and/or Reduce Phosphorus Loading

BMPs to Reduce Phosphorus Loading		
Protection Measures	**Best Management Practices**	**Adoption Rate Goal**
Prevention of TP contribution from **cropland**	Permanent Vegetation	26 acres
	No-till with Cover Crops	155 acres
	Terraces	52 acres
	Waterways	52 acres
	Vegetative Buffers	52 acres
	Nutrient Management Plans	155 acres
	Grade Stabilization Structures	52 acres
Prevention of TP contribution from **livestock**	Vegetative Filter Strip	1 project per year
	Relocate Feeding Pens	1 project every 2 years
	Relocate Pasture Feeding Sites	1 project per year
	Off-Stream Watering System	3 projects per year
	Rotational Grazing	1 project every 2 years

C. Other Concerns in the Twin Lakes Watershed

1. Sediment

The Twin Lakes Watershed has a "high" priority TMDL for the impairment of **siltation (sedimentation)** in Council Grove Lake.[18] *BMP implementation and load reductions in this report will refer to sediment and sedimentation, the TMDL will refer to siltation.*

The siltation TMDL can be related to the eutrophication TMDL in the lake due to pollutants, particularly nitrogen and phosphorus, which can be attached to suspended soil particles in the water column. Council Grove Lake's siltation TMDL is not a specific goal of this WRAPS plan as there are no quantitative numbers available to use for required reductions. However, the cropland BMPs implemented to reduce nutrient loading will positively impact the siltation TMDL in the lake and the watershed as a whole.

The total suspended solids (TSS) concentration, indicative of turbid conditions, is high and averages about 21 mg/L (ppm). Based on the 2008 bathymetric survey of Council Grove Lake conducted by the Kansas Biological Survey and funded by the Kansas Water Office, Council Grove Lake is silting in at a rate of 194 ac-ft./yr.[19] This rate of siltation is below the designed sedimentation rate of 206 ac-ft./yr. This makes eutrophication a higher priority, but the SLT hopes that the cropland sediment BMPs incorporated in the watershed will reduce excess sediment, improve water clarity in the lake and have a positive effect on the siltation TMDL.

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 contribute sediment into the ecosystem as well. Once the sediment reaches the lake, it decreases water

[18] KDHE, Siltation TMDL for Council Grove Lake, http://www.kdheks.gov/tmdl/ne/CouncilGroveSILT.pdf
[19] Kansas Biological Survey, Bathymetric and Sediment Survey of Council Grove Reservoir, https://services1.arcgis.com/q2CglofYX6ACNEeu/arcgis/rest/services/Lakes_All/FeatureServer/0/15/attachments/120

clarity and can reduce reservoir volume and storage capacity. A decrease in lake storage affects domestic and industrial uses of the lake water as well as limits public access to the lake's boat ramps and beaches. Therefore, reducing erosion is necessary to reduce sediment in Council Grove Lake. In addition, nutrient pollutants such as nitrogen and phosphorus can leach to the sediment particles and cause higher than normal concentrations, thus accelerating the eutrophication problem in Council Grove Lake.

a. Sources of the impairment

Sediment can originate from a number of sources. Land-based activities affect sediment transported downstream to lakes. Physical components of the terrain, such as slope, propensity to generate runoff, and soil type are important in sediment movement. One such source is streambank erosion and sloughing of the sides of rivers and streambanks. Others are a lack of riparian cover that causes washing on the banks of streams or rivers, or animal movement, such as livestock regularly crossing streams.

Land use

Land use activities have a significant impact on the types and quantity of sediment transfer in the watershed. Construction projects can leave both disturbed areas of soil and unvegetated roadside ditches that can erode during a rainfall event. In addition, agricultural cropland under conventional tillage practices and lacking maintenance from agricultural BMP structures can have cumulative effects on land transformation through sheet and rill erosion. Sediment transfer also can be caused by degraded pastureland or streambank sloughing. Primary land uses in the areas this WRAPS plan addresses for BMP implementation (**Section 6**) are grassland (60%), cropland (21%), and pasture/hay land (8%). Reducing erosion in these areas is necessary for a reduction in sediment.

Agricultural BMPs such as permanent vegetation, no-till with cover crops, terraces, waterways, vegetative buffers, nutrient management plans, grade stabilization structures and reducing activities within riparian areas will reduce erosion and improve water quality.

Soil erosion by wind and/or water

NRCS has established a "T-factor" in evaluating soil erosion. "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/acre for shallow soils, to five tons/acre for deep soils 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.[20]

[20] NRCS T factor. http://www.nrcs.usda.gov/technical/NRI/1997/summary_report/glossary.html

Riparian quality

In the targeted areas, the predominant land use in riparian areas is cropland (22%). This is the land that can be most vulnerable to runoff and erosion. An adequately functioning and healthy riparian area will reduce sediment flow from cropland and rangeland. Cropland needs buffer and filter strips adjacent to streams in order to impede sediment flow from fields. Conservation tillage practices, such as no-till, are also effective for slowing the flow of rainwater off of crop fields because they increase soil infiltration. The use of permanent grass and vegetative buffers along riparian areas can impede erosion and streambank sloughing. Riparian areas also 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 forested riparian areas, can be used to impede erosion and streambank sloughing. Restricting livestock along streams will prevent livestock from entering streams and degrading the banks.

Rainfall and runoff

Rainfall amounts and the subsequent runoff can affect the sediment runoff from both agricultural and urban areas into streams and Council Grove Lake. In addition, high rainfall events can cause cropland erosion and sloughing of streambanks, adding sediment to streams and rivers that will ultimately flow into Council Grove Lake.

b. Pollutant Loads

Currently, there is not an estimated sediment load for the Twin Lakes Watershed. However, it has been calculated that **if all BMPs have been implemented by the end of this 30-year WRAPS plan, a reduction of 7,992 tons per year of sediment will have been achieved.**

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

SLT members agreed on a list of acceptable BMPs that would result in progress toward significant pollutant reduction. Each agricultural BMP on cropland such as permanent vegetation, no-till with cover crops, terraces, waterways, vegetative buffers, nutrient management plans and grade stabilization structures will reduce erosion and improve water quality. When the SLT revised and updated this plan in 2019, a cover crop BMP was included, to be used in conjunction with no-till. Specific acreages or projects that need annual implementation have been determined through modeling and economic analysis and approved by the SLT, as shown in **Table 15**.

Table 15. BMPs to Prevent or Reduce Sediment Runoff and Erosion

BMPs to Reduce Sediment Runoff		
Protection Measures	**Best Management Practices and Other Actions**	**Adoption Rate Goal**
Prevention of sediment contribution from **cropland**	Permanent Vegetation	26 acres
	No-till with Cover Crops	155 acres
	Terraces	52 acres
	Waterways	52 acres
	Vegetative Buffers	52 acres
	Nutrient Management Plans	155 acres
	Grade Stabilization Structures	52 acres

The implementation of cropland BMPs in support of the eutrophication TMDL also positively affects the sediment and Cu TMDLs. In addition, the implementation of cropland BMPs serves to reduce nitrogen and phosphorus loading, thereby positively impacting the watershed's eutrophication TMDL, total phosphorus TMDL, and the dissolved oxygen 303d listing.

2. Copper

The Twin Lakes Watershed has a "low" priority TMDL for the impairment of **copper (Cu)** in the Neosho River, near Parkerville.[21] The Neosho River's Cu TMDL is not targeted specifically for improvement by this WRAPS plan. However, the BMPs implemented to reduce sediment loading will have positive impacts on the Cu TMDL in the Neosho River.

A small amount of copper is essential for good health. However, exposure to high levels of copper can cause health problems. In the short-term, this exposure can cause gastrointestinal distress; in the long-term, severe cases of copper poisoning can cause anemia and disrupt liver and kidney functions.

a. Sources of the impairment

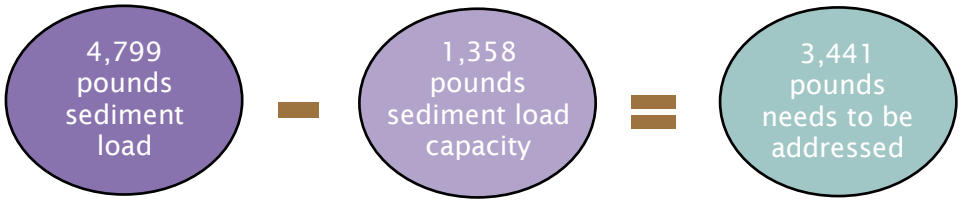
Copper is a naturally occurring metal found in rock, soil, water, and sediment. Naturally occurring copper in soil may constitute a substantial portion of estimated loadings to Neosho River because copper is transported predominantly into water segments by way of sediment. Existing nonpoint source loads of copper to the Neosho River were estimated using the Generalized Watershed Loading Function (GWLF) (Haith, et al. 1996) model. This model, in conjunction with external spreadsheet calculations, estimates dissolved and total copper loads in surface runoff from complex watersheds, such as Neosho River. Both surface runoff and groundwater sources are included in the simulations. Input data for copper in soils were obtained from Soil Conservation Service (SCS) and the United States Geological Survey (USGS).

[21] KDHE, Cu TMDL for the Neosho River, http://www.kdheks.gov/tmdl/ne/NeoshoRvParkerville_Cu.pdf

b. Pollutant loads

The current estimated Cu load in the Twin Lakes Watershed is 4,799 pounds per year, according to the TMDL section of KDHE. The amount of sediment entering the Neosho River near Parkerville contributes to the Cu TMDL. The total load reduction needed to meet the Cu TMDL in the Twin Lakes Watershed is 3,441 pounds of sediment per year, a reduction of roughly 72%. **If all sediment BMPs are implemented during this 30-year WRAPS plan, nearly 8,000 tons (16,000 pounds) per year of sediment will be prevented from entering the waters of the Twin Lakes Watershed**.

While copper is not a targeted impairment in this WRAPS plan, the SLT hopes that sediment BMPs applied to riparian areas along the Neosho River and its tributaries meet the sediment TMDL also will result in meeting the Cu TMDL.



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

SLT members agreed on a list of acceptable cropland BMPs that will result in significant nutrient and sediment loading reductions. Each cropland BMP, such as permanent vegetation, no-till with cover crops, terraces, waterways, vegetative buffers, nutrient management plans and grade stabilization structures will reduce erosion, subsequently reducing the amount of copper entering the Neosho River and improving water quality.

3. Dissolved Oxygen

Munkers Creek near Council Grove has been 303d-listed for **dissolved oxygen (DO)**. The Munkers Creek 303d listing for DO is not addressed specifically by this WRAPS plan. However, the BMPs implemented to reduce nutrient and sediment loading will have positive impacts on DO levels in Munkers Creek. The KDHE TMDL section will review this Category 5 listing in 2022, and it is the SLT's hope that this plan's implementation will prevent DO from being downgraded to a category 4a TMDL.

a. Sources of the impairment

Excess nutrients often come off crop fields through sediment leaching during runoff events. Excess nutrients also can originate from failing septic systems, livestock manure, and fertilizer runoff in rural and urban areas. Excess nutrient loading from the watershed creates accelerated rates of eutrophication, followed by decreasing amounts of DO in the water resulting in an unfavorable habitat for aquatic life.

b. Pollutant loads

Desirable criteria for healthy water dictate DO rates greater than 5 mg/L in 80% of the water column and biological oxygen demand (BOD) less than 3 mg/L. The SLT will not target the DO impairment specifically; however, this plan's implementation of sediment and nutrient BMPs subsequently will reduce the amount of nutrient loading found in runoff, having positive effects on the Munkers Creek DO 303d listing.

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

The SLT identified specific cropland and livestock BMPs to obtain significant nutrient pollutant reductions, which will have positive effects on the DO TMDL. Each agricultural BMP such as permanent vegetation, no-till with cover crops, terraces, waterways, vegetative buffers, nutrient management plans and grade stabilization structures will improve water quality by reducing nutrient runoff and leaching. Implementing vegetative filter strips, relocating feeding pens and pasture feeding sites away from streams, providing alternate watering sites and grazing management plans will all work to reduce nutrient loading from livestock areas.

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 close proximity to streams, soils more 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 nonpoint source pollution and, ultimately, 303d and TMDL listings.

A. Studies Conducted to Determine Targeted Areas

1. Spreadsheet Tool for Estimating Pollutant Load (STEPL)

STEPL is a simple watershed model that provides both agricultural and urban annual average sediment and nutrient simulations as well as an evaluation of how various best management practices 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 2012, the STEPL model was used by the Twin Lakes WRAPS group and KDHE. They determined that BMP implementation should be targeted on three sub-watersheds due to high TP contributions. These sub-watersheds are 101, 102 and 104. The watershed modeling indicated that sub-watersheds 103, 105 and 106 had the potential to contribute a significant amount of TP to the watershed as well; however, the SLT decided to limit their focus to three sub-watersheds at this time. HUCs 101 and 102 were obvious choices because they border the Neosho River which runs directly into Council Grove Lake. They prioritized sub-watershed 104 over 103, 105, and 106 based on the greater number of acres in cropland and its proximity to Munkers Creek, which also drains into Council Grove Lake.

2. Ground-truthing

Ground-truthing is a method that involves conducting "windshield surveys" which are conducted by local agency personnel and SLT members familiar with the area and its land use history. Ground-truthing determines the current BMP adoption rate, provides photos of the targeted areas, and may generate additional water quality concerns not captured by watershed modeling.

KDHE surveyed the county conservation districts for land treatment needs in 2005. In 2012, KDHE, Kansas State University, and the Twin Lakes WRAPS coordinators (there were two at that time) completed ground-truthing in STEPL-targeted sub-watersheds 101, 102, and 104. As a result of these surveys, the Twin Lakes SLT determined that BMPs for

grassed waterways, terraces and gully erosion were most needed because keeping sediment on the fields would reduce sediment and nutrient loading.

3. Aerial assessment

KDHE has analyzed aerial images and determined areas of interest for BMP targeting to include crop fields and livestock areas near stream segments. (**Figure 13**)

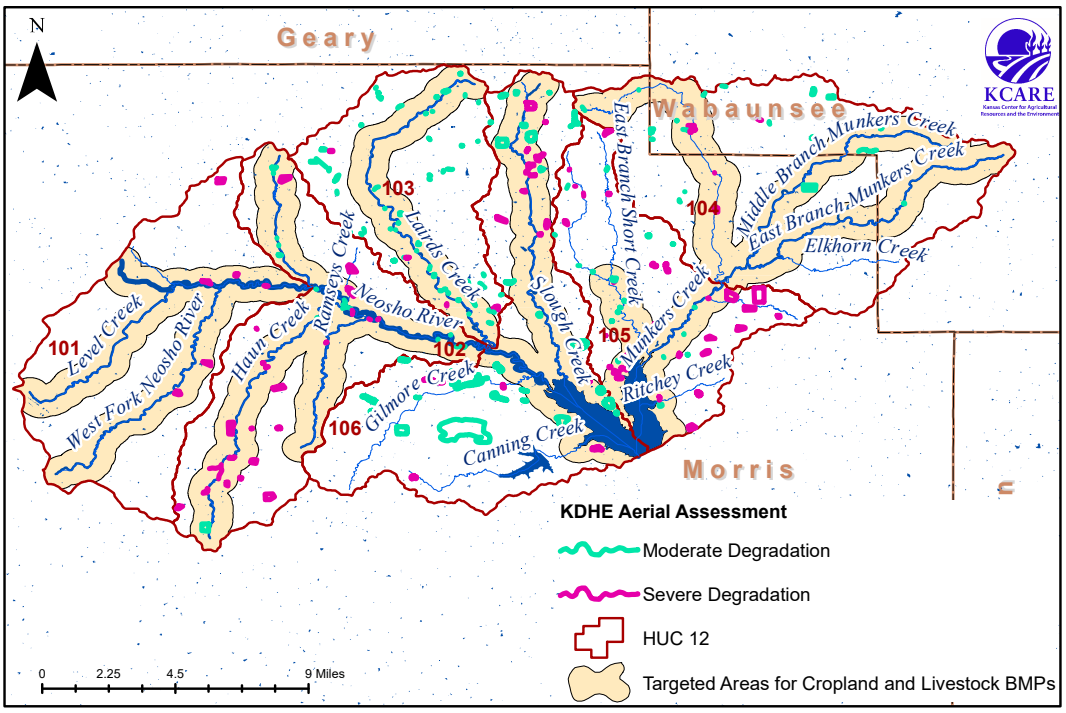


Figure 13. Twin Lakes Watershed Aerial Assessment[22]

4. Priority revisions in 2019

STEPL and ground-truthing results determined that all six sub-watersheds in the Twin Lakes Watershed are high in TP pollutants, and a need for sediment control practices on cropland exists. Aerial assessments demonstrate that BMPs could be implemented across the Twin Lakes Watershed and could result in water quality improvements in the Neosho River, Munkers Creek and, ultimately, Council Grove Lake.

In 2019, KDHE determined to focus BMP efforts based on stream proximity, considering that stream segments are the route by which pollutants travel into larger water systems and ultimately, lakes. By narrowing the focus to riparian corridors, defined as areas on either side of the stream/river, the Twin Lakes Watershed SLT can focus on the entire watershed and all six HUC 12s. Focusing BMP practices one-half mile on both sides of water segments significantly will reduce nutrient and sediment loading.

[22] Aerial assessment figure provided by the Kansas Department of Health and Environment on November 4, 2019.

B. Targeted Areas

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 utilizing BMPs in these specific areas, pollutants can be reduced at a more efficient rate.

The STEPL model, ground-truthing and the KDHE aerial assessment provided data used to determine the targeted areas for this Twin Lakes Watershed WRAPS plan. Final targeting assessment results were presented to and considered by the SLT, which decided to target the riparian corridors of all six HUC 12s in the watershed that drain into Council Grove Lake. Focusing on these areas will have positive impacts on all TMDLs in the watershed. The HUC 12s targeted include:

- 110702010**101**
- 110702010**102**
- 110702010**103**
- 110702010**104**
- 110702010**105**
- 110702010**106**

The SLT will focus BMP placement for sediment and nutrient runoff in the six HUC 12s listed above and will **target riparian corridors, one-half mile on either side of the stream segment** in the following land use areas:

1. Cropland areas will be targeted for **nutrients** (nitrogen and phosphorus).
2. Livestock areas will be targeted for **nutrients**.

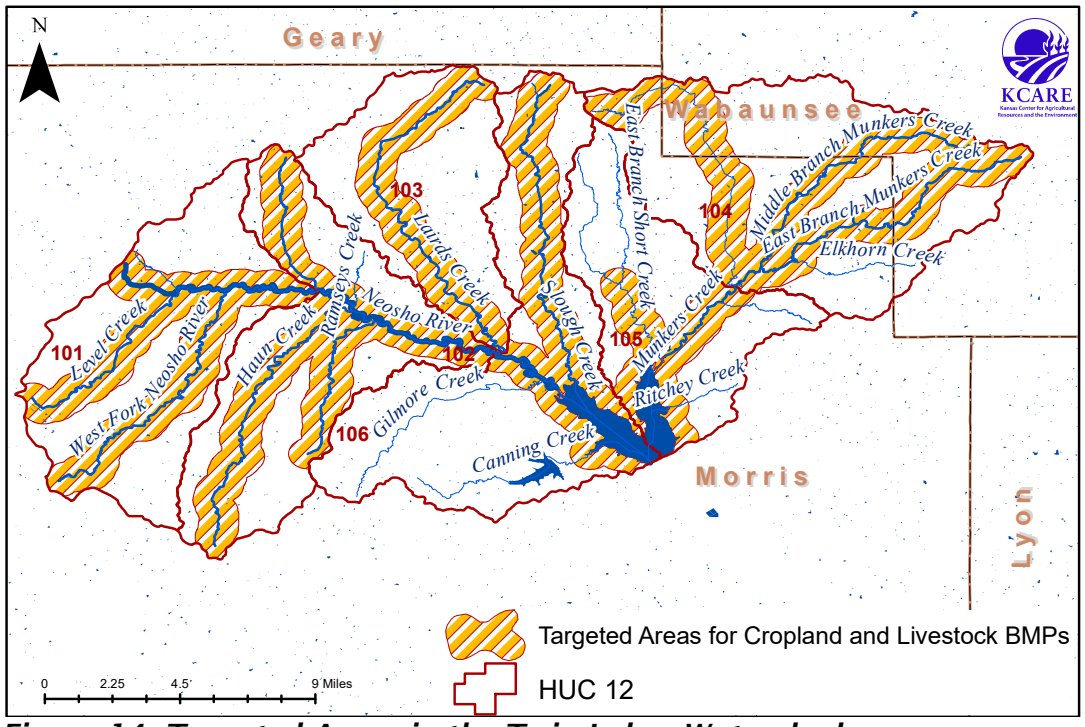


Figure 14. Targeted Areas in the Twin Lakes Watershed

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. 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 2017 Ag Census, stocking rates in the Twin Lakes Watershed ranges from 8.1 to 8.6 cattle per 100 acres.

[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 Twin Lakes Watershed will take place in HUCs 110702010**101**, **102**, **103**, **104**, **105,** and **106**. Cropland and livestock areas will be targeted in an effort to effectively improve the following TMDL impairments:

- **Eutrophication - nutrients (nitrogen and phosphorus): cropland and livestock areas**
- **Total Phosphorus: cropland and livestock areas**

The siltation TMDL in Council Grove Lake will not be targeted directly; however, cropland BMP implementation for nutrients will result in sediment load reductions. Sediment reductions will have positive impacts on the watershed's sediment and Cu TMDLs. Livestock BMPs will reduce both phosphorus and nitrogen nutrient loading, thereby improving not only the eutrophication TMDL but also the watershed's DO listings.

A. Nutrient Load Reductions in the Twin Lakes Watershed

The Twin Lakes Watershed has a "high" TMDL ranking for eutrophication (nitrogen and phosphorus) in Council Grove Lake and a "high" TMDL ranking for total phosphorus in the Neosho River near Parkerville. The watershed contains two targeted areas for nutrient load reductions: **cropland and livestock areas**. Adoption and implementation of nutrient BMPs will result in total nutrient load reductions of **159,826 pounds of nitrogen** and **73,668 pounds of phosphorus** at the conclusion of this 30-year WRAPS plan.

Riparian areas in the following HUC 12s will be targeted to reduce nutrients from entering water segments in the Twin Lakes Watershed:

- 110702010**101**
- 110702010**102**
- 110702010**103**
- 110702010**104**
- 110702010**105**
- 110702010**106**

There are 15,530 cropland acres and 45,327 grassland/pasture/hay acres in the riparian corridors of the six HUC 12s targeted for nutrient load reduction in the Twin Lakes Watershed (**Table 16**). Land use in the nutrient-targeted area makes a difference in the amount of nitrogen and phosphorus entering the water. Cropland is highly susceptible to runoff and erosion during rainfall events because nutrients leach to soil particles and enter nearby water segments. In addition, livestock areas in the six HUC 12s (grassland/pasture/hay land) have been added to the nutrient list of targeted areas. Variation in load reductions are due to differences in stocking rates and grazing duration in native grass pastures, cool-season grass pastures and cropland.

Table 15. Land Use in the Nutrient Targeted Areas

Nutrient Targeted Area Land Use in the Twin Lakes Watershed								
Land Use	Acres in Targeted HUC 12: 110702010...						Total Acres	% of Targeted Area
	101	102	103	104	105	106		
Grassland	6,799	9,921	4,059	8,753	3,547	6,217	39,296	56.0%
Cropland	4,044	2,866	2,056	4,088	838	1,638	15,530	22.1%
Pasture/Hay	806	649	598	2,975	284	719	6,031	8.6%
Dediduous Forest	561	1,057	635	720	586	856	4,415	6.3%
Developed, Open Space	640	450	230	667	194	374	2,554	3.6%
Woody Wetlands	138	359	165	29	90	287	1,069	1.5%
Water	77	58	11	45	145	369	705	1.0%
Developed, Low Intensity	59	24	4	94	76	47	305	0.4%
Mixed Forest	2	16	11	0	7	85	120	0.2%
Herbaceous Wetlands	7	7	3	4	7	32	61	0.1%
Developed, Medium Intensity	17	2	0	1	8	8	35	0.1%
Shrubland	0	1	0	11	22	1	35	< 0.1%
Barren Land	0	0	1	1	5	2	9	< 0.1%
Developed, High Intensity	0	0	0	0	0	0	0	0.0%
Totals	**13,148**	**15,411**	**7,773**	**17,389**	**5,809**	**10,634**	**70,163**	**100.0%**

1. Cropland targeted for nutrient reductions in the Twin Lakes Watershed

a. Targeted cropland areas for nutrient reductions

Cropland BMPs will be implemented in the Twin Lakes Watershed to protect the local streams, including the Neosho River, and ultimately Council Grove Lake by reducing nutrient loading. *Any cropland BMPs implemented in the targeted areas will simultaneously reduce both nutrient and sediment loading.*

As shown in **Figure 15**, cropland BMPs will be implemented along the riparian corridors in the following six HUC 12s:

- 110702010**101**
- 110702010**102**
- 110702010**103**
- 110702010**104**
- 110702010**105**
- 110702010**106**

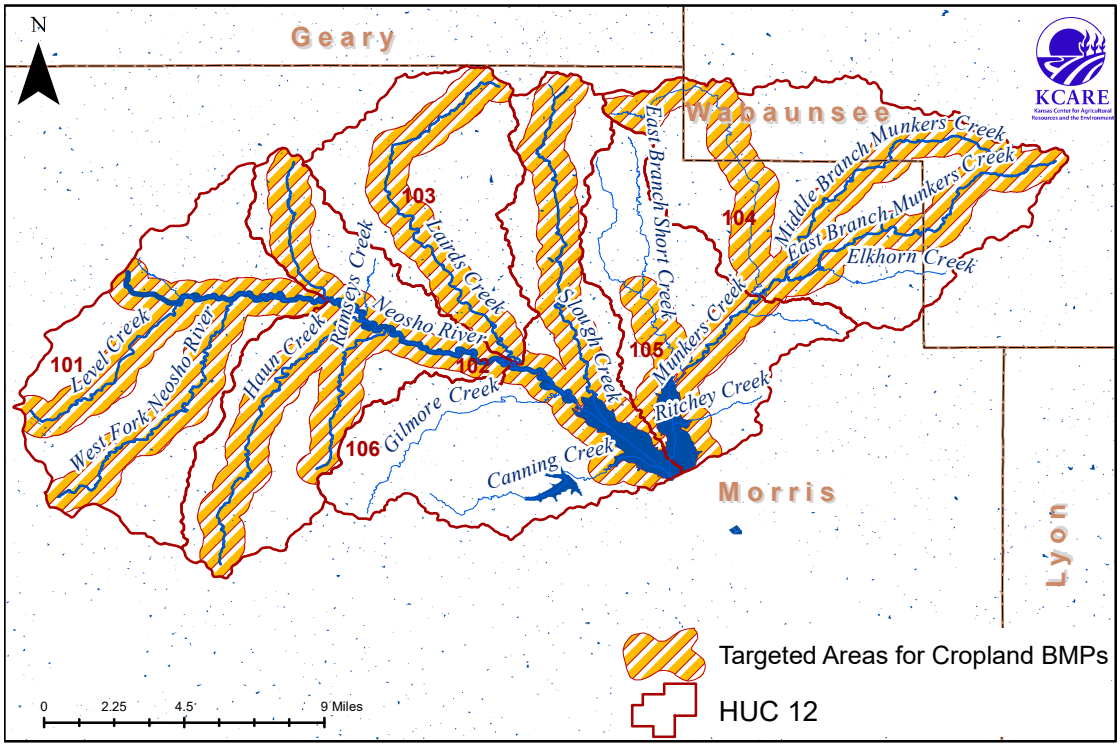


Figure 15. Cropland Targeted Area in the Twin Lakes Watershed

b. Cropland BMPs for nutrient reductions in the Twin Lakes Watershed

Within the six HUC 12 areas, the following BMPs will be implemented to reduce nutrient loading from crop fields:

- permanent vegetation,
- no-till with cover crops,
- terraces,
- waterways,
- vegetative buffers,
- nutrient management plans, and
- grade stabilization structures.

Table 16. Cropland BMPs Needed to Reduce Nutrient Loading

BMPs to Reduce Nutrient Loading		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of nutrient contribution from **cropland**	Permanent Vegetation	26 acres
	No-till with Cover Crops	155 acres
	Terraces	52 acres
	Waterways	52 acres
	Vegetative Buffers	52 acres
	Nutrient Management Plans	155 acres
	Grade Stabilization Structures	52 acres

Table 17. Adoption Rates for Cropland BMPs to Address Nutrients

Total Annual Adoption (treated acres), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Adoption
1	26	155	52	52	52	155	52	544
2	26	155	52	52	52	155	52	544
3	26	155	52	52	52	155	52	544
4	26	155	52	52	52	155	52	544
5	26	155	52	52	52	155	52	544
6	26	155	52	52	52	155	52	544
7	26	155	52	52	52	155	52	544
8	26	155	52	52	52	155	52	544
9	26	155	52	52	52	155	52	544
10	26	155	52	52	52	155	52	544
11	26	155	52	52	52	155	52	544
12	26	155	52	52	52	155	52	544
13	26	155	52	52	52	155	52	544
14	26	155	52	52	52	155	52	544
15	26	155	52	52	52	155	52	544
16	26	155	52	52	52	155	52	544
17	26	155	52	52	52	155	52	544
18	26	155	52	52	52	155	52	544
19	26	155	52	52	52	155	52	544
20	26	155	52	52	52	155	52	544
21	26	155	52	52	52	155	52	544
22	26	155	52	52	52	155	52	544
23	26	155	52	52	52	155	52	544
24	26	155	52	52	52	155	52	544
25	26	155	52	52	52	155	52	544
26	26	155	52	52	52	155	52	544
27	26	155	52	52	52	155	52	544
28	26	155	52	52	52	155	52	544
29	26	155	52	52	52	155	52	544
30	26	155	52	52	52	155	52	544
Total	**777**	**4,659**	**1,553**	**1,553**	**1,553**	**4,659**	**1,553**	**16,307**

c. *Nutrient load reductions from cropland BMP implementation*

The implementation of cropland BMPs on 544 acres per year in the six HUC 12s will result in a nitrogen load reduction of 53,800 pounds and a phosphorus reduction of 17,376 pounds at the end of this 30-year WRAPS plan (**Tables 19** and **20**).

Table 18. Cumulative Nitrogen Load Reductions from Cropland BMP Implementation

Annual Nitrogen Reduction (lbs), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	268	424	169	226	141	424	141	1,793
2	537	847	339	452	282	847	282	3,587
3	805	1,271	508	678	424	1,271	424	5,380
4	1,073	1,695	678	904	565	1,695	565	7,173
5	1,341	2,118	847	1,130	706	2,118	706	8,967
6	1,610	2,542	1,017	1,356	847	2,542	847	10,760
7	1,878	2,965	1,186	1,582	988	2,965	988	12,553
8	2,146	3,389	1,356	1,807	1,130	3,389	1,130	14,347
9	2,415	3,813	1,525	2,033	1,271	3,813	1,271	16,140
10	2,683	4,236	1,695	2,259	1,412	4,236	1,412	17,933
11	2,951	4,660	1,864	2,485	1,553	4,660	1,553	19,727
12	3,220	5,084	2,033	2,711	1,695	5,084	1,695	21,520
13	3,488	5,507	2,203	2,937	1,836	5,507	1,836	23,314
14	3,756	5,931	2,372	3,163	1,977	5,931	1,977	25,107
15	4,024	6,354	2,542	3,389	2,118	6,354	2,118	26,900
16	4,293	6,778	2,711	3,615	2,259	6,778	2,259	28,694
17	4,561	7,202	2,881	3,841	2,401	7,202	2,401	30,487
18	4,829	7,625	3,050	4,067	2,542	7,625	2,542	32,280
19	5,098	8,049	3,220	4,293	2,683	8,049	2,683	34,074
20	5,366	8,473	3,389	4,519	2,824	8,473	2,824	35,867
21	5,634	8,896	3,558	4,745	2,965	8,896	2,965	37,660
22	5,903	9,320	3,728	4,971	3,107	9,320	3,107	39,454
23	6,171	9,743	3,897	5,196	3,248	9,743	3,248	41,247
24	6,439	10,167	4,067	5,422	3,389	10,167	3,389	43,040
25	6,707	10,591	4,236	5,648	3,530	10,591	3,530	44,834
26	6,976	11,014	4,406	5,874	3,671	11,014	3,671	46,627
27	7,244	11,438	4,575	6,100	3,813	11,438	3,813	48,420
28	7,512	11,862	4,745	6,326	3,954	11,862	3,954	50,214
29	7,781	12,285	4,914	6,552	4,095	12,285	4,095	52,007
30	8,049	12,709	5,084	6,778	4,236	12,709	4,236	53,800

Table 19. Cumulative Phosphorus Reductions from Cropland BMP Implementation

Annual Phosphorus Reduction (lbs), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	62	196	39	52	65	98	65	579
2	124	393	79	105	131	196	131	1,158
3	187	589	118	157	196	295	196	1,738
4	249	785	157	209	262	393	262	2,317
5	311	982	196	262	327	491	327	2,896
6	373	1,178	236	314	393	589	393	3,475
7	435	1,374	275	367	458	687	458	4,054
8	497	1,571	314	419	524	785	524	4,634
9	560	1,767	353	471	589	884	589	5,213
10	622	1,963	393	524	654	982	654	5,792
11	684	2,160	432	576	720	1,080	720	6,371
12	746	2,356	471	628	785	1,178	785	6,950
13	808	2,552	510	681	851	1,276	851	7,530
14	870	2,749	550	733	916	1,374	916	8,109
15	933	2,945	589	785	982	1,473	982	8,688
16	995	3,141	628	838	1,047	1,571	1,047	9,267
17	1,057	3,338	668	890	1,113	1,669	1,113	9,846
18	1,119	3,534	707	942	1,178	1,767	1,178	10,426
19	1,181	3,730	746	995	1,243	1,865	1,243	11,005
20	1,243	3,927	785	1,047	1,309	1,963	1,309	11,584
21	1,306	4,123	825	1,100	1,374	2,062	1,374	12,163
22	1,368	4,319	864	1,152	1,440	2,160	1,440	12,743
23	1,430	4,516	903	1,204	1,505	2,258	1,505	13,322
24	1,492	4,712	942	1,257	1,571	2,356	1,571	13,901
25	1,554	4,909	982	1,309	1,636	2,454	1,636	14,480
26	1,617	5,105	1,021	1,361	1,702	2,552	1,702	15,059
27	1,679	5,301	1,060	1,414	1,767	2,651	1,767	15,639
28	1,741	5,498	1,100	1,466	1,833	2,749	1,833	16,218
29	1,803	5,694	1,139	1,518	1,898	2,847	1,898	16,797
30	1,865	5,890	1,178	1,571	1,963	2,945	1,963	17,376

2. Livestock areas targeted for nutrient reduction in the Twin Lakes Watershed

a. Targeted livestock areas for nutrient reductions

Livestock area BMPs will be implemented in the Twin Lakes Watershed to protect the local streams, including the Neosho River, and ultimately, Council Grove Lake by reducing nutrient loading.

As shown in **Figure 16**, livestock area BMPs will be implemented along the riparian corridors in the following six HUC 12s:

- 110702010**101**

- 110702010**102**
- 110702010**103**
- 110702010**104**
- 110702010**105**
- 110702010**106**

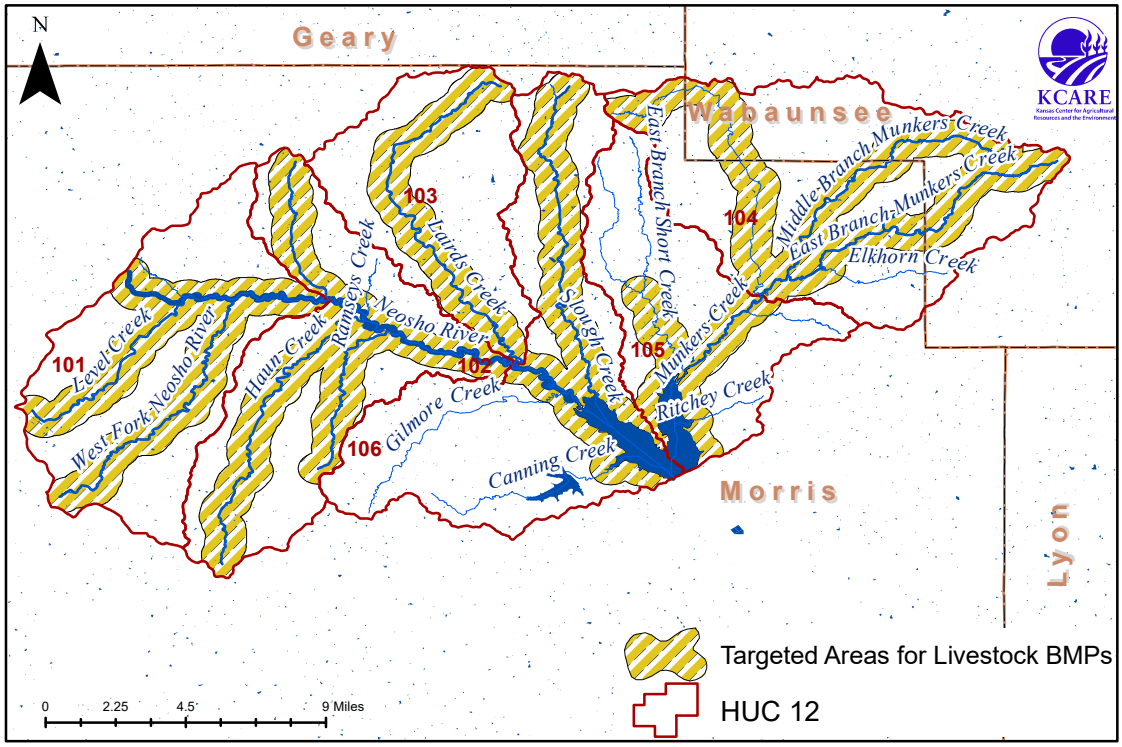


Figure 16. Livestock Targeted Area in the Twin Lakes Watershed

b. Livestock area BMPs for nutrient reductions in the Twin Lakes Watershed

Within the six HUC 12 areas, the following BMPs will be implemented to reduce nutrient loading from crop fields:

- vegetative filter strip,
- relocate feeding pens,
- relocate pasture feeding sites,
- off-stream watering systems, and
- rotational grazing.

Table 20. Nutrient BMP Adoption Rates in Livestock Areas

BMPs to Reduce Nutrient Loading		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of nutrient contribution from **livestock**	Vegetative Filter Strip	1 project per year
	Relocate Feeding Pens	1 project every 2 years
	Relocate Pasture Feeding Sites	1 project per year
	Off-Stream Watering System	3 projects per year
	Rotational Grazing	1 project every 2 years

Table 21. Adoption Rates for Livestock BMPs to Address Nutrients

Annual Livestock BMP Adoption						
Year	**Vegetative Filter Strip**	**Relocate Feeding Pens**	**Relocate Pasture Feeding Site**	**Off-Stream Watering System**	**Rotational Grazing**	**Projects Per Year**
1	1	1	1	3		6
2	1		1	3	1	6
3	1	1	1	3		6
4	1		1	3	1	6
5	1	1	1	3		6
6	1		1	3	1	6
7	1	1	1	3		6
8	1		1	3	1	6
9	1	1	1	3		6
10	1		1	3	1	6
11	1	1	1	3		6
12	1		1	3	1	6
13	1	1	1	3		6
14	1		1	3	1	6
15	1	1	1	3		6
16	1		1	3	1	6
17	1	1	1	3		6
18	1		1	3	1	6
19	1	1	1	3		6
20	1		1	3	1	6
21	1	1	1	3		6
22	1		1	3	1	6
23	1	1	1	3		6
24	1		1	3	1	6
25	1	1	1	3		6
26	1		1	3	1	6
27	1	1	1	3		6
28	1		1	3	1	6
29	1	1	1	3		6
30	1		1	3	1	6
Total	**30**	**15**	**30**	**90**	**15**	**180**

c. ***Nutrient load reductions from livestock BMP implementation***

The implementation of six livestock BMP projects per year in the six targeted HUC 12s will result in a nitrogen load reduction of 106,025 pounds and a phosphorus load reduction of 56,292 pounds at the end of this 30-year WRAPS plan (**Tables 23** and **24**).

Table 22. Cumulative Nitrogen Reductions from Livestock BMP Implementation

Annual Nitrogen Load Reductions (lbs)						
Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Annual Load Reduction
1	1,673	3,179	56	205	0	5,114
2	3,346	3,179	113	410	20	7,068
3	5,019	6,358	169	616	20	12,182
4	6,692	6,358	225	821	40	14,137
5	8,366	9,537	282	1,026	40	19,250
6	10,039	9,537	338	1,231	60	21,205
7	11,712	12,716	394	1,437	60	26,319
8	13,385	12,716	451	1,642	80	28,273
9	15,058	15,895	507	1,847	80	33,387
10	16,731	15,895	563	2,052	101	35,342
11	18,404	19,073	620	2,257	101	40,455
12	20,077	19,073	676	2,463	121	42,410
13	21,750	22,252	732	2,668	121	47,524
14	23,424	22,252	789	2,873	141	49,479
15	25,097	25,431	845	3,078	141	54,592
16	26,770	25,431	901	3,283	161	56,547
17	28,443	28,610	958	3,489	161	61,660
18	30,116	28,610	1,014	3,694	181	63,615
19	31,789	31,789	1,070	3,899	181	68,729
20	33,462	31,789	1,127	4,104	201	70,684
21	35,135	34,968	1,183	4,310	201	75,797
22	36,808	34,968	1,239	4,515	221	77,752
23	38,482	38,147	1,296	4,720	221	82,866
24	40,155	38,147	1,352	4,925	241	84,820
25	41,828	41,326	1,408	5,130	241	89,934
26	43,501	41,326	1,465	5,336	262	91,889
27	45,174	44,505	1,521	5,541	262	97,002
28	46,847	44,505	1,577	5,746	282	98,957
29	48,520	47,684	1,634	5,951	282	104,071
30	50,193	47,684	1,690	6,156	302	106,025

Table 23. Cumulative Phosphorus Reductions from Livestock BMP Implementation

Annual Phosphorus Load Reductions (lbs)						
Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Annual Load Reduction
1	888	1,688	30	109	0	2,715
2	1,777	1,688	60	218	11	3,753
3	2,665	3,376	90	327	11	6,468
4	3,553	3,376	120	436	21	7,506
5	4,442	5,063	150	545	21	10,220
6	5,330	5,063	179	654	32	11,258
7	6,218	6,751	209	763	32	13,973
8	7,106	6,751	239	872	43	15,011
9	7,995	8,439	269	981	43	17,726
10	8,883	8,439	299	1,090	53	18,764
11	9,771	10,127	329	1,198	53	21,479
12	10,660	10,127	359	1,307	64	22,517
13	11,548	11,814	389	1,416	64	25,232
14	12,436	11,814	419	1,525	75	26,269
15	13,325	13,502	449	1,634	75	28,984
16	14,213	13,502	479	1,743	85	30,022
17	15,101	15,190	508	1,852	85	32,737
18	15,989	15,190	538	1,961	96	33,775
19	16,878	16,878	568	2,070	96	36,490
20	17,766	16,878	598	2,179	107	37,528
21	18,654	18,565	628	2,288	107	40,243
22	19,543	18,565	658	2,397	117	41,281
23	20,431	20,253	688	2,506	117	43,996
24	21,319	20,253	718	2,615	128	45,033
25	22,208	21,941	748	2,724	128	47,748
26	23,096	21,941	778	2,833	139	48,786
27	23,984	23,629	808	2,942	139	51,501
28	24,872	23,629	837	3,051	150	52,539
29	25,761	25,317	867	3,160	150	55,254
30	26,649	25,317	897	3,269	160	56,292

3. Meeting the eutrophication/nutrient TMDL in the Twin Lakes Watershed

Adoption and implementation of nutrient BMPs in cropland and livestock areas will result in a total nitrogen load reduction of 159,825 pounds at the conclusion of this 30-year WRAPS plan. The load reduction goal to meet the nutrient TMDL is 242,435 pounds of nitrogen, therefore the implementation of all nutrient BMPs during the 30-year span will

fall short of meeting the nitrogen reduction goal by nearly 34% (**Table 25**). Adoption and implementation of these BMPs also will result in a total phosphorus load reduction of 73,668 pounds at the conclusion of this 30-year WRAPS plan. The load reduction goal to meet the nutrient TMDL is 68,767 pounds of phosphorus, therefore the implementation of all nutrient BMPs will exceed the phosphorus reduction goal by 107% (**Table 26**).

Table 24. Meeting the Twin Lakes Watershed Nutrient Goal: Nitrogen

Meeting the Eutrophication/Nutrient TMDL: Nitrogen		
BMP Category	**Total Load Reduction (pounds)**	**% of Nitrogen TMDL**
Cropland	53,800	22.2%
Livestock	106,025	43.7%
Total	**159,826**	**65.9%**
Nitrogen Reduction Goal: 242,435 pounds		

Table 25. Meeting the Twin Lakes Watershed Nutrient Goal: Phosphorus

Meeting the Eutrophication/Nutrient TMDL: Phosphorus		
BMP Category	**Total Load Reduction (pounds)**	**% of Phosphorous TMDL**
Cropland	17,376	25.3%
Livestock	56,292	81.9%
Total	**73,668**	**107.1%**
Phosphorus Reduction Goal: 68,767 pounds		

Table 26. Meeting the Nutrient TMDL: Cumulative Nitrogen Reductions by Area

Nitrogen Reduction from Cropland and Livestock BMPs				
Year	Cropland Reduction (lbs/yr)	Livestock Reduction (lbs/yr)	Total Reduction (lbs/yr)	% of TMDL
1	1,793	5,114	6,907	2.8%
2	3,587	7,068	10,655	4.4%
3	5,380	12,182	17,562	7.2%
4	7,173	14,137	21,310	8.8%
5	8,967	19,250	28,217	11.6%
6	10,760	21,205	31,965	13.2%
7	12,553	26,319	38,872	16.0%
8	14,347	28,273	42,620	17.6%
9	16,140	33,387	49,527	20.4%
10	17,933	35,342	53,275	22.0%
11	19,727	40,455	60,182	24.8%
12	21,520	42,410	63,930	26.4%
13	23,314	47,524	70,837	29.2%
14	25,107	49,479	74,585	30.8%
15	26,900	54,592	81,492	33.6%
16	28,694	56,547	85,240	35.2%
17	30,487	61,660	92,147	38.0%
18	32,280	63,615	95,895	39.6%
19	34,074	68,729	102,802	42.4%
20	35,867	70,684	106,551	44.0%
21	37,660	75,797	113,457	46.8%
22	39,454	77,752	117,206	48.3%
23	41,247	82,866	124,112	51.2%
24	43,040	84,820	127,861	52.7%
25	44,834	89,934	134,768	55.6%
26	46,627	91,889	138,516	57.1%
27	48,420	97,002	145,423	60.0%
28	50,214	98,957	149,171	61.5%
29	52,007	104,071	156,078	64.4%
30	53,800	106,025	159,826	65.9%

Table 27. Meeting the Nutrient TMDL: Cumulative Phosphorus Load Reductions by Area

Phosphorus Reduction from Cropland and Livestock BMPs				
Year	Cropland Reduction (lbs/yr)	Livestock Reduction (lbs/yr)	Total Reduction (lbs/yr)	% of TMDL
1	579	2,715	3,294	4.8%
2	1,158	3,753	4,911	7.1%
3	1,738	6,468	8,205	11.9%
4	2,317	7,506	9,822	14.3%
5	2,896	10,220	13,117	19.1%
6	3,475	11,258	14,734	21.4%
7	4,054	13,973	18,028	26.2%
8	4,634	15,011	19,645	28.6%
9	5,213	17,726	22,939	33.4%
10	5,792	18,764	24,556	35.7%
11	6,371	21,479	27,850	40.5%
12	6,950	22,517	29,467	42.9%
13	7,530	25,232	32,761	47.6%
14	8,109	26,269	34,378	50.0%
15	8,688	28,984	37,672	54.8%
16	9,267	30,022	39,290	57.1%
17	9,846	32,737	42,584	61.9%
18	10,426	33,775	44,201	64.3%
19	11,005	36,490	47,495	69.1%
20	11,584	37,528	49,112	71.4%
21	12,163	40,243	52,406	76.2%
22	12,743	41,281	54,023	78.6%
23	13,322	43,996	57,317	83.3%
24	13,901	45,033	58,934	85.7%
25	14,480	47,748	62,228	90.5%
26	15,059	48,786	63,845	92.8%
27	15,639	51,501	67,140	97.6%
28	16,218	52,539	68,757	100.0%
29	16,797	55,254	72,051	104.8%
30	17,376	56,292	73,668	107.1%

BMPs implemented in livestock areas will reduce both phosphorus and nitrogen nutrient loading, thereby improving not only the eutrophication TMDL but also the TP and DO listings in the watershed.

B. Sediment Load Reductions in the Twin Lakes Watershed

The Twin Lakes Watershed has a "high" TMDL ranking for sediment in Council Grove Lake. As previously mentioned, the watershed contains two targeted areas for nutrient load reductions: cropland and livestock areas along riparian corridors. The adoption and implementation of nutrient BMPs in these areas, cropland in particular, will result in a positive impact on sediment loading. It is estimated that sediment loading will be reduced by 266 tons per year for a total of 7,992 tons at the conclusion of this 30-year WRAPS plan (**Table 29**).

Table 28. Cumulative Sediment Reductions from Cropland BMP Implementation

Annual Sediment Load Reduction (tons), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	24	116	15	21	26	39	26	266
2	49	232	31	41	51	77	51	533
3	73	347	46	62	77	116	77	799
4	98	463	62	82	103	154	103	1,066
5	122	579	77	103	129	193	129	1,332
6	147	695	93	124	154	232	154	1,598
7	171	811	108	144	180	270	180	1,865
8	196	927	124	165	206	309	206	2,131
9	220	1,042	139	185	232	347	232	2,398
10	245	1,158	154	206	257	386	257	2,664
11	269	1,274	170	227	283	425	283	2,930
12	293	1,390	185	247	309	463	309	3,197
13	318	1,506	201	268	335	502	335	3,463
14	342	1,622	216	288	360	541	360	3,730
15	367	1,737	232	309	386	579	386	3,996
16	391	1,853	247	329	412	618	412	4,262
17	416	1,969	263	350	438	656	438	4,529
18	440	2,085	278	371	463	695	463	4,795
19	465	2,201	293	391	489	734	489	5,062
20	489	2,317	309	412	515	772	515	5,328
21	514	2,432	324	432	541	811	541	5,594
22	538	2,548	340	453	566	849	566	5,861
23	562	2,664	355	474	592	888	592	6,127
24	587	2,780	371	494	618	927	618	6,394
25	611	2,896	386	515	643	965	643	6,660
26	636	3,012	402	535	669	1,004	669	6,926
27	660	3,127	417	556	695	1,042	695	7,193
28	685	3,243	432	577	721	1,081	721	7,459
29	709	3,359	448	597	746	1,120	746	7,726
30	734	3,475	463	618	772	1,158	772	7,992

Sediment reductions from cropland implemented BMPs will have positive impacts on the sediment and Cu TMDLs in the watershed.

8. Information and Education

The SLT determined which Information and Education (I&E) activities are needed in the Twin Lakes Watershed. These important activities provide watershed residents with a higher awareness of local watershed issues, leading 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 Scheduled in the Twin Lakes 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 cost would be **$35,300**. *It is understood that funding from non-WRAPS sources will be required if all these activities are to take place.*

Table 29. I&E: Cropland BMP Education

Cropland BMP Implementation					
BMP	**Target Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
No-till and Cover Crops	Landowners and Farmers	Newsletter Article	Annual	No charge	Morris and Wabaunsee County Conservation Districts, No-Till on the Plains, KSRE
		One-on-One Meetings with Producers	Annual - ongoing	$500	Morris and Wabaunsee County Conservation Districts, No-Till on the Plains, KSRE, NRCS
		No-Till/Cover Crop Workshop*	Annual - Spring	$2,500 per event	Morris and Wabaunsee County Conservation Districts, No-Till on the Plains, KSRE, NRCS
		Scholarships for producers to attend No-Till Water Conference	Annual - Winter	$1,100 ($275 per person for 4 individuals)	No-till on the Plains, DOC
Nutrient Management	Farmers	Cost Share for 50 Soil Tests	Annual - ongoing	$500	Morris and Wabaunsee County Conservation Districts, KSRE, NRCS
		Newsletter Articles	Annual	No charge	Morris and Wabaunsee County Conservation Districts, KSRE
		One-on-One Meetings with Producers	Annual - ongoing	$500	KSRE Watershed Specialist, Morris and Wabaunsee County Conservation Districts, Kansas Rural Center
Permanent Vegetation, Terraces, Waterways, Vegetative Buffers, and Grade Stabilization Structures	Landowners and Farmers	Demonstrataion Project*	Annual	$2,500 per event	Kansas Rural Center, NRCS, Kansas Forest Service
		Tour/Field Day to Highlight Buffers*	Annual - ongoing	$500 per event	Morris and Wabaunsee County Conservation Districts, Kansas Forest Service, KSRE, NRCS
		Newspaper Articles	Annual - ongoing	No charge	Morris and Wabaunsee County Conservation Districts, NRCS
		Soil Testing	Ongoing	$500	Morris and Wabaunsee County Conservation Districts, KSRE, NRCS
		One-on-One Meetings with Producers	Annual - ongoing	$500	Morris and Wabaunsee County Conservation Districts, Kansas Forest Service, KSRE, NRCS

Table 30. I&E: Livestock BMP Education

Livestock BMP Implementation					
BMP	**Target Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
Vegetative Filter Strips	Landowners and Ranchers	Tour/Field Day*	Annual	$1,000 per event	Morris and Wabaunsee County Conservation Districts, KSRE, Kansas Rural Center
		Demonstration Project*	Annual	$2,500 per event	Morris and Wabaunsee County Conservation Districts, KSRE, Kansas Rural Center
		Workshop/Tour*	Annual	$500 per event	Morris and Wabaunsee County Conservation Districts, KSRE, Kansas Rural Center
		Livestock Filter Strip and Feedlot Relocation Demonstration/Tour*	Annual	$300 per event	Morris and Wabaunsee County Conservation Districts, NRCS
Relocated Feeding Pens	Landowners and Small Feedlot Operators	Demonstration Project*	Annual	$2,500 per event	Morris and Wabaunsee County Conservation Districts, KSRE, Kansas Rural Center
		Tour/Field Day*	Annual	$500 per event	Morris and Wabaunsee County Conservation Districts, KSRE, Kansas Rural Center
		Cost-share Program Promotion	Annual	No charge	Morris and Wabaunsee County Conservation Districts, KSRE, Kansas Rural Center
Relocate Pasture Feeding Site	Ranchers	Tour/Field Day*	Annual - Summer	$1,000 per event	KSRE Watershed Specialist, Morris and Wabaunsee County Conservation Districts, Kansas Rural Center, NRCS, DOC
		Grazing Information Meeting	Annual - Fall	$250 per meeting	Morris and Wabaunsee County Conservation Districts, Kansas Rural Center
		Demonstration Project*	Annual - Spring	$2,500 per event	KSRE Watershed Specialist, Morris and Wabaunsee County Conservation Districts, Kansas Rural Center, NRCS, DOC
Off-Stream Watering System	Ranchers	Demonstration Project*	Annual	$2,500 per event	KSRE Watershed Specialist, Morris and Wabaunsee County Conservation Districts, Kansas Rural Center, NRCS, DOC
		Tour/Field Day*	Annual	$1,000 per event	KSRE Watershed Specialist, Morris and Wabaunsee County Conservation Districts, Kansas Rural Center, NRCS, DOC
		Grazing Information Meeting	Annual	Combined with relocating pasture feeding site meeting	KSRE Watershed Specialist, Morris and Wabaunsee County Conservation Districts, Kansas Rural Center, NRCS, DOC
Rotational Grazing	Ranchers	Demonstration Project*	Annual - Ongoing	$1,000 per event	KSRE Watershed Specialist, Morris and Wabaunsee County Conservation Districts, Kansas Rural Center, NRCS, DOC
		Tour/Field Day*	Annual - Ongoing	$1,000 per event	KSRE Watershed Specialist, Morris and Wabaunsee County Conservation Districts, Kansas Rural Center, NRCS, DOC

Table 31. I&E: Twin Lakes Watershed Resident Education

Watershed-wide Information and Education					
BMP	**Target Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
Education of Watershed Residents	Youth	Poster, Essay and Speech Contests	Annual - Fall	$200	Morris and Wabaunsee County Conservation Districts
		Water Festival	Annual - Fall	$5,000	Morris and Wabaunsee County Conservation Districts, KSRE, NRCS
		Envirothon	Annual - Spring	$250	Morris and Wabaunsee County Conservation Districts
	Adult Residents	Presentation at annual meeting	Annual – Winter	No Charge	Morris and Wabaunsee County Conservation Districts, KSRE
		Media Campaign to promote healthy watersheds (brochures, news releases, TV, radio, social media, etc)	Ongoing	$1,000 per year	Kansas Water Office, Twin Lakes WRAPS, Morris County Conservation District, NRCS
		Educational campaign about leaking/failing septic systems	Ongoing	$1,500 per year	Local Environmental Protection Programs
		Meeting with Soil and Grassland Awards	Annual - Ongoing	$200	Morris and Wabaunsee County Conservation Districts
		Media Campaign to promote healthy watersheds (brochures, news releases, TV, radio, social media, etc)	Ongoing	$500 per year	Kansas Water Office, Twin Lakes WRAPS, Morris County Conservation District, NRCS
		Media Campaign to address urban nutrient runoff (flyers or brochures addressing phosphate and nitrate pollution from urban areas)	Annual - Ongoing	$500 per campaign	Local Environmental Protection Programs
		Watershed Display for area events	Annual - Ongoing	$500 per event	Morris and Wabaunsee County Conservation Districts, KSRE
Total annual cost for Information and Education if all events are implemented.				**$35,300**	
** These events may be combined with other events, which will reduce the expense significantly. The total is based on each event being held indvidually.*					

B. Evaluation of Information and Education Activities

All service providers conducting I&E activities funded through the Twin Lakes Watershed 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 achievement of 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 SLT reviewed all the recommended BMPs listed in this WRAPS plan to address the eutrophication TMDL and determined which BMPs will receive implementation funding in each category (cropland and livestock areas). An added benefit is that most of the targeted BMPs will have positive impacts on other impairments in the Twin Lakes Watershed. Below are expenses before and after cost share for implementing cropland and livestock BMPs. Costs can be shared with any potential funding sources (**Table 39**). Cost derivations are located in the appendix.

A. Cropland BMP Implementation Costs

Table 32. Implementation Costs: Cropland BMP Costs Before Cost Share

Annual Cost* Before Cost-Share, Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Cost
1	$3,883	$12,065	$5,280	$8,283	$5,177	$8,807	$15,530	$59,024
2	$3,999	$12,427	$5,439	$8,531	$5,332	$9,071	$15,996	$60,795
3	$4,119	$12,800	$5,602	$8,787	$5,492	$9,343	$16,476	$62,619
4	$4,243	$13,184	$5,770	$9,051	$5,657	$9,624	$16,970	$64,498
5	$4,370	$13,580	$5,943	$9,322	$5,826	$9,912	$17,479	$66,432
6	$4,501	$13,987	$6,121	$9,602	$6,001	$10,210	$18,004	$68,425
7	$4,636	$14,407	$6,305	$9,890	$6,181	$10,516	$18,544	$70,478
8	$4,775	$14,839	$6,494	$10,187	$6,367	$10,832	$19,100	$72,593
9	$4,918	$15,284	$6,689	$10,492	$6,558	$11,157	$19,673	$74,770
10	$5,066	$15,742	$6,889	$10,807	$6,754	$11,491	$20,263	$77,013
11	$5,218	$16,215	$7,096	$11,131	$6,957	$11,836	$20,871	$79,324
12	$5,374	$16,701	$7,309	$11,465	$7,166	$12,191	$21,497	$81,704
13	$5,536	$17,202	$7,528	$11,809	$7,381	$12,557	$22,142	$84,155
14	$5,702	$17,718	$7,754	$12,163	$7,602	$12,933	$22,806	$86,679
15	$5,873	$18,250	$7,987	$12,528	$7,830	$13,321	$23,491	$89,280
16	$6,049	$18,797	$8,226	$12,904	$8,065	$13,721	$24,195	$91,958
17	$6,230	$19,361	$8,473	$13,291	$8,307	$14,133	$24,921	$94,717
18	$6,417	$19,942	$8,727	$13,690	$8,556	$14,557	$25,669	$97,558
19	$6,610	$20,540	$8,989	$14,101	$8,813	$14,993	$26,439	$100,485
20	$6,808	$21,157	$9,259	$14,524	$9,077	$15,443	$27,232	$103,500
21	$7,012	$21,791	$9,537	$14,959	$9,350	$15,907	$28,049	$106,605
22	$7,223	$22,445	$9,823	$15,408	$9,630	$16,384	$28,890	$109,803
23	$7,439	$23,118	$10,117	$15,870	$9,919	$16,875	$29,757	$113,097
24	$7,662	$23,812	$10,421	$16,347	$10,217	$17,382	$30,650	$116,490
25	$7,892	$24,526	$10,734	$16,837	$10,523	$17,903	$31,569	$119,984
26	$8,129	$25,262	$11,056	$17,342	$10,839	$18,440	$32,516	$123,584
27	$8,373	$26,020	$11,387	$17,862	$11,164	$18,993	$33,492	$127,291
28	$8,624	$26,800	$11,729	$18,398	$11,499	$19,563	$34,497	$131,110
29	$8,883	$27,604	$12,081	$18,950	$11,844	$20,150	$35,532	$135,043
30	$9,149	$28,433	$12,443	$19,519	$12,199	$20,754	$36,597	$139,095
*3% Inflation							Total	$2,808,108

Table 33. Implementation Costs: Cropland BMP Costs After Cost Share

Annual Cost* After Cost-Share, Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Cost
1	$971	$6,033	$4,488	$2,071	$518	$2,202	$3,883	$20,164
2	$1,000	$6,214	$4,623	$2,133	$533	$2,268	$3,999	$20,769
3	$1,030	$6,400	$4,761	$2,197	$549	$2,336	$4,119	$21,392
4	$1,061	$6,592	$4,904	$2,263	$566	$2,406	$4,243	$22,034
5	$1,092	$6,790	$5,051	$2,331	$583	$2,478	$4,370	$22,695
6	$1,125	$6,993	$5,203	$2,400	$600	$2,552	$4,501	$23,376
7	$1,159	$7,203	$5,359	$2,472	$618	$2,629	$4,636	$24,077
8	$1,194	$7,419	$5,520	$2,547	$637	$2,708	$4,775	$24,799
9	$1,230	$7,642	$5,685	$2,623	$656	$2,789	$4,918	$25,543
10	$1,266	$7,871	$5,856	$2,702	$675	$2,873	$5,066	$26,309
11	$1,304	$8,107	$6,032	$2,783	$696	$2,959	$5,218	$27,099
12	$1,344	$8,351	$6,213	$2,866	$717	$3,048	$5,374	$27,912
13	$1,384	$8,601	$6,399	$2,952	$738	$3,139	$5,536	$28,749
14	$1,425	$8,859	$6,591	$3,041	$760	$3,233	$5,702	$29,612
15	$1,468	$9,125	$6,789	$3,132	$783	$3,330	$5,873	$30,500
16	$1,512	$9,399	$6,992	$3,226	$807	$3,430	$6,049	$31,415
17	$1,558	$9,681	$7,202	$3,323	$831	$3,533	$6,230	$32,357
18	$1,604	$9,971	$7,418	$3,422	$856	$3,639	$6,417	$33,328
19	$1,652	$10,270	$7,641	$3,525	$881	$3,748	$6,610	$34,328
20	$1,702	$10,578	$7,870	$3,631	$908	$3,861	$6,808	$35,358
21	$1,753	$10,896	$8,106	$3,740	$935	$3,977	$7,012	$36,418
22	$1,806	$11,222	$8,349	$3,852	$963	$4,096	$7,223	$37,511
23	$1,860	$11,559	$8,600	$3,968	$992	$4,219	$7,439	$38,636
24	$1,916	$11,906	$8,858	$4,087	$1,022	$4,345	$7,662	$39,795
25	$1,973	$12,263	$9,124	$4,209	$1,052	$4,476	$7,892	$40,989
26	$2,032	$12,631	$9,397	$4,336	$1,084	$4,610	$8,129	$42,219
27	$2,093	$13,010	$9,679	$4,466	$1,116	$4,748	$8,373	$43,486
28	$2,156	$13,400	$9,970	$4,600	$1,150	$4,891	$8,624	$44,790
29	$2,221	$13,802	$10,269	$4,738	$1,184	$5,037	$8,883	$46,134
30	$2,287	$14,216	$10,577	$4,880	$1,220	$5,189	$9,149	$47,518
*3% Inflation							Total	$959,312

B. Livestock BMP Implementation Costs

Table 34. Implementation Costs: Livestock BMPs Before Cost Share

Annual Cost* Before Cost-Share of Implementing Livestock BMPs						
Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Annual Cost
1	$714	$6,621	$2,203	$11,385	$0	$20,923
2	$735	$0	$2,269	$11,727	$7,210	$21,941
3	$757	$7,024	$2,337	$12,078	$0	$22,197
4	$780	$0	$2,407	$12,441	$7,649	$23,277
5	$804	$7,452	$2,479	$12,814	$0	$23,549
6	$828	$0	$2,554	$13,198	$8,115	$24,695
7	$853	$7,906	$2,630	$13,594	$0	$24,983
8	$878	$0	$2,709	$14,002	$8,609	$26,199
9	$904	$8,387	$2,791	$14,422	$0	$26,505
10	$932	$0	$2,874	$14,855	$9,133	$27,794
11	$960	$8,898	$2,961	$15,300	$0	$28,119
12	$988	$0	$3,049	$15,760	$9,690	$29,487
13	$1,018	$9,440	$3,141	$16,232	$0	$29,831
14	$1,049	$0	$3,235	$16,719	$10,280	$31,283
15	$1,080	$10,015	$3,332	$17,221	$0	$31,648
16	$1,112	$0	$3,432	$17,737	$10,906	$33,188
17	$1,146	$10,625	$3,535	$18,270	$0	$33,575
18	$1,180	$0	$3,641	$18,818	$11,570	$35,209
19	$1,216	$11,272	$3,750	$19,382	$0	$35,620
20	$1,252	$0	$3,863	$19,964	$12,275	$37,353
21	$1,290	$11,958	$3,979	$20,563	$0	$37,789
22	$1,328	$0	$4,098	$21,179	$13,022	$39,628
23	$1,368	$12,687	$4,221	$21,815	$0	$40,091
24	$1,409	$0	$4,348	$22,469	$13,815	$42,041
25	$1,451	$13,459	$4,478	$23,143	$0	$42,532
26	$1,495	$0	$4,613	$23,838	$14,656	$44,602
27	$1,540	$14,279	$4,751	$24,553	$0	$45,122
28	$1,586	$0	$4,893	$25,289	$15,549	$47,318
29	$1,634	$15,148	$5,040	$26,048	$0	$47,870
30	$1,683	$0	$5,192	$26,829	$16,496	$50,200
3% Annual Cost Inflation					Total	$1,004,569

Table 35. Implementation Costs: Livestock BMPs After Cost Share

Annual Cost* After Cost-Share of Implementing Livestock BMPs						
Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Annual Cost
1	$536	$4,966	$1,652	$8,539	$0	$15,692
2	$552	$0	$1,702	$8,795	$5,408	$16,456
3	$568	$5,268	$1,753	$9,059	$0	$16,648
4	$585	$0	$1,805	$9,331	$5,737	$17,458
5	$603	$5,589	$1,860	$9,610	$0	$17,662
6	$621	$0	$1,915	$9,899	$6,086	$18,521
7	$639	$5,929	$1,973	$10,196	$0	$18,737
8	$659	$0	$2,032	$10,502	$6,457	$19,649
9	$678	$6,290	$2,093	$10,817	$0	$19,878
10	$699	$0	$2,156	$11,141	$6,850	$20,846
11	$720	$6,674	$2,220	$11,475	$0	$21,089
12	$741	$0	$2,287	$11,820	$7,267	$22,115
13	$763	$7,080	$2,356	$12,174	$0	$22,373
14	$786	$0	$2,426	$12,539	$7,710	$23,462
15	$810	$7,511	$2,499	$12,916	$0	$23,736
16	$834	$0	$2,574	$13,303	$8,179	$24,891
17	$859	$7,969	$2,651	$13,702	$0	$25,181
18	$885	$0	$2,731	$14,113	$8,677	$26,407
19	$912	$8,454	$2,813	$14,537	$0	$26,715
20	$939	$0	$2,897	$14,973	$9,206	$28,015
21	$967	$8,969	$2,984	$15,422	$0	$28,342
22	$996	$0	$3,074	$15,885	$9,767	$29,721
23	$1,026	$9,515	$3,166	$16,361	$0	$30,068
24	$1,057	$0	$3,261	$16,852	$10,361	$31,531
25	$1,089	$10,094	$3,359	$17,358	$0	$31,899
26	$1,121	$0	$3,459	$17,878	$10,992	$33,451
27	$1,155	$10,709	$3,563	$18,415	$0	$33,842
28	$1,190	$0	$3,670	$18,967	$11,662	$35,488
29	$1,225	$11,361	$3,780	$19,536	$0	$35,903
30	$1,262	$0	$3,894	$20,122	$12,372	$37,650
3% Annual Cost Inflation					Total	$753,427

C. Total Costs for BMP Implementation and Education

Table 36. BMP Implementation Total Costs: After Cost Share

Total Annual Cost after Cost-Share by BMP Category				
Year	Cropland	Livestock	I & E	Total Cost
1	$20,164	$15,692	$35,300	$71,156
2	$20,769	$16,456	$36,359	$73,584
3	$21,392	$16,648	$37,450	$75,490
4	$22,034	$17,458	$38,573	$78,065
5	$22,695	$17,662	$39,730	$80,087
6	$23,376	$18,521	$40,922	$82,819
7	$24,077	$18,737	$42,150	$84,964
8	$24,799	$19,649	$43,415	$87,863
9	$25,543	$19,878	$44,717	$90,139
10	$26,309	$20,846	$46,058	$93,214
11	$27,099	$21,089	$47,440	$95,628
12	$27,912	$22,115	$48,863	$98,890
13	$28,749	$22,373	$50,329	$101,452
14	$29,612	$23,462	$51,839	$104,913
15	$30,500	$23,736	$53,394	$107,630
16	$31,415	$24,891	$54,996	$111,302
17	$32,357	$25,181	$56,646	$114,185
18	$33,328	$26,407	$58,346	$118,080
19	$34,328	$26,715	$60,096	$121,139
20	$35,358	$28,015	$61,899	$125,271
21	$36,418	$28,342	$63,756	$128,516
22	$37,511	$29,721	$65,668	$132,900
23	$38,636	$30,068	$67,638	$136,343
24	$39,795	$31,531	$69,668	$140,994
25	$40,989	$31,899	$71,758	$144,646
26	$42,219	$33,451	$73,910	$149,581
27	$43,486	$33,842	$76,128	$153,455
28	$44,790	$35,488	$78,412	$158,690
29	$46,134	$35,903	$80,764	$162,800
30	$47,518	$37,650	$83,187	$168,354
Total Cost	**$959,312**	**$753,427**	**$1,679,412**	**$3,392,151**

10. Technical Assistance and Funding Sources

Technical assistance and various funding sources may be required to implement the BMPs and watershed education programs listed in the Twin Lakes Watershed WRAPS plan. Possible technical assistance providers and funding sources are presented in **Tables 38** and **39.**

Table 37. Potential Technical Assistance Providers for Plan Implementation

Technical Assistance to Aid in BMP Implementation		
BMPs To Be Implemented		**Technical Assistance**
Cropland	Permanent Vegetation	Twin Lakes WRAPS Coordinator, Farm Service Agency, KDWPT, Kansas Forest Service, NRCS, Morris County Conservation District, and the KSRE Watershed Specialist
	No-Till with Cover Crops	
	Terraces	
	Waterways	
	Vegetative Buffers	
	Nutrient Management Plan	
	Grade Stabilization Structures	
Livestock	Vegetative Filter Strip	
	Relocate Feeding Pens	
	Relocate Pasture Feeding Sites	
	Off- Stream Watering Sites	
	Rotational Grazing	

Table 38. Potential Funding Sources for Plan Implementation

Potential BMP Funding Sources	
Potential Funding Sources	**Potential Funding Programs**
Division of Conservation/Conservation Districts	State Cost Share Programs
Ducks Unlimited	
EPA/KDHE	319 Funding Grants
Kansas Alliance for Wetlands and Streams	
Kansas Department of Wildlife, Parks and Tourism	Partnering for Wildlife
Kansas Forest Service	
Kansas Water Office	Kansas Reservoir Protection Initiative
Natural Resources Conservation Service (NRCS)	Conservation Reserve Program (CRP)
	Environmental Quality Incentives Program (EQIP)
	Farmable Wetlands Program (FWP)
	Forestland Enhancement Program (FLEP)
	Grassland Reserve Program (GRP)
	State Acres for Wildlife Enhancement (SAFE)
	Regional Conservation Partnership Program (RCPP)
	Wetland Reserve Program (WRP)
	Wildlife Habitat Incentive Program (WHIP)
No-till on the Plains	
Quail Forever	
US Fish and Wildlife	

11. Measurable Milestones

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

The WRAPS estimated timeframe for reaching the **nitrogen portion of the eutrophication TMDL** in Council Grove Lake is well past the 30 years written in this plan. This WRAPS plan's implementation schedule will meet roughly 66% of the required nitrogen load reduction goal in year 30. However, the **phosphorus portion of the eutrophication TMDL** in Council Grove Lake will be met in year 28 of the plan. In achieving the eutrophication TMDL in Council Grove Lake, it is can be assumed that the **phosphorus TMDL in the Neosho River near Parkerville** also has been achieved. After the nitrogen and phosphorus goals are achieved, the process will become one of protection rather than restoration.

Implementing the BMPs outlined in this plan to achieve the eutrophication TMDL will subsequently reduce sediment loading into local stream segments and Council Grove Lake. The SLT hopes that the implementation of these BMPs will result in the delisting of the siltation TMDL in Council Grove Lake, as well as other TMDL and 303d-listed impairments.

A. Measurable Milestones for BMP Implementation

Milestones will be determined at the end of every five years by number of acres treated, projects installed, contacts made to watershed residents, and water quality parameters. The SLT 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 in order to achieve the TMDL by the end of 30 years, as stipulated in this WRAPS plan.

Table 39. Short-, Medium-, and Long-Term Goals for Cropland BMP Adoption

Cropland BMP Implementation Milestones									
	Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Subtotal Adoption
Short-Term	1	26	155	52	52	52	155	52	544
	2	26	155	52	52	52	155	52	544
	3	26	155	52	52	52	155	52	544
	4	26	155	52	52	52	155	52	544
	5	26	155	52	52	52	155	52	544
	Subtotal	*129*	*777*	*259*	*259*	*259*	*777*	*259*	*2,718*
Medium-Term	6	26	155	52	52	52	155	52	544
	7	26	155	52	52	52	155	52	544
	8	26	155	52	52	52	155	52	544
	9	26	155	52	52	52	155	52	544
	10	26	155	52	52	52	155	52	544
	Subtotal	*259*	*1,553*	*518*	*518*	*518*	*1,553*	*518*	*5,436*
Long-Term	11	26	155	52	52	52	155	52	544
	12	26	155	52	52	52	155	52	544
	13	26	155	52	52	52	155	52	544
	14	26	155	52	52	52	155	52	544
	15	26	155	52	52	52	155	52	544
	16	26	155	52	52	52	155	52	544
	17	26	155	52	52	52	155	52	544
	18	26	155	52	52	52	155	52	544
	19	26	155	52	52	52	155	52	544
	20	26	155	52	52	52	155	52	544
	21	26	155	52	52	52	155	52	544
	22	26	155	52	52	52	155	52	544
	23	26	155	52	52	52	155	52	544
	24	26	155	52	52	52	155	52	544
	25	26	155	52	52	52	155	52	544
	26	26	155	52	52	52	155	52	544
	27	26	155	52	52	52	155	52	544
	28	26	155	52	52	52	155	52	544
	29	26	155	52	52	52	155	52	544
	30	26	155	52	52	52	155	52	544
	Total	**777**	**4,659**	**1,553**	**1,553**	**1,553**	**4,659**	**1,553**	**16,307**

Table 40. Short-, Medium-, and Long-Term Goals for Livestock BMP Adoption

Livestock BMP Adoption Milestones						
	Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing
Short-Term	1	1	1	1	3	
	2	1		1	3	1
	3	1	1	1	3	
	4	1		1	3	1
	5	1	1	1	3	
	Subtotal	*5*	*3*	*5*	*15*	*2*
Medium-Term	6	1		1	3	1
	7	1	1	1	3	
	8	1		1	3	1
	9	1	1	1	3	
	10	1		1	3	1
	Subtotal	*10*	*5*	*10*	*30*	*5*
Long-Term	11	1	1	1	3	
	12	1		1	3	1
	13	1	1	1	3	
	14	1		1	3	1
	15	1	1	1	3	
	16	1		1	3	1
	17	1	1	1	3	
	18	1		1	3	1
	19	1	1	1	3	
	20	1		1	3	1
	21	1	1	1	3	
	22	1		1	3	1
	23	1	1	1	3	
	24	1		1	3	1
	25	1	1	1	3	
	26	1		1	3	1
	27	1	1	1	3	
	28	1		1	3	1
	29	1	1	1	3	
	30	1		1	3	1
	Total	**30**	**15**	**30**	**90**	**15**

B. Benchmarks to Measure Water Quality and Social Progress

It is hoped that, over a five- to 30-year time frame, the Twin Lakes Watershed WRAPS plan will improve water quality throughout the watershed and in Council Grove Lake. To monitor these improvements, measurements taken at Council Grove Lake are important because the lake is the drainage endpoint of the watershed. Social indicators of success also will be examined by tracking traffic in Council Grove Lake and Park. A good example of a healthy

lake ecosystem is frequent visits by the public to enjoy outdoor recreation at the lake and the park.

After reviewing the criteria listed in **Table 42**, the SLT will assess and revise the overall strategy plan for the watershed every five years. New goals will be set and new BMPs will be implemented in order to achieve improved water quality. KDHE TMDL staff, Water Plan staff and the SLT will coordinate every five years to discuss benchmarks and TMDL update plans. The following indicator and parameter criteria shall be used to assess progress toward successful implementation to abate pollutant loads.

Table 41. Benchmarks to Measure Water Quality Progress

Benchmarks to Measure Water Quality Progress		
Impairment Addressed	**Criteria to Measure Water Quality Progress**	**Information Source**
Nutrients	**Council Grove Lake:** Summer chlorophyll α concentration ≤ 10 µg/L	KDHE
Sediment	**Council Grove Lake:** Secchi Disc Depth > 1 m	KDHE
	Fewer high event stream flow rates indicating better retention and slower release of storm water in the upper end of the watershed	USGS
Total Phosphorus	**Neosho River, near Parkerville** ALUS Index > 14, Sestonic Chlorophyll < 5 µg/l	KDHE
Impairment Addressed	**Social Indicators to Measure Water Quality Progress**	**Information Source**
Sediment/ Nutrients	Visitor traffic to Council Grove Lake	KDWPT
	Boating traffic in Council Grove Lake	KDWPT
	Trends of quantity and quality of fishing in Council Grove Lake	KDWPT
	Beach closing at Council Grove Lake	KDHE
	Taste and odor issues in public water supply from Council Grove Lake	KDHE
	Occurrence of algal blooms in Council Grove 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 tours and field days	KSRE
	Number of acres of BMPs implemented in the targeted areas	NRCS

C. Water Quality Milestones Used to Determine Improvements

The goal of the Twin Lakes Watershed WRAPS plan is to restore water quality for uses that support aquatic life, primary contact recreation and public water supply for Council Grove Lake. This restoration plan addresses specifically the high-priority eutrophication TMDL in Council Grove Lake and the high-priority total phosphorus (TP) TMDL in the Neosho River near Parkerville. In order to reach load reduction goals, a BMP implementation schedule spanning 30 years has been developed. Water quality milestones are established to enable KDHE and Twin Lakes WRAPS to measure water quality improvements within the watershed.

The BMPs included in this plan will be implemented along the riparian corridors of cropland and livestock areas throughout the Twin Lakes Watershed, including areas directly impacting the Neosho River and Munkers Creek. Therefore, BMP implementation will result in positive impacts on water quality and impairment listings for Neosho River (TP and Cu) and Munkers Creek (DO).

Water quality milestones have been developed for Council Grove Lake, along with additional indicators of water quality. The purpose of the milestones and indicators is to measure water quality improvements associated with the BMP implementation schedule contained in this plan. In order to provide the additional water quality information associated with this plan, separate water quality milestones also are included for the Neosho River and Munkers Creek, both of which are tributaries for Council Grove Lake. These water quality indicators will enable KDHE and the Twin Lakes WRAPS to measure water quality improvements within the watershed above Council Grove Lake, which should have direct effects on the water quality in the lake itself.

D. Water Quality Milestones for Council Grove Lake

As previously stated, in order to reach the nutrient load reduction goals for Council Grove Lake, a BMP implementation schedule spanning 30 years has been developed. Several water quality milestones and indicators have been developed for Council Grove Lake, as previously discussed. Water quality measures such as concentrations of total nitrogen and phosphorus, and chlorophyll *a* and Secchi disc depth measurements found at the KDHE sampling site (LM022001) will be utilized to determine the effectiveness of the BMPs implemented as part of the nutrient load reduction goals outlined in this plan.

Council Grove Lake is deemed to be argillotrophic, as its average chlorophyll *a* concentration is 5.90 ppb (TSI = 47.98), while its average total phosphorus concentration is 212 ppb. Council Grove Lake had a conservation storage capacity of 52,735 acre-feet when it was constructed in 1964. Subsequent surveys have been taken of the lake bathymetry, the most recent in 1994, indicating a conservation storage capacity of 41,394 acre-feet. The loss of 11,341 acre-feet of storage over 30 years represents an average annual loss of 378 acre-feet per year. Between the 1985 and 1994 surveys, the average annual loss was 808 acre-feet, chiefly because of the 1993 flood.[30]

Long term water quality goals/milestones for various parameters monitored in Council Grove Lake have been calculated by KDHE (**Tables 43** and **44**). It should be noted that current TMDLs for Council Grove Lake are slated to be reviewed by KDHE in the year 2022.

Table 42. Water Quality Milestones: Eutrophication in Council Grove Lake[31]

Water Quality Milestones for Council Grove Lake: Eutrophication										
Sampling Site	Current Condition	10-Year Goal		Long-Term Goal		Current Condition	10-Year Goal		Long-Term Goal	
	1996 - 2011 Average TN	Improved Condition (2011 - 2021) Average TN	Total Reduction Needed	Improved Condition Average TN	Total Reduction Needed	1990 - 2011 Average TP	Improved Condition (2012 - 2021) Average TP	Total Reduction Needed	Improved Condition Average TP	Total Reduction Needed
	Total Nitrogen (TN) (average of data collected during indicated period), ppm					Total Phosphorus (TP) (average of data collected during indicated period), ppb				
Council Grove Lake LM022001	1.01	0.87	0.14	0.8	0.21	191	151	40	100	9%

[30] KDHE, Siltation TMDL, http://www.kdheks.gov/tmdl/ne/CouncilGroveSILT.pdf
[31] Twin Lakes Water Quality Milestones provided by KDHE in 2012 for original WRAPS plan.

Table 43. Water Quality Milestones: Sediment in Council Grove Lake[32]

Water Quality Milestones for Council Grove Lake: Sediment								
Sampling Site	Current Condition	10-Year Goal		Long-Term Goal		Current Condition	10-Year Goal	Long-Term Goal
	1990 - 2011 Chlorophyll *a*	Improved Condition (2012 - 2021) Chlorophyll *a*	Total Reduction Needed	Improved Condition Chlorophyll *a*	Total Reduction Needed	1990 - 2011 Secchi (Avg.)	Improved Condition (2011 - 2021) Secchi (Avg.)	Improved Condition Secchi (Avg.)
	Chlorophyll *a* (average of data collected during indicated period), ppb					Secchi (average of data collected during indicated period), m		
Council Grove Lake LM022001	6.6	6	0.6	Maintain Average Chlorophyll *a* ≤ 10 ppb		0.43	Secchi depth > 0.7	Maintain Secchi depth > 1.0 m

E. Water Quality Milestones for the Neosho River

The Neosho River drains into Council Grove Lake and has a high-priority TP TMDL near Parkerville. The TP TMDL for the Neosho River is slated to be reviewed by KDHE in the year 2025.

BMPs implemented throughout the watershed will have positive effects on nutrient-related impairments, and it is anticipated that water quality improvements will be found at the KDHE stream sampling site Neosho River near Parkerville (SC637). **Table 45** details the 10-year and long-term water quality goals/milestones for total nitrogen (TN) and TP at sampling site SC637.

Table 44. Water Quality Milestones: Nutrients in the Neosho River[31]

Water Quality Milestones for KDHE Stream Stations in the Twin Lakes Watershed										
Sampling Site	Current Condition	10-Year Goal		Long-Term Goal		Current Condition	10-Year Goal		Long-Term Goal	
	2000 - 2008 Average TN	Improved Condition (2011 - 2021) Average TN	Total Reduction Needed (7%)	Improved Condition Average TN	Total Reduction Needed (19%)	1992 - 2008 Average TP	Improved Condition (2012 - 2021) Average TP	Total Reduction Needed	Improved Condition Average TP	Total Reduction Needed
	Total Nitrogen (TN) (average of data collected during indicated period), ppm					Total Phosphorus (TP) (average of data collected during indicated period), ppb				
Neosho River SC637	1.21	1.12	0.09	0.98	0.23	269	200	69	100	169

F. Additional Milestones for the Neosho River and Munkers Creek

The primary focus of this plan is the high-priority eutrophication TMDL for Council Grove Lake and the subsequent positive effects on its high-priority sediment TMDL as well as the high-priority TP TMDL in the Neosho River, near Parkerville.

Although, the following impairments and related milestones are not the focus of the Twin Lakes WRAPS plan, they each will be positively affected by its implementation.

[32] Twin Lakes Water Quality Milestones provided by KDHE in 2012 for original WRAPS plan.

1. Water Quality Milestones for Copper in the Neosho River

The Neosho River near Parkerville has a low-priority TMDL for Cu. The Cu TMDL is slated to be reviewed by KDHE in the year 2025. As stated, addressing the eutrophication TMDL with cropland BMP implementation will result in both nutrient and sediment load reductions. Sediment load reductions effectively will lead to reductions in copper in the Neosho River, noticeable at KDHE monitoring site SC 637, near Parkerville.

The milestones established under the Cu TMDL in the Neosho River are intended to gauge the level of participation in those programs implementing this TMDL.

With respect to copper, should participation significantly lag below expectations over the next five years or monitoring indicate lack of progress in improving water quality conditions, the state may employ more stringent conditions on agricultural producers and urban runoff in the watershed in order to meet the desired copper endpoint expressed in this TMDL.

2. Water Quality Milestones for Nutrients in Munkers Creek

Munkers Creek is 303d-listed for DO. The DO listing in Munkers Creek will be reviewed by KDHE in the year 2025. BMPs implemented throughout the watershed will have positive effects on this nutrient-related impairment, and it is anticipated that water quality improvements will be found at the KDHE stream sampling site at Munkers Creek, near Council Grove (SC631), however, this site is currently inactive. **Table 46** details the 10-year and long-term water quality goals/milestones for TN and TP at the Munkers Creek sampling location.

Table 456. Water Quality Milestones: Nutrients in the stream segment[31]

Water Quality Milestones for KDHE Stream Stations in the Twin Lakes Watershed										
Sampling Site	Current Condition	10-Year Goal		Long-Term Goal		Current Condition	10-Year Goal		Long-Term Goal	
	2000 - 2008 Average TN	Improved Condition (2011 - 2021) Average TN	Total Reduction Needed (7%)	Improved Condition Average TN	Total Reduction Needed (19%)	1992 - 2008 Average TP	Improved Condition (2012 - 2021) Average TP	Total Reduction Needed	Improved Condition Average TP	Total Reduction Needed
	Total Nitrogen (TN) (average of data collected during indicated period), ppm					Total Phosphorus (TP) (average of data collected during indicated period), ppb				
Munkers Creek SC631	1.06	0.98	0.08	0.86	0.2	141	113	28	96	45

12. Monitoring Water Quality

KDHE continues to monitor water quality in the Twin Lakes Watershed by maintaining the monitoring stations located within the watershed. **Figure 17** illustrates the locations of the monitoring sites within the Twin Lakes Watershed as well as the BMP-targeted areas identified and discussed in previous sections of this plan.

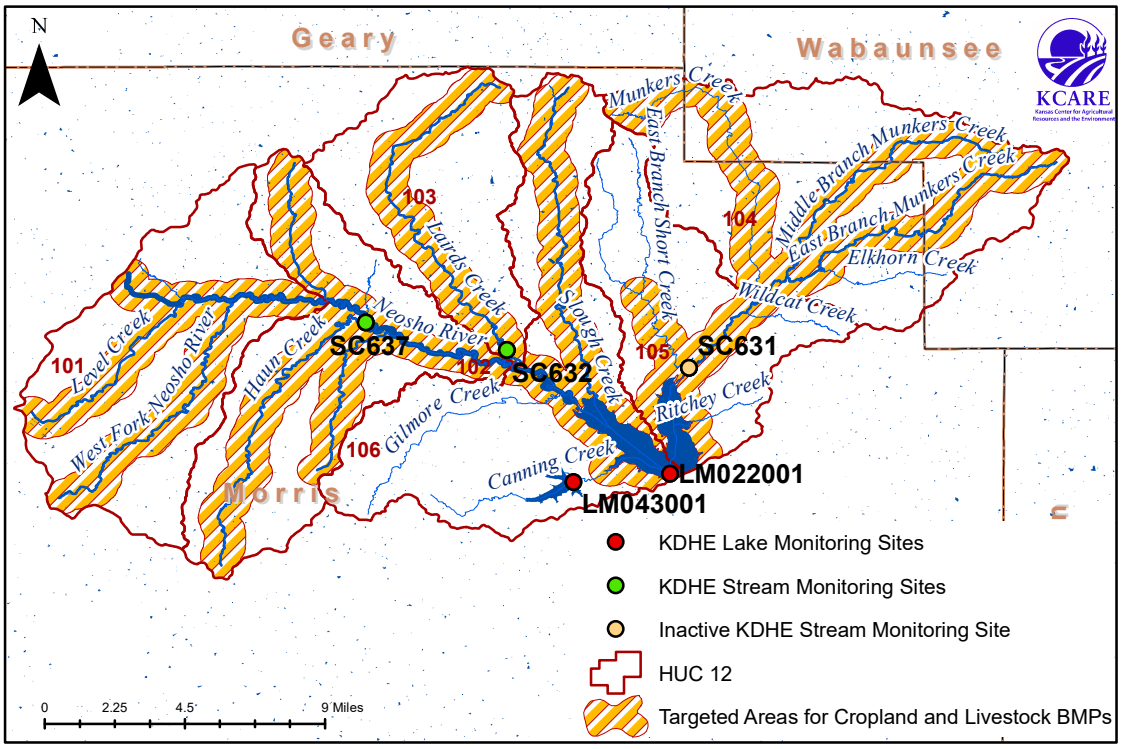


Figure 17. Monitoring Sites and Targeted Areas in the Twin Lakes Watershed

KDHE continues to monitor water quality in the Twin Lakes Watershed by maintaining three stream chemistry stations and two lake monitoring stations. The three KDHE stream chemistry stations in the watershed will continue to be sampled on a rotational basis every four years. These stations are sampled on a quarterly basis during the sampling year; the next scheduled sampling year for these stations is in 2020. These sites include:

- Neosho River (SC637) near Parkerville,
- Lairds Creek near the Neosho River confluence (SC632), and
- Munkers Creek (SC631) near Council Grove (currently inactive).

The KDHE lake monitoring stations will be sampled every three years with the next sampling year scheduled for 2020. These sites are located at:

- Council Grove Lake (LM022001) and
- Council Grove *City* Lake (LM043001).

Typically, monitoring takes place May through September. Monitoring sites are sampled for nutrients, bacteria, chemicals, turbidity, alkalinity, DO, pH, ammonia and metals. 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 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 Twin Lakes 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 for each sub-watershed, as well as the frequency of the sampling data.

The BMP implementation schedule and water quality milestones for the Twin Lakes Watershed extend through a 30-year period from 2020-2050. During that period, KDHE will continue to analyze and to evaluate the collected monitoring data. After the first 10 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 SLT can address any necessary modifications or revisions to the plan based on the data analysis. At the end of this plan in 2050, a determination will be made as to whether the water quality standards have been attained.

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 the SLT to evaluate newly available information, incorporate revisions to applicable TMDLs, or address potential water quality indicators that might trigger an immediate review.

13. Review of the WRAPS Plan

In the year 2025, this WRAPS plan will be reviewed and revised according to results from monitoring data. At this present time, the SLT will review the criteria listed below, in addition to any other concerns that may occur at this plan's future review.

The SLT will request the following reports on the milestone achievements for nitrogen and phosphorus load reductions.

- KDHE reports on current and desired endpoints for water quality in Council Grove Lake regarding **eutrophication:** The desired outcome will be to maintain summer chlorophyll *a* average concentrations below 10 µg/L, with reductions focused on nitrogen and phosphorus. Based on the BATHTUB reservoir eutrophication model, the total nitrogen and total phosphorus entering Council Grove Lake must be reduced. **Nitrogen must be reduced by 242,435 pounds per year**, which is a reduction of 32%. Meanwhile, **phosphorus must be reduced by 68,767 pounds per year**, which is a 19% reduction;[33]
- KDHE reports on current and desired endpoints for water quality at sampling site SC637 along the Neosho River near Parkerville. Total phosphorus should not exceed 1,145 pounds per year.
- KDHE reports revisions of the watershed's TMDLs, including possible nutrient and/or sediment criteria, revised load allocations, and new wasteload allocations defined for point sources; and
- KDHE reports on trends in water quality in Council Grove Lake.

In turn, the SLT 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 listed in this plan.

[33] KDHE, E TMDL, http://www.kdheks.gov/tmdl/ne/CouncilGroveTMDL.pdf

14. Appendix

A. Potential Service Providers

Table 467. Service Provider List

Organization	Programs	Purpose	Technical or Financial Assistance	Phone	Website address
Environmental Protection Agency	Clean Water State Revolving Fund Program	Provides low cost loans to communities for water pollution control activities.	Financial	913-551-7003	www.epa.gov
	Watershed Protection	To conduct holistic strategies for restoring and protecting aquatic resources based on hydrology rather than political boundaries.			
Kansas Alliance for Wetlands and Streams	Streambank Stabilization, Wetland Restoration Cost Share Programs	The Kansas Alliance for Wetlands and Streams (KAWS) organized in 1996 to promote the protection, enhancement, restoration and establishment of wetlands and streams in Kansas.	Technical	785-463-5804 NE Chapter	www.kaws.org
Kansas Department of Agriculture	Watershed structures permitting	Available for watershed districts and multipurpose small lakes development.	Technical and Financial	785-296-2933	www.agriculture.ks.gov
Kansas Department of Health and Environment	Nonpoint Source Pollution Program	Provide funds for projects that will reduce nonpoint source pollution.	Technical and Financial	785-296-5500	www.kdheks.gov
	Livestock waste Municipal waste	Compliance monitoring.			
	State Revolving Loan Fund	Makes low interest loans for projects to improve and protect water quality.			
Kansas Department of Wildlife, Parks and Tourism	Land and Water Conservation Funds	Provides funds to preserve, develop and assure access to outdoor recreation.	Technical Funds	620-672-5911	https://ksoutdoors.com/Services/Private-Landowner-Assistance
	Conservation Easements for Riparian and Wetland Areas	To provide easements to secure and enhance quality areas in the state.		785-296-2780	
	Wildlife Habitat Improvement Program	To provide limited assistance for development of wildlife habitat.		620-672-5911	
	North American Waterfowl Conservation Act	To provide up to 50 percent cost share for the purchase and/or development of wetlands and wildlife habitat.		620-342-0658	
	MARSH program in coordination with Ducks Unlimited	May provide up to 100 percent of funding for small wetland projects.		620-672-5911	
	Chickadee Checkoff	Projects help with eagles, songbirds, threatened and endangered species, turtles, lizards, butterflies, and stream darters. Funding is an optional donation line item on the KS income tax form.			
	Walk In Hunting Program	Landowners receive a payment incentive to allow public hunting on their property.			
	F.I.S.H. Program	Landowners receive a payment incentive to allow public fishing access to their ponds and streams.			
Kansas Forest Service	Conservation Tree Planting Program	Provides low cost trees and shrubs for conservation plantings.	Technical	785-532-3312	www.kansasforests.org
	Riparian and Wetland Protection Program	Work closely with other agencies to promote and assist with establishment of riparian forestland and manage existing stands.		785-532-3310	
Kansas Rural Center	The Heartland Network	The Center is committed to economically viable, environmentally sound and socially sustainable rural culture.	Technical and Financial	785-873-3431	http://www.kansasruralcenter.org
	Clean Water Farms - River Friendly Farms				
	Sustainable Food Systems Project				
	Cost share programs				

Service Provider List, Continued

Organization	Programs	Purpose	Technical or Financial Assistance	Phone	Website address
Kansas Rural Water Association	Technical assistance for Water Systems with Source Water Protection Planning	Provide education, technical assistance and leadership to public water and wastewater utilities to enhance the public health and to sustain Kansas' communities.	Technical	785-336-3760	http://www.krwa.net
Kansas State Research and Extension	Water Quality Programs	Provide programs, expertise and educational materials that relate to minimizing the impact of rural and urban activities on water quality.	Technical	785-532-7108	www.kcare.ksu.edu
	Waste Management Programs				
	Kansas Center for Agricultural Resources and Environment (KCARE)				
	Kansas Local Government Water Quality Planning and Management	Provide guidance to local governments on water protection programs.		785-532-0416	www.ksre.ksu.edu/olg
Kansas Water Office	Public Information and Education	Provide information and education to the public on Kansas Water Resources	Technical and Financial	785-296-3185	www.kwo.org
No-Till on the Plains	Field days, seasonal meetings, tours and technical consulting	Provide information and assistance concerning continuous no-till farming practices.	Technical	888-330-5142	www.notill.org
Division of Conservation and Conservation Districts	Water Resources Cost Share Program	Provide cost share assistance to landowners for establishment of water conservation practices.	Technical and Financial	Morris County Conservation District 620-767-5111	http://agriculture.ks.gov/divisions-programs/division-of-conservation
	Nonpoint Source Pollution Control Fund	Provides financial assistance for nonpoint pollution control projects which help restore water quality.			
	Riparian and Wetland Protection Program	Funds to assist with wetland and riparian development and enhancement.			
	Stream Rehabilitation Program	Assist with streams that have been adversely altered by channel modifications.			http://www.kacdnet.org/
	Kansas Water Quality Buffer Initiative	Compliments Conservation Reserve Program by offering additional financial incentives for grass filters and riparian forest buffers.		Wabaunsee County Conservation District (785) 765-3836	
	Watershed district and multipurpose lakes	Programs are available for watershed district and multipurpose small lakes.			
US Army Corps of Engineers	Planning Assistance to states	Assistance in development of plans for development, utilization and conservation of water and related land resources of drainage.	Technical	816-983-3157	www.usace.army.mil
	Environmental Restoration	Funding assistance for aquatic ecosystem restoration.			
US Fish and and Wildife	Fish and Wildlife Enhancement Program	Supports field operations which include technical assistance on wetland design.	Technical	785-539-3474	www.fws.gov
	Private Lands Program	Contracts to restore, enhance, or create wetlands.			
USDA Natural Resources Conservation Service (NRCS) and Farm Service Agency (FSA)	Conservation Compliance	Primarily for the technical assistance to develop conservation plans on cropland.	Technical and Financial	Morris County Conservation District 620-767-5111	www.ks.nrcs.usda.gov
	Conservation Operations	To provide technical assistance on private land for development and application of Resource Management Plans.			
	Watershed Planning and Operations	Primarily focused on high priority areas where agricultural improvements will meet water quality objectives.			
	Wetland Reserve Program	Cost share and easements to restore wetlands.			
	Wildlife Habitat Incentives Program	Cost share to establish wildlife habitat which includes wetlands and riparian areas.		Wabaunsee County Conservation District (785) 765-3836	
	Grassland Reserve Program, EQIP and Conservation Reserve Program	Improve and protect rangeland resources with cost-sharing practices, rental agreements, and easement purchases.			

B. BMP Definitions

1. Cropland BMPs

a. Establish 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.

b. No-till with cover crops

- No-till is a management system in which alternative methods may be used instead of tillage for weed control and seedbed preparation.
- In no-till, the soil surface is never disturbed, except for planting or drilling operations in a 100% no-till system; this maintains nutrient levels and aids in preventing nutrients from leaving the field due to runoff events.
- 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]
- No-till with cover crops has a 40% erosion, 25% nitrogen, and a 50% phosphorus reduction efficiency.

3. 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/most common BMPs.
- Terraces have a 10-year lifespan, with 30% erosion, 30% nitrogen, and a 30% phosphorus reduction efficiency.

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

4. ***Grassed waterways***
    - These 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.

5. ***Nutrient management plan***
    - 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.

6. ***Vegetative buffer***
    - Vegetative 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.

7. ***Grade Stabilization Structures***
    - These are defined as earthen, concrete, or other structure built across a drainageway to prevent gully erosion.
    - Drainage areas for the structures can vary greatly: from 20 acres to over 1,000 acres.
    - These structures have a 50% erosion, 50% nitrogen, and a 50% phosphorus reduction efficiency.

2. Livestock BMPs

a. Vegetative filter strip
- A vegetated area that receives runoff during rainfall from an animal feeding operation is a vegetative filter strip.
- They often require a land area equal to or greater than the drainage area (i.e., need to be as large as the feedlot).
- Vegetative filter strips have a 10-year lifespan and require periodic mowing or haying.
- Their average phosphorus reduction efficiency is 50%.

b. Relocate feeding sites
- Relocation of a **feedlot** means to move feedlot or pens away from a stream, waterway, or body of water to increase filtration and waste removal of manure.
- Doing this results in an average of 95% phosphorus reduction efficiency.

- Relocation of a **pasture** means to move feeding sites in a pasture away from a stream, waterway, or body of water to increase the filtration and waste removal (i.e., move bale feeders away from the stream).
- Doing this results in an average of 70% phosphorus reduction efficiency.

c. Alternative (off-stream) watering systems

- These are watering systems designed so that livestock do not enter a stream or body of water.
- 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, with an average phosphorus reduction efficiency of 85% and greater efficiencies for limited stream access.

d. 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.

C. Budget Derivations[35]

1. Cropland

Summarized derivation of cropland BMP cost estimates

- Establish permanent vegetation: $150 per treated acre with 75% cost share.
- No-till with cover crops: $78 per treated acre with 50% cost share.
- Terraces: $101 per treated acre with 15% cost share.
- Grassed waterway: $159 per treated acre with 75% cost share.
- Vegetative buffer: $100 per treated acre with 90% cost share.
- Nutrient management plan: $57 per treated acre with 75% cost share.
- Grade stabilization structures: $299 per treated acre with 75% cost share.

[35] All cost derivations were calculated using rates effective in October 2019.

2. Livestock

Summarized derivation of livestock BMP cost estimates

- Vegetative filter strip: $714 per unit with 75% cost share.
- Relocate feeding pens: $6,621 with 75% cost share. Cost includes the fencing, a new watering system, concrete, and labor.
- Relocate pasture feeding site: $2,203 with 75% cost share. Cost includes building ¼ mile of fence, a permeable surface, and labor.
- Off-stream watering system: $3,795 per unit with 75% cost share.
- Rotational grazing: $7,000 with 75% cost share. Cost includes fencing and labor.

D. 30-year Project Tables by Sub-watershed

1. Cropland BMP implementation in the Twin Lakes Watershed

HUC 101 Annual Adoption (treated acres), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Adoption
1	7	40	13	13	13	40	13	142
2	7	40	13	13	13	40	13	142
3	7	40	13	13	13	40	13	142
4	7	40	13	13	13	40	13	142
5	7	40	13	13	13	40	13	142
6	7	40	13	13	13	40	13	142
7	7	40	13	13	13	40	13	142
8	7	40	13	13	13	40	13	142
9	7	40	13	13	13	40	13	142
10	7	40	13	13	13	40	13	142
11	7	40	13	13	13	40	13	142
12	7	40	13	13	13	40	13	142
13	7	40	13	13	13	40	13	142
14	7	40	13	13	13	40	13	142
15	7	40	13	13	13	40	13	142
16	7	40	13	13	13	40	13	142
17	7	40	13	13	13	40	13	142
18	7	40	13	13	13	40	13	142
19	7	40	13	13	13	40	13	142
20	7	40	13	13	13	40	13	142
21	7	40	13	13	13	40	13	142
22	7	40	13	13	13	40	13	142
23	7	40	13	13	13	40	13	142
24	7	40	13	13	13	40	13	142
25	7	40	13	13	13	40	13	142
26	7	40	13	13	13	40	13	142
27	7	40	13	13	13	40	13	142
28	7	40	13	13	13	40	13	142
29	7	40	13	13	13	40	13	142
30	7	40	13	13	13	40	13	142

HUC 102 Annual Adoption (treated acres), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Adoption
1	5	29	10	10	10	29	10	100
2	5	29	10	10	10	29	10	100
3	5	29	10	10	10	29	10	100
4	5	29	10	10	10	29	10	100
5	5	29	10	10	10	29	10	100
6	5	29	10	10	10	29	10	100
7	5	29	10	10	10	29	10	100
8	5	29	10	10	10	29	10	100
9	5	29	10	10	10	29	10	100
10	5	29	10	10	10	29	10	100
11	5	29	10	10	10	29	10	100
12	5	29	10	10	10	29	10	100
13	5	29	10	10	10	29	10	100
14	5	29	10	10	10	29	10	100
15	5	29	10	10	10	29	10	100
16	5	29	10	10	10	29	10	100
17	5	29	10	10	10	29	10	100
18	5	29	10	10	10	29	10	100
19	5	29	10	10	10	29	10	100
20	5	29	10	10	10	29	10	100
21	5	29	10	10	10	29	10	100
22	5	29	10	10	10	29	10	100
23	5	29	10	10	10	29	10	100
24	5	29	10	10	10	29	10	100
25	5	29	10	10	10	29	10	100
26	5	29	10	10	10	29	10	100
27	5	29	10	10	10	29	10	100
28	5	29	10	10	10	29	10	100
29	5	29	10	10	10	29	10	100
30	5	29	10	10	10	29	10	100

HUC 103 Annual Adoption (treated acres), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Adoption
1	3	21	7	7	7	21	7	72
2	3	21	7	7	7	21	7	72
3	3	21	7	7	7	21	7	72
4	3	21	7	7	7	21	7	72
5	3	21	7	7	7	21	7	72
6	3	21	7	7	7	21	7	72
7	3	21	7	7	7	21	7	72
8	3	21	7	7	7	21	7	72
9	3	21	7	7	7	21	7	72
10	3	21	7	7	7	21	7	72
11	3	21	7	7	7	21	7	72
12	3	21	7	7	7	21	7	72
13	3	21	7	7	7	21	7	72
14	3	21	7	7	7	21	7	72
15	3	21	7	7	7	21	7	72
16	3	21	7	7	7	21	7	72
17	3	21	7	7	7	21	7	72
18	3	21	7	7	7	21	7	72
19	3	21	7	7	7	21	7	72
20	3	21	7	7	7	21	7	72
21	3	21	7	7	7	21	7	72
22	3	21	7	7	7	21	7	72
23	3	21	7	7	7	21	7	72
24	3	21	7	7	7	21	7	72
25	3	21	7	7	7	21	7	72
26	3	21	7	7	7	21	7	72
27	3	21	7	7	7	21	7	72
28	3	21	7	7	7	21	7	72
29	3	21	7	7	7	21	7	72
30	3	21	7	7	7	21	7	72

HUC 104 Annual Adoption (treated acres), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Adoption
1	7	41	14	14	14	41	14	143
2	7	41	14	14	14	41	14	143
3	7	41	14	14	14	41	14	143
4	7	41	14	14	14	41	14	143
5	7	41	14	14	14	41	14	143
6	7	41	14	14	14	41	14	143
7	7	41	14	14	14	41	14	143
8	7	41	14	14	14	41	14	143
9	7	41	14	14	14	41	14	143
10	7	41	14	14	14	41	14	143
11	7	41	14	14	14	41	14	143
12	7	41	14	14	14	41	14	143
13	7	41	14	14	14	41	14	143
14	7	41	14	14	14	41	14	143
15	7	41	14	14	14	41	14	143
16	7	41	14	14	14	41	14	143
17	7	41	14	14	14	41	14	143
18	7	41	14	14	14	41	14	143
19	7	41	14	14	14	41	14	143
20	7	41	14	14	14	41	14	143
21	7	41	14	14	14	41	14	143
22	7	41	14	14	14	41	14	143
23	7	41	14	14	14	41	14	143
24	7	41	14	14	14	41	14	143
25	7	41	14	14	14	41	14	143
26	7	41	14	14	14	41	14	143
27	7	41	14	14	14	41	14	143
28	7	41	14	14	14	41	14	143
29	7	41	14	14	14	41	14	143
30	7	41	14	14	14	41	14	143

HUC 105 Annual Adoption (treated acres), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Adoption
1	1	8	3	3	3	8	3	29
2	1	8	3	3	3	8	3	29
3	1	8	3	3	3	8	3	29
4	1	8	3	3	3	8	3	29
5	1	8	3	3	3	8	3	29
6	1	8	3	3	3	8	3	29
7	1	8	3	3	3	8	3	29
8	1	8	3	3	3	8	3	29
9	1	8	3	3	3	8	3	29
10	1	8	3	3	3	8	3	29
11	1	8	3	3	3	8	3	29
12	1	8	3	3	3	8	3	29
13	1	8	3	3	3	8	3	29
14	1	8	3	3	3	8	3	29
15	1	8	3	3	3	8	3	29
16	1	8	3	3	3	8	3	29
17	1	8	3	3	3	8	3	29
18	1	8	3	3	3	8	3	29
19	1	8	3	3	3	8	3	29
20	1	8	3	3	3	8	3	29
21	1	8	3	3	3	8	3	29
22	1	8	3	3	3	8	3	29
23	1	8	3	3	3	8	3	29
24	1	8	3	3	3	8	3	29
25	1	8	3	3	3	8	3	29
26	1	8	3	3	3	8	3	29
27	1	8	3	3	3	8	3	29
28	1	8	3	3	3	8	3	29
29	1	8	3	3	3	8	3	29
30	1	8	3	3	3	8	3	29

HUC 106 Annual Adoption (treated acres), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Adoption
1	3	16	5	5	5	16	5	57
2	3	16	5	5	5	16	5	57
3	3	16	5	5	5	16	5	57
4	3	16	5	5	5	16	5	57
5	3	16	5	5	5	16	5	57
6	3	16	5	5	5	16	5	57
7	3	16	5	5	5	16	5	57
8	3	16	5	5	5	16	5	57
9	3	16	5	5	5	16	5	57
10	3	16	5	5	5	16	5	57
11	3	16	5	5	5	16	5	57
12	3	16	5	5	5	16	5	57
13	3	16	5	5	5	16	5	57
14	3	16	5	5	5	16	5	57
15	3	16	5	5	5	16	5	57
16	3	16	5	5	5	16	5	57
17	3	16	5	5	5	16	5	57
18	3	16	5	5	5	16	5	57
19	3	16	5	5	5	16	5	57
20	3	16	5	5	5	16	5	57
21	3	16	5	5	5	16	5	57
22	3	16	5	5	5	16	5	57
23	3	16	5	5	5	16	5	57
24	3	16	5	5	5	16	5	57
25	3	16	5	5	5	16	5	57
26	3	16	5	5	5	16	5	57
27	3	16	5	5	5	16	5	57
28	3	16	5	5	5	16	5	57
29	3	16	5	5	5	16	5	57
30	3	16	5	5	5	16	5	57

2. Cropland BMP implementation: Cumulative nitrogen load reductions

HUC 101 Annual Nitrogen Reduction (lbs), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	68	107	43	57	36	107	36	453
2	136	214	86	114	71	214	71	907
3	203	321	128	171	107	321	107	1,360
4	271	428	171	228	143	428	143	1,813
5	339	535	214	286	178	535	178	2,267
6	407	642	257	343	214	642	214	2,720
7	475	750	300	400	250	750	250	3,173
8	543	857	343	457	286	857	286	3,627
9	610	964	385	514	321	964	321	4,080
10	678	1,071	428	571	357	1,071	357	4,533
11	746	1,178	471	628	393	1,178	393	4,986
12	814	1,285	514	685	428	1,285	428	5,440
13	882	1,392	557	742	464	1,392	464	5,893
14	949	1,499	600	800	500	1,499	500	6,346
15	1,017	1,606	642	857	535	1,606	535	6,800
16	1,085	1,713	685	914	571	1,713	571	7,253
17	1,153	1,820	728	971	607	1,820	607	7,706
18	1,221	1,927	771	1,028	642	1,927	642	8,160
19	1,289	2,035	814	1,085	678	2,035	678	8,613
20	1,356	2,142	857	1,142	714	2,142	714	9,066
21	1,424	2,249	899	1,199	750	2,249	750	9,520
22	1,492	2,356	942	1,256	785	2,356	785	9,973
23	1,560	2,463	985	1,314	821	2,463	821	10,426
24	1,628	2,570	1,028	1,371	857	2,570	857	10,880
25	1,695	2,677	1,071	1,428	892	2,677	892	11,333
26	1,763	2,784	1,114	1,485	928	2,784	928	11,786
27	1,831	2,891	1,156	1,542	964	2,891	964	12,240
28	1,899	2,998	1,199	1,599	999	2,998	999	12,693
29	1,967	3,105	1,242	1,656	1,035	3,105	1,035	13,146
30	2,035	3,212	1,285	1,713	1,071	3,212	1,071	13,599

HUC 102 Annual Nitrogen Reduction (lbs), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	58	91	37	49	30	91	30	387
2	116	183	73	97	61	183	61	774
3	174	274	110	146	91	274	91	1,161
4	232	366	146	195	122	366	122	1,548
5	289	457	183	244	152	457	152	1,935
6	347	548	219	292	183	548	183	2,322
7	405	640	256	341	213	640	213	2,709
8	463	731	292	390	244	731	244	3,095
9	521	823	329	439	274	823	274	3,482
10	579	914	366	487	305	914	305	3,869
11	637	1,005	402	536	335	1,005	335	4,256
12	695	1,097	439	585	366	1,097	366	4,643
13	753	1,188	475	634	396	1,188	396	5,030
14	810	1,280	512	682	427	1,280	427	5,417
15	868	1,371	548	731	457	1,371	457	5,804
16	926	1,462	585	780	487	1,462	487	6,191
17	984	1,554	622	829	518	1,554	518	6,578
18	1,042	1,645	658	877	548	1,645	548	6,965
19	1,100	1,737	695	926	579	1,737	579	7,352
20	1,158	1,828	731	975	609	1,828	609	7,739
21	1,216	1,919	768	1,024	640	1,919	640	8,126
22	1,274	2,011	804	1,072	670	2,011	670	8,513
23	1,331	2,102	841	1,121	701	2,102	701	8,900
24	1,389	2,194	877	1,170	731	2,194	731	9,286
25	1,447	2,285	914	1,219	762	2,285	762	9,673
26	1,505	2,376	951	1,267	792	2,376	792	10,060
27	1,563	2,468	987	1,316	823	2,468	823	10,447
28	1,621	2,559	1,024	1,365	853	2,559	853	10,834
29	1,679	2,651	1,060	1,414	884	2,651	884	11,221
30	1,737	2,742	1,097	1,462	914	2,742	914	11,608

HUC 103 Annual Nitrogen Reduction (lbs), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	29	46	18	25	15	46	15	195
2	58	92	37	49	31	92	31	389
3	87	138	55	74	46	138	46	584
4	116	184	74	98	61	184	61	779
5	146	230	92	123	77	230	77	973
6	175	276	110	147	92	276	92	1,168
7	204	322	129	172	107	322	107	1,363
8	233	368	147	196	123	368	123	1,557
9	262	414	166	221	138	414	138	1,752
10	291	460	184	245	153	460	153	1,947
11	320	506	202	270	169	506	169	2,141
12	349	552	221	294	184	552	184	2,336
13	379	598	239	319	199	598	199	2,530
14	408	644	257	343	215	644	215	2,725
15	437	690	276	368	230	690	230	2,920
16	466	736	294	392	245	736	245	3,114
17	495	782	313	417	261	782	261	3,309
18	524	828	331	441	276	828	276	3,504
19	553	874	349	466	291	874	291	3,698
20	582	920	368	490	307	920	307	3,893
21	612	966	386	515	322	966	322	4,088
22	641	1,012	405	540	337	1,012	337	4,282
23	670	1,058	423	564	353	1,058	353	4,477
24	699	1,104	441	589	368	1,104	368	4,672
25	728	1,150	460	613	383	1,150	383	4,866
26	757	1,195	478	638	398	1,195	398	5,061
27	786	1,241	497	662	414	1,241	414	5,256
28	815	1,287	515	687	429	1,287	429	5,450
29	845	1,333	533	711	444	1,333	444	5,645
30	874	1,379	552	736	460	1,379	460	5,840

HUC 104 Annual Nitrogen Reduction (lbs), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	69	109	44	58	36	109	36	461
2	138	218	87	116	73	218	73	922
3	207	327	131	174	109	327	109	1,383
4	276	435	174	232	145	435	145	1,844
5	345	544	218	290	181	544	181	2,304
6	414	653	261	348	218	653	218	2,765
7	483	762	305	406	254	762	254	3,226
8	552	871	348	465	290	871	290	3,687
9	621	980	392	523	327	980	327	4,148
10	690	1,089	435	581	363	1,089	363	4,609
11	758	1,198	479	639	399	1,198	399	5,070
12	827	1,306	523	697	435	1,306	435	5,531
13	896	1,415	566	755	472	1,415	472	5,991
14	965	1,524	610	813	508	1,524	508	6,452
15	1,034	1,633	653	871	544	1,633	544	6,913
16	1,103	1,742	697	929	581	1,742	581	7,374
17	1,172	1,851	740	987	617	1,851	617	7,835
18	1,241	1,960	784	1,045	653	1,960	653	8,296
19	1,310	2,069	827	1,103	690	2,069	690	8,757
20	1,379	2,177	871	1,161	726	2,177	726	9,218
21	1,448	2,286	915	1,219	762	2,286	762	9,679
22	1,517	2,395	958	1,277	798	2,395	798	10,139
23	1,586	2,504	1,002	1,335	835	2,504	835	10,600
24	1,655	2,613	1,045	1,394	871	2,613	871	11,061
25	1,724	2,722	1,089	1,452	907	2,722	907	11,522
26	1,793	2,831	1,132	1,510	944	2,831	944	11,983
27	1,862	2,939	1,176	1,568	980	2,939	980	12,444
28	1,931	3,048	1,219	1,626	1,016	3,048	1,016	12,905
29	2,000	3,157	1,263	1,684	1,052	3,157	1,052	13,366
30	2,069	3,266	1,306	1,742	1,089	3,266	1,089	13,826

HUC 105 Annual Nitrogen Reduction (lbs), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	15	24	10	13	8	24	8	101
2	30	48	19	26	16	48	16	203
3	46	72	29	38	24	72	24	304
4	61	96	38	51	32	96	32	406
5	76	120	48	64	40	120	40	507
6	91	144	58	77	48	144	48	609
7	106	168	67	90	56	168	56	710
8	121	192	77	102	64	192	64	812
9	137	216	86	115	72	216	72	913
10	152	240	96	128	80	240	80	1,015
11	167	264	105	141	88	264	88	1,116
12	182	288	115	153	96	288	96	1,218
13	197	312	125	166	104	312	104	1,319
14	213	336	134	179	112	336	112	1,421
15	228	360	144	192	120	360	120	1,522
16	243	384	153	205	128	384	128	1,624
17	258	408	163	217	136	408	136	1,725
18	273	432	173	230	144	432	144	1,827
19	289	456	182	243	152	456	152	1,928
20	304	480	192	256	160	480	160	2,030
21	319	503	201	269	168	503	168	2,131
22	334	527	211	281	176	527	176	2,233
23	349	551	221	294	184	551	184	2,334
24	364	575	230	307	192	575	192	2,436
25	380	599	240	320	200	599	200	2,537
26	395	623	249	332	208	623	208	2,639
27	410	647	259	345	216	647	216	2,740
28	425	671	269	358	224	671	224	2,842
29	440	695	278	371	232	695	232	2,943
30	456	719	288	384	240	719	240	3,045

HUC 106 Annual Nitrogen Reduction (lbs), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	29	46	19	25	15	46	15	196
2	59	93	37	49	31	93	31	392
3	88	139	56	74	46	139	46	588
4	117	185	74	99	62	185	62	784
5	147	232	93	124	77	232	77	980
6	176	278	111	148	93	278	93	1,176
7	205	324	130	173	108	324	108	1,372
8	235	371	148	198	124	371	124	1,569
9	264	417	167	222	139	417	139	1,765
10	293	463	185	247	154	463	154	1,961
11	323	509	204	272	170	509	170	2,157
12	352	556	222	296	185	556	185	2,353
13	381	602	241	321	201	602	201	2,549
14	411	648	259	346	216	648	216	2,745
15	440	695	278	371	232	695	232	2,941
16	469	741	296	395	247	741	247	3,137
17	499	787	315	420	262	787	262	3,333
18	528	834	333	445	278	834	278	3,529
19	557	880	352	469	293	880	293	3,725
20	587	926	371	494	309	926	309	3,921
21	616	973	389	519	324	973	324	4,117
22	645	1,019	408	543	340	1,019	340	4,313
23	675	1,065	426	568	355	1,065	355	4,509
24	704	1,112	445	593	371	1,112	371	4,706
25	733	1,158	463	618	386	1,158	386	4,902
26	763	1,204	482	642	401	1,204	401	5,098
27	792	1,250	500	667	417	1,250	417	5,294
28	821	1,297	519	692	432	1,297	432	5,490
29	851	1,343	537	716	448	1,343	448	5,686
30	880	1,389	556	741	463	1,389	463	5,882

3. Cropland BMP implementation: Cumulative phosphorus load reductions

HUC 101 Annual Phosphorus Reduction (lbs), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	15	47	9	12	16	23	16	138
2	30	94	19	25	31	47	31	276
3	45	141	28	37	47	70	47	415
4	59	187	37	50	62	94	62	553
5	74	234	47	62	78	117	78	691
6	89	281	56	75	94	141	94	829
7	104	328	66	87	109	164	109	968
8	119	375	75	100	125	187	125	1,106
9	134	422	84	112	141	211	141	1,244
10	148	469	94	125	156	234	156	1,382
11	163	515	103	137	172	258	172	1,520
12	178	562	112	150	187	281	187	1,659
13	193	609	122	162	203	305	203	1,797
14	208	656	131	175	219	328	219	1,935
15	223	703	141	187	234	351	234	2,073
16	237	750	150	200	250	375	250	2,211
17	252	797	159	212	266	398	266	2,350
18	267	843	169	225	281	422	281	2,488
19	282	890	178	237	297	445	297	2,626
20	297	937	187	250	312	469	312	2,764
21	312	984	197	262	328	492	328	2,903
22	326	1,031	206	275	344	515	344	3,041
23	341	1,078	216	287	359	539	359	3,179
24	356	1,124	225	300	375	562	375	3,317
25	371	1,171	234	312	390	586	390	3,455
26	386	1,218	244	325	406	609	406	3,594
27	401	1,265	253	337	422	633	422	3,732
28	415	1,312	262	350	437	656	437	3,870
29	430	1,359	272	362	453	679	453	4,008
30	445	1,406	281	375	469	703	469	4,147

HUC 102 Annual Phosphorus Reduction (lbs), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	15	48	10	13	16	24	16	142
2	30	96	19	26	32	48	32	284
3	46	144	29	38	48	72	48	425
4	61	192	38	51	64	96	64	567
5	76	240	48	64	80	120	80	709
6	91	288	58	77	96	144	96	851
7	107	337	67	90	112	168	112	993
8	122	385	77	103	128	192	128	1,135
9	137	433	87	115	144	216	144	1,276
10	152	481	96	128	160	240	160	1,418
11	167	529	106	141	176	264	176	1,560
12	183	577	115	154	192	288	192	1,702
13	198	625	125	167	208	313	208	1,844
14	213	673	135	179	224	337	224	1,986
15	228	721	144	192	240	361	240	2,127
16	244	769	154	205	256	385	256	2,269
17	259	817	163	218	272	409	272	2,411
18	274	865	173	231	288	433	288	2,553
19	289	913	183	244	304	457	304	2,695
20	304	962	192	256	321	481	321	2,837
21	320	1,010	202	269	337	505	337	2,978
22	335	1,058	212	282	353	529	353	3,120
23	350	1,106	221	295	369	553	369	3,262
24	365	1,154	231	308	385	577	385	3,404
25	381	1,202	240	321	401	601	401	3,546
26	396	1,250	250	333	417	625	417	3,688
27	411	1,298	260	346	433	649	433	3,829
28	426	1,346	269	359	449	673	449	3,971
29	442	1,394	279	372	465	697	465	4,113
30	457	1,442	288	385	481	721	481	4,255

HUC 103 Annual Phosphorus Reduction (lbs), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	7	23	5	6	8	12	8	68
2	15	46	9	12	15	23	15	137
3	22	69	14	19	23	35	23	205
4	29	93	19	25	31	46	31	273
5	37	116	23	31	39	58	39	342
6	44	139	28	37	46	69	46	410
7	51	162	32	43	54	81	54	478
8	59	185	37	49	62	93	62	547
9	66	208	42	56	69	104	69	615
10	73	232	46	62	77	116	77	683
11	81	255	51	68	85	127	85	752
12	88	278	56	74	93	139	93	820
13	95	301	60	80	100	151	100	888
14	103	324	65	86	108	162	108	957
15	110	347	69	93	116	174	116	1,025
16	117	371	74	99	124	185	124	1,093
17	125	394	79	105	131	197	131	1,162
18	132	417	83	111	139	208	139	1,230
19	139	440	88	117	147	220	147	1,298
20	147	463	93	124	154	232	154	1,367
21	154	486	97	130	162	243	162	1,435
22	161	510	102	136	170	255	170	1,503
23	169	533	107	142	178	266	178	1,572
24	176	556	111	148	185	278	185	1,640
25	183	579	116	154	193	290	193	1,708
26	191	602	120	161	201	301	201	1,777
27	198	625	125	167	208	313	208	1,845
28	205	649	130	173	216	324	216	1,913
29	213	672	134	179	224	336	224	1,982
30	220	695	139	185	232	347	232	2,050

HUC 104 Annual Phosphorus Reduction (lbs), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	14	45	9	12	15	23	15	134
2	29	91	18	24	30	45	30	267
3	43	136	27	36	45	68	45	401
4	57	181	36	48	60	91	60	535
5	72	227	45	60	76	113	76	669
6	86	272	54	73	91	136	91	802
7	100	317	63	85	106	159	106	936
8	115	363	73	97	121	181	121	1,070
9	129	408	82	109	136	204	136	1,204
10	144	453	91	121	151	227	151	1,337
11	158	499	100	133	166	249	166	1,471
12	172	544	109	145	181	272	181	1,605
13	187	589	118	157	196	295	196	1,739
14	201	635	127	169	212	317	212	1,872
15	215	680	136	181	227	340	227	2,006
16	230	725	145	193	242	363	242	2,140
17	244	771	154	206	257	385	257	2,274
18	258	816	163	218	272	408	272	2,407
19	273	861	172	230	287	431	287	2,541
20	287	907	181	242	302	453	302	2,675
21	301	952	190	254	317	476	317	2,809
22	316	997	199	266	332	499	332	2,942
23	330	1,043	209	278	348	521	348	3,076
24	345	1,088	218	290	363	544	363	3,210
25	359	1,133	227	302	378	567	378	3,344
26	373	1,179	236	314	393	589	393	3,477
27	388	1,224	245	326	408	612	408	3,611
28	402	1,269	254	339	423	635	423	3,745
29	416	1,315	263	351	438	657	438	3,879
30	431	1,360	272	363	453	680	453	4,012

HUC 105 Annual Phosphorus Reduction (lbs), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	4	11	2	3	4	6	4	33
2	7	22	4	6	7	11	7	65
3	11	33	7	9	11	17	11	98
4	14	44	9	12	15	22	15	131
5	18	55	11	15	18	28	18	164
6	21	67	13	18	22	33	22	196
7	25	78	16	21	26	39	26	229
8	28	89	18	24	30	44	30	262
9	32	100	20	27	33	50	33	294
10	35	111	22	30	37	55	37	327
11	39	122	24	33	41	61	41	360
12	42	133	27	35	44	67	44	392
13	46	144	29	38	48	72	48	425
14	49	155	31	41	52	78	52	458
15	53	166	33	44	55	83	55	491
16	56	177	35	47	59	89	59	523
17	60	188	38	50	63	94	63	556
18	63	200	40	53	67	100	67	589
19	67	211	42	56	70	105	70	621
20	70	222	44	59	74	111	74	654
21	74	233	47	62	78	116	78	687
22	77	244	49	65	81	122	81	719
23	81	255	51	68	85	127	85	752
24	84	266	53	71	89	133	89	785
25	88	277	55	74	92	139	92	818
26	91	288	58	77	96	144	96	850
27	95	299	60	80	100	150	100	883
28	98	310	62	83	103	155	103	916
29	102	321	64	86	107	161	107	948
30	105	333	67	89	111	166	111	981

HUC 106 Annual Phosphorus Reduction (lbs), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	7	22	4	6	7	11	7	64
2	14	44	9	12	15	22	15	129
3	21	65	13	17	22	33	22	193
4	28	87	17	23	29	44	29	258
5	35	109	22	29	36	55	36	322
6	41	131	26	35	44	65	44	386
7	48	153	31	41	51	76	51	451
8	55	175	35	47	58	87	58	515
9	62	196	39	52	65	98	65	579
10	69	218	44	58	73	109	73	644
11	76	240	48	64	80	120	80	708
12	83	262	52	70	87	131	87	773
13	90	284	57	76	95	142	95	837
14	97	306	61	81	102	153	102	901
15	104	327	65	87	109	164	109	966
16	111	349	70	93	116	175	116	1,030
17	117	371	74	99	124	186	124	1,094
18	124	393	79	105	131	196	131	1,159
19	131	415	83	111	138	207	138	1,223
20	138	436	87	116	145	218	145	1,288
21	145	458	92	122	153	229	153	1,352
22	152	480	96	128	160	240	160	1,416
23	159	502	100	134	167	251	167	1,481
24	166	524	105	140	175	262	175	1,545
25	173	546	109	145	182	273	182	1,610
26	180	567	113	151	189	284	189	1,674
27	187	589	118	157	196	295	196	1,738
28	194	611	122	163	204	306	204	1,803
29	200	633	127	169	211	316	211	1,867
30	207	655	131	175	218	327	218	1,931

4. Cropland BMP implementation: Cumulative sediment load reductions

HUC 101 Annual Soil Erosion Reduction (tons), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	6	27	4	5	6	9	6	61
2	11	53	7	9	12	18	12	123
3	17	80	11	14	18	27	18	184
4	23	107	14	19	24	36	24	246
5	28	133	18	24	30	44	30	307
6	34	160	21	28	36	53	36	368
7	39	187	25	33	42	62	42	430
8	45	214	28	38	47	71	47	491
9	51	240	32	43	53	80	53	552
10	56	267	36	47	59	89	59	614
11	62	294	39	52	65	98	65	675
12	68	320	43	57	71	107	71	737
13	73	347	46	62	77	116	77	798
14	79	374	50	66	83	125	83	859
15	85	400	53	71	89	133	89	921
16	90	427	57	76	95	142	95	982
17	96	454	60	81	101	151	101	1,044
18	101	480	64	85	107	160	107	1,105
19	107	507	68	90	113	169	113	1,166
20	113	534	71	95	119	178	119	1,228
21	118	560	75	100	125	187	125	1,289
22	124	587	78	104	130	196	130	1,351
23	130	614	82	109	136	205	136	1,412
24	135	641	85	114	142	214	142	1,473
25	141	667	89	119	148	222	148	1,535
26	147	694	93	123	154	231	154	1,596
27	152	721	96	128	160	240	160	1,657
28	158	747	100	133	166	249	166	1,719
29	163	774	103	138	172	258	172	1,780
30	169	801	107	142	178	267	178	1,842

HUC 102 Annual Soil Erosion Reduction (tons), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	6	28	4	5	6	9	6	65
2	12	57	8	10	13	19	13	131
3	18	85	11	15	19	28	19	196
4	24	113	15	20	25	38	25	261
5	30	142	19	25	32	47	32	326
6	36	170	23	30	38	57	38	392
7	42	199	26	35	44	66	44	457
8	48	227	30	40	50	76	50	522
9	54	255	34	45	57	85	57	587
10	60	284	38	50	63	95	63	653
11	66	312	42	55	69	104	69	718
12	72	340	45	61	76	113	76	783
13	78	369	49	66	82	123	82	848
14	84	397	53	71	88	132	88	914
15	90	426	57	76	95	142	95	979
16	96	454	61	81	101	151	101	1,044
17	102	482	64	86	107	161	107	1,109
18	108	511	68	91	113	170	113	1,175
19	114	539	72	96	120	180	120	1,240
20	120	567	76	101	126	189	126	1,305
21	126	596	79	106	132	199	132	1,370
22	132	624	83	111	139	208	139	1,436
23	138	653	87	116	145	218	145	1,501
24	144	681	91	121	151	227	151	1,566
25	150	709	95	126	158	236	158	1,631
26	156	738	98	131	164	246	164	1,697
27	162	766	102	136	170	255	170	1,762
28	168	794	106	141	177	265	177	1,827
29	174	823	110	146	183	274	183	1,893
30	180	851	113	151	189	284	189	1,958

HUC 103 Annual Soil Erosion Reduction (tons), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	3	15	2	3	3	5	3	36
2	7	31	4	6	7	10	7	71
3	10	46	6	8	10	15	10	107
4	13	62	8	11	14	21	14	143
5	16	77	10	14	17	26	17	178
6	20	93	12	17	21	31	21	214
7	23	108	14	19	24	36	24	249
8	26	124	17	22	28	41	28	285
9	29	139	19	25	31	46	31	321
10	33	155	21	28	34	52	34	356
11	36	170	23	30	38	57	38	392
12	39	186	25	33	41	62	41	428
13	43	201	27	36	45	67	45	463
14	46	217	29	39	48	72	48	499
15	49	232	31	41	52	77	52	535
16	52	248	33	44	55	83	55	570
17	56	263	35	47	59	88	59	606
18	59	279	37	50	62	93	62	641
19	62	294	39	52	65	98	65	677
20	65	310	41	55	69	103	69	713
21	69	325	43	58	72	108	72	748
22	72	341	45	61	76	114	76	784
23	75	356	48	63	79	119	79	820
24	78	372	50	66	83	124	83	855
25	82	387	52	69	86	129	86	891
26	85	403	54	72	90	134	90	926
27	88	418	56	74	93	139	93	962
28	92	434	58	77	96	145	96	998
29	95	449	60	80	100	150	100	1,033
30	98	465	62	83	103	155	103	1,069

HUC 104 Annual Soil Erosion Reduction (tons), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	5	26	3	5	6	9	6	59
2	11	52	7	9	11	17	11	118
3	16	77	10	14	17	26	17	178
4	22	103	14	18	23	34	23	237
5	27	129	17	23	29	43	29	296
6	33	155	21	27	34	52	34	355
7	38	180	24	32	40	60	40	415
8	43	206	27	37	46	69	46	474
9	49	232	31	41	52	77	52	533
10	54	258	34	46	57	86	57	592
11	60	283	38	50	63	94	63	652
12	65	309	41	55	69	103	69	711
13	71	335	45	60	74	112	74	770
14	76	361	48	64	80	120	80	829
15	82	386	52	69	86	129	86	889
16	87	412	55	73	92	137	92	948
17	92	438	58	78	97	146	97	1,007
18	98	464	62	82	103	155	103	1,066
19	103	489	65	87	109	163	109	1,125
20	109	515	69	92	114	172	114	1,185
21	114	541	72	96	120	180	120	1,244
22	120	567	76	101	126	189	126	1,303
23	125	592	79	105	132	197	132	1,362
24	130	618	82	110	137	206	137	1,422
25	136	644	86	114	143	215	143	1,481
26	141	670	89	119	149	223	149	1,540
27	147	695	93	124	155	232	155	1,599
28	152	721	96	128	160	240	160	1,659
29	158	747	100	133	166	249	166	1,718
30	163	773	103	137	172	258	172	1,777

HUC 105 Annual Soil Erosion Reduction (tons), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	1	7	1	1	1	2	1	15
2	3	13	2	2	3	4	3	30
3	4	20	3	4	4	7	4	45
4	6	26	4	5	6	9	6	60
5	7	33	4	6	7	11	7	76
6	8	39	5	7	9	13	9	91
7	10	46	6	8	10	15	10	106
8	11	53	7	9	12	18	12	121
9	12	59	8	11	13	20	13	136
10	14	66	9	12	15	22	15	151
11	15	72	10	13	16	24	16	166
12	17	79	11	14	18	26	18	181
13	18	85	11	15	19	28	19	196
14	19	92	12	16	20	31	20	212
15	21	99	13	18	22	33	22	227
16	22	105	14	19	23	35	23	242
17	24	112	15	20	25	37	25	257
18	25	118	16	21	26	39	26	272
19	26	125	17	22	28	42	28	287
20	28	131	18	23	29	44	29	302
21	29	138	18	25	31	46	31	317
22	31	145	19	26	32	48	32	332
23	32	151	20	27	34	50	34	348
24	33	158	21	28	35	53	35	363
25	35	164	22	29	37	55	37	378
26	36	171	23	30	38	57	38	393
27	37	177	24	32	39	59	39	408
28	39	184	25	33	41	61	41	423
29	40	191	25	34	42	64	42	438
30	42	197	26	35	44	66	44	453

HUC 106 Annual Soil Erosion Reduction (tons), Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Load Reduction
1	3	13	2	2	3	4	3	30
2	5	26	3	5	6	9	6	60
3	8	39	5	7	9	13	9	89
4	11	52	7	9	12	17	12	119
5	14	65	9	12	14	22	14	149
6	16	78	10	14	17	26	17	179
7	19	91	12	16	20	30	20	208
8	22	104	14	18	23	35	23	238
9	25	117	16	21	26	39	26	268
10	27	129	17	23	29	43	29	298
11	30	142	19	25	32	47	32	328
12	33	155	21	28	35	52	35	357
13	36	168	22	30	37	56	37	387
14	38	181	24	32	40	60	40	417
15	41	194	26	35	43	65	43	447
16	44	207	28	37	46	69	46	476
17	46	220	29	39	49	73	49	506
18	49	233	31	41	52	78	52	536
19	52	246	33	44	55	82	55	566
20	55	259	35	46	58	86	58	596
21	57	272	36	48	60	91	60	625
22	60	285	38	51	63	95	63	655
23	63	298	40	53	66	99	66	685
24	66	311	41	55	69	104	69	715
25	68	324	43	58	72	108	72	744
26	71	337	45	60	75	112	75	774
27	74	350	47	62	78	117	78	804
28	77	362	48	64	81	121	81	834
29	79	375	50	67	83	125	83	863
30	82	388	52	69	86	129	86	893

5. Cropland BMP implementation: Costs before cost share

HUC 101 Annual Cost* Before Cost-Share, Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Cost
1	$1,011	$3,142	$1,375	$2,157	$1,348	$2,293	$4,044	$15,370
2	$1,041	$3,236	$1,416	$2,222	$1,388	$2,362	$4,165	$15,831
3	$1,073	$3,333	$1,459	$2,288	$1,430	$2,433	$4,290	$16,306
4	$1,105	$3,433	$1,502	$2,357	$1,473	$2,506	$4,419	$16,795
5	$1,138	$3,536	$1,548	$2,427	$1,517	$2,581	$4,552	$17,299
6	$1,172	$3,642	$1,594	$2,500	$1,563	$2,659	$4,688	$17,818
7	$1,207	$3,751	$1,642	$2,575	$1,610	$2,738	$4,829	$18,352
8	$1,243	$3,864	$1,691	$2,653	$1,658	$2,821	$4,974	$18,903
9	$1,281	$3,980	$1,742	$2,732	$1,708	$2,905	$5,123	$19,470
10	$1,319	$4,099	$1,794	$2,814	$1,759	$2,992	$5,277	$20,054
11	$1,359	$4,222	$1,848	$2,899	$1,812	$3,082	$5,435	$20,656
12	$1,399	$4,349	$1,903	$2,986	$1,866	$3,175	$5,598	$21,276
13	$1,441	$4,479	$1,960	$3,075	$1,922	$3,270	$5,766	$21,914
14	$1,485	$4,614	$2,019	$3,167	$1,980	$3,368	$5,939	$22,571
15	$1,529	$4,752	$2,080	$3,262	$2,039	$3,469	$6,117	$23,248
16	$1,575	$4,895	$2,142	$3,360	$2,100	$3,573	$6,300	$23,946
17	$1,622	$5,042	$2,206	$3,461	$2,163	$3,680	$6,489	$24,664
18	$1,671	$5,193	$2,273	$3,565	$2,228	$3,791	$6,684	$25,404
19	$1,721	$5,349	$2,341	$3,672	$2,295	$3,904	$6,885	$26,166
20	$1,773	$5,509	$2,411	$3,782	$2,364	$4,021	$7,091	$26,951
21	$1,826	$5,674	$2,483	$3,895	$2,435	$4,142	$7,304	$27,760
22	$1,881	$5,845	$2,558	$4,012	$2,508	$4,266	$7,523	$28,593
23	$1,937	$6,020	$2,635	$4,133	$2,583	$4,394	$7,749	$29,450
24	$1,995	$6,201	$2,714	$4,257	$2,660	$4,526	$7,981	$30,334
25	$2,055	$6,387	$2,795	$4,384	$2,740	$4,662	$8,221	$31,244
26	$2,117	$6,578	$2,879	$4,516	$2,822	$4,802	$8,467	$32,181
27	$2,180	$6,776	$2,965	$4,651	$2,907	$4,946	$8,721	$33,147
28	$2,246	$6,979	$3,054	$4,791	$2,994	$5,094	$8,983	$34,141
29	$2,313	$7,188	$3,146	$4,935	$3,084	$5,247	$9,252	$35,165
30	$2,382	$7,404	$3,240	$5,083	$3,177	$5,404	$9,530	$36,220
*3% Inflation								

HUC 102 Annual Cost* Before Cost-Share, Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Cost
1	$717	$2,227	$974	$1,529	$955	$1,625	$2,866	$10,893
2	$738	$2,293	$1,004	$1,574	$984	$1,674	$2,952	$11,219
3	$760	$2,362	$1,034	$1,622	$1,014	$1,724	$3,041	$11,556
4	$783	$2,433	$1,065	$1,670	$1,044	$1,776	$3,132	$11,903
5	$806	$2,506	$1,097	$1,720	$1,075	$1,829	$3,226	$12,260
6	$831	$2,581	$1,130	$1,772	$1,107	$1,884	$3,322	$12,628
7	$856	$2,659	$1,164	$1,825	$1,141	$1,941	$3,422	$13,006
8	$881	$2,738	$1,198	$1,880	$1,175	$1,999	$3,525	$13,397
9	$908	$2,821	$1,234	$1,936	$1,210	$2,059	$3,631	$13,799
10	$935	$2,905	$1,271	$1,994	$1,246	$2,121	$3,739	$14,213
11	$963	$2,992	$1,310	$2,054	$1,284	$2,184	$3,852	$14,639
12	$992	$3,082	$1,349	$2,116	$1,322	$2,250	$3,967	$15,078
13	$1,022	$3,175	$1,389	$2,179	$1,362	$2,317	$4,086	$15,530
14	$1,052	$3,270	$1,431	$2,245	$1,403	$2,387	$4,209	$15,996
15	$1,084	$3,368	$1,474	$2,312	$1,445	$2,458	$4,335	$16,476
16	$1,116	$3,469	$1,518	$2,381	$1,488	$2,532	$4,465	$16,970
17	$1,150	$3,573	$1,564	$2,453	$1,533	$2,608	$4,599	$17,480
18	$1,184	$3,680	$1,611	$2,526	$1,579	$2,686	$4,737	$18,004
19	$1,220	$3,791	$1,659	$2,602	$1,626	$2,767	$4,879	$18,544
20	$1,256	$3,904	$1,709	$2,680	$1,675	$2,850	$5,026	$19,100
21	$1,294	$4,021	$1,760	$2,761	$1,725	$2,935	$5,176	$19,673
22	$1,333	$4,142	$1,813	$2,844	$1,777	$3,024	$5,332	$20,264
23	$1,373	$4,266	$1,867	$2,929	$1,831	$3,114	$5,492	$20,872
24	$1,414	$4,394	$1,923	$3,017	$1,885	$3,208	$5,656	$21,498
25	$1,456	$4,526	$1,981	$3,107	$1,942	$3,304	$5,826	$22,143
26	$1,500	$4,662	$2,040	$3,200	$2,000	$3,403	$6,001	$22,807
27	$1,545	$4,802	$2,101	$3,296	$2,060	$3,505	$6,181	$23,491
28	$1,592	$4,946	$2,165	$3,395	$2,122	$3,610	$6,366	$24,196
29	$1,639	$5,094	$2,229	$3,497	$2,186	$3,719	$6,557	$24,922
30	$1,688	$5,247	$2,296	$3,602	$2,251	$3,830	$6,754	$25,669
*3% Inflation								

HUC 103 Annual Cost* Before Cost-Share, Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Cost
1	$514	$1,597	$699	$1,097	$685	$1,166	$2,056	$7,814
2	$529	$1,645	$720	$1,129	$706	$1,201	$2,118	$8,049
3	$545	$1,695	$742	$1,163	$727	$1,237	$2,181	$8,290
4	$562	$1,745	$764	$1,198	$749	$1,274	$2,247	$8,539
5	$579	$1,798	$787	$1,234	$771	$1,312	$2,314	$8,795
6	$596	$1,852	$810	$1,271	$794	$1,352	$2,383	$9,059
7	$614	$1,907	$835	$1,309	$818	$1,392	$2,455	$9,331
8	$632	$1,964	$860	$1,349	$843	$1,434	$2,529	$9,610
9	$651	$2,023	$886	$1,389	$868	$1,477	$2,604	$9,899
10	$671	$2,084	$912	$1,431	$894	$1,521	$2,683	$10,196
11	$691	$2,147	$939	$1,474	$921	$1,567	$2,763	$10,502
12	$711	$2,211	$968	$1,518	$949	$1,614	$2,846	$10,817
13	$733	$2,277	$997	$1,563	$977	$1,662	$2,931	$11,141
14	$755	$2,346	$1,027	$1,610	$1,006	$1,712	$3,019	$11,475
15	$777	$2,416	$1,057	$1,659	$1,037	$1,764	$3,110	$11,820
16	$801	$2,489	$1,089	$1,708	$1,068	$1,817	$3,203	$12,174
17	$825	$2,563	$1,122	$1,760	$1,100	$1,871	$3,299	$12,539
18	$850	$2,640	$1,155	$1,812	$1,133	$1,927	$3,398	$12,916
19	$875	$2,719	$1,190	$1,867	$1,167	$1,985	$3,500	$13,303
20	$901	$2,801	$1,226	$1,923	$1,202	$2,045	$3,605	$13,702
21	$928	$2,885	$1,263	$1,980	$1,238	$2,106	$3,713	$14,113
22	$956	$2,971	$1,300	$2,040	$1,275	$2,169	$3,825	$14,537
23	$985	$3,061	$1,339	$2,101	$1,313	$2,234	$3,940	$14,973
24	$1,014	$3,152	$1,380	$2,164	$1,353	$2,301	$4,058	$15,422
25	$1,045	$3,247	$1,421	$2,229	$1,393	$2,370	$4,179	$15,885
26	$1,076	$3,344	$1,464	$2,296	$1,435	$2,441	$4,305	$16,361
27	$1,108	$3,445	$1,508	$2,365	$1,478	$2,514	$4,434	$16,852
28	$1,142	$3,548	$1,553	$2,436	$1,522	$2,590	$4,567	$17,358
29	$1,176	$3,655	$1,599	$2,509	$1,568	$2,668	$4,704	$17,878
30	$1,211	$3,764	$1,647	$2,584	$1,615	$2,748	$4,845	$18,415
*3% Inflation								

HUC 104 Annual Cost* Before Cost-Share, Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Cost
1	$1,022	$3,176	$1,390	$2,180	$1,363	$2,318	$4,088	$15,537
2	$1,053	$3,271	$1,432	$2,246	$1,404	$2,388	$4,211	$16,003
3	$1,084	$3,369	$1,475	$2,313	$1,446	$2,459	$4,337	$16,483
4	$1,117	$3,470	$1,519	$2,382	$1,489	$2,533	$4,467	$16,978
5	$1,150	$3,575	$1,564	$2,454	$1,534	$2,609	$4,601	$17,487
6	$1,185	$3,682	$1,611	$2,528	$1,580	$2,688	$4,739	$18,012
7	$1,220	$3,792	$1,660	$2,603	$1,627	$2,768	$4,881	$18,552
8	$1,257	$3,906	$1,709	$2,681	$1,676	$2,851	$5,028	$19,109
9	$1,295	$4,023	$1,761	$2,762	$1,726	$2,937	$5,179	$19,682
10	$1,333	$4,144	$1,814	$2,845	$1,778	$3,025	$5,334	$20,272
11	$1,373	$4,268	$1,868	$2,930	$1,831	$3,116	$5,494	$20,881
12	$1,415	$4,396	$1,924	$3,018	$1,886	$3,209	$5,659	$21,507
13	$1,457	$4,528	$1,982	$3,109	$1,943	$3,305	$5,829	$22,152
14	$1,501	$4,664	$2,041	$3,202	$2,001	$3,405	$6,003	$22,817
15	$1,546	$4,804	$2,102	$3,298	$2,061	$3,507	$6,183	$23,501
16	$1,592	$4,948	$2,165	$3,397	$2,123	$3,612	$6,369	$24,206
17	$1,640	$5,096	$2,230	$3,499	$2,187	$3,720	$6,560	$24,933
18	$1,689	$5,249	$2,297	$3,604	$2,252	$3,832	$6,757	$25,681
19	$1,740	$5,407	$2,366	$3,712	$2,320	$3,947	$6,960	$26,451
20	$1,792	$5,569	$2,437	$3,823	$2,389	$4,065	$7,168	$27,244
21	$1,846	$5,736	$2,510	$3,938	$2,461	$4,187	$7,383	$28,062
22	$1,901	$5,908	$2,586	$4,056	$2,535	$4,313	$7,605	$28,904
23	$1,958	$6,085	$2,663	$4,178	$2,611	$4,442	$7,833	$29,771
24	$2,017	$6,268	$2,743	$4,303	$2,689	$4,575	$8,068	$30,664
25	$2,078	$6,456	$2,825	$4,432	$2,770	$4,713	$8,310	$31,584
26	$2,140	$6,650	$2,910	$4,565	$2,853	$4,854	$8,559	$32,531
27	$2,204	$6,849	$2,997	$4,702	$2,939	$5,000	$8,816	$33,507
28	$2,270	$7,055	$3,087	$4,843	$3,027	$5,150	$9,081	$34,512
29	$2,338	$7,266	$3,180	$4,988	$3,118	$5,304	$9,353	$35,548
30	$2,408	$7,484	$3,275	$5,138	$3,211	$5,463	$9,634	$36,614
*3% Inflation								

HUC 105 Annual Cost* Before Cost-Share, Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Cost
1	$210	$651	$285	$447	$279	$475	$838	$3,185
2	$216	$671	$293	$460	$288	$489	$863	$3,281
3	$222	$691	$302	$474	$296	$504	$889	$3,379
4	$229	$711	$311	$488	$305	$519	$916	$3,480
5	$236	$733	$321	$503	$314	$535	$943	$3,585
6	$243	$755	$330	$518	$324	$551	$971	$3,692
7	$250	$777	$340	$534	$334	$567	$1,001	$3,803
8	$258	$801	$350	$550	$344	$584	$1,031	$3,917
9	$265	$825	$361	$566	$354	$602	$1,062	$4,035
10	$273	$849	$372	$583	$364	$620	$1,093	$4,156
11	$282	$875	$383	$601	$375	$639	$1,126	$4,280
12	$290	$901	$394	$619	$387	$658	$1,160	$4,409
13	$299	$928	$406	$637	$398	$678	$1,195	$4,541
14	$308	$956	$418	$656	$410	$698	$1,231	$4,677
15	$317	$985	$431	$676	$423	$719	$1,268	$4,818
16	$326	$1,014	$444	$696	$435	$740	$1,306	$4,962
17	$336	$1,045	$457	$717	$448	$763	$1,345	$5,111
18	$346	$1,076	$471	$739	$462	$785	$1,385	$5,264
19	$357	$1,108	$485	$761	$476	$809	$1,427	$5,422
20	$367	$1,142	$500	$784	$490	$833	$1,469	$5,585
21	$378	$1,176	$515	$807	$505	$858	$1,514	$5,752
22	$390	$1,211	$530	$831	$520	$884	$1,559	$5,925
23	$401	$1,247	$546	$856	$535	$911	$1,606	$6,103
24	$413	$1,285	$562	$882	$551	$938	$1,654	$6,286
25	$426	$1,323	$579	$909	$568	$966	$1,703	$6,474
26	$439	$1,363	$597	$936	$585	$995	$1,755	$6,669
27	$452	$1,404	$614	$964	$602	$1,025	$1,807	$6,869
28	$465	$1,446	$633	$993	$620	$1,056	$1,861	$7,075
29	$479	$1,490	$652	$1,023	$639	$1,087	$1,917	$7,287
30	$494	$1,534	$671	$1,053	$658	$1,120	$1,975	$7,506
*3% Inflation								

HUC 106 Annual Cost* Before Cost-Share, Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Cost
1	$410	$1,273	$557	$874	$546	$929	$1,638	$6,225
2	$422	$1,311	$574	$900	$562	$957	$1,687	$6,412
3	$434	$1,350	$591	$927	$579	$985	$1,738	$6,605
4	$447	$1,391	$609	$955	$597	$1,015	$1,790	$6,803
5	$461	$1,432	$627	$983	$615	$1,045	$1,844	$7,007
6	$475	$1,475	$646	$1,013	$633	$1,077	$1,899	$7,217
7	$489	$1,520	$665	$1,043	$652	$1,109	$1,956	$7,434
8	$504	$1,565	$685	$1,074	$672	$1,142	$2,015	$7,657
9	$519	$1,612	$705	$1,107	$692	$1,177	$2,075	$7,886
10	$534	$1,660	$727	$1,140	$712	$1,212	$2,137	$8,123
11	$550	$1,710	$748	$1,174	$734	$1,248	$2,201	$8,367
12	$567	$1,762	$771	$1,209	$756	$1,286	$2,267	$8,618
13	$584	$1,814	$794	$1,246	$778	$1,324	$2,335	$8,876
14	$601	$1,869	$818	$1,283	$802	$1,364	$2,405	$9,142
15	$619	$1,925	$842	$1,321	$826	$1,405	$2,478	$9,417
16	$638	$1,983	$868	$1,361	$851	$1,447	$2,552	$9,699
17	$657	$2,042	$894	$1,402	$876	$1,491	$2,629	$9,990
18	$677	$2,103	$921	$1,444	$902	$1,535	$2,707	$10,290
19	$697	$2,166	$948	$1,487	$930	$1,581	$2,789	$10,598
20	$718	$2,231	$977	$1,532	$957	$1,629	$2,872	$10,916
21	$740	$2,298	$1,006	$1,578	$986	$1,678	$2,958	$11,244
22	$762	$2,367	$1,036	$1,625	$1,016	$1,728	$3,047	$11,581
23	$785	$2,438	$1,067	$1,674	$1,046	$1,780	$3,139	$11,929
24	$808	$2,512	$1,099	$1,724	$1,078	$1,833	$3,233	$12,287
25	$832	$2,587	$1,132	$1,776	$1,110	$1,888	$3,330	$12,655
26	$857	$2,664	$1,166	$1,829	$1,143	$1,945	$3,430	$13,035
27	$883	$2,744	$1,201	$1,884	$1,177	$2,003	$3,532	$13,426
28	$910	$2,827	$1,237	$1,941	$1,213	$2,063	$3,638	$13,829
29	$937	$2,912	$1,274	$1,999	$1,249	$2,125	$3,748	$14,243
30	$965	$2,999	$1,312	$2,059	$1,287	$2,189	$3,860	$14,671
*3% Inflation								

6. Cropland BMP implementation: Costs after cost share

HUC 101 Annual Cost* After Cost-Share, Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Cost
1	$253	$1,571	$1,169	$539	$135	$573	$1,011	$5,251
2	$260	$1,618	$1,204	$555	$139	$591	$1,041	$5,408
3	$268	$1,667	$1,240	$572	$143	$608	$1,073	$5,570
4	$276	$1,717	$1,277	$589	$147	$627	$1,105	$5,738
5	$284	$1,768	$1,315	$607	$152	$645	$1,138	$5,910
6	$293	$1,821	$1,355	$625	$156	$665	$1,172	$6,087
7	$302	$1,876	$1,396	$644	$161	$685	$1,207	$6,270
8	$311	$1,932	$1,437	$663	$166	$705	$1,243	$6,458
9	$320	$1,990	$1,480	$683	$171	$726	$1,281	$6,651
10	$330	$2,050	$1,525	$704	$176	$748	$1,319	$6,851
11	$340	$2,111	$1,571	$725	$181	$771	$1,359	$7,056
12	$350	$2,174	$1,618	$746	$187	$794	$1,399	$7,268
13	$360	$2,240	$1,666	$769	$192	$817	$1,441	$7,486
14	$371	$2,307	$1,716	$792	$198	$842	$1,485	$7,711
15	$382	$2,376	$1,768	$816	$204	$867	$1,529	$7,942
16	$394	$2,447	$1,821	$840	$210	$893	$1,575	$8,180
17	$406	$2,521	$1,875	$865	$216	$920	$1,622	$8,426
18	$418	$2,596	$1,932	$891	$223	$948	$1,671	$8,679
19	$430	$2,674	$1,990	$918	$229	$976	$1,721	$8,939
20	$443	$2,755	$2,049	$945	$236	$1,005	$1,773	$9,207
21	$456	$2,837	$2,111	$974	$243	$1,036	$1,826	$9,483
22	$470	$2,922	$2,174	$1,003	$251	$1,067	$1,881	$9,768
23	$484	$3,010	$2,239	$1,033	$258	$1,099	$1,937	$10,061
24	$499	$3,100	$2,307	$1,064	$266	$1,132	$1,995	$10,363
25	$514	$3,193	$2,376	$1,096	$274	$1,165	$2,055	$10,674
26	$529	$3,289	$2,447	$1,129	$282	$1,200	$2,117	$10,994
27	$545	$3,388	$2,520	$1,163	$291	$1,236	$2,180	$11,324
28	$561	$3,489	$2,596	$1,198	$299	$1,274	$2,246	$11,663
29	$578	$3,594	$2,674	$1,234	$308	$1,312	$2,313	$12,013
30	$596	$3,702	$2,754	$1,271	$318	$1,351	$2,382	$12,374
*3% Inflation								

HUC 102 Annual Cost* After Cost-Share, Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Cost
1	$179	$1,113	$828	$382	$96	$406	$717	$3,721
2	$184	$1,147	$853	$394	$98	$419	$738	$3,833
3	$190	$1,181	$879	$405	$101	$431	$760	$3,948
4	$196	$1,217	$905	$418	$104	$444	$783	$4,066
5	$202	$1,253	$932	$430	$108	$457	$806	$4,188
6	$208	$1,291	$960	$443	$111	$471	$831	$4,314
7	$214	$1,329	$989	$456	$114	$485	$856	$4,443
8	$220	$1,369	$1,019	$470	$117	$500	$881	$4,577
9	$227	$1,410	$1,049	$484	$121	$515	$908	$4,714
10	$234	$1,453	$1,081	$499	$125	$530	$935	$4,855
11	$241	$1,496	$1,113	$514	$128	$546	$963	$5,001
12	$248	$1,541	$1,147	$529	$132	$562	$992	$5,151
13	$255	$1,587	$1,181	$545	$136	$579	$1,022	$5,306
14	$263	$1,635	$1,216	$561	$140	$597	$1,052	$5,465
15	$271	$1,684	$1,253	$578	$145	$615	$1,084	$5,629
16	$279	$1,734	$1,290	$595	$149	$633	$1,116	$5,797
17	$287	$1,787	$1,329	$613	$153	$652	$1,150	$5,971
18	$296	$1,840	$1,369	$632	$158	$672	$1,184	$6,151
19	$305	$1,895	$1,410	$651	$163	$692	$1,220	$6,335
20	$314	$1,952	$1,452	$670	$168	$712	$1,256	$6,525
21	$324	$2,011	$1,496	$690	$173	$734	$1,294	$6,721
22	$333	$2,071	$1,541	$711	$178	$756	$1,333	$6,923
23	$343	$2,133	$1,587	$732	$183	$779	$1,373	$7,130
24	$354	$2,197	$1,635	$754	$189	$802	$1,414	$7,344
25	$364	$2,263	$1,684	$777	$194	$826	$1,456	$7,564
26	$375	$2,331	$1,734	$800	$200	$851	$1,500	$7,791
27	$386	$2,401	$1,786	$824	$206	$876	$1,545	$8,025
28	$398	$2,473	$1,840	$849	$212	$903	$1,592	$8,266
29	$410	$2,547	$1,895	$874	$219	$930	$1,639	$8,514
30	$422	$2,624	$1,952	$901	$225	$958	$1,688	$8,769
*3% Inflation								

HUC 103 Annual Cost* After Cost-Share, Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Cost
1	$129	$799	$594	$274	$69	$291	$514	$2,669
2	$132	$823	$612	$282	$71	$300	$529	$2,750
3	$136	$847	$630	$291	$73	$309	$545	$2,832
4	$140	$873	$649	$300	$75	$319	$562	$2,917
5	$145	$899	$669	$309	$77	$328	$579	$3,005
6	$149	$926	$689	$318	$79	$338	$596	$3,095
7	$153	$954	$709	$327	$82	$348	$614	$3,188
8	$158	$982	$731	$337	$84	$358	$632	$3,283
9	$163	$1,012	$753	$347	$87	$369	$651	$3,382
10	$168	$1,042	$775	$358	$89	$380	$671	$3,483
11	$173	$1,073	$799	$368	$92	$392	$691	$3,588
12	$178	$1,106	$822	$379	$95	$403	$711	$3,695
13	$183	$1,139	$847	$391	$98	$416	$733	$3,806
14	$189	$1,173	$873	$403	$101	$428	$755	$3,920
15	$194	$1,208	$899	$415	$104	$441	$777	$4,038
16	$200	$1,244	$926	$427	$107	$454	$801	$4,159
17	$206	$1,282	$953	$440	$110	$468	$825	$4,284
18	$212	$1,320	$982	$453	$113	$482	$850	$4,412
19	$219	$1,360	$1,012	$467	$117	$496	$875	$4,545
20	$225	$1,400	$1,042	$481	$120	$511	$901	$4,681
21	$232	$1,442	$1,073	$495	$124	$526	$928	$4,821
22	$239	$1,486	$1,105	$510	$127	$542	$956	$4,966
23	$246	$1,530	$1,139	$525	$131	$559	$985	$5,115
24	$254	$1,576	$1,173	$541	$135	$575	$1,014	$5,268
25	$261	$1,623	$1,208	$557	$139	$593	$1,045	$5,427
26	$269	$1,672	$1,244	$574	$143	$610	$1,076	$5,589
27	$277	$1,722	$1,281	$591	$148	$629	$1,108	$5,757
28	$285	$1,774	$1,320	$609	$152	$647	$1,142	$5,930
29	$294	$1,827	$1,359	$627	$157	$667	$1,176	$6,108
30	$303	$1,882	$1,400	$646	$162	$687	$1,211	$6,291
*3% Inflation								

HUC 104 Annual Cost* After Cost-Share, Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Cost
1	$256	$1,588	$1,181	$545	$136	$580	$1,022	$5,308
2	$263	$1,636	$1,217	$561	$140	$597	$1,053	$5,467
3	$271	$1,685	$1,253	$578	$145	$615	$1,084	$5,631
4	$279	$1,735	$1,291	$596	$149	$633	$1,117	$5,800
5	$288	$1,787	$1,330	$613	$153	$652	$1,150	$5,974
6	$296	$1,841	$1,370	$632	$158	$672	$1,185	$6,153
7	$305	$1,896	$1,411	$651	$163	$692	$1,220	$6,338
8	$314	$1,953	$1,453	$670	$168	$713	$1,257	$6,528
9	$324	$2,012	$1,497	$690	$173	$734	$1,295	$6,724
10	$333	$2,072	$1,542	$711	$178	$756	$1,333	$6,926
11	$343	$2,134	$1,588	$733	$183	$779	$1,373	$7,133
12	$354	$2,198	$1,635	$754	$189	$802	$1,415	$7,347
13	$364	$2,264	$1,684	$777	$194	$826	$1,457	$7,568
14	$375	$2,332	$1,735	$800	$200	$851	$1,501	$7,795
15	$386	$2,402	$1,787	$824	$206	$877	$1,546	$8,029
16	$398	$2,474	$1,841	$849	$212	$903	$1,592	$8,269
17	$410	$2,548	$1,896	$875	$219	$930	$1,640	$8,518
18	$422	$2,625	$1,953	$901	$225	$958	$1,689	$8,773
19	$435	$2,703	$2,011	$928	$232	$987	$1,740	$9,036
20	$448	$2,785	$2,072	$956	$239	$1,016	$1,792	$9,307
21	$461	$2,868	$2,134	$984	$246	$1,047	$1,846	$9,587
22	$475	$2,954	$2,198	$1,014	$253	$1,078	$1,901	$9,874
23	$490	$3,043	$2,264	$1,044	$261	$1,111	$1,958	$10,170
24	$504	$3,134	$2,332	$1,076	$269	$1,144	$2,017	$10,475
25	$519	$3,228	$2,402	$1,108	$277	$1,178	$2,078	$10,790
26	$535	$3,325	$2,474	$1,141	$285	$1,214	$2,140	$11,113
27	$551	$3,425	$2,548	$1,175	$294	$1,250	$2,204	$11,447
28	$568	$3,527	$2,624	$1,211	$303	$1,287	$2,270	$11,790
29	$585	$3,633	$2,703	$1,247	$312	$1,326	$2,338	$12,144
30	$602	$3,742	$2,784	$1,284	$321	$1,366	$2,408	$12,508
*3% Inflation								

HUC 105 Annual Cost* After Cost-Share, Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Cost
1	$52	$326	$242	$112	$28	$119	$210	$1,088
2	$54	$335	$249	$115	$29	$122	$216	$1,121
3	$56	$345	$257	$119	$30	$126	$222	$1,154
4	$57	$356	$265	$122	$31	$130	$229	$1,189
5	$59	$366	$273	$126	$31	$134	$236	$1,225
6	$61	$377	$281	$130	$32	$138	$243	$1,261
7	$63	$389	$289	$133	$33	$142	$250	$1,299
8	$64	$400	$298	$137	$34	$146	$258	$1,338
9	$66	$412	$307	$142	$35	$151	$265	$1,378
10	$68	$425	$316	$146	$36	$155	$273	$1,420
11	$70	$437	$325	$150	$38	$160	$282	$1,462
12	$72	$451	$335	$155	$39	$164	$290	$1,506
13	$75	$464	$345	$159	$40	$169	$299	$1,551
14	$77	$478	$356	$164	$41	$174	$308	$1,598
15	$79	$492	$366	$169	$42	$180	$317	$1,646
16	$82	$507	$377	$174	$44	$185	$326	$1,695
17	$84	$522	$389	$179	$45	$191	$336	$1,746
18	$87	$538	$400	$185	$46	$196	$346	$1,798
19	$89	$554	$412	$190	$48	$202	$357	$1,852
20	$92	$571	$425	$196	$49	$208	$367	$1,908
21	$95	$588	$437	$202	$50	$215	$378	$1,965
22	$97	$606	$451	$208	$52	$221	$390	$2,024
23	$100	$624	$464	$214	$54	$228	$401	$2,085
24	$103	$642	$478	$221	$55	$234	$413	$2,147
25	$106	$662	$492	$227	$57	$242	$426	$2,212
26	$110	$682	$507	$234	$58	$249	$439	$2,278
27	$113	$702	$522	$241	$60	$256	$452	$2,346
28	$116	$723	$538	$248	$62	$264	$465	$2,417
29	$120	$745	$554	$256	$64	$272	$479	$2,489
30	$123	$767	$571	$263	$66	$280	$494	$2,564
*3% Inflation								

HUC 106 Annual Cost* After Cost-Share, Cropland BMPs								
Year	Permanent Vegetation	No-Till with Cover Crops	Terraces	Waterways	Vegetative Buffers	Nutrient Management Plan	Grade Stabilization Structures	Total Cost
1	$102	$636	$473	$218	$55	$232	$410	$2,127
2	$105	$655	$488	$225	$56	$239	$422	$2,191
3	$109	$675	$502	$232	$58	$246	$434	$2,256
4	$112	$695	$517	$239	$60	$254	$447	$2,324
5	$115	$716	$533	$246	$61	$261	$461	$2,394
6	$119	$738	$549	$253	$63	$269	$475	$2,466
7	$122	$760	$565	$261	$65	$277	$489	$2,539
8	$126	$783	$582	$269	$67	$286	$504	$2,616
9	$130	$806	$600	$277	$69	$294	$519	$2,694
10	$134	$830	$618	$285	$71	$303	$534	$2,775
11	$138	$855	$636	$294	$73	$312	$550	$2,858
12	$142	$881	$655	$302	$76	$321	$567	$2,944
13	$146	$907	$675	$311	$78	$331	$584	$3,032
14	$150	$934	$695	$321	$80	$341	$601	$3,123
15	$155	$962	$716	$330	$83	$351	$619	$3,217
16	$159	$991	$738	$340	$85	$362	$638	$3,313
17	$164	$1,021	$760	$350	$88	$373	$657	$3,413
18	$169	$1,052	$782	$361	$90	$384	$677	$3,515
19	$174	$1,083	$806	$372	$93	$395	$697	$3,621
20	$180	$1,116	$830	$383	$96	$407	$718	$3,729
21	$185	$1,149	$855	$394	$99	$419	$740	$3,841
22	$190	$1,184	$881	$406	$102	$432	$762	$3,956
23	$196	$1,219	$907	$418	$105	$445	$785	$4,075
24	$202	$1,256	$934	$431	$108	$458	$808	$4,197
25	$208	$1,293	$962	$444	$111	$472	$832	$4,323
26	$214	$1,332	$991	$457	$114	$486	$857	$4,453
27	$221	$1,372	$1,021	$471	$118	$501	$883	$4,587
28	$227	$1,413	$1,052	$485	$121	$516	$910	$4,724
29	$234	$1,456	$1,083	$500	$125	$531	$937	$4,866
30	$241	$1,499	$1,116	$515	$129	$547	$965	$5,012
*3% Inflation								