John Redmond Reservoir Watershed WRAPS (Watershed Restoration and Protection Strategies) Plan

2020



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John Redmond Reservoir WRAPS

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As of December 2020, the JRR Watershed has two separate Stakeholder Leadership Teams with a total of 45 members. SLT membership includes representatives from local producers and agency personnel in the Neosho Headwaters/Eagle Creek/Lower Cottonwood (NELC) and the Upper Cottonwood Watersheds.

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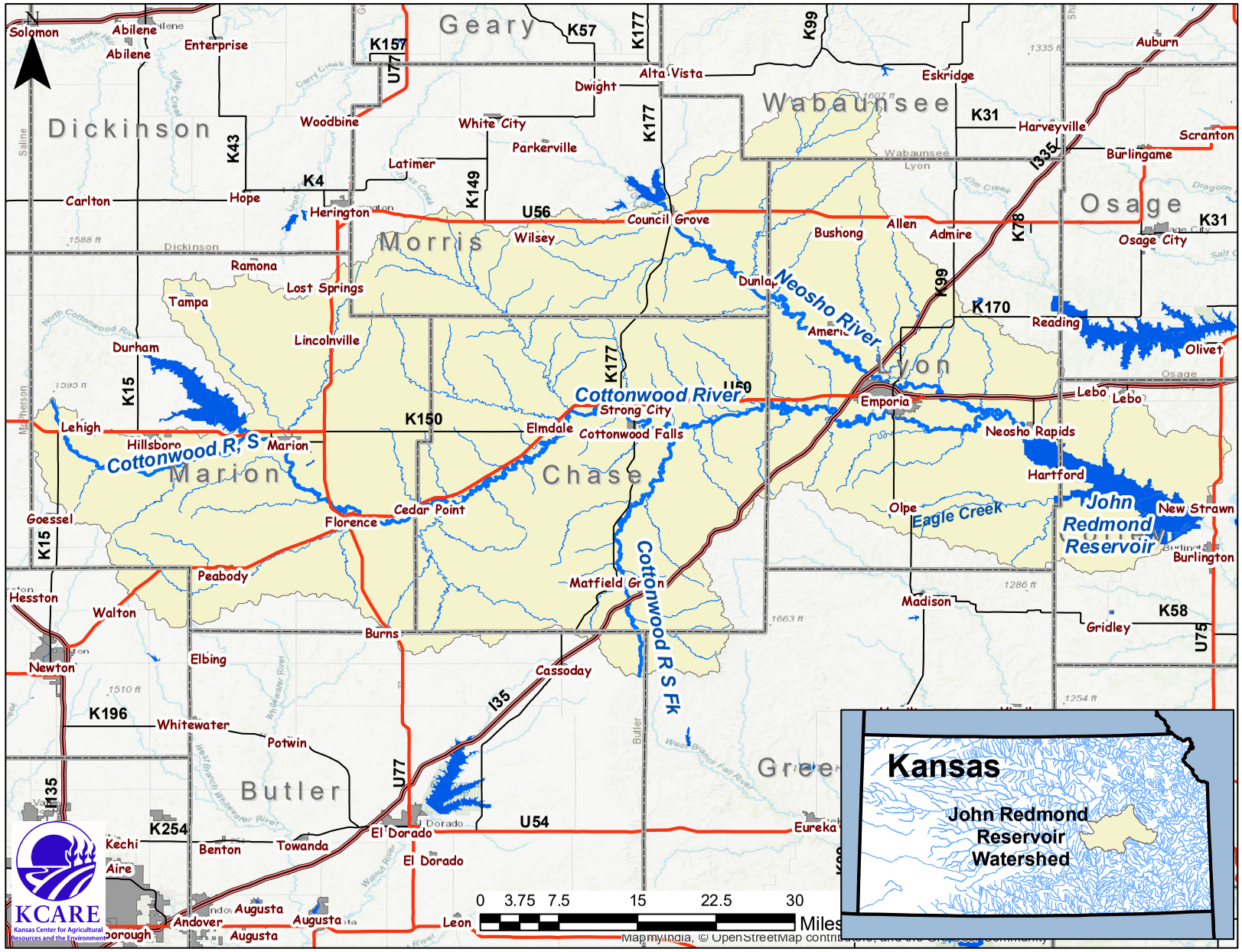

Geary
Dickinson
Wabaunsee
Morris
Lyon
Osage
Marion
Chase
Butler
Greenwood
Solomon
Abilene
Enterprise
Dwight
Alta Vista
Eskridge
Auburn
Woodbine
White City
Parkerville
Harveyville
Scranton
Burlingame
Latimer
Carlton
Hope
Herington
Council Grove
Wilsey
Bushong
Allen
Admire
Osage City
Ramona
Lost Springs
Tampa
Lincolnville
Durham
Dunlap
Neosho River
Reading
Olivet
Cottonwood River
Strong City
Emporia
Lebo
Lehigh
Hillsboro
Marion
Elmdale
Cottonwood Falls
Neosho Rapids
Cottonwood R S
Hartford
John Redmond Reservoir
New Strawn
Burlington
Goessel
Florence
Cedar Point
Olpe
Eagle Creek
Peabody
Matfield Green
Cottonwood R S Fk
Madison
Gridley
Hesston
Walton
Burns
Newton
Elbing
Cassoday
Whitewater
Potwin
El Dorado
Eureka
Kechi
Benton
Towanda
Aire
Andover
Augusta
Leon
K157
K177
K99
K31
K4
K43
K149
U56
K78
K170
K15
K150
U50
K196
K254
U54
K58
U75
U77
I335
I135
Kansas
John Redmond Reservoir Watershed
0 3.75 7.5 15 22.5 30
Miles
KCARE
Kansas Center for Agricultural Resources and the Environment

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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.

JRR: John Redmond Reservoir

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.

NELC: The combined area of Neosho Headwaters, Eagle Creek and Lower Cottonwood watersheds

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, each of 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.

USDA: United States Department of Agriculture.

WRAPS: Watershed Restoration and Protection Strategy.

1. Preface and Plan Update

The purpose of this Watershed Restoration and Protection Strategy (WRAPS) report for the **John Redmond Reservoir (JRR) 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 Teams (SLTs) will have the capability, capacity and confidence to make decisions to restore and protect the water quality and watershed conditions of the John Redmond Reservoir (JRR) Watershed.

Plan Update: A TMDL revision by the Kansas Department of Health and Environment (KDHE) resulted in outdated WRAPS plan implementation goals, therefore necessitating a plan update. KDHE determined that the updated WRAPS plan should account for the entire drainage area affecting the John Redmond Reservoir. Therefore, this plan update will combine the following original WRAPS plans into one single plan: *Cottonwood* (Upper and Lower, 2012), *Eagle Creek* (2011), and *John Redmond/Neosho Headwaters* (2010). The combined and updated plan will be referred to as the "John Redmond Reservoir Watershed WRAPS" or "JRR Watershed WRAPS". For clarity and ease of use, the JRR Watershed WRAPS plan will be split into two sections beginning in Section 6 when targeted areas are discussed. These sections are:

1. Neosho Headwaters, Eagle Creek and Lower Cottonwood, referred to as "NELC" and
2. Upper Cottonwood

The JRR WRAPS plan was updated and revised in late 2020 by Kansas State University staff and KDHE, with the guidance of the JRR WRAPS Coordinators and SLT.

Note: Tables throughout this plan use rounded figures.

2. John Redmond Reservoir 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 John Redmond Reservoir (JRR) 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)?

A Watershed Restoration and Protection Strategy (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 it addresses only part of the need; actively protecting watersheds is also 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 JRR Watershed, located in the Neosho Basin (**Figure 1**). This basin drains the Neosho River and

its tributaries into Oklahoma and eventually empties into the Gulf of Mexico. The dam at John Redmond Reservoir is the geographical endpoint of this WRAPS plan.

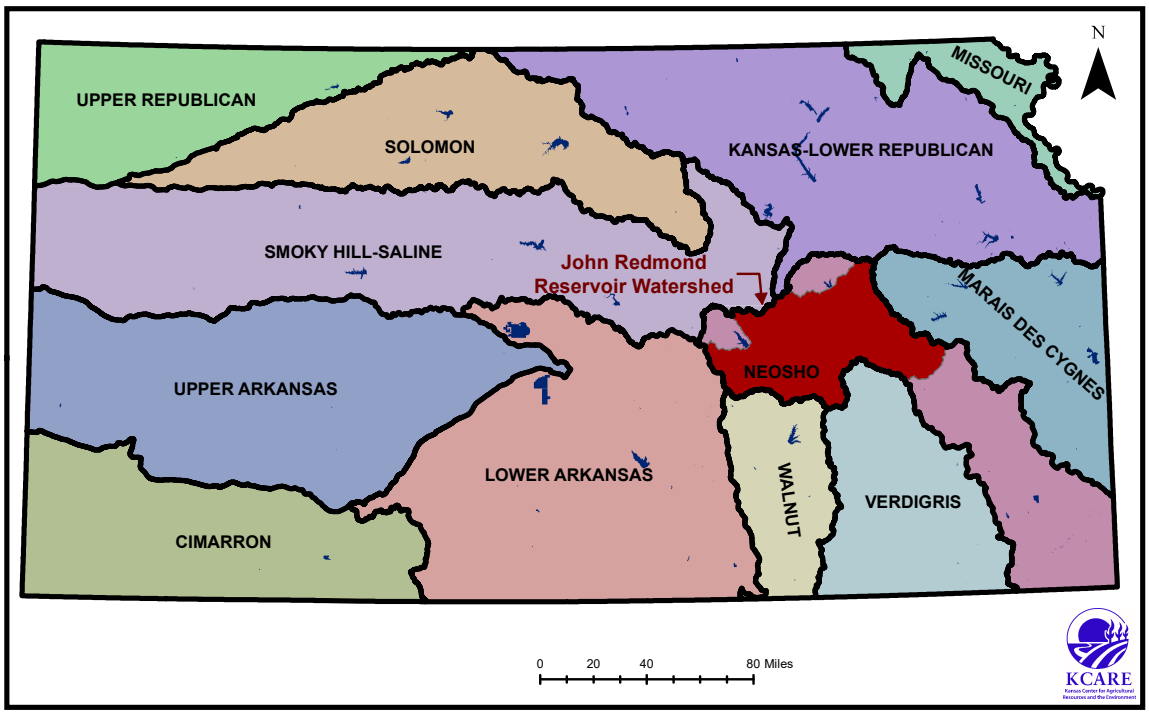


Figure 1. The 12 River Basins of Kansas, Highlighting the JRR Watershed

The JRR Watershed (**Figure 2**) is located in east-central Kansas and overlays portions of nine counties. The majority of the JRR Watershed is in Chase, Lyon, Marion and Morris counties, with smaller portions located in northwest Coffey county and southwest Wabaunsee county. Fragments of the watershed are located in northern Butler, Greenwood and Harvey counties.

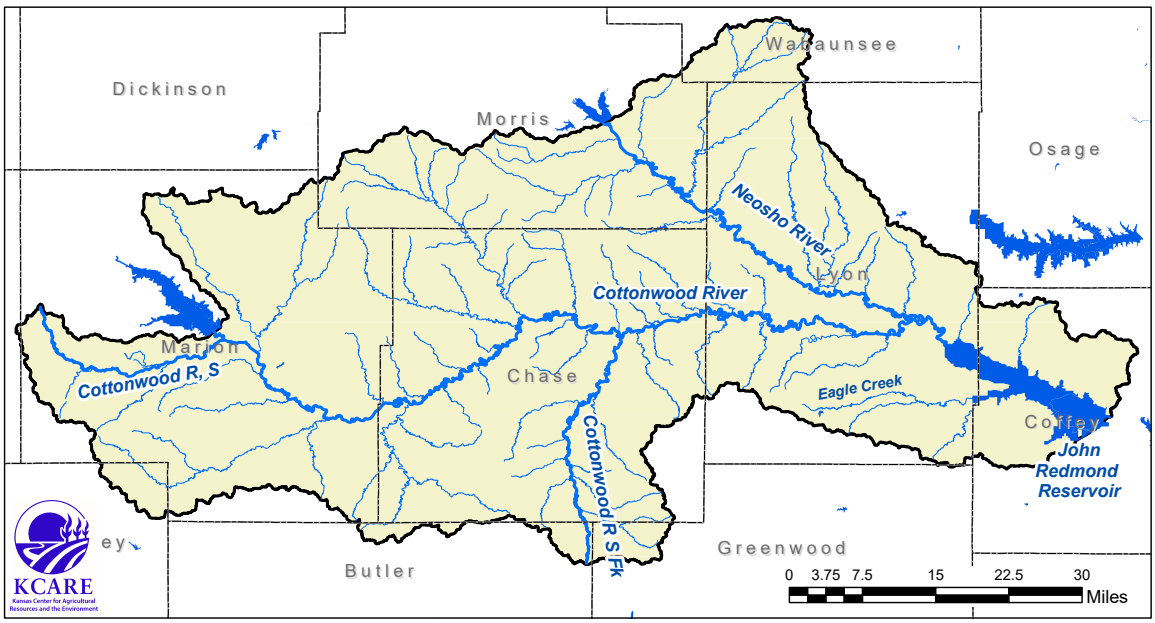


Figure 2. The JRR Watershed

D. Overview of the JRR Watershed

The JRR WRAPS plan is designed to improve the health, storage capacity, and lifespan of the John Redmond Reservoir while positively impacting water quality throughout the entire watershed and its tributaries. The Neosho River and its primary tributary, the Cottonwood River, are the main sources of inflow to John Redmond Reservoir in east-central Kansas.

The JRR Watershed is comprised of 1,641,934 acres:

- Neosho Headwaters and Eagle Creek = 556,562 acres,
- Lower Cottonwood = 616,404 acres, and
- Upper Cottonwood = 468,968 acres.

This equates to an approximate area of 2,566 square miles for the JRR Watershed.

Eagle Creek is part of the Neosho Headwaters Watershed (**Figure 3**); in the past, this area has had its own WRAPS group and plan. For the purpose of simplifying the JRR WRAPS plan, Eagle Creek has been included as part of the Neosho Headwaters. Therefore, from this point forward, any areas referred to as Neosho Headwaters can be assumed also to include the Eagle Creek Watershed.

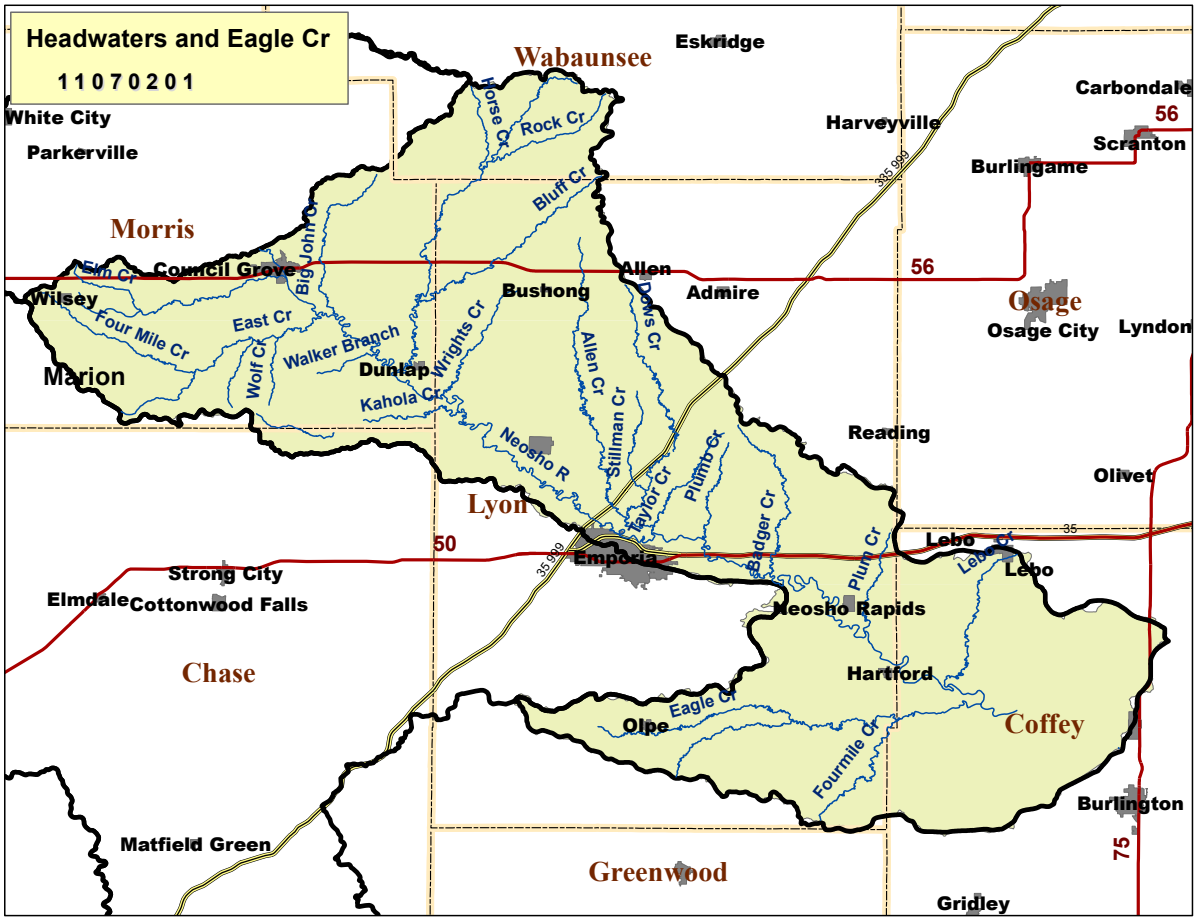


Figure 3. Neosho Headwaters Portion of the JRR Watershed

The Cottonwood Watershed covers the area that drains the Cottonwood River and its tributaries from the dam at Marion Lake to the confluence of the Cottonwood and Neosho Rivers. The Cottonwood Watershed is divided into the Lower Cottonwood (**Figure 4**) and the Upper Cottonwood (**Figure 5**) Watersheds. Marion Lake is located on the headwaters of the Cottonwood River and is part of the Upper Cottonwood Watershed; however, Marion Lake has its own WRAPS group and plan, and is not part of this JRR Watershed WRAPS plan.

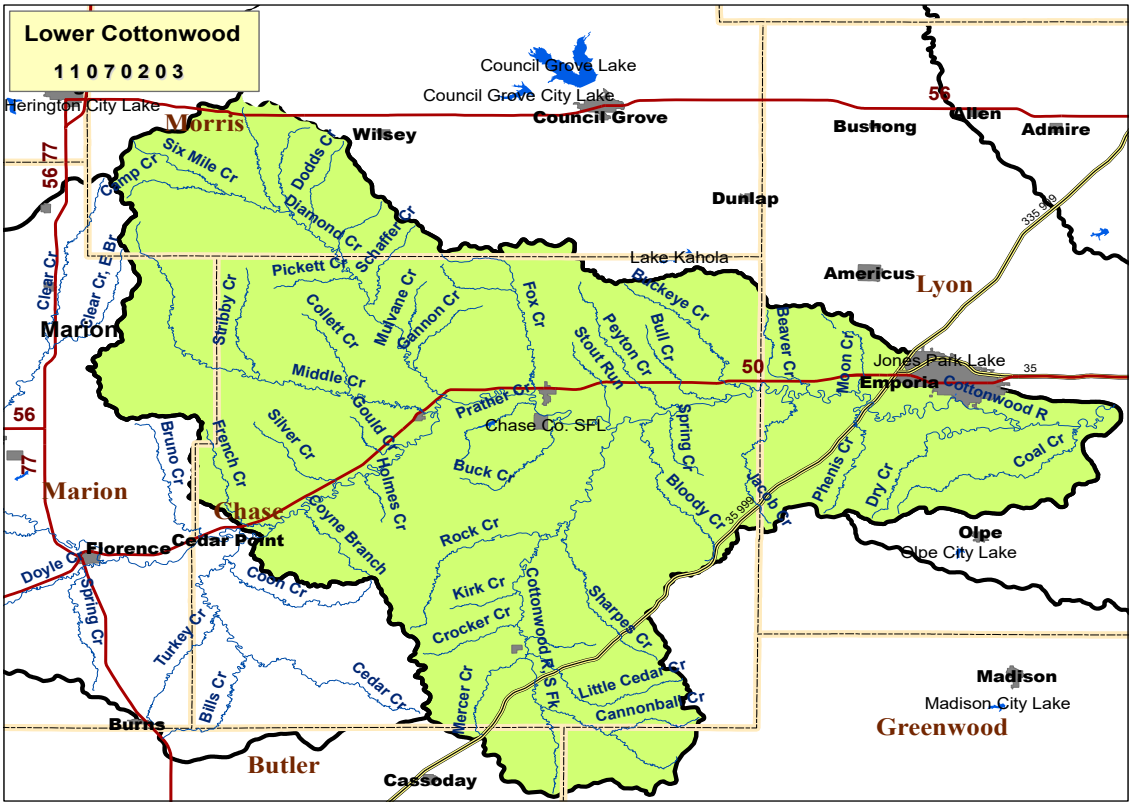


Figure 4. Lower Cottonwood Portion of the JRR Watershed

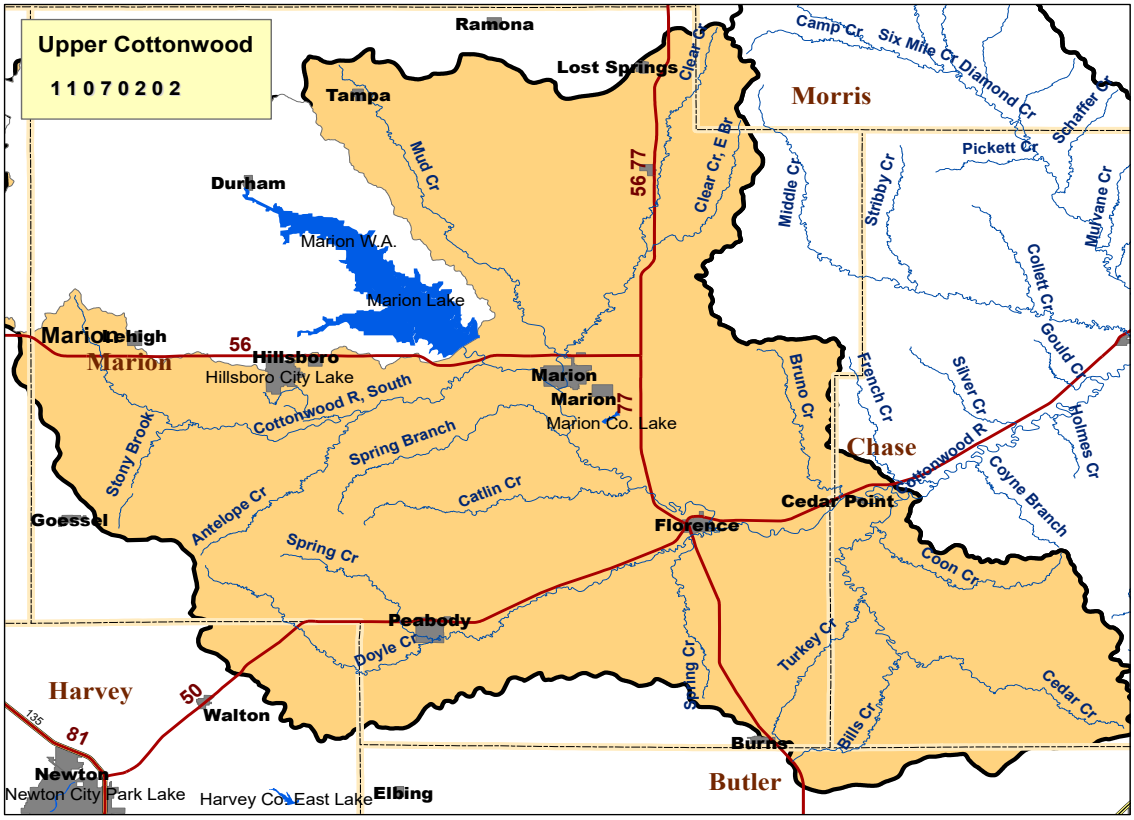


Figure 5. Upper Cottonwood Portion of the JRR Watershed

This WRAPS plan will combine the Neosho Headwaters (including Eagle Creek) and the Lower Cottonwood watersheds and refer to them as the "NELC" Watershed. The NELC Watershed makes up a total of 1,172,966 acres of the JRR Watershed, leaving the Upper Cottonwood standing on its own with 468,969 acres. The NELC and the Upper Cottonwood are treated as separate watersheds based on differences in leadership and BMP implementation.

E. Elevation of the JRR Watershed

Elevation determines watershed boundaries. As shown in **Figure 6**, the upper boundary of the JRR Watershed has an average elevation of 1,644 feet, and the lowest point of the watershed has an elevation of 1,036 feet.

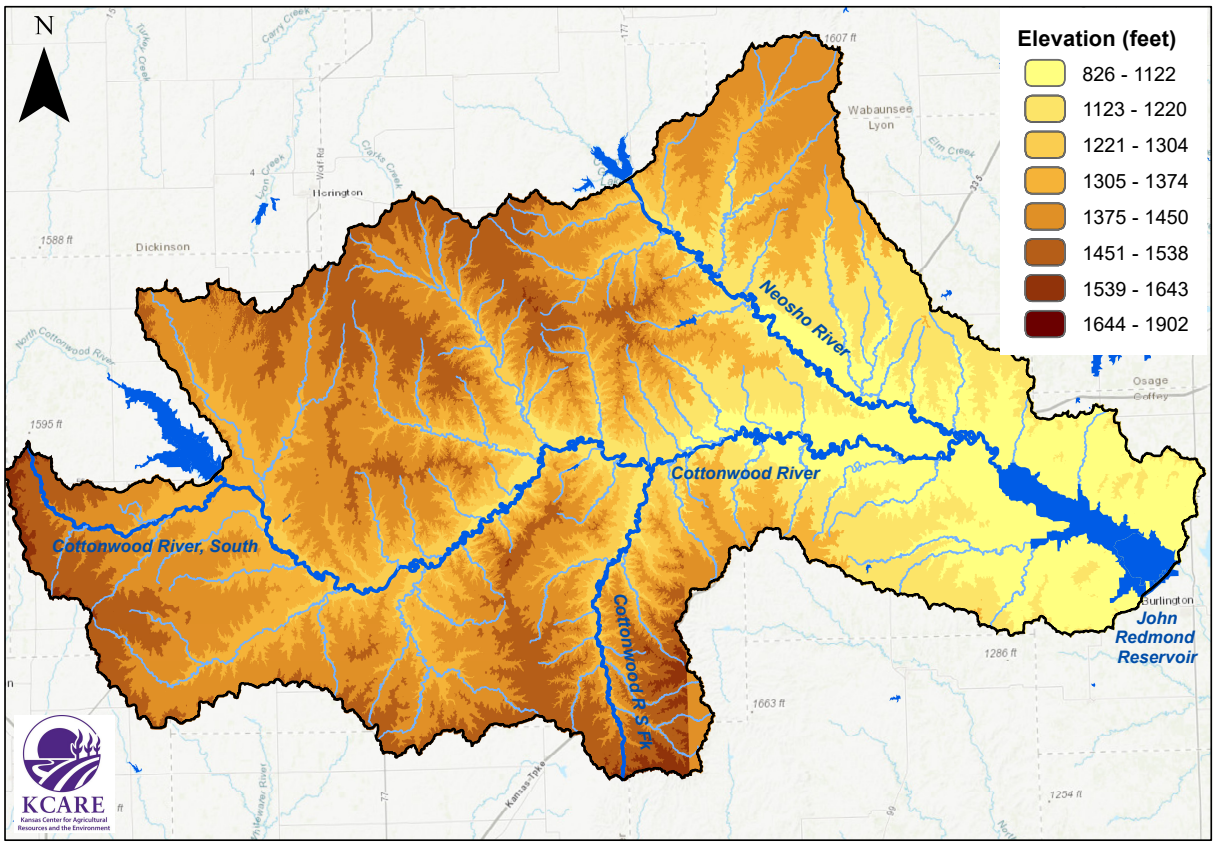


Figure 6. Elevation Relief Map of the JRR Watershed

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.

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 square miles)
- 11**07**0201: Sub-region drainage of the Neosho and Verdigris River Basins in Arkansas, Kansas, Missouri and Oklahoma (Area = 20,500 square miles)
- 1107**02**01: Accounting unit drainage of the Neosho River Basin in Arkansas, Kansas Missouri and Oklahoma (Area = 12,400 square miles)
- 110702**01**: Cataloging unit drainage of the section of the Neosho River Headwaters, in Kansas (Area = 870 square miles)
- 110702**02:** Cataloging unit drainage of the section of the Cottonwood River referred to as the Upper Cottonwood in Kansas (Area = 733 square miles)
- 110702**03:** Cataloging unit drainage of the section of the Cottonwood River referred to as the Lower Cottonwood in Kansas (Area = 963 square 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 further divided into smaller HUC 12 watersheds.

As previously mentioned, the JRR Watershed is located in the Neosho Basin which is home to seven HUC 8 (meaning an 8-digit identifier code) classifications. This WRAPS plan will include the majority of three of the seven HUC 8s in the Neosho Basin. These are:

1. NELC, defined as the Neosho Headwaters and Eagle Creek (11070201) and Lower Cottonwood (11070203), and
2. Upper Cottonwood (11070202).

The JRR Watershed WRAPS consists of three HUC 8s, eleven HUC 10s and 57 HUC 12 delineations to include the following numbers:

- ***JRR Watershed HUC 8s***: 11070201, 11070202, and 11070203 (**Figure 7**).
- ***JRR Watershed HUC 10s***: 1107020102, 1107020103, 1107020104, 1107020201, 1107020202, 1107020203, 1107020204, 1107020301, 1107020302, 1107020303, and 1107020304 (**Figure 7**).
- ***NELC HUC 12s***: 110702010**201**, 110702010**202**, 110702010**203**, 110702010**204**, 110702010**205**, 110702010**206**, 110702010**207**, 110702010**208**, 110702010**209**, 110702010**301**, 110702010**302**, 110702010**303**, 110702010**304**, 110702010**305**, 110702010**401**, 110702010**402**, 110702010**403**, 110702010**404**, 110702010**405**, 110702010**406**, 110702010**407,** 110702030**101**, 110702030**102**, 110702030**103**, 110702030**104**, 110702030**201**, 110702030**202**, 110702030**203**, 110702030**204**, 110702030**205**, 110702030**301**, 110702030**302**, 110702030**303**, 110702030**304**, 110702030**305**, 110702030**401**, 110702030**402**, 110702030**403**, 110702030**404**, 110702030**405**, and 110702030**406** (**Figure 8**).
- ***Upper Cottonwood HUC 12's***: 110702020**106**, 110702020**107**, 110702020**108**, 110702020**201**, 110702020**202**, 110702020**203**, 110702020**204**, 110702020**205**, 110702020**301**, 110702020**302**, 110702020**303**, 110702020**401**, 110702020**402**, 110702020**403**, 110702020**404**, and 110702020**405** (**Figure 9**).

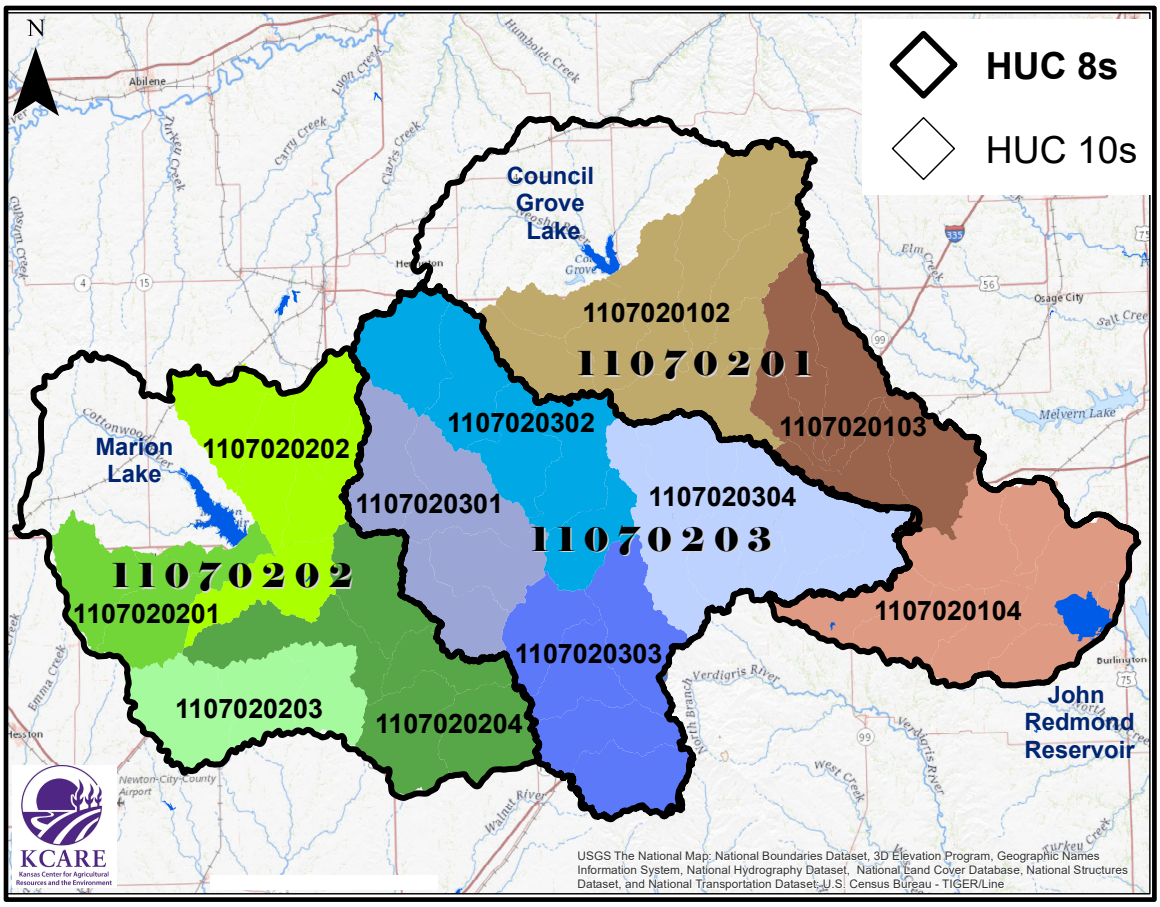


Figure 7. HUC 8 and 10 Delineations in the JRR Watershed

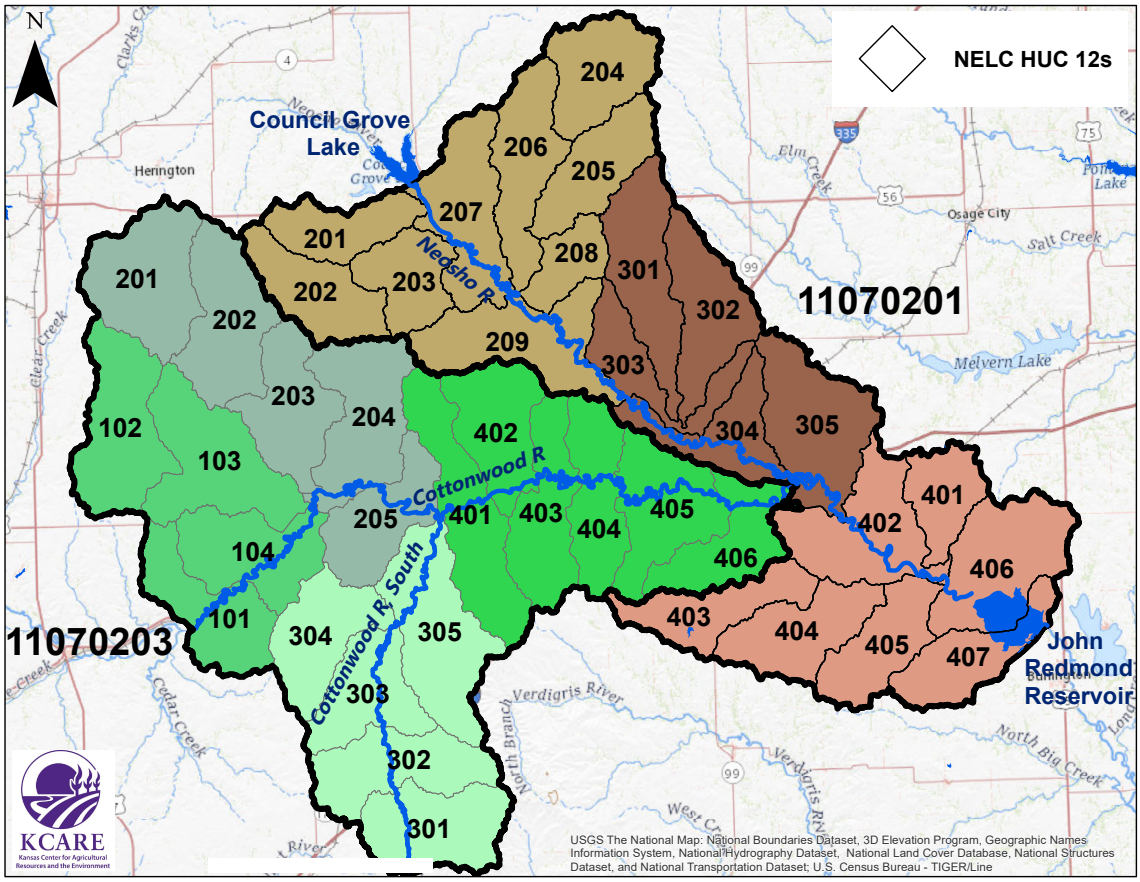


Figure 8. NELC HUC 12 Delineations

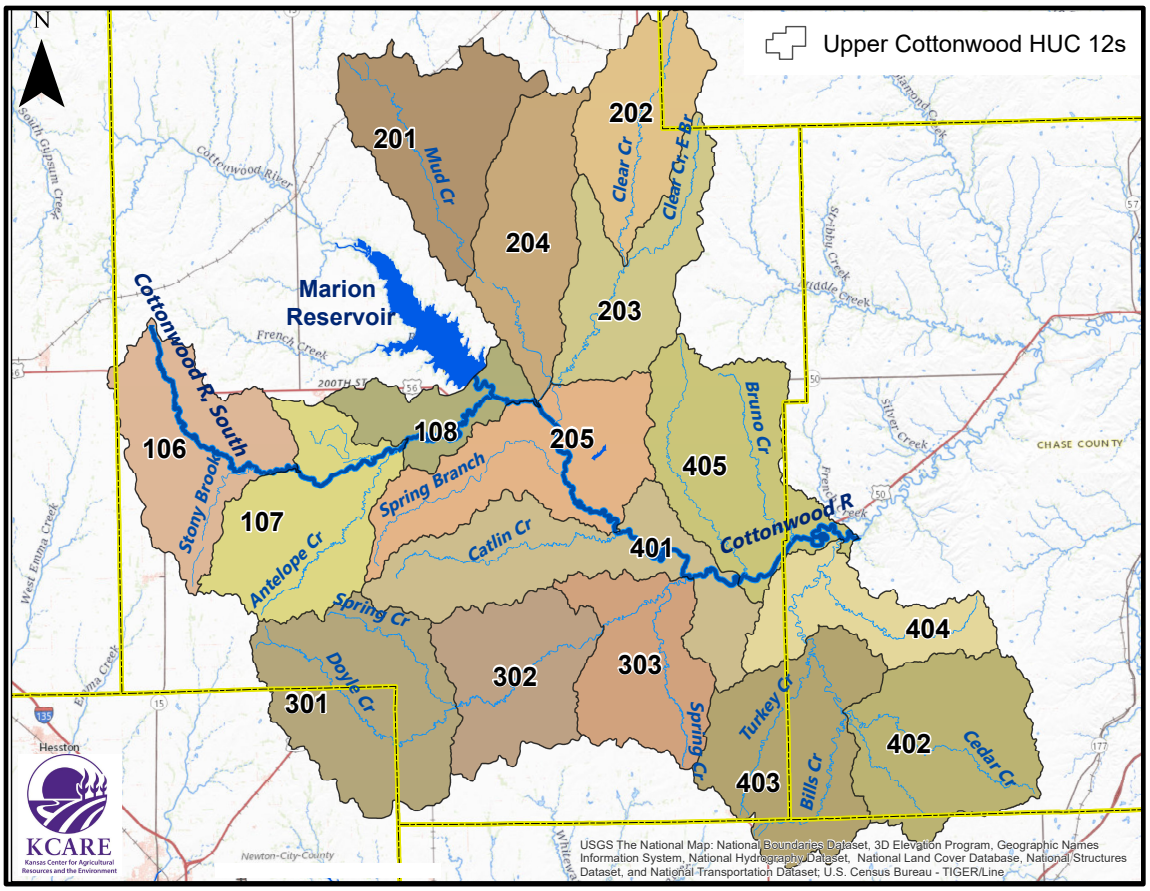


Figure 9. Upper Cottonwood HUC 12 Delineations

Targeting for BMP implementation within the JRR 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.*

When looking at this watershed, it is important to note that a portion of the Neosho Headwaters is not included in this WRAPS plan as the Council Grove Lake has its own WRAPS group and plan, titled **Twin Lakes WRAPS**. Similarly, a portion of the Upper Cottonwood Watershed is not included in this plan as the Marion Reservoir has its own WRAPS group and plan, titled **Marion WRAPS**. All of Lower Cottonwood is included in this WRAPS plan.

G. John Redmond Reservoir WRAPS History

According to the Kansas Unified Watershed Assessment prepared by KDHE and the NRCS (Natural Resources Conservation Service) in 1999, the NELC and Upper Cottonwood have been designated as Category I watersheds. This indicates that these watersheds are in need of restoration and protection to sustain their water quality. A Category I watershed does not meet state water quality standards, or it fails to achieve aquatic system goals related to habitat and ecosystem health. Category I watersheds also are assigned a priority for restoration. Statewide, there are 92 watersheds: within the NELC, the Neosho Headwaters is ranked 38th, the Lower Cottonwood is ranked 43rd, and the Upper Cottonwood is ranked 36th.

H. Leadership in the JRR Watershed

The U.S. Army Corps of Engineers (USACE) began construction of the John Redmond Reservoir dam in 1959. In 1963, the reservoir had a storage capacity of 82,230 acre-feet. According to the Kansas Water Office, the reservoir's capacity during the latest survey year (2019) was 59,399 acre-feet[1]. This represents a loss of nearly 42% due to sediment entering the reservoir from the watershed, with a calculated sedimentation rate of 765 acre-feet/year from 1964-2014[2]. John Redmond Reservoir is ranked third of all Kansas reservoirs in capacity loss percentage.

The reservoir's capacity loss and area flooding drew the attention of local agencies and other stakeholders, and the Neosho Headwaters SLT was formed in 2008. The SLT convened with the hope of decreasing the sedimentation rate by improving conditions in the watershed; they submitted their original WRAPS plan titled "John Redmond Reservoir WRAPS Neosho Headwaters Watershed" to KDHE in 2010. Their goals were to:

- Protect long-term water storage capacity and water quality in the John Redmond Reservoir,
- Protect water quality in the Neosho River and tributary streams,
- Restore and protect riparian areas along the Neosho River and tributary streams,
- Protect native tallgrass prairies,
- Provide protection from flooding,
- Protect the productivity of agricultural lands, and
- Protect public drinking water and industrial water supplies.

The Eagle Creek WRAPS plan was submitted in 2012 with a single goal: promote and install BMPs within the Eagle Creek Watershed to improve and protect the quantity and quality of water within John Redmond Reservoir.

SLT groups representing the Upper and Lower Cottonwood Watersheds began meeting in 2009. These groups formed out of concern for the Cottonwood River and flooding events along the river. Although they were split into two separate SLTs, these groups shared the same set of issues and goals. Their goals were to:

- Achieve high-priority total maximum daily loads (TMDLs) in the watershed,
- Protect public drinking water supplies,
- Preserve productivity of agricultural lands,
- Minimize impacts of flooding along the Cottonwood River by utilizing the BMPs listed in this WRAPS plan,
- Protect recreational uses on rivers, streams and lakes, and
- Protect aquatic life in rivers, streams and lakes.

[1] *Kansas Water Supply Reservoirs Current Capacity Due to Sedimentation*, Kansas Water Office, 2019.
[2] Scientific Investigations Report 2016-5040. https://pubs.usgs.gov/sir/2016/5040/sir20165040.pdf . Kansas Water Office and USGS, 2016

The two Cottonwood (Upper and Lower) SLTs had representation from several watershed districts within the basin. A large focus of the Lower Cottonwood was on flooding: the SLT wanted to slow the rate of flooding along the Cottonwood River and subsequent erosion by improving conditions in the watershed. They planned to implement new conservation management practices on cropland, along streambanks, and in livestock areas. In addition, construction of retention structures would take place. The two Cottonwood SLTs worked together to submit a single WRAPS plan titled "Cottonwood River WRAPS Upper and Lower Cottonwood Watershed" to KDHE in 2011.

In 2020, the aforementioned SLT groups created a new leadership structure and now plan to work together to implement the JRR WRAPS plan. This reorganization means that Neosho Headwaters (including Eagle Creek) now joins the Lower Cottonwood Watershed. *In this plan, this group is referred to as the NELC.* The NELC has its own SLT and one WRAPS Coordinator. The Upper Cottonwood will stand alone with its existing SLT and WRAPS Coordinator. Both SLTs will implement BMPs and operate with the same goal: **to improve the health and lifespan of the John Redmond Reservoir**. The NELC and Upper Cottonwood SLTs will work to slow the rate of sedimentation in the reservoir by improving farm management practices throughout the watershed; these efforts will keep soil on the fields and streambanks and protect local water segments from carrying sediment into the lake.

Stakeholders for both groups will include the WRAPS coordinators, local landowners, and producers from all nine counties; Conservation Districts from all nine counties; Natural Resources Conservation Service (NRCS) and KDHE personnel; and any other interested parties.

I. Goals of the Stakeholder Leadership Teams (SLTs)

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.

JRR WRAPS will operate under two separate SLTs: the NELC and the Upper Cottonwood. These SLTs have 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 main **goal** of this plan is **to improve the health and lifespan of the John Redmond Reservoir**. In order to achieve this goal, the two SLTs set specific objectives for their watersheds.

The objectives of the NELC SLT are to:

- Reduce sediment and nutrient loading into John Redmond Reservoir.
- Reduce sediment and nutrients entering stream segments throughout the watershed, specifically improving nutrient levels in Allen Creek, Eagle Creek, South Fork Cottonwood River, and Fox Creek to address dissolved oxygen and biology impairments.
- Improve soil health in the watershed.

- Focus soil and weather conservation practices and innovation practices near riparian areas to achieve load reduction goals.
- Develop and support the SLT as demonstration partners to highlight common advantages to water quality protection and agricultural production in the watershed.
- Support and showcase a demonstration farm in the watershed.

The objectives of the Upper Cottonwood SLT are to:

- Reduce sediment and nutrient loading into John Redmond Reservoir.
- Reduce bacteria and nutrient loading into Marion County Lake.
- Develop a demonstration farm to show the benefits of proper land management; for example, the use of no-till, nutrient management, soil health and buffers.
- Utilize the Regional Conservation Partnership Program (RCPP) to install and improve existing forestry riparian stream buffer/borders.
- Reduce bacteria levels in Mud Creek.
- Increase awareness of water quality issues using information and education.

Accomplishing these goals will involve 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 JRR Watershed to achieve the greatest water quality improvement at a minimal cost. Targeted areas will be discussed in **Section 6** of this plan.

The SLTs hope that these efforts will protect the productivity of agricultural lands throughout the watershed, reduce siltation, and improve water quality in local streams and in John Redmond Reservoir.

The **main pollutants** for the JRR 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 JRR Watershed is part of the **Neosho RAC**.[3] 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 JRR Watershed, they will be the only goals detailed in this plan.

Neosho RAC Goals:

1. Prolong the water supply storage in John Redmond Reservoir to the year 2065 by reducing the sedimentation rate by an average of 300 acre-feet per year through watershed practices such as no-till, filter strips and streambank stabilization. By 2025, all streambank hotspots

[3] 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.

will be stabilized. By 2030, 80% of the priority cropland in need of conservation will be treated with no-till practices.

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

- The Kansas Water Office (KWO) is directed to work with the Streambank Team (KWO, KDHE, and KDA-DOC) to stabilize all streambank hotspots, as defined by the KWO, by 2025 in the Cottonwood-Neosho Region above John Redmond Reservoir. Funds will need to be created to fund the stabilization of the streambanks each year to complete reaches in order as they proceed from the reservoir.
- The Kansas Water Office, in cooperation with the Kansas Department of Health and Environment, the Kansas Department of Agriculture-Department of Conservation, and the local WRAPS groups, is directed to treat 80% of priority cropland, as defined by the WRAPS 9-element plans, with no-till practices, such as cover crops. In addition, treat with other sedimentation reduction farming practices, filter strips, terraces, and waterways by 2030 in the Cottonwood-Neosho Region above John Redmond Reservoir. Additional funds will need to be created to fund this action as well.
    - As a component of this plan, a review of the sedimentation rate of John Redmond Reservoir will be evaluated. This evaluation will include scheduling and completing a bathymetric survey every five years and installing sedimentation monitoring stations to monitor the sedimentation rate and the progress and benefit of sedimentation reduction practices.
    - As an additional component, the effectiveness of BMPs for effects on hydrology and reduction of sediment and nutrients will be assessed and the information and education will be provided to those implementing practices. The education and information portion can be accomplished through the implementation of a Water Technology Farm that incorporates no-till practices and other agriculture BMPs addressing sedimentation, along with a possible streambank stabilization project.
- To ensure that there are funds available each year, a steady funding source must be established. The best funding source at this time appears to be the issuing of bonds to commence early implementation, and is recommend by the RAC, however, other funding sources are not excluded. Bonds should be sought at an amount no less than 8.5 million/year.

2. Every five years, assess the effectiveness of BMPs for effects on hydrology and reduction of sediment and nutrients, and provide that information and education to those who implement 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 JRR Watershed. This section includes descriptions and data about the watershed's land cover and use, special water designations, annual rainfall, aquifers, population, public water supplies and permitted wastewater facilities.

A. Land Cover and Land Uses

Land use activities have a significant impact on the types and quantity of nutrient and sediment pollutants in the JRR Watershed. The three major land uses in this watershed are grassland (61%), cropland (19%), and pasture/hay (9%). Grassland and pasture/hay land uses often can 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. Cropland is the main source of sediment and nutrient runoff from overland flow. Nutrients leach into sediment during runoff events and are deposited in nearby streams and, eventually, the reservoir. 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 other land uses in the watershed, including: forest (3%), developed open space (3%), water (1%), wetlands (1%), 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.

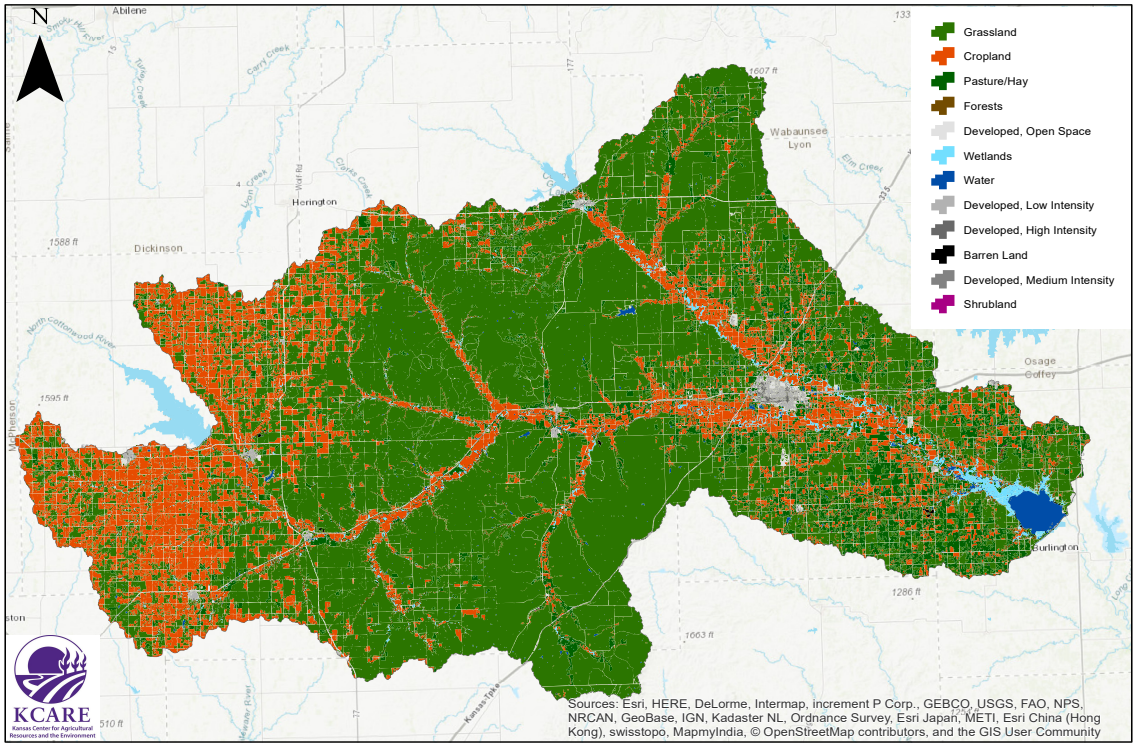


Figure 10. Land Cover and Land Use in the JRR Watershed

Table 1. Land Use in the JRR Watershed

Land Use in the John Redmond Reservoir Watershed (acres)													
Land Use in:	Barren Land	Cropland	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Developed, Open Space	Forests	Grassland	Pasture/ Hay	Shrubland	Water	Wetlands	Total Acres
NELC	701	145,042	11,925	3,398	816	33,817	37,916	768,548	136,267	288	16,258	17,991	**1,172,966**
Upper Cottonwood	156	170,735	3,709	608	84	18,992	14,903	238,381	13,907	21	2,202	5,271	**468,969**
Total acres in JRR Watershed	857	315,778	15,634	4,005	900	52,809	52,819	1,006,929	150,174	309	18,460	23,262	**1,641,934**
% of JRR Watershed	0.05%	19.23%	0.95%	0.24%	0.05%	3.22%	3.22%	61.33%	9.15%	0.02%	1.12%	1.42%	**100.00%**

B. Designated Uses

The stream segments and lakes/reservoirs in the JRR 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 JRR 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[4], 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

[4] 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 28-30 and 61.

Table 3. Designated Water Uses in the JRR Watershed

Designated Water Uses: John Redmond Reservoir Watershed								
Water Segment Name	**AL**	**CR**	**DS**	**FP**	**GR**	**IW**	**IR**	**LW**
*Allen Creek, Badger Creek, Big John Creek, Bluff Creek, Bruno Creek, Coon Creek, Cottonwood River (Segments 2, 3, 7, 8), Cottonwood River - North (Segment 14), Crocker Creek, *Doyle Creek, East Creek, Kahola Creek, Lebo Creek, Mercer Creek, Mile-and-a-Half Creek, Munkers Creek - East Branch, *Neosho River, Peyton Creek, Pickett Creek, Rock Creek (Segments 7, 9, 37), Rock Creek - East Branch, Spring Creek (Segments 29, 41), Taylor Creek, Turkey Creek, Unnamed Stream	E	C	X	X	X	X	X	X
Antelope Creek	E	C	O	X	X	O	X	X
Beaver Creek, Bills Creek, Buckeye Creek, Cannonball Creek, *Clear Creek (Segment 5), Coal Creek, Cottonwood River - South (Segments 17, 18), Corn Creek, Crooked Creek, Diamond Creek, Dows Creek, *Eagle Creek, Eagle Creek South, Fourmile Creek, *French Creek, Gould Creek, Holmes Creek, Horse Creek, Mulvane Creek, Plumb Creek, Prather Creek, School Creek, Spring Branch, Stout Run, Wolf Creek, Wrights Creek	E	b	X	X	X	X	X	X
Bloody Creek, Catlin Creek, Cedar Creek, *Cottonwood River (Segment 1 in HUC 11070203), *Cottonwood River - South Fork (Segment 9), Middle Creek, *Mud Creek, Spring Creek (Segment 29)	S	C	X	X	X	X	X	X
Buck Creek, Cottonwood River (Segment 1 in HUC 11070202), *Fox Creek	E	B	X	X	X	X	X	X
Bull Creek, Moon Creek	E	b	O	X	X	O	O	X
Camp Creek	E	C	O	X	O	O	O	X
Chase County State Fishing Lake (SFL), *Marion County Lake, *Olpe City Lake	E	A	X	X	O	X	X	X
Clear Creek - East Branch, Stillman Creek, Stony Brook	E	b	O	X	O	O	X	X
Collett Creek, Cottonwood River - South Fork (Segment 10), Jacob Creek, Six Mile Creek	S	b	X	X	X	X	X	X
Cottonwood River (Segments 2, 4, *6)	S	B	X	X	X	X	X	X
Coyne Branch, Dry Creek, French Creek, Gannon Creek, Phenis Creek, Plum Creek, Schaffer Creek, Sharpes Creek, Silver Creek, Stribby Creek	E	b	X	O	X	X	X	X
Dodds Creek	E	b	O	O	X	O	X	X
Dry Creek	E	b	O	X	O	O	O	O
Elm Creek, Flint Hills National Wildlife Refuge (NWR), *Palmer Creek	E	a	X	X	X	X	X	X
Hillsboro City Lake	E	B	X	X	O	X	X	X
Kirk Creek	E	b	O	X	X	O	O	O
Little Cedar Creek	S	A	X	X	X	X	X	X
*John Redmond Reservoir, *Lake Kahola	E	A	X	X	X	X	X	X
*Jones Park Lake, Peter Pan Lake	E	B	X	X	X	X	X	X
Spring Creek (Segment 28)	E	C	O	X	O	O	X	X

**Asterisks refer to a violation of designated use and indicate a TMDL has been written.*

C. Special Aquatic Life Use Waters

Special Aquatic Life Use (SALU) waters[5] 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 JRR Watershed has the following SALU-listed waters: Bloody Creek, Catlin Creek, Cedar Creek, Collett Creek, Cottonwood River (Segments 1, 2, 4 and 6), Cottonwood River - South Fork (Segments 9 and 10), Jacob Creek, Little Cedar Creek, Middle Creek, Mud Creek, Neosho River, Six Mile Creek and Spring Creek (Segment 29) (**Figure 11**).

The special aquatic life use waters are located primarily in areas surrounded by grassland; however, cropland lies adjacent to the river in the flat floodplains. Pollutants that might threaten the health of these waters come from cropland. Sediment from ephemeral gullies, nutrients from fertilizer and applied manure and *E. coli* from livestock are some of these potential pollutants.

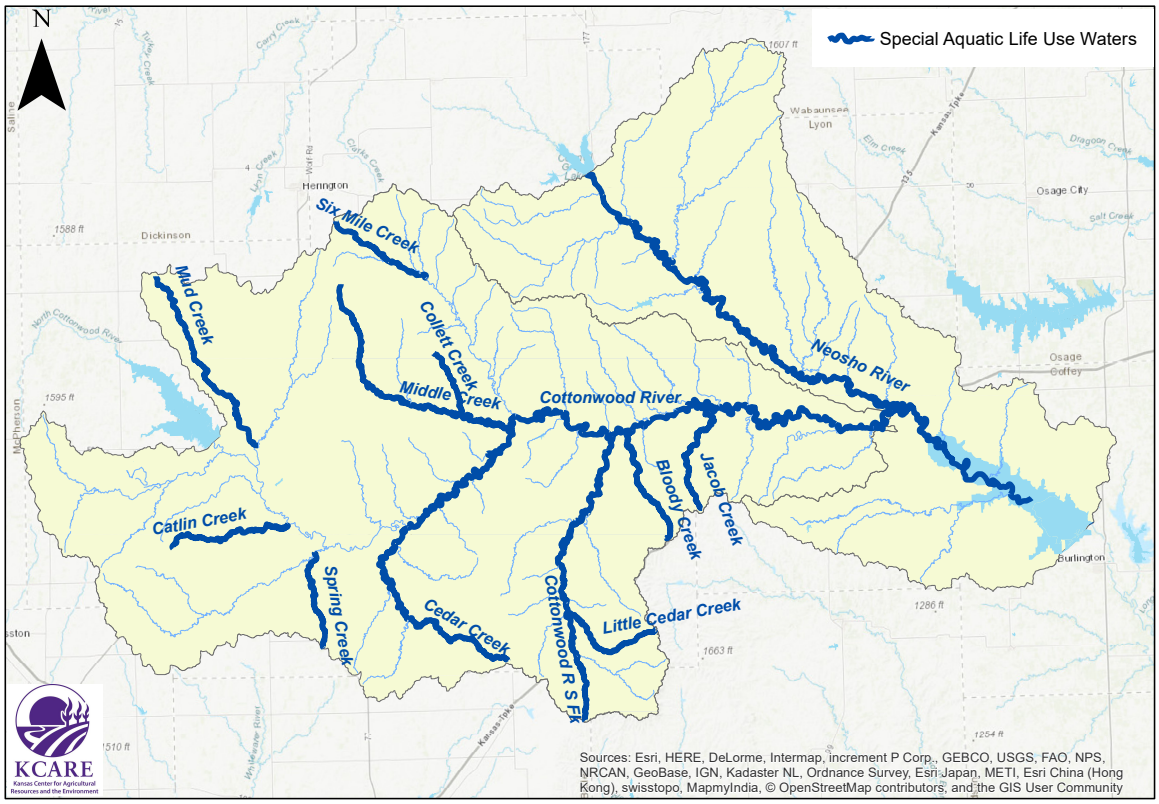


Figure 11. SALU Waters in the JRR Watershed

[5] 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
List of ESW, SALU and ONRW. KDHE, 2007. https://www.kdheks.gov/nps/resources/specwaterinfo.pdf

D. Exceptional State Waters

Exceptional State Waters (ESW)[5] are defined as "any of the surface waters or surface water segments that are of remarkable quality or of significant recreational or ecological value." The JRR Watershed has the following ESW-listed waters: Cedar Creek and Cottonwood River - South Fork (Segments 9 and 10) (**Figure 12**).

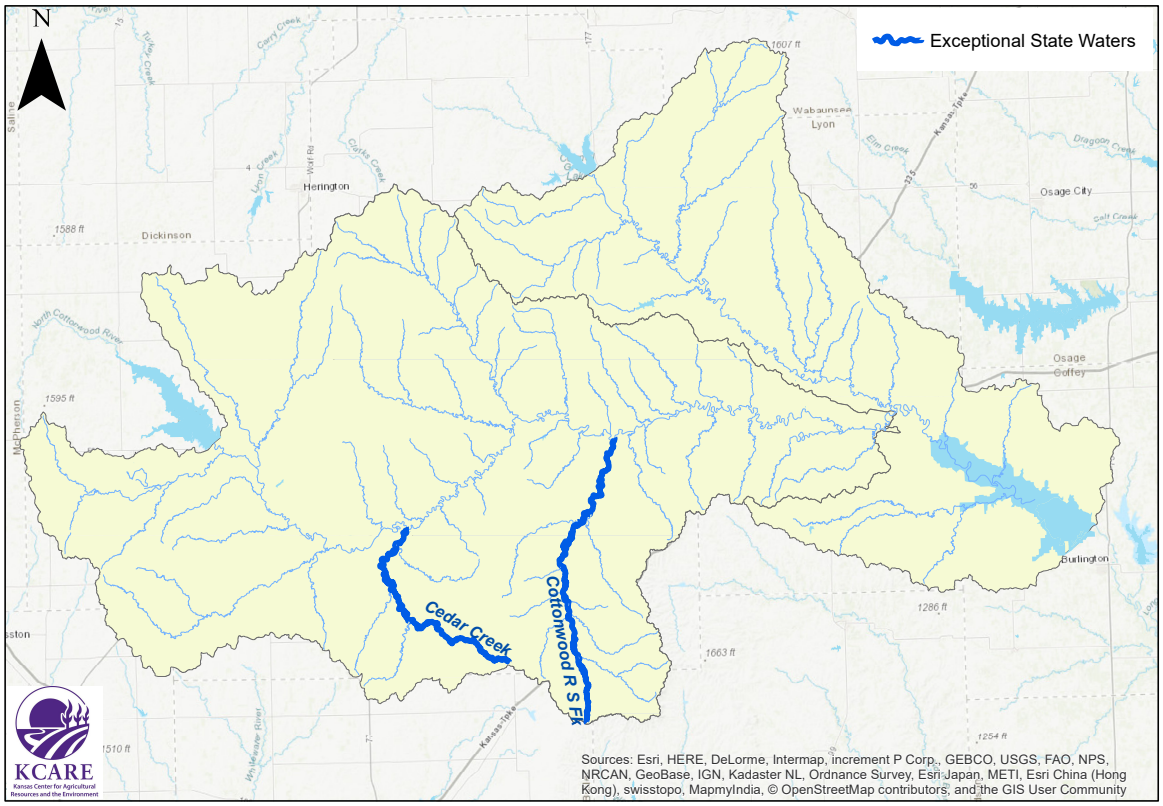


Figure 12. ESW in the JRR Watershed

E. Outstanding National Resource Waters

Outstanding National Resource Waters (ONRW)[5] are defined as "any of the surface waters or surface water segments of extraordinary recreational or ecological significance." The JRR Watershed has one ONRW-listed water: Flint Hills National Wildlife Refuge (**Figure 13**).

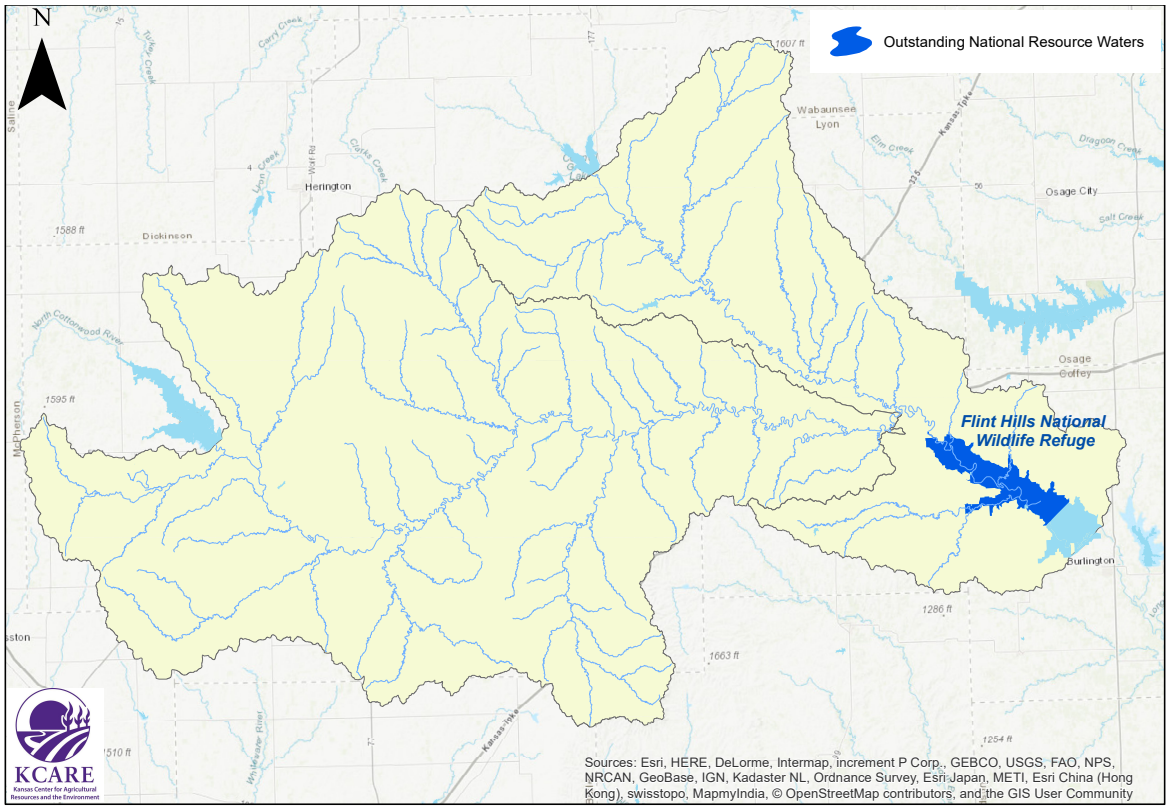


Figure 13. ONRW in the John Redmond Reservoir Watershed

F. Rainfall and Runoff

Rainfall amounts and duration affect sediment and nutrient runoff during high-intensity rainfall events, most of which occur in late spring and early summer. This is the time frame when cropland is either bare, or crop biomass is small; likewise, grasses are short and do not help to prevent runoff. Both of these situations can lead to pollutants entering the waterways. As shown in **Figure 14**, precipitation data from the cities of Council Grove, Emporia and Marion were used to calculate the average annual rainfall in the watershed. The JRR Watershed averages 35.4 inches of rainfall annually (**Figure 15**).

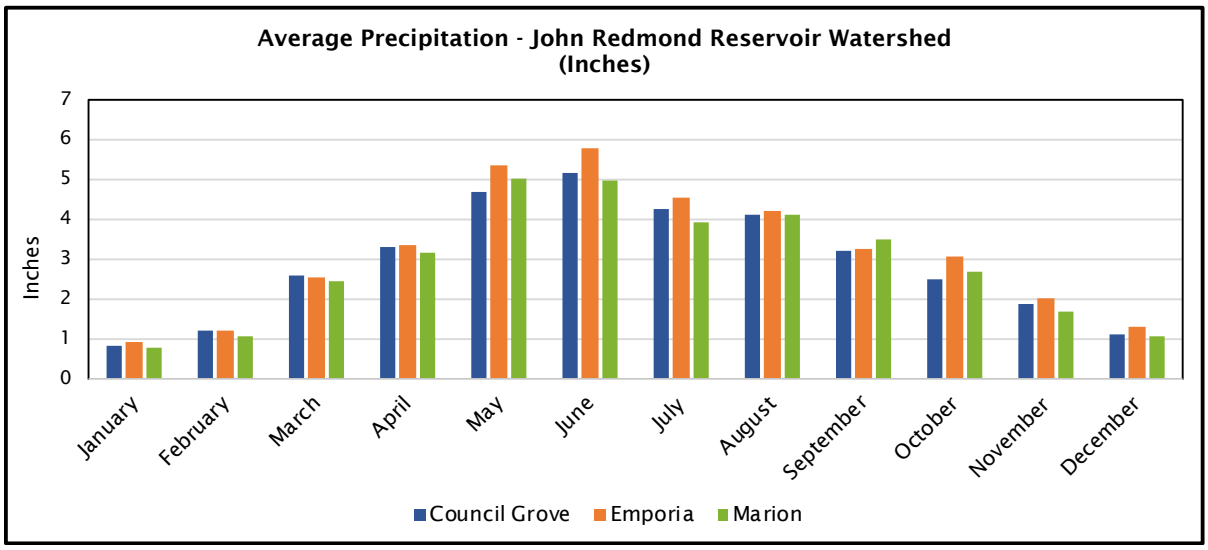


Figure 14. JRR Watershed Monthly Average Precipitation[6]

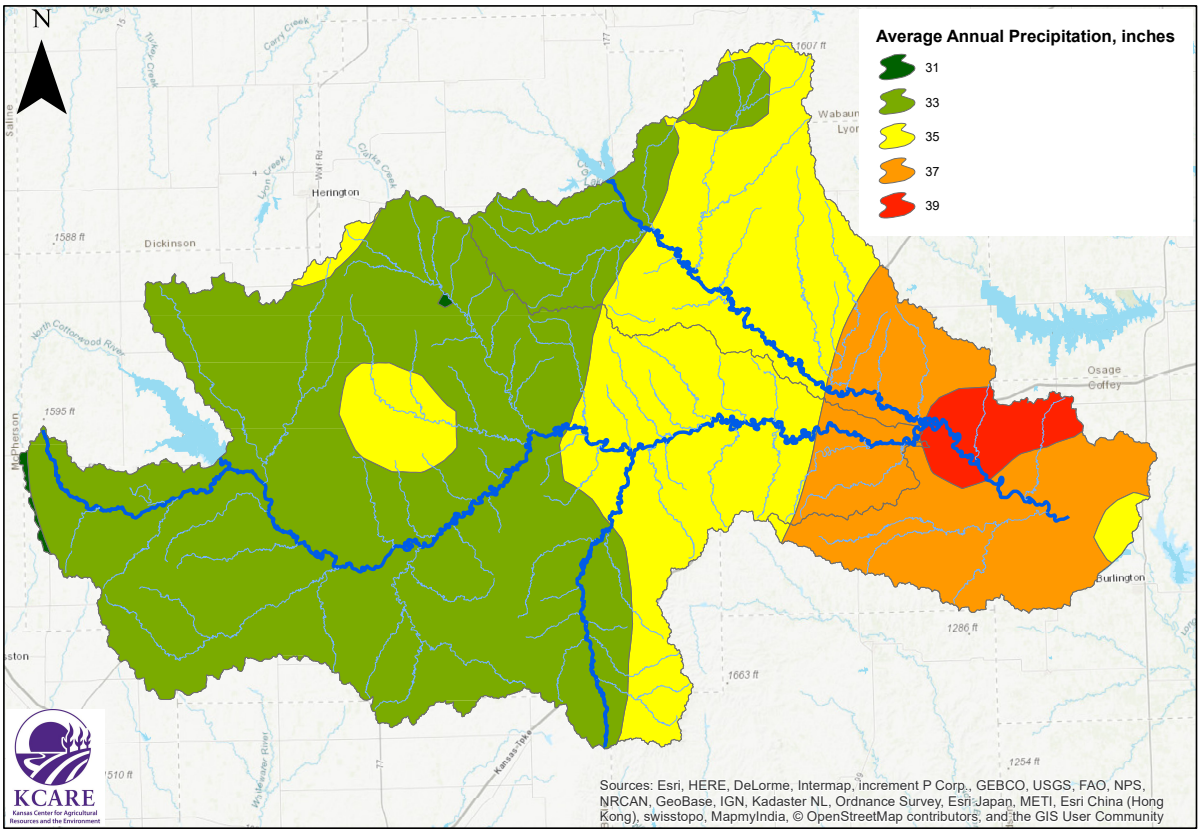


Figure 15. Annual Precipitation in the JRR Watershed

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

G. Population and Wastewater Systems

Using a watershed area of 2,566 square miles, the total population for the JRR Watershed is estimated to be 43,263. The average population density for Kansas, represented as persons per square mile, is 32.9; the average for the JRR Watershed is 17 persons per square mile (**Table 4**). Most of the JRR Watershed is considered below-average population with the highest urban population of 24,916 in Emporia, located in Lyon County (**Figure 16**). *The county 'average persons per square mile' figures in Table 4 include higher density urban areas; therefore, the average of 17 persons per square mile was derived by using the total population in the watershed.*

Table 4. Population in the Counties of the JRR Watershed

Estimating the John Redmond Reservoir Watershed Population							
County	Population 2010 Census	Population 2019 Estimates	Square Miles in County	% of County in the JRR Watershed	Square Miles in the JRR Watershed	Persons in JRR Watershed (2010)	Average Persons/ Square Mile
Butler	65,880	66,911	1,430	3%	37	1,713	45
Chase	2,790	2,648	773	94%	727	2,623	4
Coffey	8,601	8,179	627	25%	157	2,150	14
Greenwood	6,689	5,982	1,143	3%	30	177	6
Harvey	34,684	34,429	540	4%	22	1,387	63
Lyon	33,690	33,195	847	70%	593	23,583	40
Marion	12,660	11,884	944	67%	633	8,482	13
Morris	5,923	5,620	695	46%	320	2,725	9
Wabaunsee	7,053	6,931	794	6%	48	423	9
TOTAL	**177,970**	**175,779**	**7,794**		**2,566**	**43,263**	**17**

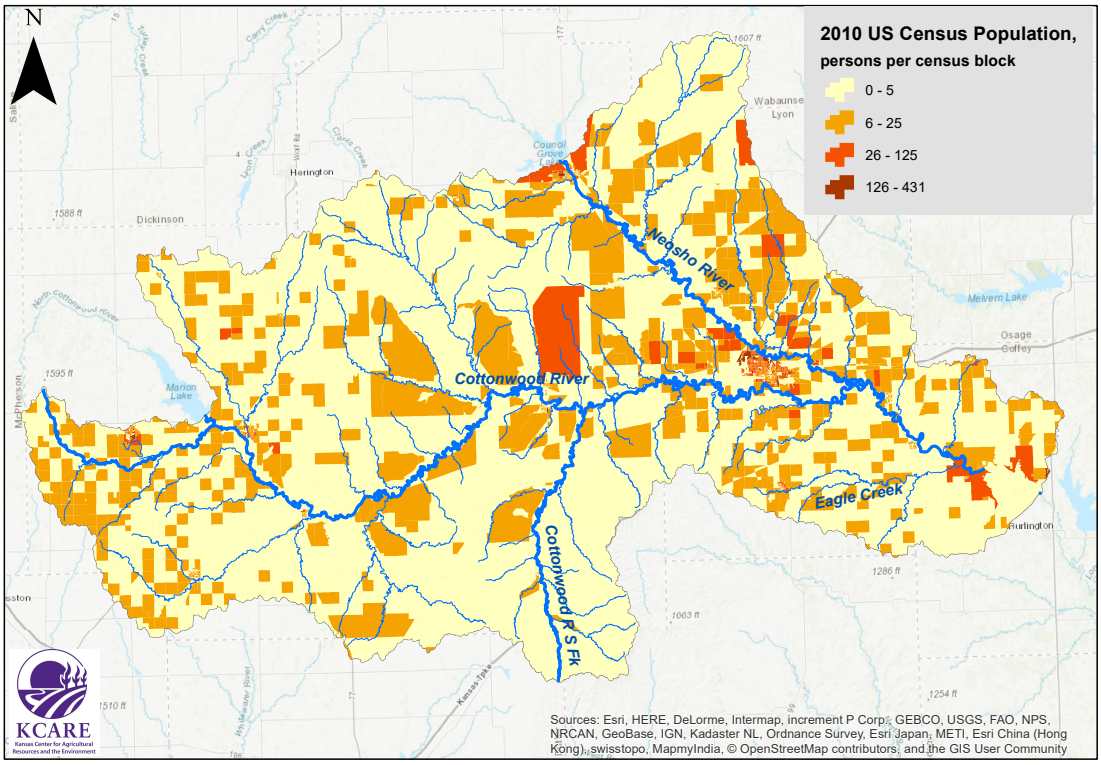


Figure 16. Population in the JRR Watershed

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 JRR Watershed. Using a rural population of roughly 4,697 (**Table 5**) and an estimated 2.29 people per rural Kansas household, it can be determined that there are approximately 2,051 onsite wastewater treatment systems installed in the watershed with an expected failure rate of roughly 20%, or 410 systems.[7]

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

John Redmond Reservoir Watershed Municipal Population		
Township	**2010 Census**	**2019 Estimates**
Americus	896	887
Bushong	34	33
Cedar Point	28	26
Cottonwood Falls	903	858
Council Grove	2,182	2,079
Dunlap	30	28
Elmdale	55	52
Emporia	24,916	24,765
Florence	465	438
Hartford	371	370
Hillsboro	2,993	2,834
Lebo	940	894
Lincolnville	203	194
Lost Springs	70	67
Marion	1,927	1,787
Matfield Green	47	43
Olpe	546	539
Peabody	1,210	1,109
Strong City	485	454
Tampa	112	103
Wilsey	153	141
TOTAL URBAN POPULATION	**38,566**	**37,701**
TOTAL RURAL POPULATION	**4,697**	
John Redmond Reservoir Watershed: TOTAL POPULATION	**43,263**	

*Numbers from 2019 listed in **Tables 4 and 5** are estimates from The League of Kansas Municipalities[8] organization, therefore calculations for current population and wastewater systems in the watershed were determined by utilizing 2010 U.S. Census data.[9]*

[7] Cooperative Extension Service, University of Kentucky, College of Agriculture. http://www2.ca.uky.edu/agcomm/pubs/HENV/HENV502/HENV502.pdf
[8] Kansas League of Municipalities. https://www.lkm.org/
[9] 2010 U. S. Census. https://www.census.gov/quickfacts/fact/table/US/PST045219

H. Aquifers

Two **alluvial** aquifers underlie the JRR Watershed along the Cottonwood and Neosho Rivers (**Figure 17**). The alluvial aquifers are part of and connected to the river systems, consisting of sediment deposited by rivers in the stream valleys.

- The Cottonwood River alluvial aquifer lies along and below the river. Portions of the following water segments are part of this aquifer: Catlin Creek, Cedar Creek, Clear Creek, Diamond Creek, Doyle Creek, Mud Creek, Middle Creek, Spring Branch, Spring Creek, South Fork of the Cottonwood River and Turkey Creek.
- The Neosho River alluvial aquifer lies along and below the river. Portions of the following water segments are part of this aquifer: Allen Creek, Badger Creek, Bluff Creek, Buckeye Creek, Dows Creek, Eagle Creek, East Creek, Elm Creek, Kahola Creek, Lebo Creek, and Rock Creek.

The JRR Watershed includes a small portion of the Dakota Aquifer, located in the northwestern part of the Upper Cottonwood Watershed. The Dakota Aquifer extends from southwestern Kansas to the Arctic Circle. In recent years, the Dakota Aquifer has been used for irrigation purposes in southwest and in north-central Kansas. This aquifer also provides water for municipal, industrial, and stock water supplies.

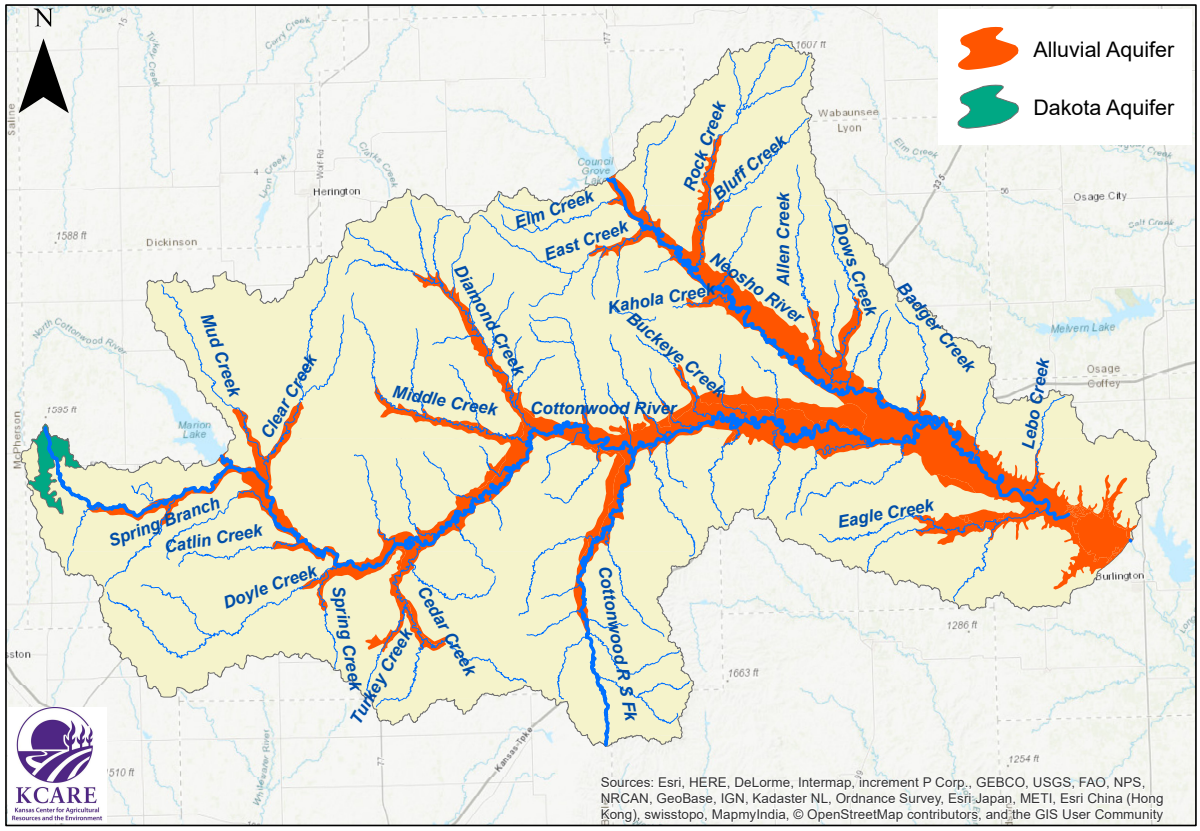


Figure 17. Aquifers in the JRR Watershed

I. Public Water Supplies

Sediment can affect a Public Water Supply (PWS) that derives its water from a surface water supply, either by making it difficult to access the water at the intake or to treat the water prior to consumption. Reservoirs can be affected by sediment due to capacity reduction. Nutrients and bacteria also will affect surface water supplies, causing excess treatment costs prior to public consumption. PWS within this watershed are shown in **Table 6**. Most of the rural population in the JRR Watershed obtain their water through private groundwater wells.

Table 6. JRR Watershed Public Water Suppliers[10]

Public Water Suppliers in the John Redmond Reservoir Watershed		
Public Water Suppliers	**County**	**Population**
Cedar Point, City of	Chase	26
Centre High School	Marion	181
Chase County RWD 1	Chase	330
Coffey County RWD 2	Coffey	1,146
Coffey County RWD 2E	Coffey	1,254
Cottonwood Falls, City of	Chase	858
Council Grove, City of	Morris	2,079
Elmdale, City of	Chase	52
Emporia, City of	Lyon	24,765
Florence, City of	Marion	438
Hartford, City of	Lyon	370
Hillsboro, City of	Marion	2,834
Lebo, City of	Coffey	894
Lyon County RWD 1	Lyon	1,595
Lyon County RWD 2	Lyon	750
Lyon County RWD 3	Lyon	479
Lyon County RWD 4	Lyon	980
Lyon County RWD 5	Lyon	1,310
Marion County Improvement District 2	Marion	234
Marion County RWD 2	Marion	175
Marion County RWD 4	Marion	1,398
Marion, City of	Marion	1,787
Matfield Green, City of	Chase	43
Morning Star Ranch	Marion	35
Olpe, City of	Lyon	539
Park Place Communities Management LLC	Lyon	200
Peabody, City of	Marion	1,109
Public Wholesale WSD 26	Chase	1
Strong City, City of	Chase	454
Wilsey, City of	Morris	141
Total Population Served		**46,457**
RWD - Rural Water District		

[10] Kansas Department of Health and Environment, November 4, 2019.

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. Although the Safe Drinking Water Act does not require protection planning to be part of the SWAP process, KDHE encourages public water supplies and their surrounding communities to use the SWA on a voluntary basis as the foundation for future protection planning efforts. The SWA must be made available to the public. KDHE's Watershed Management Section has implemented the Kansas SWAP plan, and all SWAs are completed[11].

In Kansas, there are approximately 763 public water supplies that require SWAs. A SWA includes the following: delineation of the source water assessment area, inventory of potential contaminant sources, and susceptibility analysis. The susceptibility analysis provides a Susceptibility Likelihood Score (SLS) which indicates the vulnerability that each PWS has for the following contaminant sources: eutrophication, inorganic compounds, microbiological, nitrates, pesticides, sedimentation, synthetic organic compounds and volatile organic compounds.

The JRR Watershed has 30 active PWS sites. Twelve public water suppliers within the JRR Watershed were required to develop a SWA in 2003: City of Cedar Point, Centre High School, Cottonwood Falls, Council Grove, Elmdale, Emporia, Florence, Hillsboro, Marion, Matfield Green, Morning Star Ranch, and Strong City. Knowing the SLS for contaminant categories can assist communities and the watershed SLT with their planning efforts for protecting water sources (**Table 7**).

Table 7. SLS for PWS in the JRR Watershed

Susceptibility Likelihood Scores (SLS)								
Public Water Suppliers	Contaminant Source Categories							
	Eutrophication	Inorganic Compounds	Microbiological	Nitrates	Pesticides	Sedimentation	Synthetic Organic Compounds	Volatile Organic Compounds
Cedar Point, City of		Low	Low	Low	Low		Low	Low
Centre High School		Low	Low	Low	Low		Low	Low
Cottonwood Falls, City of	Moderate	Low	Low		Low	Moderate	Low	Low
Council Grove, City of	Moderate	Low	Low		Low	Moderate	Low	Low
Elmdale, City of		Low	Low	Low	Low		Moderate	Low
Emporia, City of	Moderate	Low	Low		Moderate	Moderate	Moderate	Moderate
Florence, City of		Low	Low	Low	Low		Low	Low
Hillsboro, City of	Moderate	Low	Low		Low	Moderate	Low	Low
Marion, City of	Low	Low	Low		Low	Low	Low	Low
Matfield Green, City of		Low	Moderate	Moderate	Moderate		Low	Low
Morning Star Ranch		Low	Low	Low	Low		Low	Low
Strong City, City of		Moderate	Moderate	Moderate	Moderate		Moderate	Moderate
* Low = low susceptibility for that contaminant category								
* Moderate = moderate susceptibility for that contaminant category								

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

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 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 45 permitted NPDES facilities in the JRR Watershed (**Table 8**).

Table 8. NPDES Permitted Facilities in the JRR Watershed[12]

NPDES Permitted Facilities in the John Redmond Reservoir Watershed				
Facility Name	**Facility Type**	**Description**	**City**	**County**
Florence, Ciy of	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Florence	Marion
Marion, City of	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Marion	Marion
Tampa, City of	Lagoon, Non-discharging	Waste Stabilization Pond, Non-overflowing	Tampa	Marion
Marion County Improvement District 3	Lagoon, Non-discharging	Waste Stabilization Pond, Non-overflowing	Pilsen	Marion
Marion County Sewer District 1	Lagoon, Non-discharging	Waste Stabilization Pond, Non-overflowing	Marion	Marion
World Impact Training Center	Lagoon, Discharging	Waste Stabilization Pond, Non-overflowing/irrigation	Florence	Marion
USD 397 Centre High School	Lagoon, Non-discharging	Waste Stabilization Pond, Non-overflowing	Lost Springs	Marion
Lost Springs, City of	Lagoon, Non-discharging	Waste Stabilization Pond, Non-overflowing	Lost Springs	Marion
Hillsboro, City of	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Hillsboro	Marion
Flint Hills Industries	Miscellaneous	Physical/chemical treatment	Hillsboro	Marion
Lincolnville, City of	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Lincolnville	Marion
Peabody, City of	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Peabody	Marion
Florence Water Treatment Plant	Miscellaneous	Waste Stabilization Pond, Non-overflowing/irrigation	Florence	Marion
Lake Kahola Wastewater Treatment Plant	Lagoon, Non-discharging	Waste Stabilization Pond, Non-overflowing	Dunlap	Morris
Camp Wood YMCA Camp	Lagoon, Non-discharging	Waste Stabilization Pond, Non-overflowing	Elmdale	Chase
Emporia RV Park Wastewater Treatment Plant	Lagoon, Non-discharging	Waste Stabilization Pond, Non-overflowing	Emporia	Lyon
Country Mobile Home Park	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Emporia	Lyon
KTA - Emporia Service Area	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Emporia	Lyon
Green Acres Mobile Home Park	Mechanical	Activated Sludge Conventional	Cunningham	Lyon
KTA - Matfield Green Service Area	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Matfield Green	Chase
Burdick Meat Market & Locker	Lagoon, Non-discharging	Waste Stabilization Pond, Non-overflowing	Burdick	Morris
BPE Manufacturing	Lagoon, Non-discharging	Miscellaneous Cooling Water To Drainage (No Treatment)	Emporia	Lyon
Emporia Industrial Park LII Pond	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Emporia	Lyon
Tyson Fresh Meats -Emporia Main Plt	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Emporia	Lyon
Emporia PWS Treatment Plant	Mechanical	Activated Sludge Complete Mix	Emporia	Lyon
Evergy - Emporia Energy Center	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Emporia	Lyon
Americus, City Of	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Americus	Lyon
Coffey County Sewer District #1 (Jacobs Creek)	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	near Burlington	Coffey
Cottonwood Falls, City Of	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Cottonwood Falls	Chase
Council Grove, City Of	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Council Grove	Morris
Elmdale, City Of	Lagoon, Non-discharging	Waste Stabilization Pond, Non-overflowing	Elmdale	Chase
Emporia, City Of	Mechanical	Activated Sludge Extend. Aeration	Emporia	Lyon
Emporia, City Of	Mechanical	Municipal Stormwater	Emporia	Lyon
Hartford, City Of	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Hartford	Lyon
Lebo, City Of	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Lebo	Coffey
Neosho Rapids, City Of	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Neosho Rapids	Lyon
Olpe, City Of	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Olpe	Lyon
Strong City, City Of	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Strong City	Chase
Wilsey, City Of	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Wilsey	Morris
Public Wholesale Water District #26	Mechanical	Reverse Osmosis (Public Water Supply)	Strong City	Chase
Penny's Concrete, Incorporated - Emporia	Lagoon, Non-discharging	Waste Stabilization Pond, Non-overflowing	Emporia	Lyon
Builders Choice Concrete - Emporia	Lagoon, Discharging	Waste Stabilization Pond, Overflowing	Emporia	Lyon
Emporia, City Of	Mechanical	Municipal Stormwater	Emporia	Lyon
Harshman Construction - Paxton Quarry	Lagoon, Discharging	Mine Pit Dewatering (No Wash)	Marion	Coffey
Apac-Kansas Hartford/Nelson	Mechanical	Mine Pit Dewatering (With Wash)	Hartford	Lyon

[12] NPDES Facilities Provided by KDHE in June 2020.

K. Livestock Operations in the JRR 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 livestock 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 are required to have a permit, such as a dairy operation that generates a daily outflow from the milking barn. See *www.kdheks.gov/feedlots* for more information.

Table 9. Permitted Facilities in the JRR Watershed

Permitted Livestock Facilities	
County	**Number of Facilities**
Butler	1
Chase	21
Coffey	3
Lyon	23
Marion	115
Morris	28
Total	191

As shown in **Table 9**, there are 191 active permitted livestock facilities in six of the nine counties within the JRR 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 JRR 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 also can have pollution potential for nutrients, sediment and bacteria, if the areas are not managed properly. Examples of unconfined areas are watering areas, loafing areas or feeding areas. 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 JRR Watershed

Water quality in the JRR Watershed is monitored at 33 active sampling sites (**Figure 18**). These sites include 10 lake monitoring sites and 23 KDHE stream monitoring stations: nine permanent sites and 14 rotational sites. There are currently an additional three inactive monitoring sites.

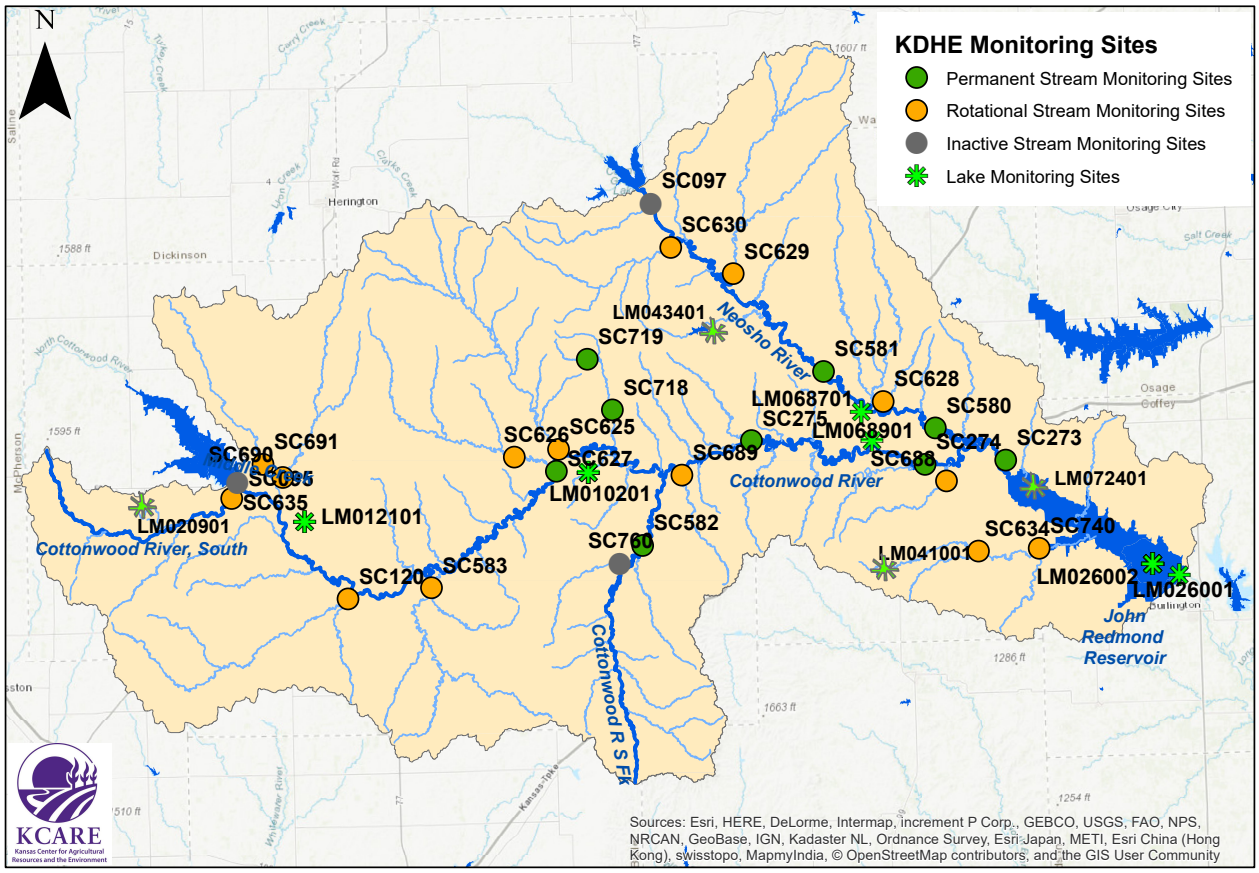


Figure 18. JRR Watershed Monitoring Sites

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 JRR 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.

The JRR Watershed has 12 *303d-listed* waters identified by KDHE. Portions of the Cottonwood River are designated as Category 5, or 303d-listed, for several impairments to include total suspended solids (TSS), total phosphorus (TP), and atrazine. The Neosho River near Neosho Rapids is 303d-listed for lead, and the Flint Hills National Wildlife Refuge (NWR) is listed for siltation. Bloody Creek is 303d-listed for sulfate, while Eagle Creek and Mud Creek are listed for atrazine. Hillsboro and Peter Pan Lakes are 303d-listed for eutrophication (**Table 10**) *All category 4a (TMDL) listings are described in the following "TMDL" section.*

Table 10. 303d-Listed Waters in the JRR Watershed[13]

303d List of Impaired Waters				
Water Segment	**Category**	**Impairment**	**Priority**	**Sampling Station**
Bloody Creek near Saffordville	5	Sulfate	2023	SC689
Cottonwood River near Elmdale	5	Atrazine	2023	SC627
		Total Suspended Solids		
Cottonwood River near Plymouth	5	Total Suspended Solids	2023	SC275
Eagle Creek near Olpe	5	Atrazine	2023	SC634
Flint Hills NWR	5	Siltation	2023	LM072401
Hillsboro City Lake	5	Eutrophication	2023	LM020901
Mud Creek near Marion	5	Atrazine	2023	SC691
Neosho River near Neosho Rapids	5	Lead	2023	SC273
Peter Pan Lake	5	Eutrophication	2023	LM068901
South Cottonwood River near Canada	5	Atrazine	2023	SC635
		Total Phosphorus		

[13] Kansas Department of Health and Environment, 2018. http://www.kdheks.gov/tmdl/2018/Approved_2018_303_d)_List_of_All_Impaired_Waters.pdf, Pages 28-30.

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 contain 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. A TMDL indicates the desired outcome of the process using the current situation as a 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. Consistent water monitoring in the JRR Watershed will indicate when TMDLs should be reviewed by the KDHE TMDL Management Section.

2. JRR Watershed TMDLs

The JRR Watershed is large, and the KDHE monitoring program has identified 19 TMDLs. This WRAPS plan will focus BMP implementation to address those TMDLs shown in **Table 11**; other TMDLs may be positively affected by BMP implementation. The ultimate goal of this plan is to improve water quality in the John Redmond Reservoir.

Table 11. TMDLs in the JRR Watershed[14]

TMDL List of Impaired Waters					
Water Segment	**Category**	**Impairment**	**Priority**	**Goal of TMDL**	**Sampling Station**
Allen Creek near Emporia	4a	Dissolved Oxygen	Medium	DO standard of > 5 mg/L, BOD < 3.2 mg/L	SC628
Clear Creek near Marion	4a	Sulfate	Low	250 mg/L - naturally caused TMDL	SC690
Cottonwood River near Elmdale	4a	Sulfate	Low	250 mg/L - naturally caused TMDL	SC627
Cottonwood River near Emporia	4a	Total Phosphorus	High	ALUS score ≥ 14, 5 µg/L sestonic chlorophyll	SC274
Doyle Creek near Florence	4a	Sulfate	Low	250 mg/L - naturally caused TMDL	SC120
Eagle Creek near Olpe	4a	Dissolved Oxygen	High	DO standard of > 5 mg/L, BOD ≤ 2.0 mg/L	SC634
Fox Creek near Strong City	4a	Biology	Medium	≤ 1 sampling w/MBI value > 4.5	SC718
Jones Park Lake	4a	Eutrophication	Low	Summer Chlorophyll *a* concentration ≤ 12 µg/L	LM068701
John Redmond Reservoir	4a	Eutrophication	Medium	Summer Chlorophyll *a* concentration ≤ 12 µg/L	LM026001
		Siltation		Secchi disc depth > 0.8 m	
Lake Kahola	4a	Eutrophication	Medium	Summer Chlorophyll *a* concentration ≤ 10 µg/L	LM043401
Marion County Lake	4a	Dissolved Oxygen	Medium	> 5 mg/L	LM012101
	4a	Eutrophication	Medium	Summer Chlorophyll *a* concentration ≤ 12 µg/L, Total Nitrogen < 0.62 mg/L	LM012101
Mud Creek near Marion	4a	*E. coli*	High	< 2,000 colonies per FCB/100 ml	SC691
Neosho River at Neosho Rapids	4a	Total Phosphorus	High	ALUS score ≥ 14, 5 µg/L sestonic chlorophyll	SC273
Olpe City Lake	4a	Eutrophication	High	Summer Chlorophyll *a* concentration ≤ 12 µg/L	LM041001
		Siltation		Secchi disc depth > 0.5 m	
Palmer Creek near Strong City	4a	Biology	Medium	≤ 1 sampling w/MBI value > 4.5	SC719
South Fork Cottonwood River near Bazaar	4a	Biology	Medium	≤ 1 sampling w/MBI value > 4.5	SC582

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

5. Watershed Impairments to be Addressed

The JRR Watershed SLTs (NELC and Upper Cottonwood, as described in Section 2-I) acknowledge all 303d- and TMDL-listed water segments in the watershed. While there are 12 303d listings, and 19 TMDL listings in the JRR Watershed, **the SLTs will focus their efforts to achieve one desired outcome: the delisting of the John Redmond Reservoir for its eutrophication and siltation TMDLs (Table 12)**. All goals and BMPs will aim to protect the JRR Watershed from further degradation.

Table 12. JRR Watershed TMDL Impairment Loads and Goals

Load Allocations for the John Redmond Reservoir Watershed			
Impairment/TMDL	**Current Load**	**Allowed Load**	**Required Reduction**
Eutrophication: Phosphorus in the John Redmond Reservoir	1,352,982 pounds/year	1,066,574 pounds/year	286,408 pounds/year
Siltation: John Redmond Reservoir	888,600 tons/year	591,000 tons/year	297,600 tons/year

Although this WRAPS plan only specifically addresses the eutrophication and siltation TMDLs in the John Redmond Reservoir, the two watershed SLTs realize that the BMP implementation required to achieve this goal will positively impact 303d- and TMDL-listed water bodies throughout the watershed. There are four key TMDL-listed impairments in six water bodies where the SLTs specifically wish to see improvement:

- **Biology** in Fox Creek and the South Fork of the Cottonwood River,
- **Dissolved oxygen** in Allen Creek, Eagle Creek and Marion County Lake,
- ***E. coli*** in Mud Creek, and
- **Eutrophication** in Marion County Lake.

A. Eutrophication: Phosphorus

The JRR Watershed has a medium-priority TMDL for the impairment of **eutrophication** in the John Redmond Reservoir.[15] Eutrophication is caused by excess nutrient loading (primarily phosphorus and nitrogen) that creates conditions favorable for algae blooms and aquatic plant growth. This reservoir is classified as argillotrophic, meaning that it produces low levels of phytoplankton because the water is clouded by high levels of suspended clay particles; therefore, the John Redmond Reservoir could support the growth of potentially harmful blue-green algae if conducive environmental conditions are present.

The John Redmond Reservoir has concentrations of chlorophyll *a* averaging 6.53 ppb. This relates to a Trophic State Index of 48.98, making it mesotrophic in scale. Sampling done by KDHE shows elevated total phosphorus concentrations (averaging 175 ppb). One hundred

[15] KDHE, E TMDL for John Redmond Reservoir, https://www.kdheks.gov/tmdl/ne/RedmondE.pdf

percent of the samples are over 50 ppb. The Total Kjeldahl Nitrogen concentrations average 0.84 mg/L, nitrate concentrations average 0.70 mg/L, and nitrite is often below the detection limit. Light is indicated to be the primary limiting factor (see **Appendix B**). Surface water in John Redmond Reservoir has high turbidity, dominated by inorganic materials because the reservoir receives a steady inflow of silt. Bioassays performed by the Kansas Biological Survey indicate that phosphorus and nitrogen are co-limiting. The chlorophyll *a* to total phosphorus yield is low; the algal production is reduced because light cannot penetrate through the turbid water.

There is an accompanying TMDL for siltation in John Redmond Reservoir. Because much of the phosphorus entering the lake is attached to sediment, the reductions in total suspended solids will lead to total phosphorus reductions. The relationship between total suspended solids and total phosphorus concentrations were determined by developing a regression of the data from monitoring station 273, located at Neosho River at Neosho Rapids (**Figure 18**).

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 JRR 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. In the JRR Watershed at the time of this document's publication, there are 45 NPDES facilities, including 24 discharging lagoons.

Population
Watershed population can affect nutrient runoff. There are roughly 2,051 domestic onsite wastewater systems estimated in the JRR Watershed, located mainly in rural areas. Although the functional condition of these systems generally is 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 permitted federally. 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 nutrient loads. In addition to livestock-contributed waste, improperly disposed of pet waste also can be a contributor to the nutrient loads, although at a much smaller quantity.

Grazing density
Approximately 61% of the JRR 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 waterways. Grazing density (Flint Hills grasslands) ranges from 8.0 to 17.1 cattle per 100 acres across the watershed, which is an average of 10.9 head per 100 acres.[16] The Flint Hills grasslands are considered to be high density when compared with statewide grazing density numbers.

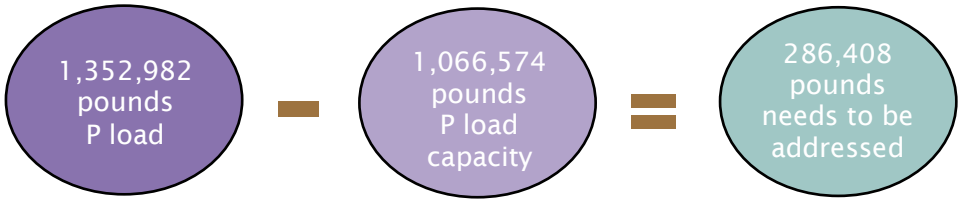
Rainfall and runoff
Rainfall amounts and subsequent runoff affect nutrient runoff from agricultural and urban areas into streams and the John Redmond Reservoir. The amount and timing of rainfall events affect manure runoff from livestock that are allowed access to streams, or manure applied before a rainfall event or on frozen ground. Rainfall 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

Phosphorus
The current estimated phosphorus (P) load in the JRR Watershed is 1,352,982 pounds per year, according to the TMDL section of KDHE.[17] The amount of phosphorus in the watershed contributes to the eutrophication TMDL in the John Redmond Reservoir, as well

[16] https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/Kansas/index.php
https://www.nass.usda.gov/Statistics_by_State/Kansas/Publications/County_Estimates/20KScattle.pdf
[17] Kansas Department of Health and Environment. May 2020.

as several other water bodies with eutrophication, dissolved oxygen, biology, and total phosphorus impairments in this watershed. The total load reduction needed to meet the phosphorus TMDL in the JRR Watershed is 286,408 pounds, a reduction of roughly 21%. **If all BMPs are implemented, 287,772 pounds of phosphorus will be reduced from the watershed at the end of this 30-year plan.** This exceeds the required reduction goal by 0.48%.



Nitrogen

There are no current quantitative nitrogen load reduction figures available; therefore, there is not a specific nitrogen load reduction required to meet the TMDL. However, it is known that BMPs implemented to reduce phosphorus loads also will reduce nitrogen loads, resulting in nitrogen reductions. **The implementation of this plan will result in a nitrogen load reduction of 1,075,164 total pounds over the life of this 30-year plan**.

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

The watershed SLTs 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 buffers, conservation crop rotations, no-till with cover crops, nutrient management plans, permanent vegetation, terraces, and waterways will improve water quality by reducing nutrient runoff and leaching. Implementing fenced-off streams, filter strips, off-stream watering, and rotational grazing and relocating pasture feeding sites will help to reduce nutrient loading from livestock areas. Streambank stabilization projects will reduce sediment erosion and simultaneously will reduce nutrient loading. Specific acreages or projects that need annual implementation have been determined through modeling and economic analysis and have been approved by the SLTs (**Table 13**).

Table 13. BMPs to Prevent and/or Reduce Nutrient Loading

BMPs to Reduce Nutrient Loading		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of nutrient contribution from **cropland**	Buffers	2,030 acres
	Conservation Crop Rotation	1,095 acres
	No-till with Cover Crops	2,772 acres
	Nutrient Management Plans	918 acres
	Permanent Vegetation	371 acres
	Terraces	1,095 acres
	Waterways	2,030 acres
Prevention of nutrient contribution from **livestock**	Fence off Streams	3 projects every 2 years
	Filter Strips	10 projects every 2 years
	Off-stream Watering	3 projects per year
	Relocate Pasture Feeding Sites	3 projects per year
	Rotational Grazing	4 projects every 2 years
Prevention of nutrient contribution from **streambanks**	Streambank Stabilization	3,626 feet per year

The implementation of cropland BMPs in support of the eutrophication TMDL also reduces sediment loading, thereby positively impacting the watershed's sediment. The implementation of both cropland and livestock BMPs in the watershed subsequently improves the Biology TMDLs in Fox Creek near Strong City and the South Fork Cottonwood River; the Dissolved Oxygen TMDLs in Allen Creek near Emporia, Eagle Creek near Olpe, and Marion County Lake; the E. coli *TMDL in Mud Creek near Marion; and the eutrophication TMDL in Marion County Lake. In addition to these priority areas, all other biology, dissolved oxygen, eutrophication, siltation and total phosphorus, 303d- and TMDL-listed areas in the JRR Watershed will be affected positively.*

B. Siltation

The JRR Watershed has a medium-priority TMDL for the impairment of **siltation (sedimentation)** in the John Redmond Reservoir.[18] *BMP implementation and load reductions in this report will refer to this impairment as 'sediment' and 'sedimentation', while the TMDL will refer to it as 'siltation'.*

The siltation TMDL can be related to the eutrophication TMDL in the reservoir due to pollutants (particularly phosphorus and nitrogen) which can be attached to suspended soil particles in the water column.

[18] KDHE, Siltation TMDL for John Redmond Reservoir, https://www.kdheks.gov/tmdl/ne/RedmondSILT.pdf

Surface water in the John Redmond Reservoir has high turbidity, dominated by inorganic materials because the lake receives a steady inflow of silt. The lake is light-limited and, based on samples taken by KDHE, the average transparency (Secchi Disc depth) is 23 cm, the average turbidity is 50.4 formazin turbidity units, and the average total suspended solid concentration is 46 mg/L. Lakes/reservoirs are considered to have a siltation problem if they meet the following criteria: chronically turbid, trophic state index plots indicate light limitation, average chlorophyll *a* concentrations less than 7.2 ppb, and Secchi Disc depth less than 0.5 meters.

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 sediment reaches the reservoir, it decreases water clarity and can reduce reservoir volume and storage capacity. A decrease in reservoir storage affects domestic and industrial uses of the water and also limits public access to the reservoir's boat ramps and beaches. Therefore, reducing erosion is necessary to reduce sediment in the John Redmond Reservoir. In addition, nutrient pollutants such as phosphorus and nitrogen can leach to the sediment particles causing higher-than-normal concentrations and accelerating the eutrophication problem in the reservoir.

1. 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 which 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 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. This WRAPS plan will address the following primary land uses for BMP implementation (**Section 6**): grassland (61%), cropland (19%), and pasture/hay land (9%). Reducing erosion in these areas is necessary for a reduction in sediment.

Agricultural BMPs such as buffers, conservation crop rotations, no-till, nutrient management plans, permanent vegetation, terraces, and waterways within high priority and riparian corridor areas will reduce erosion and improve water quality.

Soil erosion by wind and/or water

NRCS has established a "T-factor" for evaluating soil erosion. "T" represents the soil loss tolerance factor and is defined as the maximum amount of erosion at which soil quality as

a medium for plant growth can be maintained. A T-factor 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 productivity loss by erosion. T-factors represent the goal for maximum annual soil loss in sustaining the productivity of land use.[19]

Riparian quality

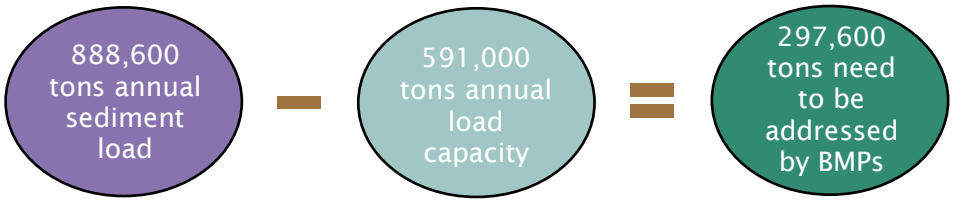
In the targeted areas, the predominant land use in riparian areas is cropland (19%). This is the land that can be most vulnerable to runoff and erosion. An adequately functioning and healthy riparian area will reduce sediment flow from cropland and rangeland. Cropland needs buffer and filter strips adjacent to streams in order to impede sediment flow from fields. Conservation tillage practices, such as no-till, increase soil infiltration which slows the flow of rainwater off of crop fields. 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 the John Redmond Reservoir. In addition, high rainfall events can cause cropland erosion and sloughing of streambanks, adding sediment to streams and rivers that will ultimately flow into the reservoir.

2. Pollutant loads

The current estimated siltation load in the JRR Watershed is 888,600 tons per year, according to the TMDL section of KDHE. The total load reduction needed to meet the siltation TMDL is 297,600 tons of sediment, a reduction of roughly 33%. **If all BMPs have been implemented by the end of this 30-year WRAPS plan, a reduction of 343,045 tons per year of sediment will have been saved.** This exceeds the TMDL goal by 15%.



3. 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 (buffers, conservation

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

crop rotations, no-till with cover crops, nutrient management plans, permanent vegetation, terraces, and waterways) will reduce erosion and improve water quality. When the SLTs revised and updated this plan in 2020, a cover crop BMP was included, to be used in conjunction with no-till. Streambank stabilization projects also will reduce sediment erosion. Specific acreages or projects needing annual implementation have been determined through modeling and economic analysis and were approved by the SLTs, as shown in **Table 14**.

Table 14. BMPs to Prevent and/or Reduce Sediment Loss

BMPs to Reduce Sediment Loading		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of sediment loss from **cropland**	Buffers	2,030 acres
	Conservation Crop Rotation	1,095 acres
	No-till with Cover Crops	2,772 acres
	Nutrient Management Plans	918 acres
	Permanent Vegetation	371 acres
	Terraces	1,095 acres
	Waterways	2,030 acres
Prevention of sediment loss from **streambanks**	Streambank Stabilization	3,626 feet per year

C. Other Impairments in the JRR Watershed

In addition to the priority eutrophication and siltation TMDLs in the John Redmond Reservoir, there are 10 impairments in 31 water segments/bodies that have been 303d- and TMDL-listed in the JRR Watershed. Many of these impairments and water segments will be impacted positively by BMP implementation.

1. Atrazine

Atrazine is a relatively inexpensive herbicide widely used in corn, sorghum and soybean production. Atrazine enters streams and lakes by way of sediment runoff. It has a slow chemical breakdown, so once atrazine enters the water, it can linger for a long time. Atrazine is one of the most commonly detected herbicides in groundwater and has been connected to health issues in animals and humans, including reproductive system problems in humans. This chemical is lab-created, requires a license for usage and is considered a health threat in contaminated waters.

Four water segments in the JRR Watershed are 303d-listed for an atrazine impairment:

- Cottonwood River near Elmdale,
- Eagle Creek near Olpe,
- Mud Creek near Marion, and
- South Cottonwood near Canada.

Atrazine is not a targeted impairment in this plan; however, BMPs implemented to reduce sediment loads will reduce the amount of sediment runoff entering the stream segments, resulting in lower amounts of atrazine loading.

2. Biology

There is a direct relation between levels of nutrient loading and biological integrity. Decreased nutrient loads should result in improved aquatic communities and biological metrics indicative of improved water quality. The goal of this TMDL is to maintain Macroinvertebrate Biotic Index scores below 4.5 and maintain healthy total phosphorus and total nitrogen levels.

Three water segments in the JRR Watershed have medium-priority biology TMDL impairments:

- Fox Creek near Strong City,
- Palmer Creek near Strong City, and
- South Fork Cottonwood River near Bazaar.

Biology TMDLs are not a priority focus in this plan; however, implementing BMPs to address eutrophication and sediment throughout the watershed means that biology in these water segments should be impacted positively.

3. Dissolved oxygen

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 dissolved oxygen (DO) in the water. This results in an unfavorable habitat for aquatic life. 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.

Three water bodies in the JRR Watershed are TMDL-listed for DO:

- Allen Creek near Emporia (medium priority),
- Eagle Creek near Olpe (high priority), and
- Marion County Lake (medium priority).

This plan does not target the DO impairment specifically; however, this plan's implementation of nutrient and sediment BMPs subsequently will reduce the amount of nutrient loading found in runoff, having positive effects on DO-impaired waters.

4. E. coli

The presence of bacteria in waterways can originate from livestock production area runoff, close proximity of mammals to water sources, and manure application to agricultural fields. Bacteria is present in livestock manure and can be transported into

waterways if livestock have access to streams. Bacteria can originate in both rural and urban areas and caused by both point and nonpoint sources. It must be noted that not all bacteria can be attributed to livestock: wildlife contributes to bacteria loads as well. In addition, failing septic systems can be a source of bacteria from humans.

One water segment in the JRR Watershed has a high-priority TMDL for *E. coli*:

- Mud Creek near Marion

E. coli is not targeted directly by this WRAPS plan, however, BMPs implemented along streambanks in the Upper Cottonwood will reduce bacteria loading and could positively impact the *E. coli* TMDL in Mud Creek.

5. Eutrophication

Eutrophication is a natural process that occurs when a water body receives excess nutrients. These nutrients, primarily phosphorus and nitrogen, create optimum conditions favorable for algal blooms and plant growth. Some species of blue-green algae produce chemicals harmful to both animals and humans. Proliferation of algae and its subsequent decomposition also can deplete available DO in the water profile. This results in an unfavorable habitat for aquatic life and poor-quality drinking water for livestock.

As previously mentioned, this WRAPS plan will address the eutrophication TMDL in the John Redmond Reservoir. Six additional lakes in the watershed, outside of the John Redmond Reservoir, are 303d- or TMDL-listed for eutrophication. They are:

- Peter Pan Lake, 303d-listed;
- Hillsboro City Lake, 303d-listed;
- Jones Park Lake, low-priority TMDL;
- Lake Kahola, medium-priority TMDL;
- Marion County Lake, medium-priority TMDL; and
- Olpe City Lake, high-priority TMDL.

Although this plan will not address directly the eutrophication in these six lakes, BMP implementation throughout the watershed, upstream from the John Redmond Reservoir, will have a positive impact on each of these lake's nutrient levels.

6. Lead

Lead does not occur naturally in Kansas water sources. Lead can enter drinking water when a chemical reaction occurs in plumbing materials containing lead. The dissolving of metal from pipes and fixtures is known as corrosion. This reaction is more severe when water has high acidity or low mineral content. How much lead enters the water is related to the acidity or alkalinity of the water, the types and amounts of minerals in the water, the amount of lead that the water comes into contact with, the water temperature, the amount of wear in the pipes, the time water stays in pipes, and the presence of protective scales or coatings in the pipes.

The JRR Watershed has one stream 303d-listed for having a lead impairment:

- Neosho River near Neosho Rapids.

This plan will not address lead in the Neosho River.

7. Siltation

Silt, or sediment, accumulation in streams and lakes is caused by soil erosion into the waterways. Silt decreases water clarity and can reduce water storage capacity. Sediment accumulation introduces nutrients attached to soil particles into water bodies, thus accelerating biology, DO and eutrophication problems. Sedimentation can be caused by overland erosion from cropland, degraded pastureland, streambank sloughing or improperly contained construction projects.

As previously mentioned, this WRAPS plan will address the siltation TMDL in the John Redmond Reservoir. Two additional areas in the JRR Watershed, outside of the reservoir, are 303d- and TMDL-listed for siltation. They are:

- Flint Hills Natural Wildlife Refuge, 303d-listed; and
- Olpe City Lake, high-priority TMDL.

This plan will not address the siltation impairments in these two areas; however, sediment BMP implementation addressing the John Redmond Reservoir siltation TMDL undoubtedly will have a positive impact in these areas.

8. Sulfate

Sulfur is an essential plant nutrient. Aquatic organisms utilize sulfur, and reduced concentrations of it have a detrimental effect on algal growth. The most common form of sulfur in well-oxygenated waters is sulfate. When sulfate is less than 0.5 mg/L, algal growth will not occur. On the other hand, sulfate salts can be major contaminants in natural waters.

Sulfate in Kansas waters can occur naturally or as the result of municipal or industrial discharges. Naturally occurring sulfates can result from the breakdown of leaves that fall into a stream, or water passing through rock or soil containing gypsum and other common minerals. The suggested limit for sulfate is 250 mg/L. High sulfate concentrations in drinking water have three effects: the formation of hard scales in boilers and heat exchangers, a bitter taste, and laxative effects for those unused to it. Sulfates are not considered toxic to plants or animals at normal concentrations; however, high concentrations of sulfates can be toxic to cattle.

Four water bodies in the JRR Watershed have been listed for having sulfate impairments:

- Bloody Creek near Saffordville, 303d-listed;
- Cottonwood River near Elmdale, low-priority TMDL;
- Clear Creek near Marion, low-priority TMDL; and
- Doyle Creek near Florence, low-priority TMDL.

The JRR Watershed WRAPS plan will not address sulfate impairments.

9. Total phosphorus

Phosphorus loading can originate in both rural and urban areas and can be caused by both point and nonpoint sources. Land use activities can affect phosphorus runoff into streams. Some examples of this include fertilizer or manure applied to frozen ground or cropland prior to a rainfall event can be transported easily downstream; or livestock allowed access to streams to drink or loaf will contribute manure directly into the stream.

Three water segments in the JRR Watershed have been listed for total phosphorus impairments:

- South Cottonwood River near Canada, 303d-listed;
- Cottonwood River near Emporia, high-priority TMDL; and
- Neosho River at Neosho Rapids, high-priority TMDL.

This plan will not address directly total phosphorus impairments in these two rivers. BMP implementation addressing the eutrophication and siltation TMDLs in the John Redmond Reservoir will result in nutrient (including phosphorus) load reductions throughout the JRR Watershed. Therefore, the implementation of this WRAPS plan will result in total phosphorus load reductions in the Cottonwood and Neosho Rivers.

10. Total suspended solids

Total suspended solids (TSS) are particles such as soil, algae, and finely-divided plant material suspended in water. These pollutants may attach to sediment particles on the land and be carried into water segments with storm water runoff. Once in the water, the pollutants may be released from the sediment or travel farther downstream. These particles can come from cropland, streambanks, construction sites, or industrial and municipal wastewater. High TSS levels can block light from reaching submerged vegetation, which slows photosynthesis. High levels also can cause an increase in surface water temperature, as the suspended particles absorb heat from sunlight, harming aquatic life. There are several additional ways that high TSS levels can damage aquatic life including: clogging gills, reducing growth rates, and smothering the eggs of fish, aquatic insects, and larvae. High TSS levels also can cause problems for industrial use, as solids may clog or scour pipes and machinery.

The JRR Watershed has two 303d listings for TSS impairment:

- Cottonwood River near Elmdale, and
- Cottonwood River near Plymouth.

TSS will not be a targeted priority for this WRAPS plan. The Cottonwood River will be targeted for BMP implementation with sediment and livestock BMPs to address the eutrophication and siltation TMDLs in the John Redmond Reservoir. These BMPs will have a subsequent positive impact on the TSS levels in the Cottonwood River and throughout the watershed.

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 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 where soils are more prone to erosion and nutrient leaching, close proximity to streams, and a greater potential for high water flow. Areas such as these are considered to be of 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. Soil and Water Assessment Tool (SWAT)

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

To determine targeted areas for BMP implementation in the JRR Watershed, the Department of Biological and Agricultural Engineering (BAE) at Kansas State University used SWAT to estimate annual average pollutant loadings such as nutrients and sediment eroding into the stream. The average annual loads were calculated for each sub-watershed at the end of the simulation, with some areas having higher loads than others. Based on experience and technical knowledge, the areas or sub-watersheds with the top 20-30% of the highest loads among all areas within the watershed are selected as critical (targeted) areas for cropland and livestock BMPs implementation.

Specifically, Kansas State University BAE used the ArcGIS interface of ArcSWAT version 9.2. This version used spatially distributed data on topography, soils, land cover, land management, and weather to predict water, sediment, nutrient, and pesticide yields. A

modeled watershed is divided spatially into sub-watersheds using digital elevation data according to the drainage area specified by the user. Sub-watersheds are modeled as having non-uniform slope, uniform climatic conditions determined from the nearest weather station, and they are further subdivided into lumped, non-spatial hydrologic response units (HRUs) consisting of all areas within the sub-watershed having similar soil, land use, and slope characteristics. The use of HRUs allows slope, soil, and land-use heterogeneity to be simulated within each sub-watershed but ignores pollutant attenuation between the source area and stream and limits spatial representation of wetlands, buffers, and other BMPs within a sub-watershed.

The model includes sub-basin, reservoir, and channel-routing components.

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

Data for the JRR Watershed SWAT model was collected from a variety of reliable online and printed data sources, as well as knowledgeable agency personnel within the watershed. Input data and their online sources are:

- 30 meters DEM (USGS National Elevation Dataset),
- 30m NLCD 2001 Land Cover data layer (USDA-NRCS),
- STATSGO soil dataset (USDA/NRCS),
- NCDC NOAA daily weather data (NOAA National Climatic Data Center),
- Point sources (KDHE on county basis),
- Septic tanks (US Census),
- Crop rotations (local knowledge), and
- Grazing management plans (local knowledge).

The maps produced by the modeling are displayed below (**Figures 19-24**). The darker or

brighter the colors on the map, the greater potential for nutrient runoff and sediment and load potential.

The maps below are sourced from the original 2010 John Redmond Reservoir, Neosho Headwaters and 2012 Cottonwood (Upper and Lower) WRAPS plans, therefore the maps themselves do not align with this plan's targeted area structure (NELC and Upper Cottonwood).

Neosho Headwaters SWAT maps (Figures 19, 20, and 21):

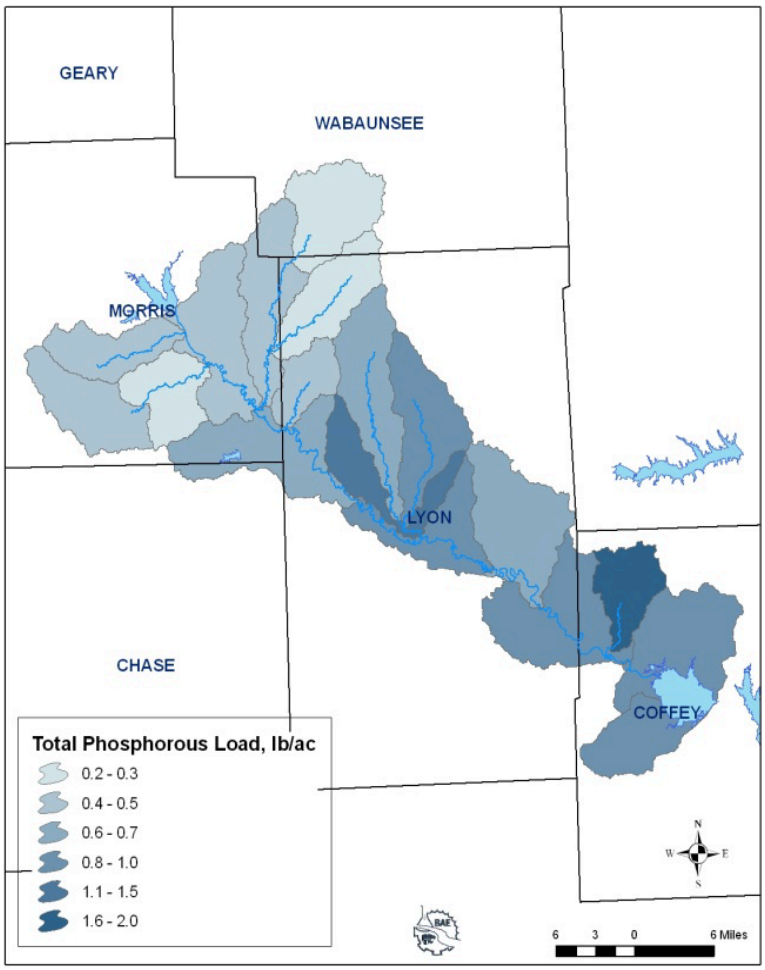


Figure 19. Total Phosphorus Load (Pounds/Acre) as Indicated by SWAT

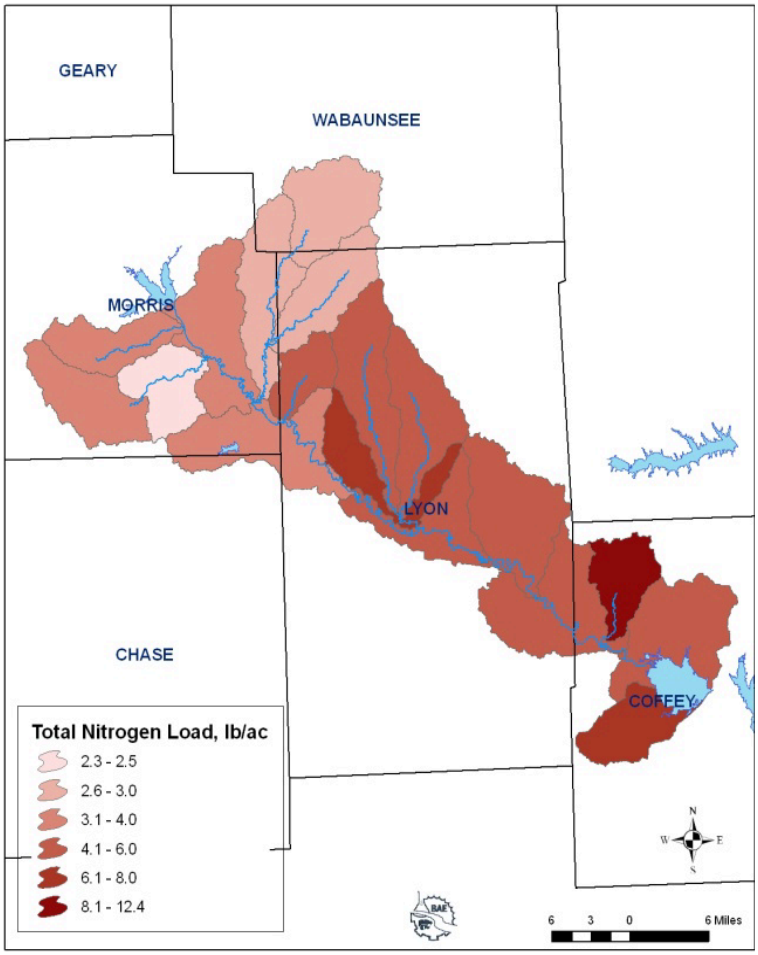


Figure 20. Total Nitrogen Load (Pounds/Acre) as Indicated by SWAT

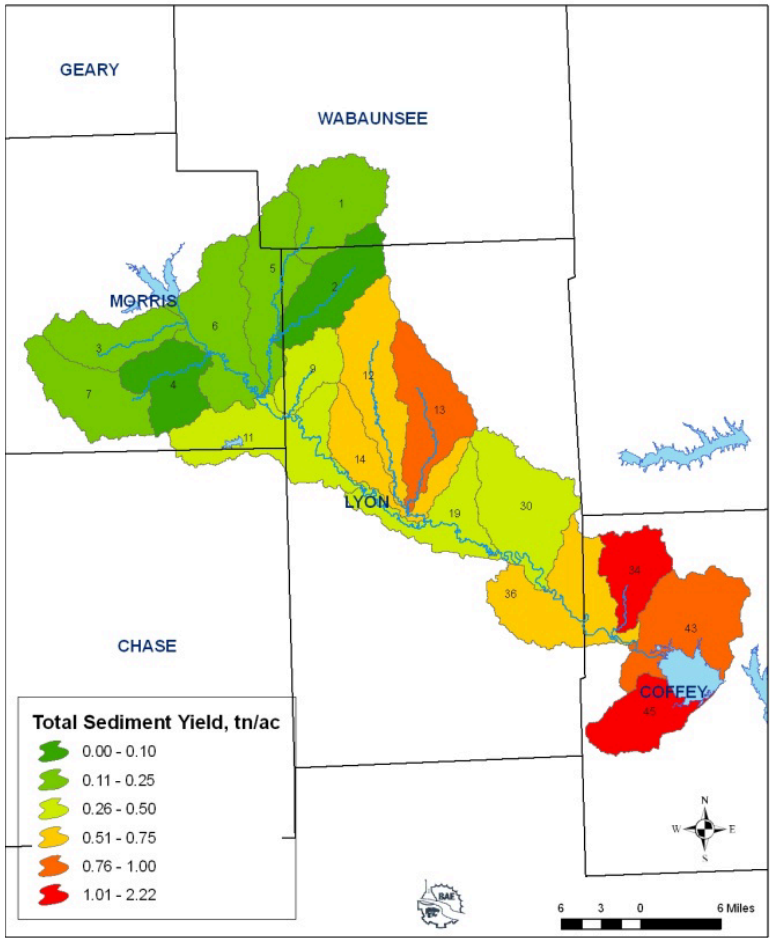


Figure 21. Total Sediment Load/Yield (Tons/Acre) as Indicated by SWAT

Upper and Lower Cottonwood SWAT maps (Figures 22, 23, and 24):

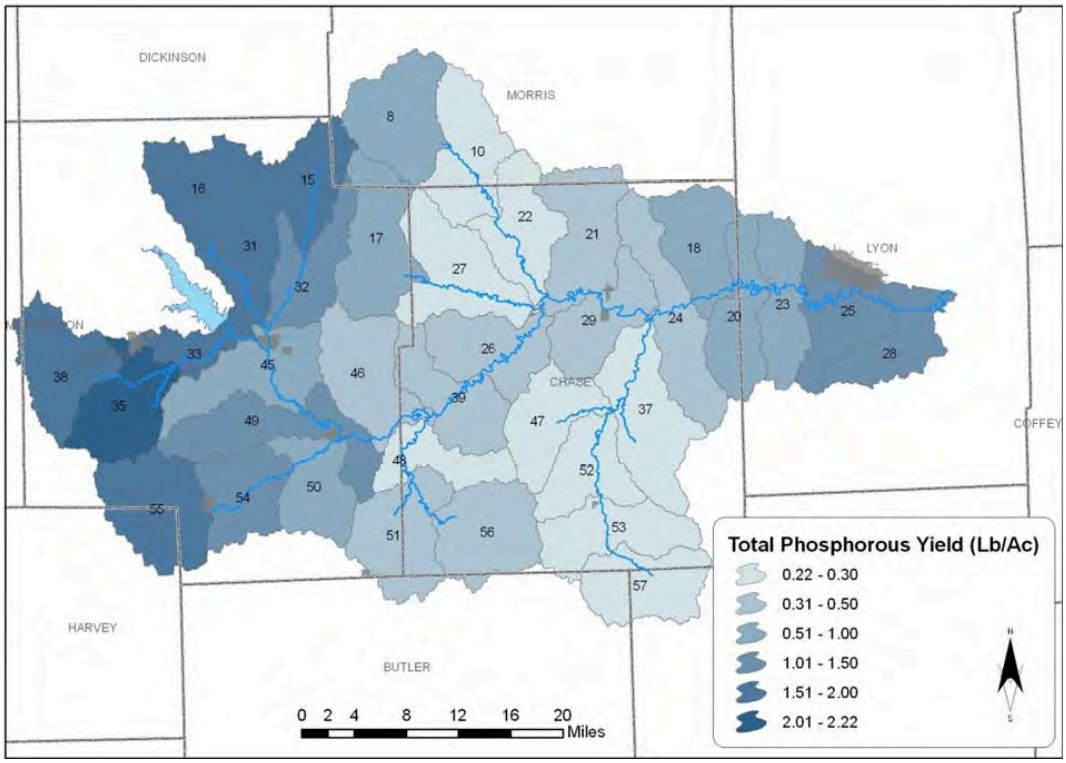


Figure 22. Total Phosphorus Loads (Pounds/Acre) as Indicated by SWAT

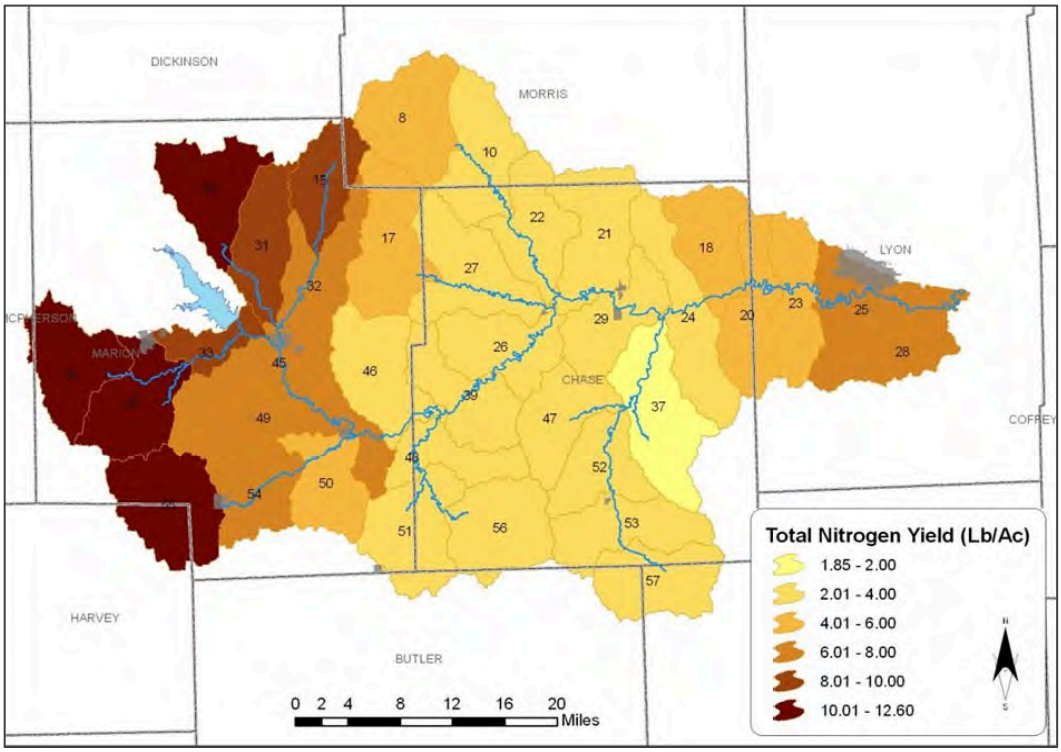


Figure 23. Total Nitrogen Loads (Pounds/Acre) as Indicated by SWAT

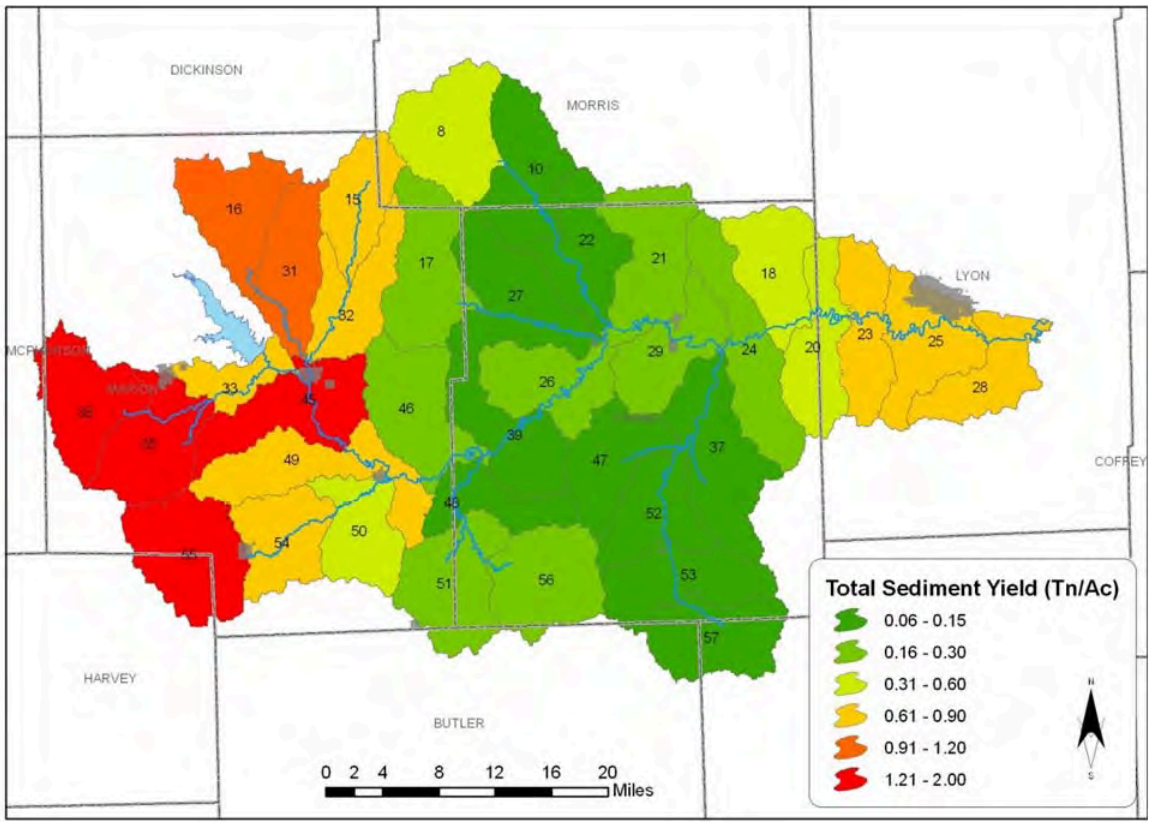


Figure 24. Total Sediment Load/Yield (Tons/Acre) as Indicated by SWAT

2. Ground-truthing

After using SWAT to locate initial targeted areas, the area was ground-truthed. Ground-truthing is a method that involves "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.

In 2009, ground-truthing took place in the Neosho Headwaters and Cottonwood Watersheds. The SWAT model was revised for each using the ground-truthing information. This allowed the SWAT model to develop a more accurate determination of appropriate targeted areas. The SWAT model then determined the number of implementation acres for each BMP to meet load reductions.

3. Aerial assessments

KDHE analyzed aerial images and determined areas of interest for BMP targeting to include crop fields and livestock areas for the NELC (**Figure 25**) and Upper Cottonwood (**Figure 26**) Watersheds. Aerial images[20] indicate both medium and severe degradation.

[20] Aerial assessment figure provided by the Kansas Department of Health and Environment, June 2019.

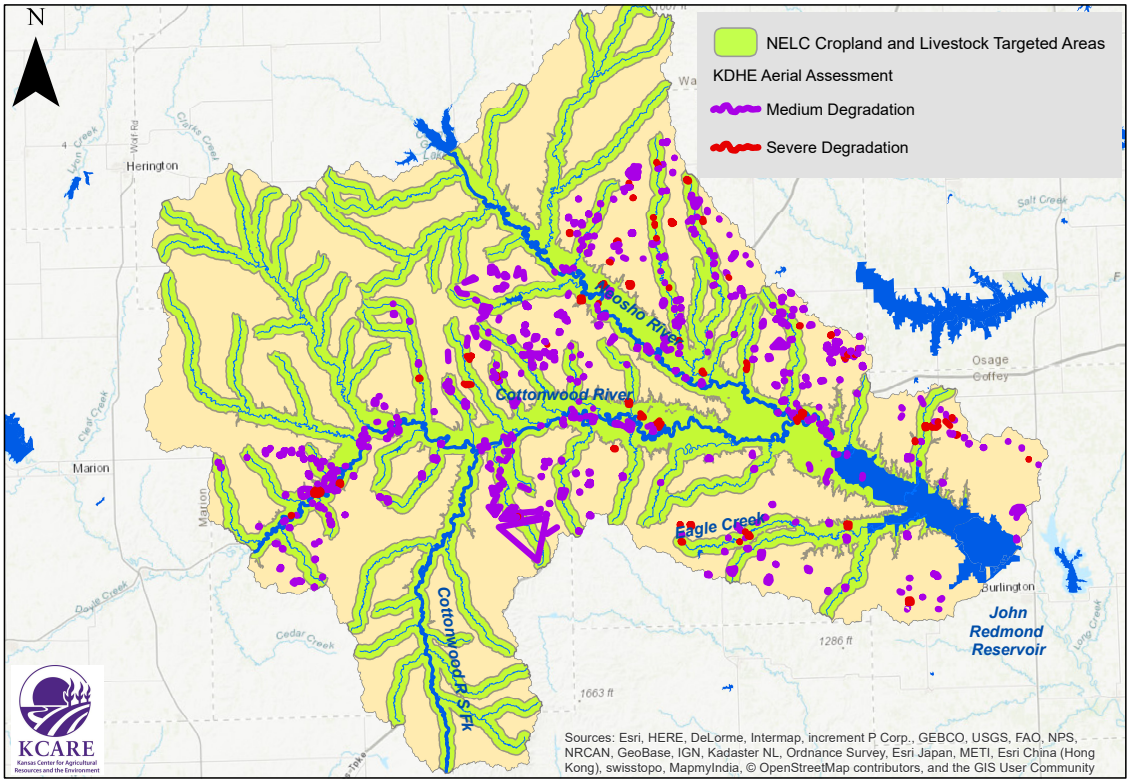


Figure 25. NELC Watershed Aerial Assessment

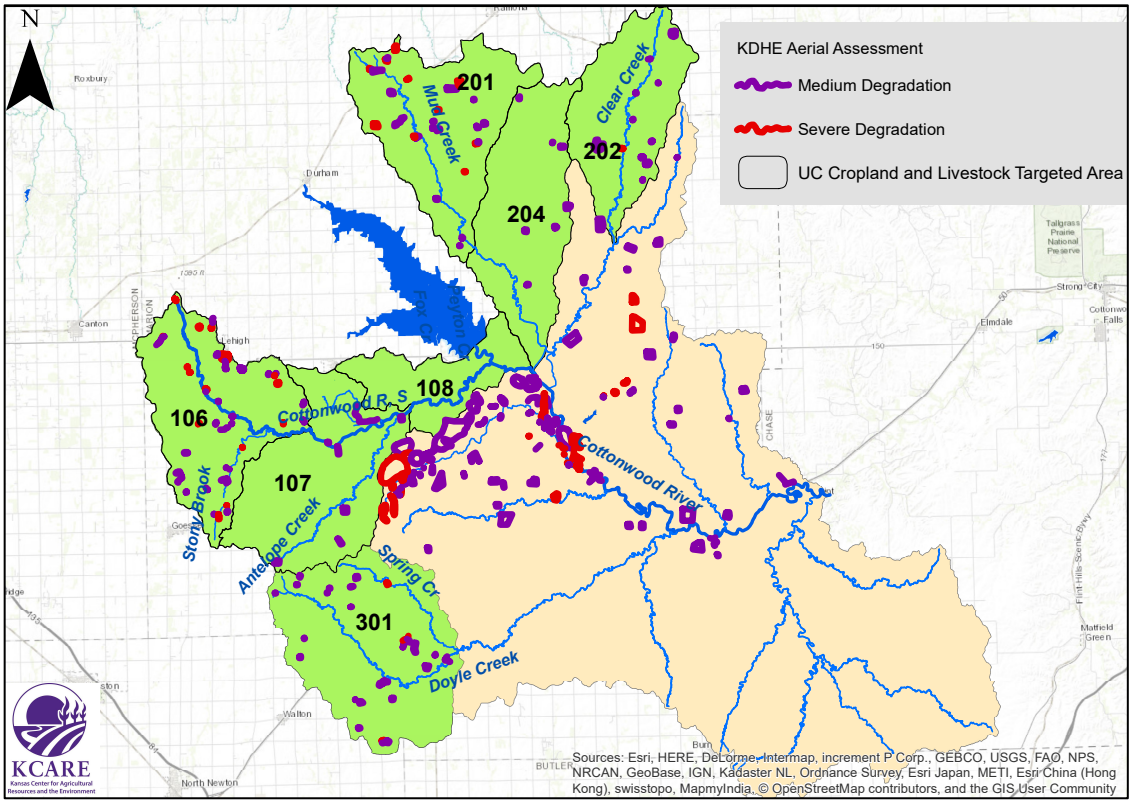


Figure 26. Upper Cottonwood Watershed Aerial Assessment

4. Priority revisions in 2020

SWAT and ground-truthing results determined what areas in the watersheds were most susceptible to cropland erosion. Aerial assessments showed that BMPs could be implemented throughout the JRR Watershed, especially in severely degraded areas, resulting in water quality improvements in the Cottonwood River, Neosho River, and smaller stream segments. These will work to improve the water quality in the John Redmond Reservoir.

In 2020, KDHE chose 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 and reservoirs. By concentrating on riparian corridors, defined as areas on either side of a stream/river, the JRR Watershed SLTs make impacts on the majority of this large watershed. Focusing BMP practices one-half mile on both sides of water segments will significantly reduce nutrient and sediment loading.

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, stream proximity and land use practices. By utilizing BMPs in these specific areas, pollutants can be reduced more efficiently.

The SWAT models, in conjunction with ground-truthing and KDHE aerial assessments, provided data used to determine the targeted areas for this JRR WRAPS plan. Final targeting assessment results were presented to and considered by the NELC and Upper Cottonwood SLTs.

From this point forward, up to Section 10, this WRAPS plan will be split into two sections separately covering the NELC and the Upper Cottonwood Watersheds' targeted areas, implementation, education and associated costs.

1. Targeting the NELC Watershed for BMP implementation

a. NELC monitoring sites

Water monitoring data are used to characterize waters, identify trends over time, identify emerging problems, determine whether pollution control programs are working, help direct pollution control efforts to where they are most needed, and respond to emergencies such as floods and spills. Water monitoring has led to 303d and TMDL listings in the JRR Watershed.

There are currently 26 water monitoring sites in the NELC Watershed. This includes 18 active KDHE sites and eight lake monitoring sites. There are an additional two inactive sites (**Figure 27**).

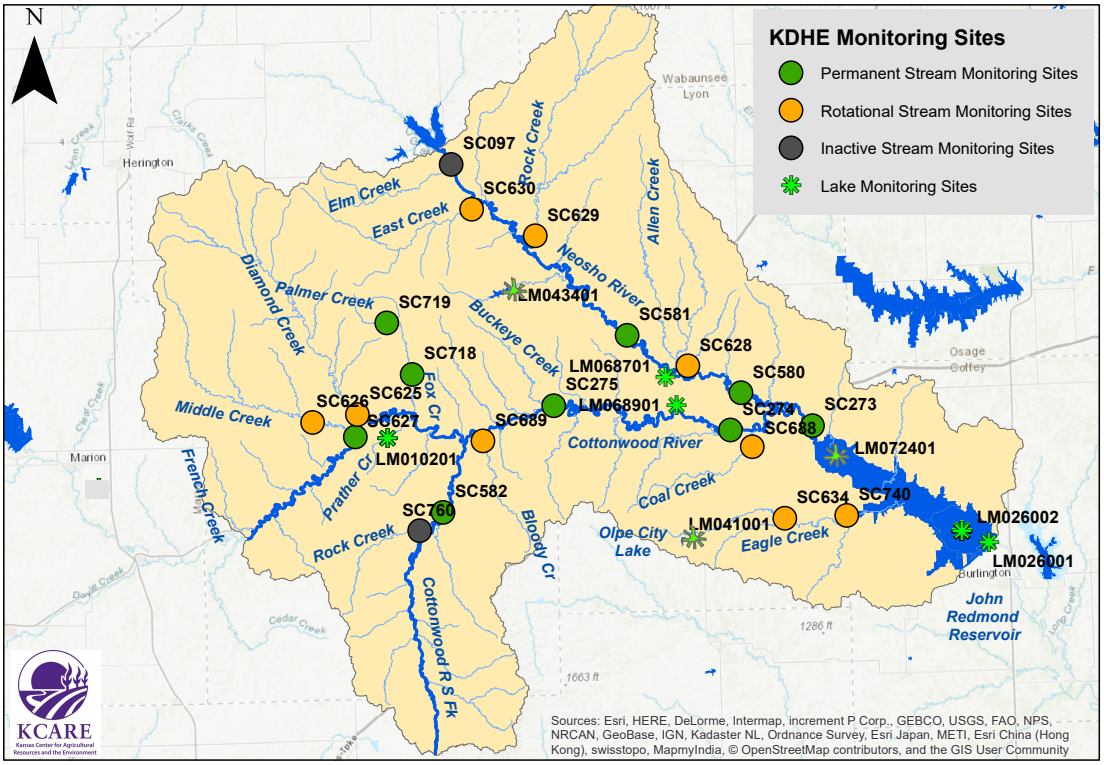


Figure 27. NELC Water Monitoring Sites

b. NELC impairments

There are 19 impaired waters in the NELC Watershed containing the following nine impairments: atrazine, biology, eutrophication, dissolved oxygen, lead, siltation, sulfate, total phosphorus and total suspended solids (**Tables 15** and **16**). As previously mentioned, this plan will function to improve all water quality in the JRR Watershed with the ultimate goal of improving, and eventually delisting, the eutrophication and siltation TMDLs in the John Redmond Reservoir. Maps showing the locations of 303d- and TMDL-listed waters in the NELC Watershed are found in **Figures 28** and **29**.

Table 15. 303d-Listed Waters in the NELC Watershed

303d List of Impaired Waters - NELC				
Water Segment	**Category**	**Impairment**	**Priority**	**Sampling Station**
Bloody Creek near Saffordville	5	Sulfate	2023	SC689
Cottonwood River near Elmdale	5	Atrazine	2023	SC627
		Total Suspended Solids		
Cottonwood River near Plymouth	5	Total Suspended Solids	2023	SC275
Eagle Creek near Olpe	5	Atrazine	2023	SC634
Flint Hills NWR	5	Siltation	2023	LM072401
Neosho River near Neosho Rapids	5	Lead	2023	SC273
Peter Pan Lake	5	Eutrophication	2023	LM068901

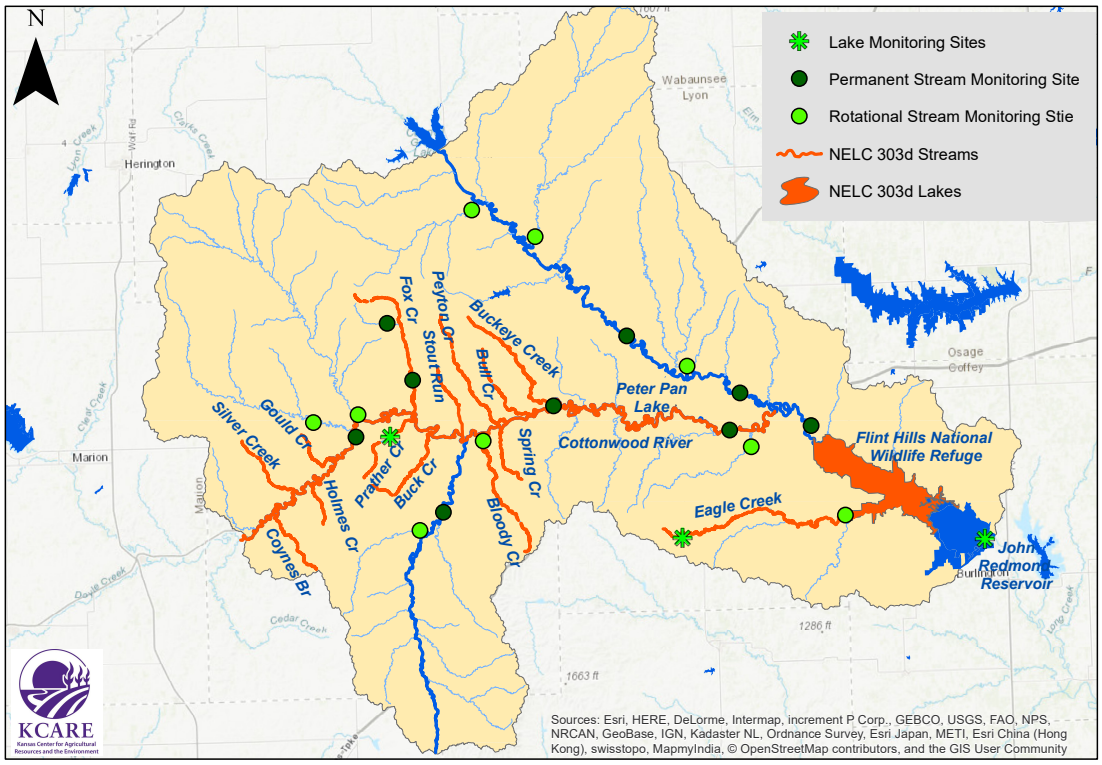


Figure 28. 303d-Listed Waters in the NELC Watershed

Table 16. TMDL-Listed Waters in the NELC Watershed

TMDLs in the NELC				
Water Segment	**Category**	**Impairment**	**Priority**	**Sampling Station**
Allen Creek near Emporia	4a	Dissolved Oxygen	Medium	SC628
Cottonwood River near Elmdale	4a	Sulfate	Low	SC627
Cottonwood River near Emporia	4a	Total Phosphorus	High	SC274
Eagle Creek near Olpe	4a	Dissolved Oxygen	High	SC634
Fox Creek near Strong City	4a	Biology	Medium	SC718
Jones Park Lake	4a	Eutrophication	Low	LM068701
John Redmond Reservoir	4a	Eutrophication Siltation	Medium	LM026001
Lake Kahola	4a	Eutrophication	Medium	LM043401
Neosho River at Neosho Rapids	4a	Total Phosphorus	High	SC273
Olpe City Lake	4a	Eutrophication Siltation	High	LM041001
Palmer Creek near Strong City	4a	Biology	Medium	SC719
South Fork Cottonwood River near Bazaar	4a	Biology	Medium	SC582

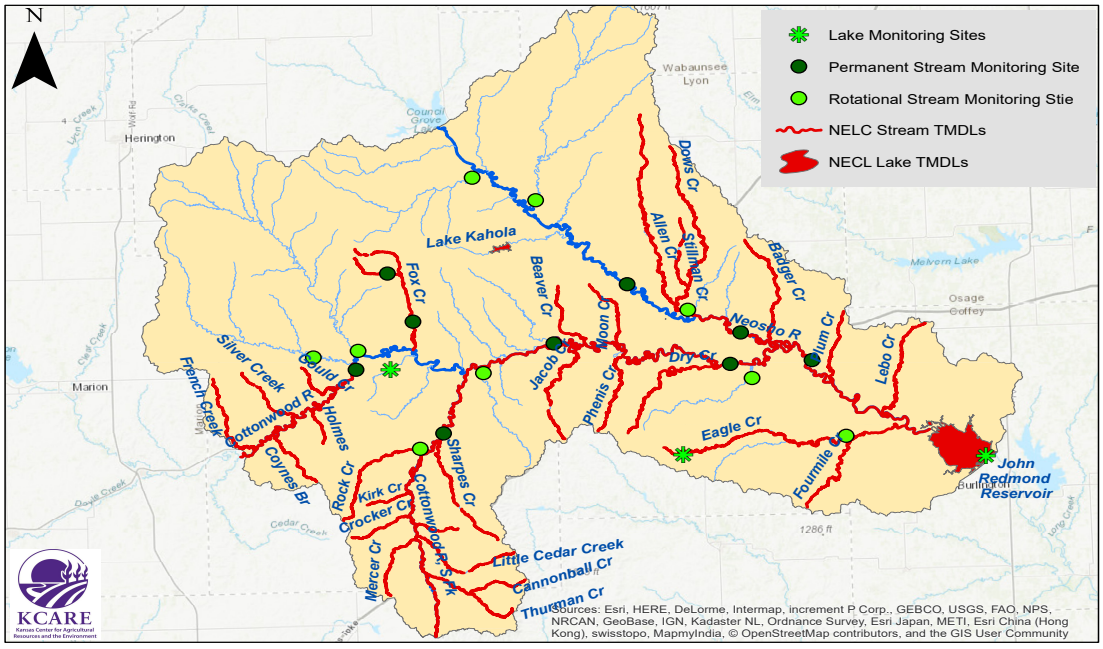


Figure 29. TMDL-Impaired Waters in the NELC Watershed

c. NELC targeted areas

The NELC SLT, with guidance from KDHE, will target the riparian corridors of 40 HUC 12s in the NELC watershed that drain into the John Redmond Reservoir:

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For the sake of simplification, these 40 targeted HUC 12s will be referred to as the "NELC riparian corridors" for the remainder of this plan. Focusing on these areas will have positive impacts on all TMDLs in the watershed.

The NELC SLT will focus BMP placement for nutrient and sediment runoff throughout the entire watershed as mentioned above and will *target riparian corridors* **(Figure 30),** *one-half mile on either side of the stream segment* in the following land use areas:

- Cropland areas will be targeted for **nutrients** (phosphorus and nitrogen) and **sediment**.
- Livestock areas will be targeted for **nutrients**.
- Streambanks will be targeted for **sediment** (with positive effects on nutrients).

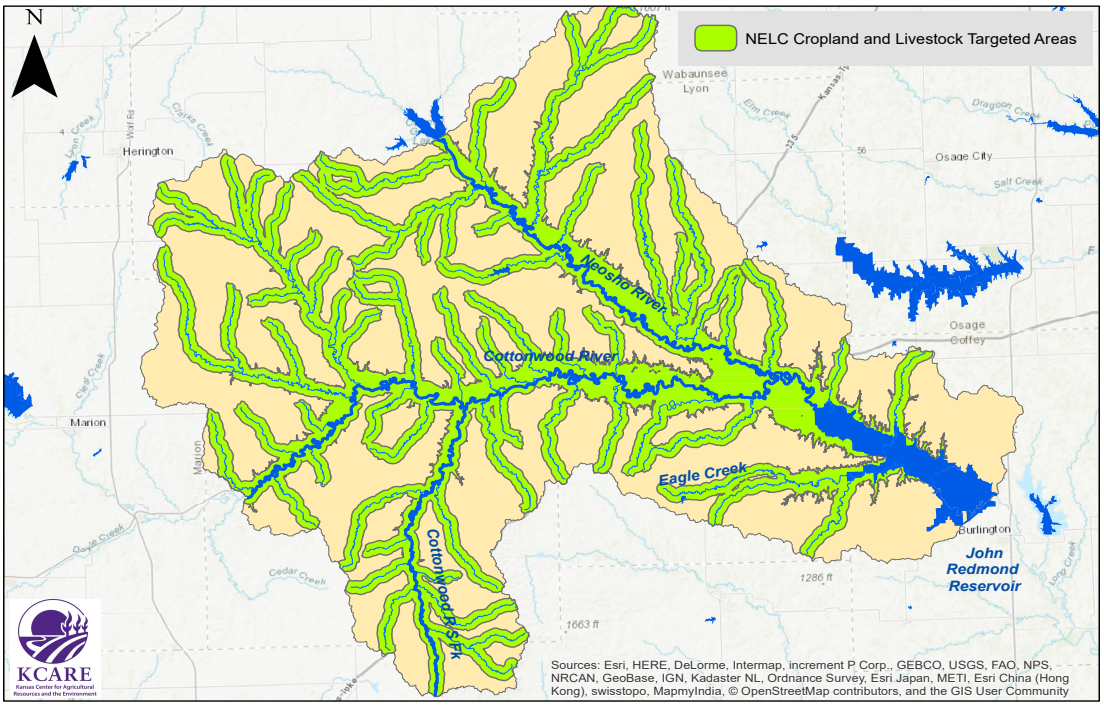


Figure 30. NELC Targeted Areas in the JRR Watershed

2. Targeting the Upper Cottonwood Watershed for BMP implementation

a. Upper Cottonwood monitoring sites

Water monitoring will be one tool utilized to analyze the effectiveness of targeted BMP implementation in the JRR Watershed. There are currently seven water monitoring sites in the Upper Cottonwood Watershed. This includes five active KDHE sites and two lake monitoring sites. There is one additional inactive site (**Figure 31**).

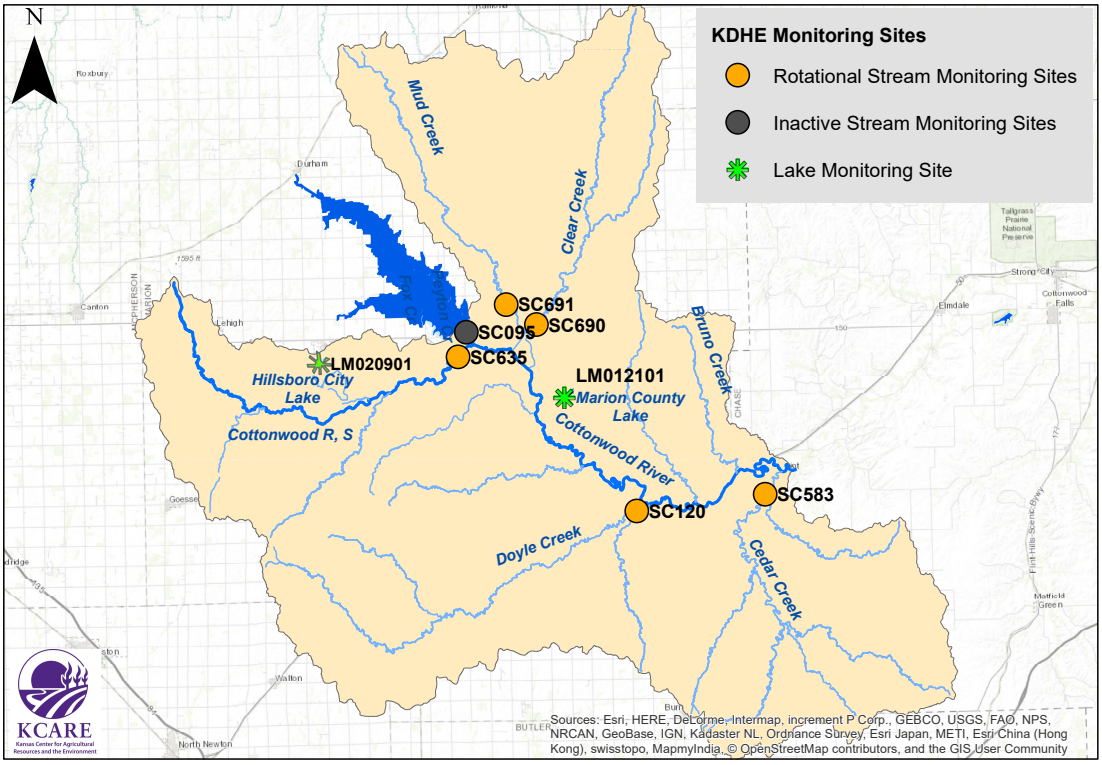


Figure 31. Upper Cottonwood Watershed Monitoring Sites

b. Upper Cottonwood impairments

There are seven impaired waters in the Upper Cottonwood Watershed, comprised of the following six impairments: atrazine, *E. coli*, eutrophication, dissolved oxygen, sulfate, and total phosphorus (**Tables 17** and **18**). As previously mentioned, this plan will function to improve all water quality in the JRR Watershed with the ultimate goal of improving, and eventually delisting, the eutrophication and siltation TMDLs in the John Redmond Reservoir. **Figures 32** and **33** show the locations of the impaired waters.

Table 17. 303d-Listed Waters in the Upper Cottonwood Watershed

303d List of Impaired Waters - Upper Cottonwood				
Water Segment	**Category**	**Impairment**	**Priority**	**Sampling Station**
Hillsboro City Lake	5	Eutrophication	2023	LM020901
Mud Creek near Marion	5	Atrazine	2023	SC691
South Cottonwood River near Canada	5	Atrazine	2023	SC635
		Total Phosphorus		

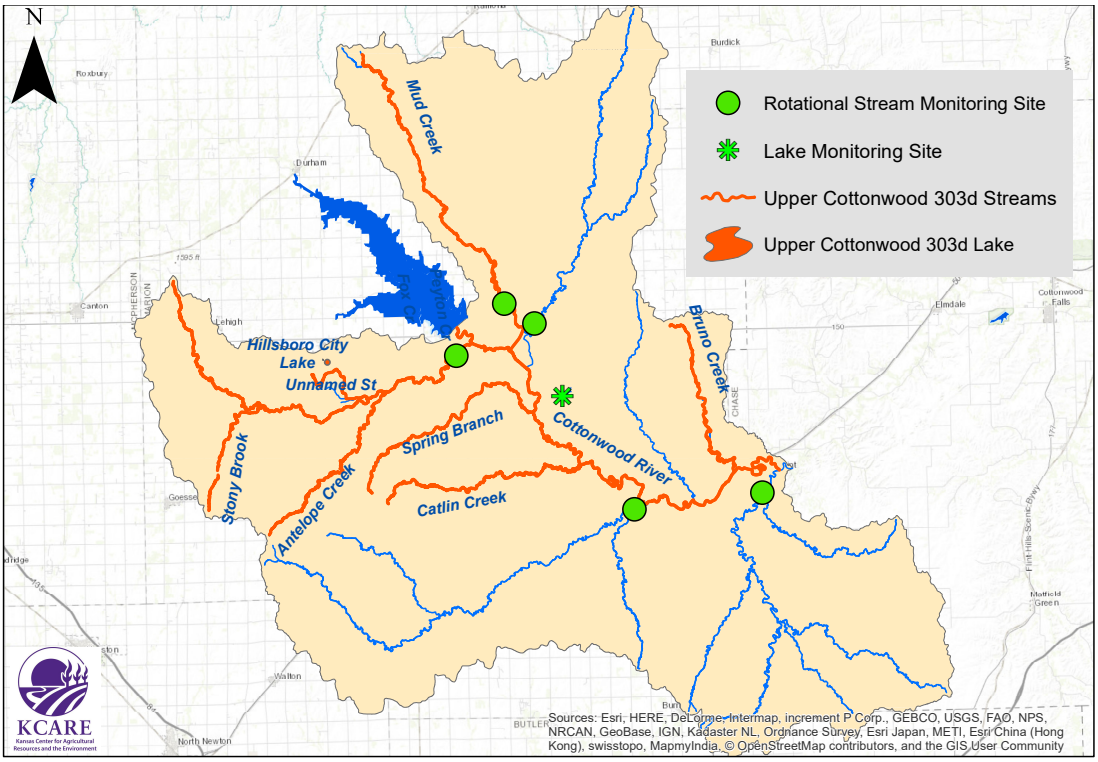


Figure 32. 303d-Listed Waters in the Upper Cottonwood Watershed

Table 18. TMDL-Listed Waters in the Upper Cottonwood Watershed

TMDLs in the Upper Cottonwood				
Water Segment	**Category**	**Impairment**	**Priority**	**Sampling Station**
Clear Creek near Marion	4a	Sulfate	Low	SC690
Doyle Creek near Florence	4a	Sulfate	Low	SC120
Marion County Lake	4a	Dissolved Oxygen	Medium	LM012101
	4a	Eutrophication	Medium	LM012101
Mud Creek near Marion	4a	*E. coli*	High	SC691

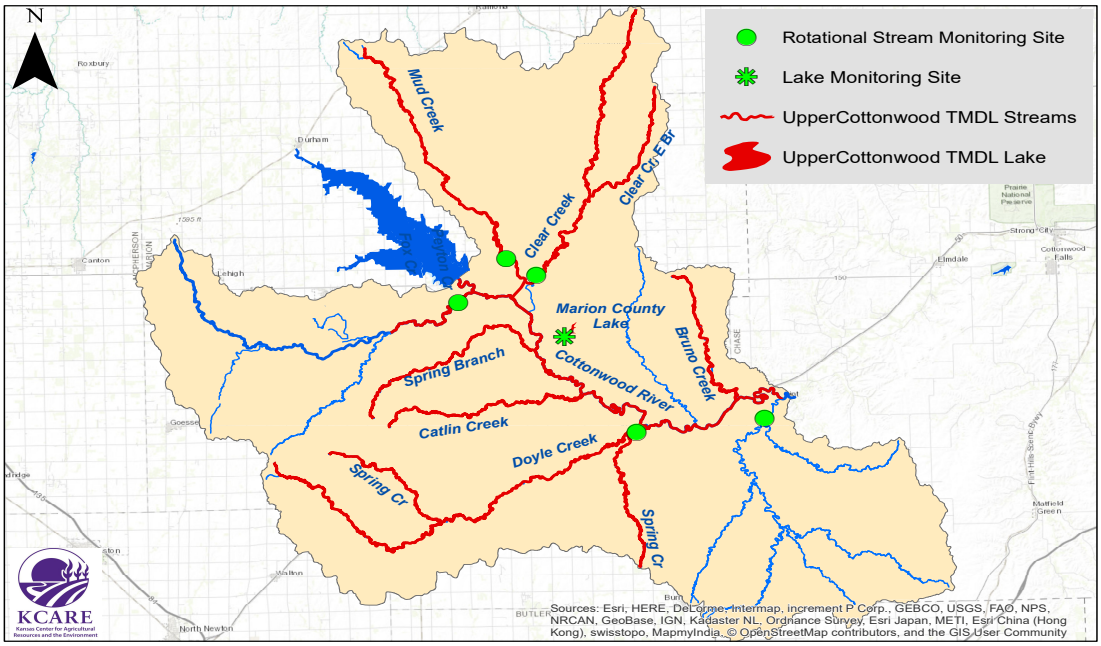


Figure 33. TMDL-Listed Waters in the Upper Cottonwood Watershed

c. Upper Cottonwood targeted areas

The Upper Cottonwood SLT, with guidance from KDHE, will continue to target the HUC 12s that they prioritized in the 2012 WRAPS plan. The Upper Cottonwood Watershed will target the following seven HUC 12s for BMP implementation:

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- 204
- 301

The SLT will focus BMP placement for sediment and nutrient runoff in the seven HUC 12s listed above and will implement BMPs in the following land use areas **(Figure 34):**

- Cropland areas will be targeted for **nutrients** (phosphorus and nitrogen) and **sediment**.
- Livestock areas will be targeted for **nutrients**.
- Streambanks will be targeted for **sediment** (with positive effects on nutrients).

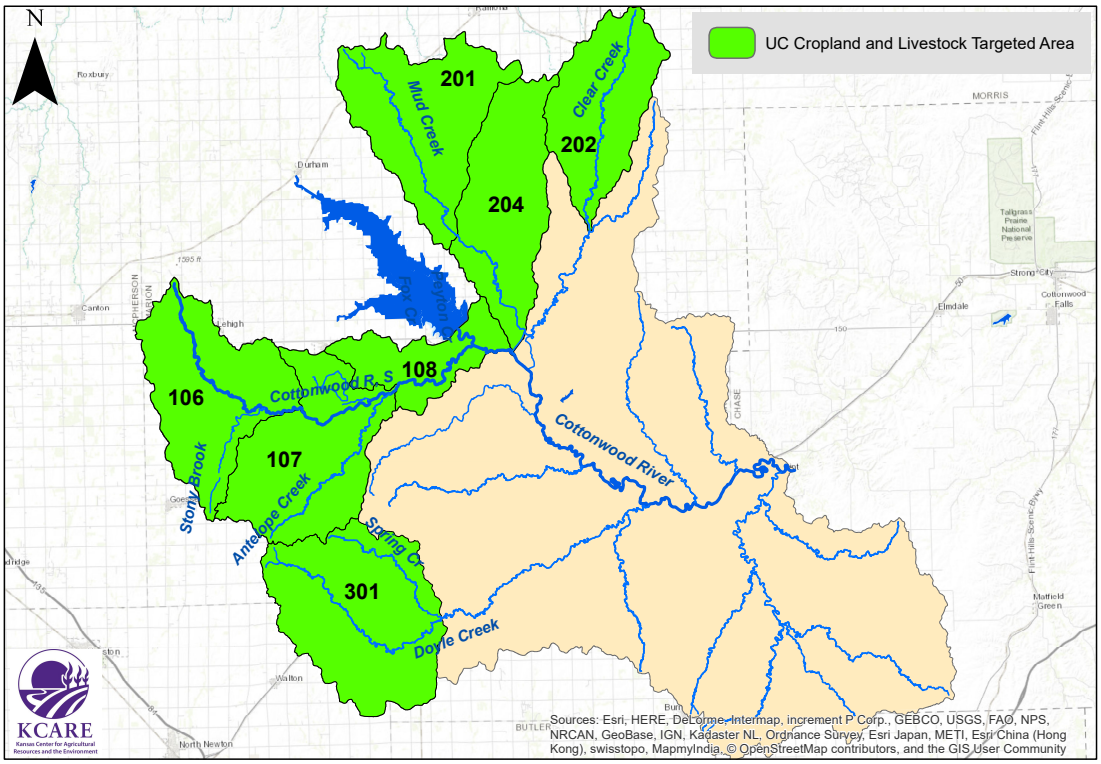


Figure 34. Upper Cottonwood Targeted Areas in the JRR Watershed

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.[21] 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[22] and these three publications: *Decreasing Phosphorus and Nitrogen Excretion by Dairy Cattle*[23], *Fertilizing Cropland with Beef Manure*[24], and *Estimating*

[21] https://www.bookstore.ksre.ksu.edu/pubs/MF2572.pdf
[22] https://www-mwps.sws.iastate.edu/catalog/manure-management/livestock-waste-facilities-handbook
[23] Sudduth, T.Q. and M.J. Loveless. *Decreasing Phosphorus and nitrogen Excretion by Dairy Cattle*. https://www.clemson.edu/extension/camm/manuals/dairy/dch3b_04.pdf
[24] Schmitt, Michael and George Rehm. *Fertilizing Cropland with Beef Manure*. 2002. University of

Manure Nutrient Excretion[25]. Livestock BMPs and load reduction efficiencies are derived from numerous sources, including Kansas State University Research and Extension Publication MF-2737[26] and MF-2454[27]. 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 JRR Watershed ranges from 8.0 to 17.1 cattle per 100 acres.

Minnesota Extension Bulletin.

[25] Koelsch, Rick. *Estimating Manure Nutrient Excretion.* 2007. University of Nebraska Extension Bulletin.

[26] MF-2737 Available at: https://www.bookstore.ksre.ksu.edu/pubs/MF2737.pdf

[27] MF-2454 Available at: https://www.bookstore.ksre.ksu.edu/pubs/MF2454.pdf

7. Implementation in the JRR Watershed

BMP implementation in the JRR Watershed will take place in the NELC and Upper Cottonwood areas of the watershed and will work to improve water quality in the John Redmond Reservoir by focusing on the reduction of nutrient and sediment pollutant loads.

The NELC and Upper Cottonwood Watersheds are managed by two different WRAPS coordinators and SLTs, therefore the next three sections of this plan will be separated by location and be organized as follows:

Section 7A: Implementation/BMP Adoption in the NELC
Section 7B: Implementation/BMP Adoption in the Upper Cottonwood
Section 7C: Meeting Load Reductions in the JRR Watershed (NELC and Upper Cottonwood)

Section 8A: Information and Education in the NELC
Section 8B: Information and Education in the Upper Cottonwood

Section 9A: Implementation Costs in the NELC
Section 9B: Implementation Costs in the Upper Cottonwood
Section 9C: Total Costs for Implementation in the JRR Watershed (NELC and Upper Cottonwood)

The NELC and Upper Cottonwood sections will merge in **Section 10:** Technical Assistance and Funding Sources.

7A. Implementation in the NELC

There is a total of 504,342 acres in the targeted area in the **NELC Watershed**. The largest land uses in the 40 nutrient- and sediment-targeted HUC 12s in the NELC portion of the JRR Watershed include: 98,658 cropland acres and 330,650 grassland/pasture/hay acres (**Table 19**).

Table 19. NELC Targeted Area Land Uses

Targeted Area Land Use in the NELC													
Land Use in: HUC 110702010...	Barren Land	Cropland	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Developed, Open Space	Forests	Grassland	Pasture/ Hay	Shrubland	Water	Wetlands	Total Acres
201	9	1,323	225	26	1	471	843	6,508	975	5	69	125	10,581
202	0	1,165	34	1	0	283	829	7,091	440	0	46	217	10,105
203	1	452	40	0	0	294	637	7,175	616	9	26	64	9,311
204	0	780	2	0	0	343	786	10,411	1,203	14	34	17	13,590
205	2	698	40	0	0	230	603	5,933	612	6	32	14	8,171
206	0	2,729	41	0	0	293	868	3,013	1,493	9	11	127	8,583
207	13	4,240	337	128	44	563	709	8,794	1,166	17	57	539	16,607
208	0	1,479	35	0	0	270	284	3,069	764	2	21	2	5,924
209	3	4,597	136	6	0	407	609	7,330	1,399	10	437	1,045	15,978
301	0	2,137	99	20	0	476	1,083	5,808	2,024	4	55	19	11,724
302	0	2,535	242	40	2	638	791	5,824	4,127	4	78	27	14,309
303	4	5,640	297	23	2	645	389	2,415	2,868	3	25	264	12,573
304	0	4,914	797	315	37	1,002	406	3,506	3,395	8	206	1,133	15,718
305	9	4,053	147	55	6	503	938	4,170	2,923	1	149	647	13,600
401	2	1,469	124	19	2	202	557	1,521	2,177	4	39	201	6,317
402	1	6,341	323	41	5	877	1,354	3,214	6,423	21	831	1,948	21,378
403	0	1,231	142	14	3	318	720	2,106	2,392	4	106	7	7,042
404	33	1,892	52	0	0	394	1,201	2,176	4,448	6	30	27	10,259
405	141	1,148	28	3	0	331	956	2,348	3,426	1	372	630	9,384
406	0	205	16	0	0	110	558	1,076	471	8	230	2,468	5,142
Land Use in: HUC 110702030...													
101	1	1,629	76	11	0	356	1,037	8,396	84	0	101	397	12,088
102	0	2,147	17	0	0	274	574	5,411	174	0	45	239	8,881
103	0	2,128	152	40	0	368	1,354	10,507	464	6	99	440	15,557
104	9	3,241	168	67	1	428	906	8,247	470	0	231	510	14,278
201	0	2,774	26	0	0	413	535	8,903	681	1	75	186	13,593
202	0	1,606	5	0	0	293	1,044	13,629	344	0	86	300	17,306
203	0	1,877	35	13	1	270	880	11,076	94	0	53	303	14,603
204	10	2,388	283	80	4	441	737	9,146	1,548	10	187	267	15,101
205	3	2,860	362	77	8	477	459	10,002	2,161	0	332	226	16,966
301	0	319	4	2	0	232	273	9,196	2,014	0	74	83	12,198
302	0	540	121	53	0	402	500	10,056	1,084	18	60	70	12,902
303	0	1,020	144	2	0	161	413	9,205	1,212	1	39	109	12,306
304	0	364	54	0	0	83	431	5,411	382	0	14	45	6,784
305	50	2,261	107	30	0	336	554	8,821	764	0	105	375	13,405
401	27	2,612	147	50	0	314	654	13,856	2,078	2	165	113	20,017
402	0	2,956	154	33	0	362	702	7,190	1,323	1	99	108	12,928
403	0	3,078	150	56	0	435	746	6,284	1,784	4	141	258	12,934
404	3	3,825	198	74	0	560	832	5,644	2,079	5	132	213	13,564
405	15	7,054	986	444	211	811	883	4,062	3,214	3	279	930	18,891
406	6	4,953	143	15	0	561	521	3,842	2,984	4	61	657	13,747
Total	**341**	**98,658**	**6,487**	**1,737**	**327**	**16,226**	**29,154**	**262,372**	**68,278**	**189**	**5,229**	**15,344**	**504,342**

Land use in targeted areas makes a difference in the amount of nutrients and sediment entering the water. Proximity to a water segment is a targeting factor, as the closer the land use area is to a water segment, the higher the priority. Riparian corridors are considered to be ½ mile on both sides of a water segment, and cropland in riparian corridor areas is highly susceptible to runoff and erosion during rainfall events. This results in nutrients leaching to sediment particles, thereby delivering both nutrients and sediment into nearby water segments. The majority of the NELC Watershed is considered to be livestock area (grassland and pasture/hay land); therefore, livestock areas in the riparian corridors have been added to the list of targeted areas. Targeting streambanks is a given when it comes to sediment loss and erosion because poorly structured streambanks can contribute excessive amounts of sediment with each heavy rainfall event.

BMP implementation in the NELC portion of the JRR Watershed will take place along riparian corridors in 40 HUC 12s throughout the watershed, referred to as the "NELC riparian corridors". Cropland and livestock areas along the NELC riparian corridors and streambanks along the Neosho and Cottonwood Rivers will be targeted for BMP implementation in an effort to improve the following TMDL impairments in the John Redmond Reservoir:

- **Eutrophication - nutrients (phosphorus and nitrogen): cropland and livestock areas**
- **Siltation: cropland and streambanks**

Water impairments throughout the NELC Watershed will be positively impacted by BMP implementation and subsequent nutrient and sediment load reductions.

A. Nutrient Load Reductions in the NELC

The JRR Watershed has a medium-priority TMDL ranking for eutrophication (phosphorus and nitrogen) in the John Redmond Reservoir. BMPs will be implemented in the NELC portion of the JRR Watershed to protect the local streams and, ultimately, the John Redmond Reservoir from excessive nutrient loading. *Any BMPs implemented in the targeted areas simultaneously will reduce both nutrient and sediment loading.*

The NELC riparian corridors will be targeted to reduce nutrients from entering water segments. This watershed contains three targeted areas for nutrient load reductions: **cropland, livestock,** and **streambank** areas. Adoption and implementation of nutrient BMPs will result in total nutrient load reductions of **126,877 pounds of phosphorus** and **374,689 pounds of nitrogen** at the conclusion of this 30-year WRAPS plan.

Cropland and livestock BMP implementation will take place along the riparian corridors throughout the NELC area of the JRR Watershed (**Figure 35**).

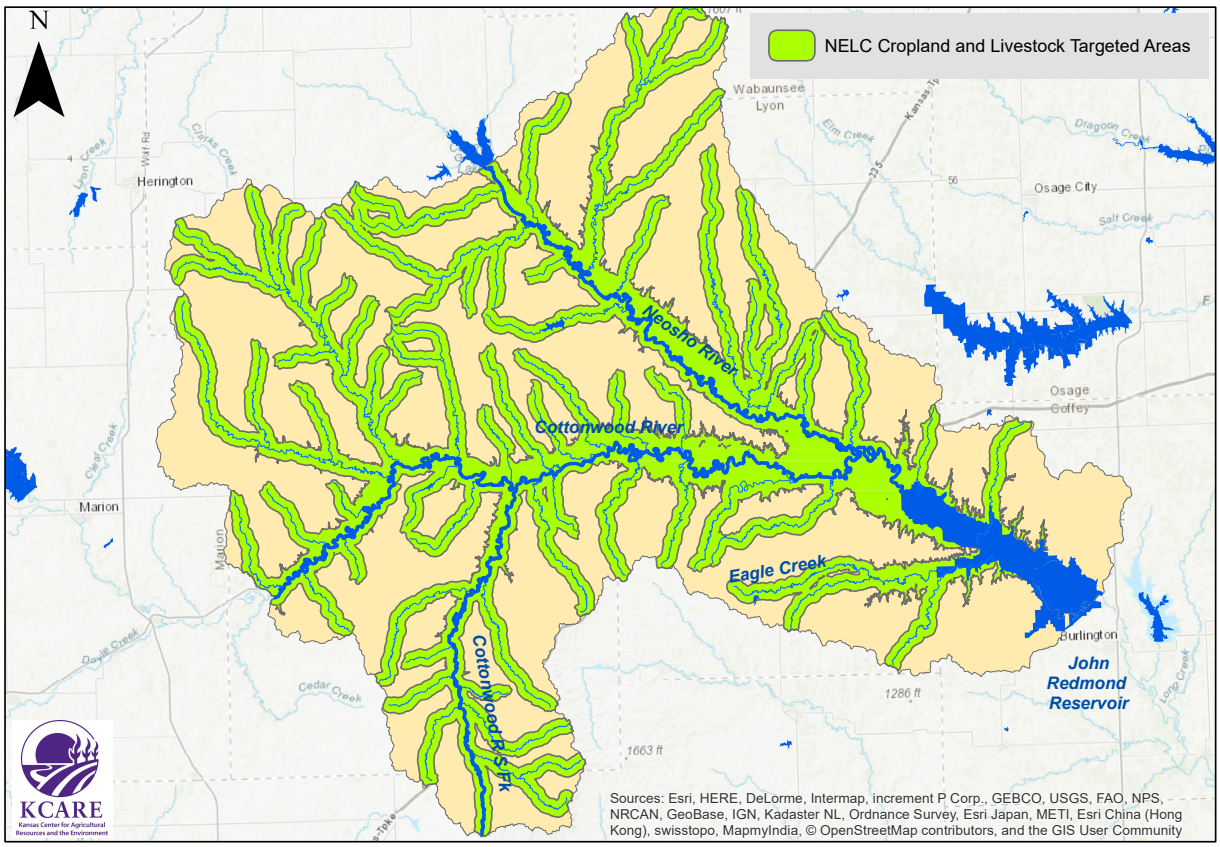


Figure 35. Targeted Areas for BMP Implementation in the NELC

Streambank BMP implementation, also referred to as streambank stabilization or restoration, will take place along the Cottonwood River. Sites will be chosen based on The Watershed Institute (TWI) study funded in 2009 by the Kansas Water Office, and implementation will take place once sites are approved by the SLT and KDHE.

1. Cropland targeted for nutrient reductions in the NELC

a. Cropland BMPs for nutrient reductions in the NELC

Within the 40 HUC 12 areas, the following BMPs will be implemented to reduce nutrient loading from crop fields:

- buffers,
- conservation crop rotation,
- no-till with cover crops,
- nutrient management plans,
- permanent vegetation,
- terraces, and
- waterways.

Table 20. Cropland BMPs Needed to Reduce Nutrient Loading

BMPs to Reduce Nutrient Loading in the NELC		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of nutrient contribution from **cropland**	Buffers	970 acres
	Conservation Crop Rotation	388 acres
	No-till with Cover Crops	1,358 acres
	Nutrient Management Plans	388 acres
	Permanent Vegetation	194 acres
	Terraces	388 acres
	Waterways	970 acres

Table 21. Adoption Rate of Cropland BMPs in the NELC

Annual Adoption (treated acres), Cropland BMPs								
Year	**Buffers**	**Conservation Crop Rotation**	**No-Till with Cover Crops**	**Nutrient Management Plans**	**Permanent Vegetation**	**Terraces**	**Waterways**	**Total Adoption**
1	970	388	1,358	388	194	388	970	4,656
2	970	388	1,358	388	194	388	970	4,656
3	970	388	1,358	388	194	388	970	4,656
4	970	388	1,358	388	194	388	970	4,656
5	970	388	1,358	388	194	388	970	4,656
6	970	388	1,358	388	194	388	970	4,656
7	970	388	1,358	388	194	388	970	4,656
8	970	388	1,358	388	194	388	970	4,656
9	970	388	1,358	388	194	388	970	4,656
10	970	388	1,358	388	194	388	970	4,656
11	970	388	1,358	388	194	388	970	4,656
12	970	388	1,358	388	194	388	970	4,656
13	970	388	1,358	388	194	388	970	4,656
14	970	388	1,358	388	194	388	970	4,656
15	970	388	1,358	388	194	388	970	4,656
16	970	388	1,358	388	194	388	970	4,656
17	970	388	1,358	388	194	388	970	4,656
18	970	388	1,358	388	194	388	970	4,656
19	970	388	1,358	388	194	388	970	4,656
20	970	388	1,358	388	194	388	970	4,656
21	970	388	1,358	388	194	388	970	4,656
22	970	388	1,358	388	194	388	970	4,656
23	970	388	1,358	388	194	388	970	4,656
24	970	388	1,358	388	194	388	970	4,656
25	970	388	1,358	388	194	388	970	4,656
26	970	388	1,358	388	194	388	970	4,656
27	970	388	1,358	388	194	388	970	4,656
28	970	388	1,358	388	194	388	970	4,656
29	970	388	1,358	388	194	388	970	4,656
30	970	388	1,358	388	194	388	970	4,656
Total	**29,101**	**11,640**	**40,741**	**11,640**	**5,820**	**11,640**	**29,101**	**139,685**

b. Nutrient load reductions from cropland BMP implementation

The implementation of cropland BMPs on 4,656 acres per year in the riparian areas of the 40 targeted HUC 12s will result in a phosphorus reduction of 43,377 pounds and a nitrogen load reduction of 241,744 pounds at the end of this 30-year WRAPS plan (**Tables 22** and **23**).

Table 22. Phosphorus Reductions from Cropland BMP Implementation

Annual Phosphorus Reduction (lbs), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	343	69	480	69	130	82	274	1,446
2	685	137	959	137	260	164	548	2,892
3	1,028	206	1,439	206	391	247	822	4,338
4	1,371	274	1,919	274	521	329	1,096	5,784
5	1,713	343	2,398	343	651	411	1,371	7,230
6	2,056	411	2,878	411	781	493	1,645	8,675
7	2,398	480	3,358	480	911	576	1,919	10,121
8	2,741	548	3,838	548	1,042	658	2,193	11,567
9	3,084	617	4,317	617	1,172	740	2,467	13,013
10	3,426	685	4,797	685	1,302	822	2,741	14,459
11	3,769	754	5,277	754	1,432	905	3,015	15,905
12	4,112	822	5,756	822	1,562	987	3,289	17,351
13	4,454	891	6,236	891	1,693	1,069	3,563	18,797
14	4,797	959	6,716	959	1,823	1,151	3,838	20,243
15	5,140	1,028	7,195	1,028	1,953	1,233	4,112	21,689
16	5,482	1,096	7,675	1,096	2,083	1,316	4,386	23,135
17	5,825	1,165	8,155	1,165	2,213	1,398	4,660	24,581
18	6,167	1,233	8,634	1,233	2,344	1,480	4,934	26,026
19	6,510	1,302	9,114	1,302	2,474	1,562	5,208	27,472
20	6,853	1,371	9,594	1,371	2,604	1,645	5,482	28,918
21	7,195	1,439	10,073	1,439	2,734	1,727	5,756	30,364
22	7,538	1,508	10,553	1,508	2,864	1,809	6,030	31,810
23	7,881	1,576	11,033	1,576	2,995	1,891	6,304	33,256
24	8,223	1,645	11,513	1,645	3,125	1,974	6,579	34,702
25	8,566	1,713	11,992	1,713	3,255	2,056	6,853	36,148
26	8,908	1,782	12,472	1,782	3,385	2,138	7,127	37,594
27	9,251	1,850	12,952	1,850	3,515	2,220	7,401	39,040
28	9,594	1,919	13,431	1,919	3,646	2,303	7,675	40,486
29	9,936	1,987	13,911	1,987	3,776	2,385	7,949	41,932
30	10,279	2,056	14,391	2,056	3,906	2,467	8,223	43,377

Table 23. Nitrogen Load Reductions from Cropland BMP Implementation

Annual Nitrogen Reduction (lbs), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	2,286	457	1,624	446	869	549	1,829	8,058
2	4,571	914	3,248	891	1,737	1,097	3,657	16,116
3	6,857	1,371	4,872	1,337	2,606	1,646	5,486	24,174
4	9,143	1,829	6,496	1,783	3,474	2,194	7,314	32,232
5	11,428	2,286	8,120	2,229	4,343	2,743	9,143	40,291
6	13,714	2,743	9,744	2,674	5,211	3,291	10,971	48,349
7	16,000	3,200	11,368	3,120	6,080	3,840	12,800	56,407
8	18,285	3,657	12,992	3,566	6,948	4,388	14,628	64,465
9	20,571	4,114	14,616	4,011	7,817	4,937	16,457	72,523
10	22,857	4,571	16,240	4,457	8,686	5,486	18,285	80,581
11	25,142	5,028	17,863	4,903	9,554	6,034	20,114	88,639
12	27,428	5,486	19,487	5,349	10,423	6,583	21,942	96,697
13	29,714	5,943	21,111	5,794	11,291	7,131	23,771	104,756
14	31,999	6,400	22,735	6,240	12,160	7,680	25,600	112,814
15	34,285	6,857	24,359	6,686	13,028	8,228	27,428	120,872
16	36,571	7,314	25,983	7,131	13,897	8,777	29,257	128,930
17	38,856	7,771	27,607	7,577	14,765	9,326	31,085	136,988
18	41,142	8,228	29,231	8,023	15,634	9,874	32,914	145,046
19	43,428	8,686	30,855	8,469	16,503	10,423	34,742	153,104
20	45,713	9,143	32,479	8,914	17,371	10,971	36,571	161,162
21	47,999	9,600	34,103	9,360	18,240	11,520	38,399	169,221
22	50,285	10,057	35,727	9,806	19,108	12,068	40,228	177,279
23	52,570	10,514	37,351	10,251	19,977	12,617	42,056	185,337
24	54,856	10,971	38,975	10,697	20,845	13,165	43,885	193,395
25	57,142	11,428	40,599	11,143	21,714	13,714	45,713	201,453
26	59,427	11,885	42,223	11,589	22,582	14,263	47,542	209,511
27	61,713	12,343	43,847	12,034	23,451	14,811	49,370	217,569
28	63,999	12,800	45,471	12,480	24,320	15,360	51,199	225,627
29	66,284	13,257	47,095	12,926	25,188	15,908	53,028	233,686
30	68,570	13,714	48,719	13,371	26,057	16,457	54,856	241,744

2. Livestock areas targeted for nutrient reduction in the NELC

a. Livestock area BMPs for nutrient reductions in the NELC

Within the targeted 40 HUC 12 areas, the following BMPs will be implemented to reduce nutrient loading from livestock areas:

- fenced-off streams,
- filter strips,
- off-stream watering systems,
- pasture feeding site relocations, and
- rotational grazing.

Table 24. Nutrient BMP Adoption Rates in Livestock Areas

BMPs to Reduce Nutrient Loading in the NELC		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of nutrient contribution from **livestock**	Fence off Streams	1 project every year
	Filter Strips	5 projects every 2 years
	Off-stream Watering	2 projects per year
	Relocate Pasture Feeding Sites	2 projects per year
	Rotational Grazing	3 projects every 2 years

Table 25. Adoption Rates of Livestock BMPs to Address Nutrients

Annual Livestock BMP Adoption						
Year	**Fence Off Streams**	**Filter Strip**	**Off-stream Watering System**	**Relocate Pasture Feeding Site**	**Rotational Grazing**	**Projects Per Year**
1	1	2	2	2	1	8
2	1	3	2	2	2	10
3	1	2	2	2	1	8
4	1	3	2	2	2	10
5	1	2	2	2	1	8
6	1	3	2	2	2	10
7	1	2	2	2	1	8
8	1	3	2	2	2	10
9	1	2	2	2	1	8
10	1	3	2	2	2	10
11	1	2	2	2	1	8
12	1	3	2	2	2	10
13	1	2	2	2	1	8
14	1	3	2	2	2	10
15	1	2	2	2	1	8
16	1	3	2	2	2	10
17	1	2	2	2	1	8
18	1	3	2	2	2	10
19	1	2	2	2	1	8
20	1	3	2	2	2	10
21	1	2	2	2	1	8
22	1	3	2	2	2	10
23	1	2	2	2	1	8
24	1	3	2	2	2	10
25	1	2	2	2	1	8
26	1	3	2	2	2	10
27	1	2	2	2	1	8
28	1	3	2	2	2	10
29	1	2	2	2	1	8
30	1	3	2	2	2	10
Total	**30**	**75**	**60**	**60**	**45**	270

b. Nutrient load reductions from livestock BMP implementation

The implementation of 18 livestock BMP projects every two years in the 40 targeted HUC 12s will result in a phosphorus load reduction of 70,584 pounds and a nitrogen load reduction of 132,946 pounds at the end of this 30-year WRAPS plan (**Tables 26** and **27**).

Table 26. Phosphorus Reductions from Livestock BMP Implementation

Annual Phosphorus Load Reductions (lbs), Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Annual Load Reduction
1	59	1,777	50	41	7	1,934
2	59	4,442	100	83	22	4,706
3	118	6,218	151	124	30	6,640
4	118	8,883	201	165	44	9,411
5	177	10,660	251	207	52	11,346
6	177	13,325	301	248	66	14,117
7	236	15,101	351	289	74	16,051
8	236	17,766	401	331	89	18,823
9	295	19,543	452	372	96	20,757
10	295	22,208	502	413	111	23,528
11	354	23,984	552	454	118	25,463
12	354	26,649	602	496	133	28,234
13	413	28,426	652	537	140	30,168
14	413	31,091	702	578	155	32,939
15	472	32,867	753	620	162	34,874
16	472	35,532	803	661	177	37,645
17	531	37,309	853	702	184	39,579
18	531	39,974	903	744	199	42,351
19	590	41,750	953	785	207	44,285
20	590	44,415	1,003	826	221	47,056
21	649	46,192	1,054	868	229	48,991
22	649	48,857	1,104	909	243	51,762
23	708	50,633	1,154	950	251	53,696
24	708	53,298	1,204	992	266	56,468
25	767	55,075	1,254	1,033	273	58,402
26	767	57,740	1,304	1,074	288	61,173
27	826	59,516	1,355	1,116	295	63,108
28	826	62,181	1,405	1,157	310	65,879
29	885	63,958	1,455	1,198	317	67,813
30	885	66,623	1,505	1,239	332	70,584

Table 27. Nitrogen Load Reductions from Livestock BMPs

Annual Nitrogen Load Reductions (lbs), Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Annual Load Reduction
1	111	3,346	94	78	14	3,644
2	111	8,366	189	156	42	8,863
3	222	11,712	283	233	56	12,507
4	222	16,731	378	311	83	17,726
5	334	20,077	472	389	97	21,370
6	334	25,097	567	467	125	26,589
7	445	28,443	661	545	139	30,233
8	445	33,462	756	623	167	35,452
9	556	36,808	850	700	181	39,096
10	556	41,828	945	778	208	44,315
11	667	45,174	1,039	856	222	47,959
12	667	50,193	1,134	934	250	53,178
13	778	53,540	1,228	1,012	264	56,822
14	778	58,559	1,323	1,089	292	62,041
15	889	61,905	1,417	1,167	306	65,685
16	889	66,925	1,512	1,245	334	70,904
17	1,001	70,271	1,606	1,323	347	74,548
18	1,001	75,290	1,701	1,401	375	79,767
19	1,112	78,636	1,795	1,479	389	83,411
20	1,112	83,656	1,890	1,556	417	88,630
21	1,223	87,002	1,984	1,634	431	92,274
22	1,223	92,021	2,079	1,712	459	97,494
23	1,334	95,367	2,173	1,790	472	101,137
24	1,334	100,387	2,268	1,868	500	106,357
25	1,445	103,733	2,362	1,945	514	110,000
26	1,445	108,752	2,457	2,023	542	115,220
27	1,556	112,099	2,551	2,101	556	118,863
28	1,556	117,118	2,646	2,179	584	124,083
29	1,668	120,464	2,740	2,257	598	127,726
30	1,668	125,483	2,835	2,335	625	132,946

3. Streambank areas targeted for nutrient reduction in the NELC

a. Streambank stabilization for nutrient reductions in the NELC

Streambank stabilization projects will take place along the Cottonwood and Neosho Rivers in an effort to reduce sediment loss. Because nutrients are carried away as they leach to soil particles, nutrient loading will be reduced as well.

Sites will be chosen based on the TWI study from 2009. The project will stabilize 3,234 feet of streambank annually for the duration of this 30-year WRAPS plan, for a total of 97,020 linear feet of streambank protected from soil erosion and soil loss.

b. Nutrient load reductions from streambank BMP implementation

The implementation of 3,234 linear feet of streambank stabilization each project year along the Cottonwood and/or Neosho Rivers will result in a phosphorus load reduction of 12,916 pounds at the end of this 30-year WRAPS plan.

Table 28. Phosphorus Load Reduction from Streambank Stabilization

Annual Phosphorus Load Reductions (lbs), Streambank Stabilization			
Year	Streambank Stabilization (feet)	Phosphorus Reduction (lbs)	Cumulative P Load Reduction (lbs)
1	3,234	431	431
2	3,234	431	861
3	3,234	431	1,292
4	3,234	431	1,722
5	3,234	431	2,153
6	3,234	431	2,583
7	3,234	431	3,014
8	3,234	431	3,444
9	3,234	431	3,875
10	3,234	431	4,305
11	3,234	431	4,736
12	3,234	431	5,166
13	3,234	431	5,597
14	3,234	431	6,027
15	3,234	431	6,458
16	3,234	431	6,888
17	3,234	431	7,319
18	3,234	431	7,749
19	3,234	431	8,180
20	3,234	431	8,610
21	3,234	431	9,041
22	3,234	431	9,471
23	3,234	431	9,902
24	3,234	431	10,333
25	3,234	431	10,763
26	3,234	431	11,194
27	3,234	431	11,624
28	3,234	431	12,055
29	3,234	431	12,485
30	3,234	431	12,916

4. Meeting the eutrophication/nutrient TMDL in the NELC

a. Phosphorus load reduction in the NELC

Adoption and implementation of cropland, livestock and streambank BMPs in the NELC will result in a total phosphorus load reduction of 126,877 pounds at the conclusion of this 30-year WRAPS plan.

Table 29. Cumulative Phosphorus Reductions from BMP Implementation

Phosphorus Load Reduction from Cropland, Livestock, and Streambank BMPs					
Year	Cropland Load Reduction (lbs/yr)	Livestock Load Reduction (lbs/yr)	Streambank Load Reduction (lbs/yr)	Total Load Reduction (lbs/yr)	% of TMDL
1	1,446	1,934	431	3,811	1%
2	2,892	4,706	861	8,458	3%
3	4,338	6,640	1,292	12,269	4%
4	5,784	9,411	1,722	16,917	6%
5	7,230	11,346	2,153	20,728	7%
6	8,675	14,117	2,583	25,375	9%
7	10,121	16,051	3,014	29,186	10%
8	11,567	18,823	3,444	33,834	12%
9	13,013	20,757	3,875	37,645	13%
10	14,459	23,528	4,305	42,292	15%
11	15,905	25,463	4,736	46,103	16%
12	17,351	28,234	5,166	50,751	18%
13	18,797	30,168	5,597	54,562	19%
14	20,243	32,939	6,027	59,209	21%
15	21,689	34,874	6,458	63,020	22%
16	23,135	37,645	6,888	67,668	24%
17	24,581	39,579	7,319	71,479	25%
18	26,026	42,351	7,749	76,126	27%
19	27,472	44,285	8,180	79,937	28%
20	28,918	47,056	8,610	84,585	30%
21	30,364	48,991	9,041	88,396	31%
22	31,810	51,762	9,471	93,043	32%
23	33,256	53,696	9,902	96,854	34%
24	34,702	56,468	10,333	101,502	35%
25	36,148	58,402	10,763	105,313	37%
26	37,594	61,173	11,194	109,960	38%
27	39,040	63,108	11,624	113,771	40%
28	40,486	65,879	12,055	118,419	41%
29	41,932	67,813	12,485	122,230	43%
30	43,377	70,584	12,916	126,877	44%
JRR Phosphorus TMDL Goal: 286,408 Pounds per Year					

The NELC portion of the BMPs implemented in the JRR Watershed will result in a reduction of 126,877 pounds of phosphorus (**Table 29**).

The John Redmond Reservoir phosphorus load reduction goal required to meet the eutrophication TMDL in the reservoir is 286,408 pounds of phosphorus; therefore, the NELC is doing its part in meeting this goal by reaching 44% of the TMDL.

b. Nitrogen load reduction in the NELC

While there is no nitrogen load reduction goal required for the eutrophication TMDL, adoption and implementation of nutrient BMPs in cropland and livestock areas will result in a total nitrogen load reduction of 374,689 pounds at the conclusion of this 30-year WRAPS plan.

Table 30. Cumulative Nitrogen Reductions from BMP Implementation

Nitrogen Load Reduction from Cropland and Livestock BMPs			
Year	Cropland Load Reduction (lbs/yr)	Livestock Load Reduction (lbs/yr)	Total Load Reduction (lbs/yr)
1	8,058	3,644	11,702
2	16,116	8,863	24,979
3	24,174	12,507	36,681
4	32,232	17,726	49,959
5	40,291	21,370	61,660
6	48,349	26,589	74,938
7	56,407	30,233	86,640
8	64,465	35,452	99,917
9	72,523	39,096	111,619
10	80,581	44,315	124,896
11	88,639	47,959	136,598
12	96,697	53,178	149,876
13	104,756	56,822	161,577
14	112,814	62,041	174,855
15	120,872	65,685	186,557
16	128,930	70,904	199,834
17	136,988	74,548	211,536
18	145,046	79,767	224,814
19	153,104	83,411	236,515
20	161,162	88,630	249,793
21	169,221	92,274	261,495
22	177,279	97,494	274,772
23	185,337	101,137	286,474
24	193,395	106,357	299,752
25	201,453	110,000	311,453
26	209,511	115,220	324,731
27	217,569	118,863	336,433
28	225,627	124,083	349,710
29	233,686	127,726	361,412
30	241,744	132,946	374,689
There are no nitrogen TMDL load reduction goals for JRR.			

B. Sediment Load Reductions in the NELC

The JRR Watershed has a medium TMDL ranking for siltation, also referred to as sediment, in the John Redmond Reservoir. Sediment BMPs will be implemented in the NELC portion of the JRR Watershed to protect the local streams, and, ultimately, the John Redmond Reservoir from excessive sediment loss. *Any BMPs implemented in the targeted areas simultaneously will reduce both sediment and nutrient loading.*

The NELC contains two targeted land areas for sediment load reductions: **cropland and streambank areas**. Adoption and implementation of sediment BMPs will result in a total of **240,899 tons** of sediment saved at the conclusion of this 30-year WRAPS plan.

Cropland BMP implementation will take place along the riparian corridors throughout the NELC area of the JRR Watershed (**Figure 36**).

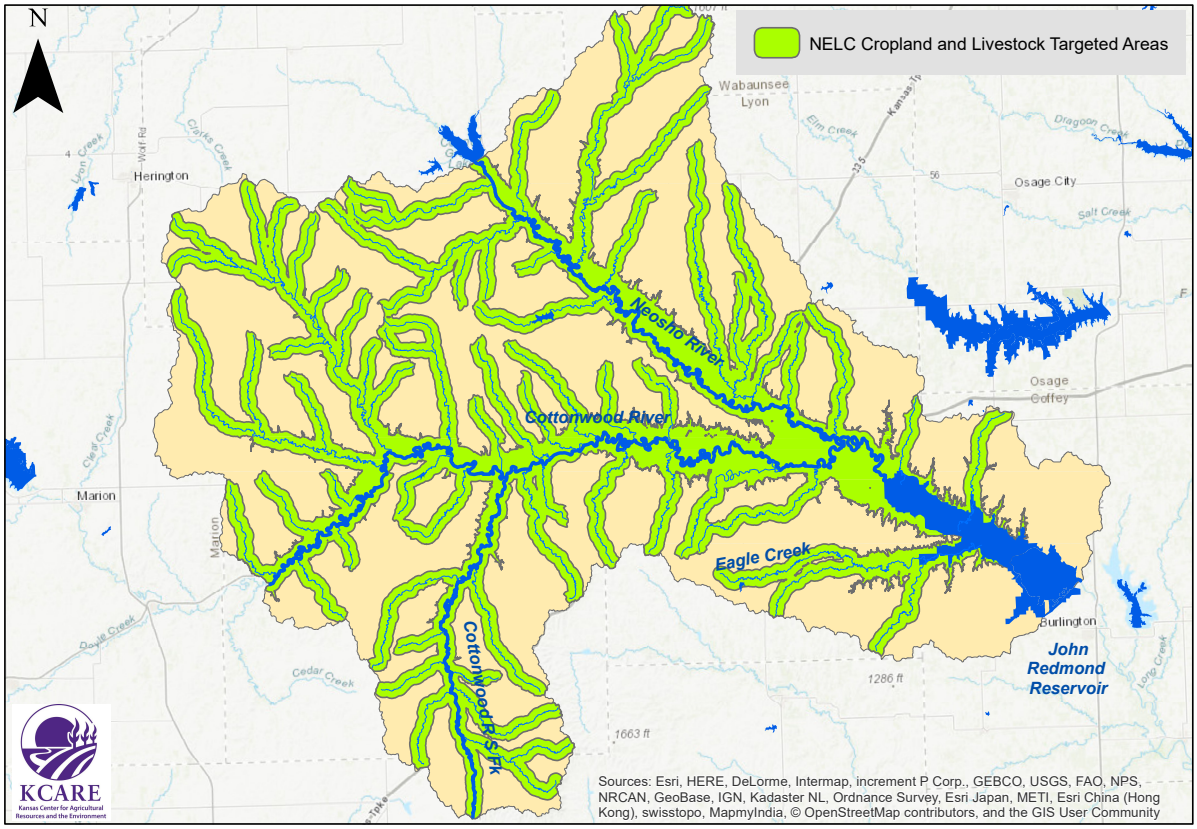


Figure 36. Targeted Areas for BMP Implementation in the NELC

Streambank BMP implementation, also referred to as stabilization or restoration, will take place along the Cottonwood and Neosho Rivers. Sites will be chosen based on a 2009 study from The Watershed Institute (TWI) and funded by the Kansas Water Office. Implementation will take place once the site is approved by the SLT and KDHE.

1. Cropland targeted for sediment load reductions in the NELC

a. Cropland BMPs for sediment load reductions in the NELC

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

- buffers,
- conservation crop rotation,
- no-till with cover crops,
- nutrient management plans,
- permanent vegetation,
- terraces, and
- waterways.

Table 30. Cropland BMPs Needed to Reduce Sediment Load

BMPs to Reduce Sediment Loading in the NELC		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of sediment loss from **cropland**	Buffers	970 acres
	Conservation Crop Rotation	388 acres
	No-till with Cover Crops	1,358 acres
	Nutrient Management Plans	388 acres
	Permanent Vegetation	194 acres
	Terraces	388 acres
	Waterways	970 acres

Table 31. Adoption Rate of Cropland BMPs in the NELC

Annual Adoption (treated acres), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Adoption
1	970	388	1,358	388	194	388	970	4,656
2	970	388	1,358	388	194	388	970	4,656
3	970	388	1,358	388	194	388	970	4,656
4	970	388	1,358	388	194	388	970	4,656
5	970	388	1,358	388	194	388	970	4,656
6	970	388	1,358	388	194	388	970	4,656
7	970	388	1,358	388	194	388	970	4,656
8	970	388	1,358	388	194	388	970	4,656
9	970	388	1,358	388	194	388	970	4,656
10	970	388	1,358	388	194	388	970	4,656
11	970	388	1,358	388	194	388	970	4,656
12	970	388	1,358	388	194	388	970	4,656
13	970	388	1,358	388	194	388	970	4,656
14	970	388	1,358	388	194	388	970	4,656
15	970	388	1,358	388	194	388	970	4,656
16	970	388	1,358	388	194	388	970	4,656
17	970	388	1,358	388	194	388	970	4,656
18	970	388	1,358	388	194	388	970	4,656
19	970	388	1,358	388	194	388	970	4,656
20	970	388	1,358	388	194	388	970	4,656
21	970	388	1,358	388	194	388	970	4,656
22	970	388	1,358	388	194	388	970	4,656
23	970	388	1,358	388	194	388	970	4,656
24	970	388	1,358	388	194	388	970	4,656
25	970	388	1,358	388	194	388	970	4,656
26	970	388	1,358	388	194	388	970	4,656
27	970	388	1,358	388	194	388	970	4,656
28	970	388	1,358	388	194	388	970	4,656
29	970	388	1,358	388	194	388	970	4,656
30	970	388	1,358	388	194	388	970	4,656
Total	**29,101**	**11,640**	**40,741**	**11,640**	**5,820**	**11,640**	**29,101**	**139,685**

b. Sediment load reductions from cropland BMP implementation

The implementation of cropland BMPs on 4,656 acres per year in the riparian corridors of the 40 HUC 12s will result in a sediment load reduction of 25,628 tons at the end of this 30-year WRAPS plan (**Table 32**).

Table 32. Sediment Reductions from Cropland BMP Implementation

Annual Soil Erosion Reduction (tons), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	228	46	256	0	87	55	183	854
2	457	91	512	0	174	110	365	1,709
3	685	137	767	0	260	164	548	2,563
4	914	183	1,023	0	347	219	731	3,417
5	1,142	228	1,279	0	434	274	914	4,271
6	1,370	274	1,535	0	521	329	1,096	5,126
7	1,599	320	1,791	0	608	384	1,279	5,980
8	1,827	365	2,047	0	694	439	1,462	6,834
9	2,056	411	2,302	0	781	493	1,645	7,688
10	2,284	457	2,558	0	868	548	1,827	8,543
11	2,513	503	2,814	0	955	603	2,010	9,397
12	2,741	548	3,070	0	1,042	658	2,193	10,251
13	2,969	594	3,326	0	1,128	713	2,375	11,105
14	3,198	640	3,581	0	1,215	767	2,558	11,960
15	3,426	685	3,837	0	1,302	822	2,741	12,814
16	3,655	731	4,093	0	1,389	877	2,924	13,668
17	3,883	777	4,349	0	1,476	932	3,106	14,522
18	4,111	822	4,605	0	1,562	987	3,289	15,377
19	4,340	868	4,861	0	1,649	1,042	3,472	16,231
20	4,568	914	5,116	0	1,736	1,096	3,655	17,085
21	4,797	959	5,372	0	1,823	1,151	3,837	17,939
22	5,025	1,005	5,628	0	1,910	1,206	4,020	18,794
23	5,253	1,051	5,884	0	1,996	1,261	4,203	19,648
24	5,482	1,096	6,140	0	2,083	1,316	4,385	20,502
25	5,710	1,142	6,396	0	2,170	1,370	4,568	21,356
26	5,939	1,188	6,651	0	2,257	1,425	4,751	22,211
27	6,167	1,233	6,907	0	2,344	1,480	4,934	23,065
28	6,396	1,279	7,163	0	2,430	1,535	5,116	23,919
29	6,624	1,325	7,419	0	2,517	1,590	5,299	24,774
30	6,852	1,370	7,675	0	2,604	1,645	5,482	25,628

2. Streambank areas targeted for sediment load reduction in the NELC

a. Streambank stabilization for sediment load reductions in the NELC

Streambank stabilization projects will take place along the Cottonwood and Neosho Rivers. Sites will be chosen based on data from the 2009 TWI study.

In each year of this 30-year plan, 3,234 feet of streambank will be stabilized for a total of 97,020 linear feet of streambank protected from soil erosion and soil loss. Nutrient loss will be reduced as well, because nutrients are carried away as they leach to soil particles.

b. Sediment load reductions from streambank BMP implementation

The implementation of 3,234 linear feet of streambank stabilization each project year along the Cottonwood River will result in a sediment load reduction of 215,261 tons at the end of this 30-year WRAPS plan.

Table 33. Sediment Load Reduction from Streambank Stabilization

Annual Sediment Load Reduction (tons), Streambank Stabilization			
Year	Streambank Stabilization (feet)	Soil Load Reduction (tons)	Cumulative Erosion Reduction (tons)
1	3,234	7,175	7,175
2	3,234	7,175	14,351
3	3,234	7,175	21,526
4	3,234	7,175	28,701
5	3,234	7,175	35,877
6	3,234	7,175	43,052
7	3,234	7,175	50,227
8	3,234	7,175	57,403
9	3,234	7,175	64,578
10	3,234	7,175	71,754
11	3,234	7,175	78,929
12	3,234	7,175	86,104
13	3,234	7,175	93,280
14	3,234	7,175	100,455
15	3,234	7,175	107,630
16	3,234	7,175	114,806
17	3,234	7,175	121,981
18	3,234	7,175	129,156
19	3,234	7,175	136,332
20	3,234	7,175	143,507
21	3,234	7,175	150,682
22	3,234	7,175	157,858
23	3,234	7,175	165,033
24	3,234	7,175	172,208
25	3,234	7,175	179,384
26	3,234	7,175	186,559
27	3,234	7,175	193,734
28	3,234	7,175	200,910
29	3,234	7,175	208,085
30	3,234	7,175	215,261

3. Meeting the siltation TMDL in the NELC

a. Sediment load reduction in the NELC

Adoption and implementation of cropland and streambank BMPs in the NELC will result in a total sediment load reduction of 240,889 tons at the conclusion of this 30-year WRAPS plan.

Table 34. Cumulative Sediment Load Reductions

Sediment Load Reduction from Cropland and Streambank BMPs				
Year	Cropland Load Reduction (tons/yr)	Streambank Load Reduction (tons/yr)	Total Load Reduction (tons/yr)	% of TMDL
1	854	7,175	8,030	3%
2	1,709	14,351	16,059	5%
3	2,563	21,526	24,089	8%
4	3,417	28,701	32,118	11%
5	4,271	35,877	40,148	13%
6	5,126	43,052	48,178	16%
7	5,980	50,227	56,207	19%
8	6,834	57,403	64,237	22%
9	7,688	64,578	72,266	24%
10	8,543	71,754	80,296	27%
11	9,397	78,929	88,326	30%
12	10,251	86,104	96,355	32%
13	11,105	93,280	104,385	35%
14	11,960	100,455	112,415	38%
15	12,814	107,630	120,444	40%
16	13,668	114,806	128,474	43%
17	14,522	121,981	136,503	46%
18	15,377	129,156	144,533	49%
19	16,231	136,332	152,563	51%
20	17,085	143,507	160,592	54%
21	17,939	150,682	168,622	57%
22	18,794	157,858	176,651	59%
23	19,648	165,033	184,681	62%
24	20,502	172,208	192,711	65%
25	21,356	179,384	200,740	67%
26	22,211	186,559	208,770	70%
27	23,065	193,734	216,799	73%
28	23,919	200,910	224,829	76%
29	24,774	208,085	232,859	78%
30	25,628	215,261	240,888	81%
JRR Siltation/Sediment Goal: 297,600 tons per year				

The NELC portion of the JRR Watershed-implemented BMPs will result in a reduction of 240,888 tons of sediment.

The JRR sediment load reduction goal required to meet the siltation TMDL is 297,600 tons, therefore the NELC is doing its part in meeting this goal by reaching nearly 81% of the TMDL.

7B. Implementation in the Upper Cottonwood

There is a total of 197,573 acres in the targeted area in the Upper Cottonwood Watershed. The largest land uses in the seven nutrient- and sediment-targeted HUC 12s in the Upper Cottonwood portion of the JRR Watershed include: 106,035 cropland acres and 72,078 grassland/pasture/hay acres (**Table 35**).

Table 35. Upper Cottonwood Targeted Area Land Uses

Targeted Area Land Use in the Upper Cottonwood													
Land Use in: HUC 110702020...	Barren Land	Cropland	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Developed, Open Space	Forests	Grassland	Pasture/ Hay	Shrubland	Water	Wetlands	Total Acres
106	0	16,811	260	8	0	1,345	953	10,137	909	0	108	282	30,811
107	0	17,667	362	107	17	1,360	1,353	10,052	542	3	55	428	31,944
108	0	8,795	326	63	23	745	417	2,856	198	1	80	123	13,626
201	2	19,339	115	6	4	1,212	516	8,763	885	3	41	225	31,110
202	0	10,280	256	18	5	1,403	568	10,192	906	2	54	144	23,828
204	0	14,759	107	5	0	1,248	746	9,655	791	3	57	246	27,616
301	0	18,386	391	71	4	1,580	1,310	15,172	1,021	0	285	418	38,638
Total	**2**	**106,035**	**1,818**	**278**	**52**	**8,893**	**5,861**	**66,827**	**5,251**	**12**	**679**	691	**197,573**

As discussed in section 7A, land use in the targeted area makes a difference in the amount of nutrients and sediment entering the water. Cropland makes up the majority of this watershed's targeted area, and cropland can be highly susceptible to runoff and erosion during rainfall events. This results in nutrients leaching to sediment particles, thereby delivering both nutrients and sediment into nearby water segments.

Livestock areas make up the second largest land use in the targeted area. Livestock areas can contribute to nutrient loading when nutrients find their way into stream segments. Targeting streambanks is a given, as poorly structured streambanks can contribute excessive amounts of sediment with each rainfall event.

BMP implementation in the Upper Cottonwood portion of the JRR Watershed will take place in targeted cropland and livestock areas within seven targeted HUC 12s (110702020106, 107, 108, 201, 202, 204 and 301). Streambank stabilization projects along the Cottonwood River will take place as well. All BMP implementation projects will take place in an effort to improve the following TMDL impairments in the John Redmond Reservoir:

- **Eutrophication - nutrients (phosphorus and nitrogen): cropland and livestock areas**
- **Siltation: cropland and streambanks**

Water impairments throughout the Upper Cottonwood Watershed will be impacted positively by BMP implementation and the subsequent nutrient and sediment load reductions.

A. Nutrient Load Reductions in the Upper Cottonwood

The JRR Watershed has a medium TMDL ranking for eutrophication (phosphorus and nitrogen) in the John Redmond Reservoir. BMPs will be implemented in the Upper

Cottonwood portion of the JRR Watershed to protect the local streams and, ultimately, the John Redmond Reservoir from excessive nutrient loading. *Any BMPs implemented in the targeted areas simultaneously will reduce both nutrient and sediment loading.*

The Upper Cottonwood contains three targeted land areas for nutrient load reductions: **cropland, livestock, and streambank** areas. Adoption and implementation of nutrient BMPs will result in total nutrient load reductions of **160,895 pounds of phosphorus** and **700,474 pounds of nitrogen** at the conclusion of this 30-year WRAPS plan.

Cropland and livestock BMP implementation will take place in the following seven HUC 12s (**Figure 37**):

- 110702020**106**
- 110702020**107**
- 110702020**108**
- 110702020**201**
- 110702020**202**
- 110702020**204**
- 110702020**301**

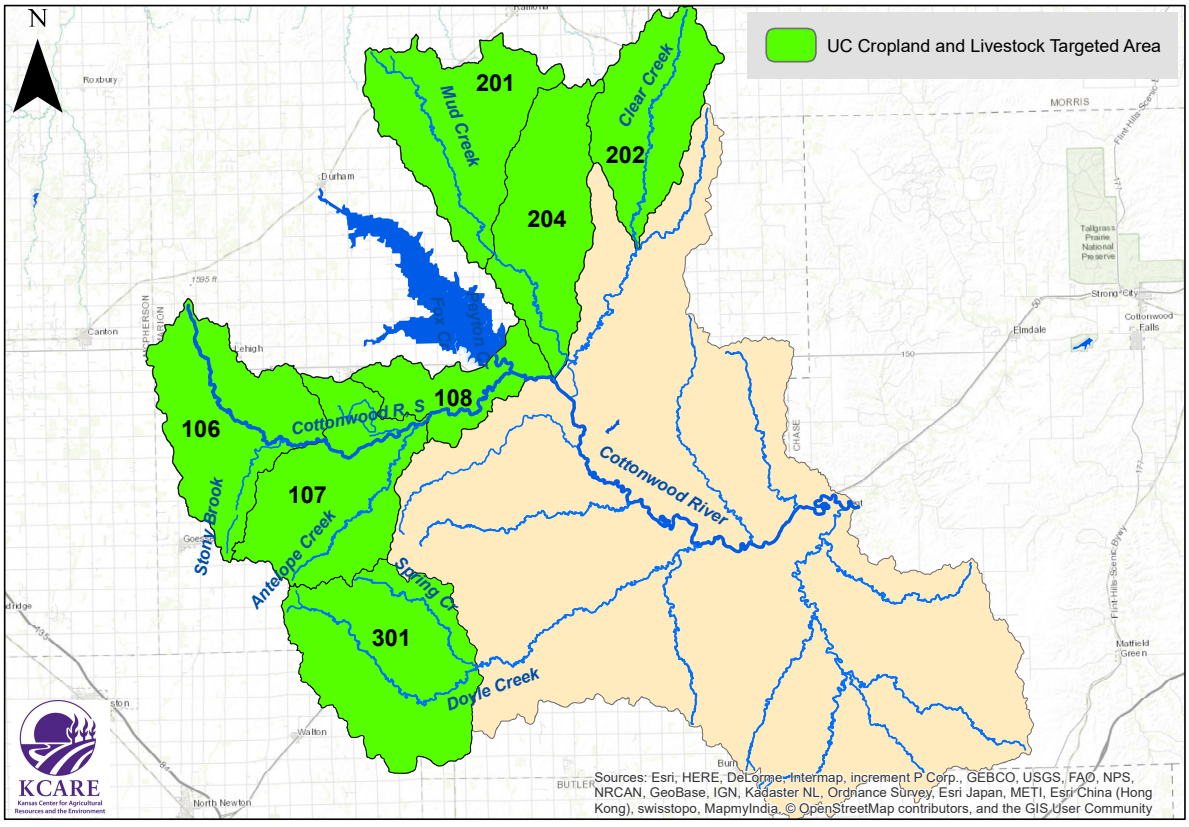


Figure 37. Targeted Areas for BMP Implementation in the Upper Cottonwood

Streambank BMP implementation, also referred to as stabilization or restoration, will take place along the Cottonwood River. Sites will be chosen based on a 2009 study from The

Watershed Institute (TWI), funded by the Kansas Water Office. Implementation will take place once the site is approved by the SLT and KDHE.

1. Cropland targeted for nutrient reductions in the Upper Cottonwood

a. Cropland BMPs for nutrient reductions in the Upper Cottonwood

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

- buffers,
- conservation crop rotation,
- no-till with cover crops,
- nutrient management plans,
- permanent vegetation,
- terraces, and
- waterways.

Table 36. Cropland BMPs Needed to Reduce Nutrient Loading

BMPs to Reduce Nutrient Loading in the Upper Cottonwood		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of nutrient contribution from **cropland**	Buffers	1,060 acres
	Conservation Crop Rotation	707 acres
	No-till with Cover Crops	1,414 acres
	Nutrient Management Plans	530 acres
	Permanent Vegetation	177 acres
	Terraces	707 acres
	Waterways	1,060 acres

Table 37. Adoption Rate of Cropland BMPs in the Upper Cottonwood

Total Annual Adoption (treated acres), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Adoption
1	1,060	707	1,414	530	177	707	1,060	5,655
2	1,060	707	1,414	530	177	707	1,060	5,655
3	1,060	707	1,414	530	177	707	1,060	5,655
4	1,060	707	1,414	530	177	707	1,060	5,655
5	1,060	707	1,414	530	177	707	1,060	5,655
6	1,060	707	1,414	530	177	707	1,060	5,655
7	1,060	707	1,414	530	177	707	1,060	5,655
8	1,060	707	1,414	530	177	707	1,060	5,655
9	1,060	707	1,414	530	177	707	1,060	5,655
10	1,060	707	1,414	530	177	707	1,060	5,655
11	1,060	707	1,414	530	177	707	1,060	5,655
12	1,060	707	1,414	530	177	707	1,060	5,655
13	1,060	707	1,414	530	177	707	1,060	5,655
14	1,060	707	1,414	530	177	707	1,060	5,655
15	1,060	707	1,414	530	177	707	1,060	5,655
16	1,060	707	1,414	530	177	707	1,060	5,655
17	1,060	707	1,414	530	177	707	1,060	5,655
18	1,060	707	1,414	530	177	707	1,060	5,655
19	1,060	707	1,414	530	177	707	1,060	5,655
20	1,060	707	1,414	530	177	707	1,060	5,655
21	1,060	707	1,414	530	177	707	1,060	5,655
22	1,060	707	1,414	530	177	707	1,060	5,655
23	1,060	707	1,414	530	177	707	1,060	5,655
24	1,060	707	1,414	530	177	707	1,060	5,655
25	1,060	707	1,414	530	177	707	1,060	5,655
26	1,060	707	1,414	530	177	707	1,060	5,655
27	1,060	707	1,414	530	177	707	1,060	5,655
28	1,060	707	1,414	530	177	707	1,060	5,655
29	1,060	707	1,414	530	177	707	1,060	5,655
30	1,060	707	1,414	530	177	707	1,060	5,655
Total	**31,809**	**21,206**	**42,412**	**15,905**	**5,302**	**21,206**	**31,809**	**169,650**

b. Nutrient load reductions from cropland BMP implementation

The implementation of cropland BMPs on 5,655 acres per year in the seven HUC 12s will result in a **phosphorus reduction of 130,713 pounds** and a **nitrogen load reduction of 646,654 pounds** at the end of this 30-year WRAPS plan (**Tables 38** and **39**).

Table 38. Phosphorus Load Reductions from Cropland BMP Implementation

Annual Phosphorus Reduction (lbs), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	983	328	1,310	246	311	393	786	4,357
2	1,966	655	2,621	491	622	786	1,572	8,714
3	2,948	983	3,931	737	934	1,179	2,359	13,071
4	3,931	1,310	5,242	983	1,245	1,572	3,145	17,428
5	4,914	1,638	6,552	1,229	1,556	1,966	3,931	21,785
6	5,897	1,966	7,862	1,474	1,867	2,359	4,717	26,143
7	6,880	2,293	9,173	1,720	2,179	2,752	5,504	30,500
8	7,862	2,621	10,483	1,966	2,490	3,145	6,290	34,857
9	8,845	2,948	11,794	2,211	2,801	3,538	7,076	39,214
10	9,828	3,276	13,104	2,457	3,112	3,931	7,862	43,571
11	10,811	3,604	14,414	2,703	3,423	4,324	8,649	47,928
12	11,794	3,931	15,725	2,948	3,735	4,717	9,435	52,285
13	12,776	4,259	17,035	3,194	4,046	5,111	10,221	56,642
14	13,759	4,586	18,346	3,440	4,357	5,504	11,007	60,999
15	14,742	4,914	19,656	3,686	4,668	5,897	11,794	65,356
16	15,725	5,242	20,966	3,931	4,980	6,290	12,580	69,713
17	16,708	5,569	22,277	4,177	5,291	6,683	13,366	74,071
18	17,690	5,897	23,587	4,423	5,602	7,076	14,152	78,428
19	18,673	6,224	24,898	4,668	5,913	7,469	14,939	82,785
20	19,656	6,552	26,208	4,914	6,224	7,862	15,725	87,142
21	20,639	6,880	27,518	5,160	6,536	8,256	16,511	91,499
22	21,622	7,207	28,829	5,405	6,847	8,649	17,297	95,856
23	22,604	7,535	30,139	5,651	7,158	9,042	18,084	100,213
24	23,587	7,862	31,450	5,897	7,469	9,435	18,870	104,570
25	24,570	8,190	32,760	6,143	7,781	9,828	19,656	108,927
26	25,553	8,518	34,070	6,388	8,092	10,221	20,442	113,284
27	26,536	8,845	35,381	6,634	8,403	10,614	21,229	117,641
28	27,518	9,173	36,691	6,880	8,714	11,007	22,015	121,999
29	28,501	9,500	38,002	7,125	9,025	11,401	22,801	126,356
30	29,484	9,828	39,312	7,371	9,337	11,794	23,587	130,713

Table 39. Nitrogen Load Reductions from Cropland BMP Implementation

Annual Nitrogen Reduction (lbs), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	5,723	1,908	3,815	1,431	1,812	2,289	4,578	21,555
2	11,445	3,815	7,630	2,861	3,624	4,578	9,156	43,110
3	17,168	5,723	11,445	4,292	5,436	6,867	13,734	64,665
4	22,890	7,630	15,260	5,723	7,249	9,156	18,312	86,221
5	28,613	9,538	19,075	7,153	9,061	11,445	22,890	107,776
6	34,336	11,445	22,890	8,584	10,873	13,734	27,468	129,331
7	40,058	13,353	26,705	10,015	12,685	16,023	32,047	150,886
8	45,781	15,260	30,521	11,445	14,497	18,312	36,625	172,441
9	51,503	17,168	34,336	12,876	16,309	20,601	41,203	193,996
10	57,226	19,075	38,151	14,307	18,122	22,890	45,781	215,551
11	62,949	20,983	41,966	15,737	19,934	25,179	50,359	237,107
12	68,671	22,890	45,781	17,168	21,746	27,468	54,937	258,662
13	74,394	24,798	49,596	18,598	23,558	29,758	59,515	280,217
14	80,116	26,705	53,411	20,029	25,370	32,047	64,093	301,772
15	85,839	28,613	57,226	21,460	27,182	34,336	68,671	323,327
16	91,562	30,521	61,041	22,890	28,995	36,625	73,249	344,882
17	97,284	32,428	64,856	24,321	30,807	38,914	77,827	366,437
18	103,007	34,336	68,671	25,752	32,619	41,203	82,405	387,993
19	108,729	36,243	72,486	27,182	34,431	43,492	86,984	409,548
20	114,452	38,151	76,301	28,613	36,243	45,781	91,562	431,103
21	120,175	40,058	80,116	30,044	38,055	48,070	96,140	452,658
22	125,897	41,966	83,932	31,474	39,867	50,359	100,718	474,213
23	131,620	43,873	87,747	32,905	41,680	52,648	105,296	495,768
24	137,342	45,781	91,562	34,336	43,492	54,937	109,874	517,323
25	143,065	47,688	95,377	35,766	45,304	57,226	114,452	538,879
26	148,788	49,596	99,192	37,197	47,116	59,515	119,030	560,434
27	154,510	51,503	103,007	38,628	48,928	61,804	123,608	581,989
28	160,233	53,411	106,822	40,058	50,740	64,093	128,186	603,544
29	165,956	55,319	110,637	41,489	52,553	66,382	132,764	625,099
30	171,678	57,226	114,452	42,920	54,365	68,671	137,342	646,654

2. Livestock areas targeted for nutrient reduction in the Upper Cottonwood

a. Livestock area BMPs for nutrient reductions in the Upper Cottonwood

Within the seven HUC 12 areas, the following BMPs will be implemented to reduce nutrient loading from livestock areas:

- fenced-off streams,
- filter strips,
- off-stream watering systems,
- pasture feeding site relocations, and
- rotational grazing.

Table 40. Nutrient BMP Adoption Rates in Livestock Areas

BMPs to Reduce Nutrient Loading in the Upper Cottonwood		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of nutrient contribution from **livestock**	Fence off Streams	1 project every 2 years
	Filter Strips	1 project every year
	Off-stream Watering	1 project every year
	Relocate Pasture Feeding Sites	1 project every year
	Rotational Grazing	1 project every 2 years

Table 41. Adoption Rates of Livestock BMPs to Address Nutrients

Annual Livestock BMP Adoption						
Year	**Fence Off Streams**	**Filter Strip**	**Off-stream Watering System**	**Relocate Pasture Feeding Site**	**Rotational Grazing**	**Projects Per Year**
1	1	1	1	1	1	5
2	0	1	1	1	0	3
3	1	1	1	1	1	5
4	0	1	1	1	0	3
5	1	1	1	1	1	5
6	0	1	1	1	0	3
7	1	1	1	1	1	5
8	0	1	1	1	0	3
9	1	1	1	1	1	5
10	0	1	1	1	0	3
11	1	1	1	1	1	5
12	0	1	1	1	0	3
13	1	1	1	1	1	5
14	0	1	1	1	0	3
15	1	1	1	1	1	5
16	0	1	1	1	0	3
17	1	1	1	1	1	5
18	0	1	1	1	0	3
19	1	1	1	1	1	5
20	0	1	1	1	0	3
21	1	1	1	1	1	5
22	0	1	1	1	0	3
23	1	1	1	1	1	5
24	0	1	1	1	0	3
25	1	1	1	1	1	5
26	0	1	1	1	0	3
27	1	1	1	1	1	5
28	0	1	1	1	0	3
29	1	1	1	1	1	5
30	0	1	1	1	0	3
Total	**15**	**30**	**30**	**30**	**15**	**120**

b. Nutrient load reductions from livestock BMP implementation

The implementation of eight livestock BMP projects every two years in the seven targeted HUC 12s will result in a **phosphorus load reduction of 28,575 pounds** and

a **nitrogen load reduction of 53,820 pounds** at the end of this 30-year WRAPS plan (**Tables 42** and **43**).

Table 42. Phosphorus Reductions from Livestock BMP Implementation

Annual Phosphorus Load Reductions (lbs), Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-Stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Annual Load Reduction
1	30	888	25	21	7	971
2	30	1,777	50	41	7	1,905
3	59	2,665	75	62	15	2,876
4	59	3,553	100	83	15	3,810
5	89	4,442	125	103	22	4,781
6	89	5,330	151	124	22	5,715
7	118	6,218	176	145	30	6,686
8	118	7,106	201	165	30	7,620
9	148	7,995	226	186	37	8,591
10	148	8,883	251	207	37	9,525
11	177	9,771	276	227	44	10,496
12	177	10,660	301	248	44	11,430
13	207	11,548	326	269	52	12,401
14	207	12,436	351	289	52	13,335
15	236	13,325	376	310	59	14,306
16	236	14,213	401	331	59	15,240
17	266	15,101	426	351	66	16,211
18	266	15,989	452	372	66	17,145
19	295	16,878	477	393	74	18,116
20	295	17,766	502	413	74	19,050
21	325	18,654	527	434	81	20,021
22	325	19,543	552	454	81	20,955
23	354	20,431	577	475	89	21,926
24	354	21,319	602	496	89	22,860
25	384	22,208	627	516	96	23,831
26	384	23,096	652	537	96	24,765
27	413	23,984	677	558	103	25,736
28	413	24,872	702	578	103	26,670
29	443	25,761	727	599	111	27,641
30	443	26,649	753	620	111	28,575

Table 43. Nitrogen Load Reductions from Livestock BMP Implementation

Annual Nitrogen Load Reductions (lbs), Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Annual Load Reduction
1	56	1,673	47	39	14	1,829
2	56	3,346	94	78	14	3,588
3	111	5,019	142	117	28	5,417
4	111	6,692	189	156	28	7,176
5	167	8,366	236	195	42	9,005
6	167	10,039	283	233	42	10,764
7	222	11,712	331	272	56	12,593
8	222	13,385	378	311	56	14,352
9	278	15,058	425	350	69	16,181
10	278	16,731	472	389	69	17,940
11	334	18,404	520	428	83	19,769
12	334	20,077	567	467	83	21,528
13	389	21,750	614	506	97	23,357
14	389	23,424	661	545	97	25,116
15	445	25,097	709	584	111	26,945
16	445	26,770	756	623	111	28,704
17	500	28,443	803	661	125	30,533
18	500	30,116	850	700	125	32,292
19	556	31,789	898	739	139	34,121
20	556	33,462	945	778	139	35,880
21	611	35,135	992	817	153	37,709
22	611	36,808	1,039	856	153	39,468
23	667	38,482	1,087	895	167	41,297
24	667	40,155	1,134	934	167	43,056
25	723	41,828	1,181	973	181	44,885
26	723	43,501	1,228	1,012	181	46,644
27	778	45,174	1,276	1,051	195	48,473
28	778	46,847	1,323	1,089	195	50,232
29	834	48,520	1,370	1,128	208	52,061
30	834	50,193	1,417	1,167	208	53,820

3. Streambank areas targeted for nutrient reduction in the Upper Cottonwood

a. Streambank stabilization for nutrient reductions in the Upper Cottonwood

Streambank stabilization projects will take place along the Cottonwood River to reduce sediment loss. Because nutrients are carried away as they leach to soil particles, streambank stabilization projects will also serve to reduce nutrient loading in the watershed.

Sites will be chosen based on the 2009 TWI study. An annual 392 feet of streambank will be stabilized in each year of this 30-year WRAPS plan, for a total of 11,760 linear feet of streambank protected from soil erosion and soil loss.

b. Nutrient load reductions from streambank BMP implementation

The implementation of 392 linear feet of streambank stabilization along the Cottonwood River each project year will result in a phosphorus load reduction of **1,607 pounds** at the end of this 30-year WRAPS plan.

Table 44. Phosphorus Load Reduction from Streambank Stabilization

Annual Phosphorus Load Reductions (lbs), Streambank Stabilization			
Year	Streambank Stabilization (feet)	Phosphorus Reduction (lbs)	Cumulative P Load Reduction (lbs)
1	392	54	54
2	392	54	107
3	392	54	161
4	392	54	214
5	392	54	268
6	392	54	321
7	392	54	375
8	392	54	429
9	392	54	482
10	392	54	536
11	392	54	589
12	392	54	643
13	392	54	696
14	392	54	750
15	392	54	804
16	392	54	857
17	392	54	911
18	392	54	964
19	392	54	1,018
20	392	54	1,072
21	392	54	1,125
22	392	54	1,179
23	392	54	1,232
24	392	54	1,286
25	392	54	1,339
26	392	54	1,393
27	392	54	1,447
28	392	54	1,500
29	392	54	1,554
30	392	54	1,607

4. Meeting the eutrophication/nutrient TMDL in the Upper Cottonwood

a. Phosphorus load reductions in the Upper Cottonwood

Adoption and implementation of cropland, livestock and streambank BMPs in the Upper Cottonwood will result in a **total phosphorus load reduction of 160,895 pounds** at the conclusion of this 30-year WRAPS plan (**Tables 45** and **46**).

Table 45. Cumulative Phosphorus Reductions from BMP Implementation

Phosphorus Load Reduction from Cropland, Livestock, and Streambank BMPs					
Year	Cropland Load Reduction (lbs/yr)	Livestock Load Reduction (lbs/yr)	Streambank Load Reduction (lbs/yr)	Total Load Reduction (lbs/yr)	% of TMDL
1	4,357	971	54	5,382	2.8%
2	8,714	1,905	107	10,726	5.5%
3	13,071	2,876	161	16,108	8.3%
4	17,428	3,810	214	21,453	11.1%
5	21,785	4,781	268	26,834	13.8%
6	26,143	5,715	321	32,179	16.6%
7	30,500	6,686	375	37,561	19.4%
8	34,857	7,620	429	42,905	22.1%
9	39,214	8,591	482	48,287	24.9%
10	43,571	9,525	536	53,632	27.6%
11	47,928	10,496	589	59,013	30.4%
12	52,285	11,430	643	64,358	33.2%
13	56,642	12,401	696	69,739	35.9%
14	60,999	13,335	750	75,084	38.7%
15	65,356	14,306	804	80,466	41.5%
16	69,713	15,240	857	85,810	44.2%
17	74,071	16,211	911	91,192	47.0%
18	78,428	17,145	964	96,537	49.7%
19	82,785	18,116	1,018	101,918	52.5%
20	87,142	19,050	1,072	107,263	55.3%
21	91,499	20,021	1,125	112,645	58.0%
22	95,856	20,955	1,179	117,989	60.8%
23	100,213	21,926	1,232	123,371	63.6%
24	104,570	22,860	1,286	128,716	66.3%
25	108,927	23,831	1,339	134,097	69.1%
26	113,284	24,765	1,393	139,442	71.8%
27	117,641	25,736	1,447	144,824	74.6%
28	121,999	26,670	1,500	150,168	77.4%
29	126,356	27,641	1,554	155,550	80.1%
30	130,713	28,575	1,607	160,895	56.2%
JRR Phosphorus TMDL Goal: 286,408 pounds reduced per year					

The JRR phosphorus load reduction goal required to meet the eutrophication TMDL is 286,408 pounds of phosphorus; therefore, the Upper Cottonwood Watershed is doing its part to meet this goal by reaching 56.2% of the TMDL.

b. Nitrogen load reduction in the Upper Cottonwood

While there is no nitrogen load reduction goal required for the eutrophication TMDL, adoption and implementation of nutrient BMPs in cropland and livestock areas will result in a **total nitrogen load reduction of 700,475 pounds** at the conclusion of this 30-year WRAPS plan (**Table 46**).

Table 46. Cumulative Nitrogen Reductions from BMP Implementation

Nitrogen Reduction from Cropland and Livestock BMPs			
Year	Cropland Load Reduction (lbs/yr)	Livestock Load Reduction (lbs/yr)	Total Load Reduction (lbs/yr)
1	21,555	1,829	23,384
2	43,110	3,588	46,698
3	64,665	5,417	70,082
4	86,221	7,176	93,397
5	107,776	9,005	116,780
6	129,331	10,764	140,095
7	150,886	12,593	163,479
8	172,441	14,352	186,793
9	193,996	16,181	210,177
10	215,551	17,940	233,492
11	237,107	19,769	256,875
12	258,662	21,528	280,190
13	280,217	23,357	303,574
14	301,772	25,116	326,888
15	323,327	26,945	350,272
16	344,882	28,704	373,586
17	366,437	30,533	396,970
18	387,993	32,292	420,285
19	409,548	34,121	443,669
20	431,103	35,880	466,983
21	452,658	37,709	490,367
22	474,213	39,468	513,681
23	495,768	41,297	537,065
24	517,323	43,056	560,380
25	538,879	44,885	583,764
26	560,434	46,644	607,078
27	581,989	48,473	630,462
28	603,544	50,232	653,776
29	625,099	52,061	677,160
30	646,654	53,820	700,475
There are no nitrogen TMDL load reduction goalsl for JRR.			

B. Sediment Load Reductions in the Upper Cottonwood

The JRR Watershed has a medium TMDL ranking for siltation, also referred to as sediment, in the John Redmond Reservoir. Sediment BMPs will be implemented in the Upper Cottonwood portion of the JRR Watershed to protect the local streams and, ultimately, the John Redmond Reservoir from excessive sediment loss. *Any BMPs implemented in the targeted areas will simultaneously reduce both sediment and nutrient loading.*

The Upper Cottonwood Watershed contains two targeted land areas for sediment load reductions: **cropland** and **streambank** areas. Adoption and implementation of sediment BMPs will result in a total of **102,156 tons of sediment saved** at the conclusion of this 30-year WRAPS plan.

Cropland BMP implementation will take place in the following seven HUC 12s (**Figure 38**):

- 110702020**106**
- 110702020**107**
- 110702020**108**
- 110702020**201**
- 110702020**202**
- 110702020**204**
- 110702020**301**

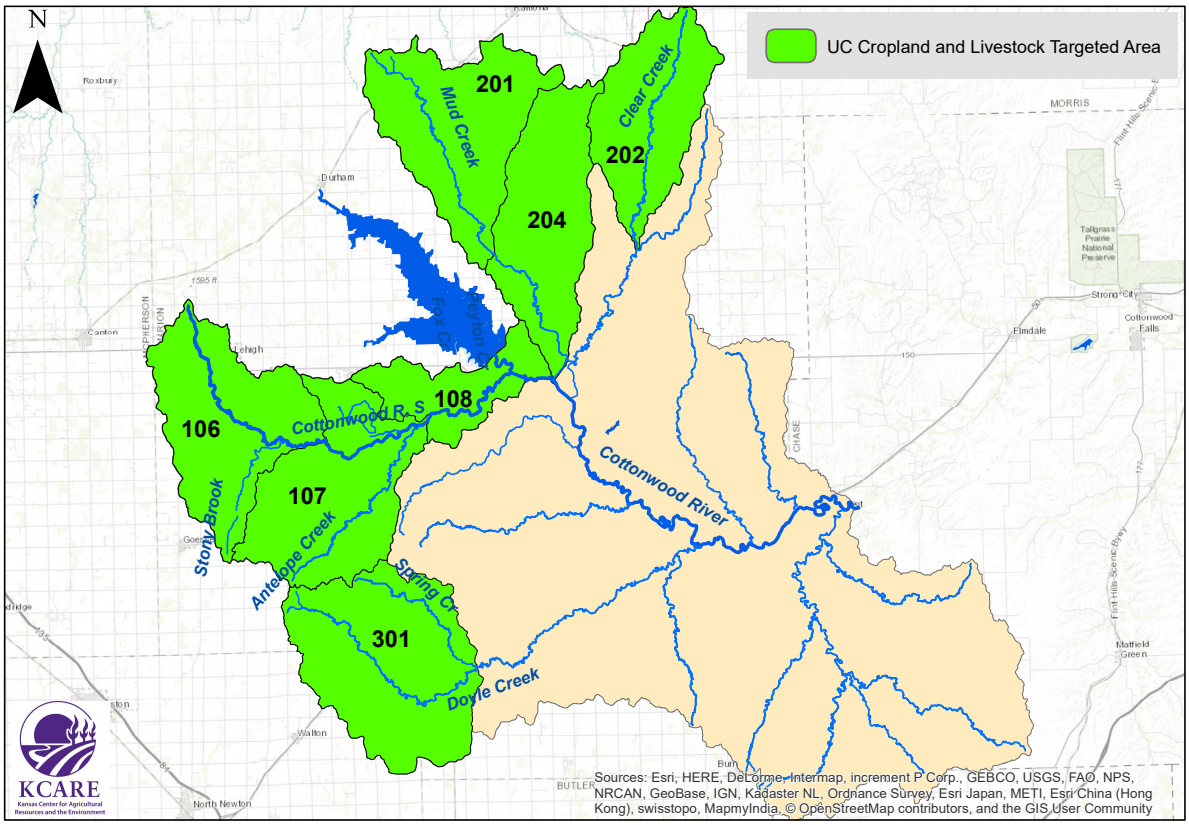


Figure 38. Targeted Areas for BMP Implementation in the Upper Cottonwood

Streambank BMP implementation, also referred to as stabilization or restoration, will take place along the Cottonwood River. Sites will be chosen based on a 2009 study by The Watershed Institute (TWI) and funded by the Kansas Water Office. Implementation will take place once the site is approved by the SLT and KDHE.

1. Cropland targeted for sediment load reductions in the Upper Cottonwood

a. Cropland BMPs for sediment load reductions in the Upper Cottonwood

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

- buffers,
- conservation crop rotation,
- no-till with cover crops,
- nutrient management plans,
- permanent vegetation,
- terraces, and
- waterways.

Table 47. Cropland BMPs Needed to Reduce Sediment Load

BMPs to Reduce Sediment Loading in the Upper Cottonwood		
Protection Measures	**Best Management Practices**	**Annual Adoption Rate Goal**
Prevention of sediment loss from **cropland**	Buffers	1,060 acres
	Conservation Crop Rotation	707 acres
	No-till with Cover Crops	1,414 acres
	Nutrient Management Plans	530 acres
	Permanent Vegetation	177 acres
	Terraces	707 acres
	Waterways	1,060 acres

Table 48. Adoption Rate for Cropland BMPs in the Upper Cottonwood

Total Annual Adoption (treated acres), Cropland BMPs								
Year	**Buffers**	**Conservation Crop Rotation**	**No-Till with Cover Crops**	**Nutrient Management Plans**	**Permanent Vegetation**	**Terraces**	**Waterways**	**Total Adoption**
1	1,060	707	1,414	530	177	707	1,060	5,655
2	1,060	707	1,414	530	177	707	1,060	5,655
3	1,060	707	1,414	530	177	707	1,060	5,655
4	1,060	707	1,414	530	177	707	1,060	5,655
5	1,060	707	1,414	530	177	707	1,060	5,655
6	1,060	707	1,414	530	177	707	1,060	5,655
7	1,060	707	1,414	530	177	707	1,060	5,655
8	1,060	707	1,414	530	177	707	1,060	5,655
9	1,060	707	1,414	530	177	707	1,060	5,655
10	1,060	707	1,414	530	177	707	1,060	5,655
11	1,060	707	1,414	530	177	707	1,060	5,655
12	1,060	707	1,414	530	177	707	1,060	5,655
13	1,060	707	1,414	530	177	707	1,060	5,655
14	1,060	707	1,414	530	177	707	1,060	5,655
15	1,060	707	1,414	530	177	707	1,060	5,655
16	1,060	707	1,414	530	177	707	1,060	5,655
17	1,060	707	1,414	530	177	707	1,060	5,655
18	1,060	707	1,414	530	177	707	1,060	5,655
19	1,060	707	1,414	530	177	707	1,060	5,655
20	1,060	707	1,414	530	177	707	1,060	5,655
21	1,060	707	1,414	530	177	707	1,060	5,655
22	1,060	707	1,414	530	177	707	1,060	5,655
23	1,060	707	1,414	530	177	707	1,060	5,655
24	1,060	707	1,414	530	177	707	1,060	5,655
25	1,060	707	1,414	530	177	707	1,060	5,655
26	1,060	707	1,414	530	177	707	1,060	5,655
27	1,060	707	1,414	530	177	707	1,060	5,655
28	1,060	707	1,414	530	177	707	1,060	5,655
29	1,060	707	1,414	530	177	707	1,060	5,655
30	1,060	707	1,414	530	177	707	1,060	5,655
Total	**31,809**	**21,206**	**42,412**	**15,905**	**5,302**	**21,206**	**31,809**	**169,650**

b. Sediment load reductions from cropland BMP implementation

The implementation of cropland BMPs on 5,655 acres per year in the seven HUC 12s will result in a sediment load reduction of 75,368 tons at the end of this 30-year WRAPS plan (**Table 49)**.

Table 49. Sediment Reductions from Cropland BMP Implementation

Annual Sediment Load Reduction (tons), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	641	214	684	0	203	257	513	2,512
2	1,283	428	1,368	0	406	513	1,026	5,025
3	1,924	641	2,053	0	609	770	1,539	7,537
4	2,566	855	2,737	0	812	1,026	2,053	10,049
5	3,207	1,069	3,421	0	1,016	1,283	2,566	12,561
6	3,849	1,283	4,105	0	1,219	1,539	3,079	15,074
7	4,490	1,497	4,789	0	1,422	1,796	3,592	17,586
8	5,131	1,710	5,474	0	1,625	2,053	4,105	20,098
9	5,773	1,924	6,158	0	1,828	2,309	4,618	22,610
10	6,414	2,138	6,842	0	2,031	2,566	5,131	25,123
11	7,056	2,352	7,526	0	2,234	2,822	5,645	27,635
12	7,697	2,566	8,210	0	2,437	3,079	6,158	30,147
13	8,339	2,780	8,895	0	2,641	3,335	6,671	32,660
14	8,980	2,993	9,579	0	2,844	3,592	7,184	35,172
15	9,621	3,207	10,263	0	3,047	3,849	7,697	37,684
16	10,263	3,421	10,947	0	3,250	4,105	8,210	40,196
17	10,904	3,635	11,631	0	3,453	4,362	8,723	42,709
18	11,546	3,849	12,316	0	3,656	4,618	9,237	45,221
19	12,187	4,062	13,000	0	3,859	4,875	9,750	47,733
20	12,829	4,276	13,684	0	4,062	5,131	10,263	50,246
21	13,470	4,490	14,368	0	4,266	5,388	10,776	52,758
22	14,112	4,704	15,052	0	4,469	5,645	11,289	55,270
23	14,753	4,918	15,736	0	4,672	5,901	11,802	57,782
24	15,394	5,131	16,421	0	4,875	6,158	12,316	60,295
25	16,036	5,345	17,105	0	5,078	6,414	12,829	62,807
26	16,677	5,559	17,789	0	5,281	6,671	13,342	65,319
27	17,319	5,773	18,473	0	5,484	6,927	13,855	67,831
28	17,960	5,987	19,157	0	5,687	7,184	14,368	70,344
29	18,602	6,201	19,842	0	5,890	7,441	14,881	72,856
30	19,243	6,414	20,526	0	6,094	7,697	15,394	75,368

2. Streambank areas targeted for sediment load reduction in the Upper Cottonwood

a. Streambank stabilization for sediment load reductions in the Upper Cottonwood

Streambank stabilization projects will take place along the Cottonwood River. Sites will be chosen based on data from the 2009 TWI study. In each year of this 30-year plan, 392 feet of streambank will be stabilized, for a total of 11,760 linear feet of

streambank protected from soil erosion and soil loss. Because nutrients are carried away as they leach to soil particles, streambank stabilization projects will reduce nutrient loss as well.

b. Sediment load reductions from streambank BMP implementation

The implementation of 392 linear feet of streambank stabilization each project year along the Cottonwood River will result in a **sediment load reduction of 26,788 tons** at the end of this 30-year WRAPS plan.

Table 50. Sediment Load Reduction from Streambank Stabilization

Annual Sediment Load Reduction (tons), Streambank Stabilization			
Year	Streambank Stabilization (feet)	Soil Load Reduction (tons)	Cumulative Erosion Reduction (tons)
1	392	893	893
2	392	893	1,786
3	392	893	2,679
4	392	893	3,572
5	392	893	4,465
6	392	893	5,358
7	392	893	6,250
8	392	893	7,143
9	392	893	8,036
10	392	893	8,929
11	392	893	9,822
12	392	893	10,715
13	392	893	11,608
14	392	893	12,501
15	392	893	13,394
16	392	893	14,287
17	392	893	15,180
18	392	893	16,073
19	392	893	16,966
20	392	893	17,859
21	392	893	18,751
22	392	893	19,644
23	392	893	20,537
24	392	893	21,430
25	392	893	22,323
26	392	893	23,216
27	392	893	24,109
28	392	893	25,002
29	392	893	25,895
30	392	893	26,788

3. Meeting the siltation TMDL in the Upper Cottonwood

Adoption and implementation of cropland and streambank BMPs will result in a **total sediment load reduction of 102,156 tons** at the conclusion of this 30-year WRAPS plan.

Table 51. Cumulative Sediment Reductions from BMP Implementation

Sediment Load Reduction from Cropland and Streambank BMPs				
Year	Cropland Load Reduction (tons/yr)	Streambank Load Reduction (tons/yr)	Total Load Reduction (tons/yr)	% of TMDL
1	2,512	893	3,405	1.7%
2	5,025	1,786	6,810	3.4%
3	7,537	2,679	10,216	5.0%
4	10,049	3,572	13,621	6.7%
5	12,561	4,465	17,026	8.4%
6	15,074	5,358	20,431	10.1%
7	17,586	6,250	23,836	11.8%
8	20,098	7,143	27,242	13.5%
9	22,610	8,036	30,647	15.1%
10	25,123	8,929	34,052	16.8%
11	27,635	9,822	37,457	18.5%
12	30,147	10,715	40,862	20.2%
13	32,660	11,608	44,268	21.9%
14	35,172	12,501	47,673	23.6%
15	37,684	13,394	51,078	25.2%
16	40,196	14,287	54,483	26.9%
17	42,709	15,180	57,888	28.6%
18	45,221	16,073	61,294	30.3%
19	47,733	16,966	64,699	32.0%
20	50,246	17,859	68,104	33.7%
21	52,758	18,751	71,509	35.3%
22	55,270	19,644	74,915	37.0%
23	57,782	20,537	78,320	38.7%
24	60,295	21,430	81,725	40.4%
25	62,807	22,323	85,130	42.1%
26	65,319	23,216	88,535	43.7%
27	67,831	24,109	91,941	45.4%
28	70,344	25,002	95,346	47.1%
29	72,856	25,895	98,751	48.8%
30	75,368	26,788	102,156	34.3%
JRR Siltation/Sediment TMDL Goal: 297,600 tons per year				

The JRR sediment load reduction goal required to meet the siltation TMDL is 297,600 tons, therefore the Upper Cottonwood is doing its part in meeting this goal by reaching 34.3% of the TMDL.

7C. Meeting Load Reductions in the JRR Watershed

The implementation of nutrient and sediment BMPs in the NELC and Upper Cottonwood areas of the JRR Watershed will meet and exceed TMDL load reduction goals.

A. Meeting the Eutrophication TMDL in the JRR Watershed

1. Phosphorus load reductions

The TMDL goal for phosphorus load reductions in the JRR Watershed is 286,408 pounds/year. This goal was met and narrowly exceeded in year 30 of this plan by almost 0.5%.

Table 52. Meeting the Eutrophication TMDL in the JRR Watershed

Meeting the Eutrophication TMDL		
	Phosphorus Load Reduction (lbs) Achieved during 30-year Plan	**Percent of TMDL**
NELC	126,877	44.28%
Upper Cottonwood	160,895	56.20%
Total Reduction	**287,772**	**100.48%**
Phosphorus Load Reduction Goal: 286,408 lbs		

Table 53. Phosphorus Load Reductions in the JRR Watershed

Phosphorus Load Reduction in the JRR Watershed				
Year	NELC Total Reduction (pounds/year)	UC Total Reduction (pounds/year)	Total Reduction (pounds/year) in the JRR Watershed	% of TMDL
1	3,811	5,382	9,193	3.2%
2	8,458	10,726	19,184	6.7%
3	12,269	16,108	28,377	9.9%
4	16,917	21,453	38,370	13.4%
5	20,728	26,834	47,562	16.6%
6	25,375	32,179	57,554	20.1%
7	29,186	37,561	66,747	23.3%
8	33,834	42,905	76,739	26.8%
9	37,645	48,287	85,932	30.0%
10	42,292	53,632	95,924	33.5%
11	46,103	59,013	105,116	36.7%
12	50,751	64,358	115,109	40.2%
13	54,562	69,739	124,301	43.4%
14	59,209	75,084	134,293	46.9%
15	63,020	80,466	143,486	50.1%
16	67,668	85,810	153,478	53.6%
17	71,479	91,192	162,671	56.8%
18	76,126	96,537	172,663	60.3%
19	79,937	101,918	181,855	63.5%
20	84,585	107,263	191,848	67.0%
21	88,396	112,645	201,041	70.2%
22	93,043	117,989	211,032	73.7%
23	96,854	123,371	220,225	76.9%
24	101,502	128,716	230,218	80.4%
25	105,313	134,097	239,410	83.6%
26	109,960	139,442	249,402	87.1%
27	113,771	144,824	258,595	90.3%
28	118,419	150,168	268,587	93.8%
29	122,230	155,550	277,780	97.0%
30	126,877	160,895	287,772	100.5%
JRR Phosphorus TMDL Goal: 286,408 Pounds per Year				

2. Nitrogen load reductions

Nitrogen contributes to eutrophication in water segments and in the John Redmond Reservoir. Although no quantitative TMDL load reductions were required, the implementation of cropland and livestock BMPs throughout the NELC and Upper Cottonwood portions of the JRR Watershed will result in a load reduction of **1,075,164 pounds/year of nitrogen** over the 30 years of this WRAPS plan (**Table 54**).

Table 54. Nitrogen Load Reductions in the JRR Watershed

Nitrogen Load Reduction in the JRR Watershed			
Year	NELC Total Reduction (pounds/year)	UC Total Reduction (pounds/year)	Total Reduction (pounds/year) in the JRR Watershed
1	11,702	23,384	35,086
2	24,979	46,698	71,677
3	36,681	70,082	106,763
4	49,959	93,397	143,356
5	61,660	116,780	178,440
6	74,938	140,095	215,033
7	86,640	163,479	250,119
8	99,917	186,793	286,710
9	111,619	210,177	321,796
10	124,896	233,492	358,388
11	136,598	256,875	393,473
12	149,876	280,190	430,066
13	161,577	303,574	465,151
14	174,855	326,888	501,743
15	186,557	350,272	536,829
16	199,834	373,586	573,420
17	211,536	396,970	608,506
18	224,814	420,285	645,099
19	236,515	443,669	680,184
20	249,793	466,983	716,776
21	261,495	490,367	751,862
22	274,772	513,681	788,453
23	286,474	537,065	823,539
24	299,752	560,380	860,132
25	311,453	583,764	895,217
26	324,731	607,078	931,809
27	336,433	630,462	966,895
28	349,710	653,776	1,003,486
29	361,412	677,160	1,038,572
30	374,689	700,475	1,075,164
There are no nitrogen TMDL load reduction goals for JRR.			

B. Meeting the Siltation TMDL in the JRR Watershed

The TMDL goal for siltation load reductions in the JRR Watershed is 297,600 tons/year. This goal will be met in year 27 of this WRAPS plan and will be exceeded in year 30 by more than 15%.

Table 55. Meeting the Siltation TMDL in the JRR Watershed

Meeting the Siltation TMDL		
	Sediment Load Reduction (tons) Achieved during 30-year Plan	**Percent of TMDL**
NELC	240,889	80.94%
Upper Cottonwood	102,156	34.32%
Total Reduction	**343,045**	**115.26%**
Sediment Load Reduction Goal: 297,600 tons		

Table 56. Sediment Load Reductions in the JRR Watershed

Sediment Load Reduction in the JRR Watershed				
Year	NELC Total Reduction (tons/year)	UC Total Reduction (tons/year)	Total Reduction (tons/year) in the JRR Watershed	% of TMDL
1	8,030	3,405	11,435	3.8%
2	16,059	6,810	22,869	7.7%
3	24,089	10,216	34,305	11.5%
4	32,118	13,621	45,739	15.4%
5	40,148	17,026	57,174	19.2%
6	48,178	20,431	68,609	23.1%
7	56,207	23,836	80,043	26.9%
8	64,237	27,242	91,479	30.7%
9	72,266	30,647	102,913	34.6%
10	80,296	34,052	114,348	38.4%
11	88,326	37,457	125,783	42.3%
12	96,355	40,862	137,217	46.1%
13	104,385	44,268	148,653	50.0%
14	112,415	47,673	160,088	53.8%
15	120,444	51,078	171,522	57.6%
16	128,474	54,483	182,957	61.5%
17	136,503	57,888	194,391	65.3%
18	144,533	61,294	205,827	69.2%
19	152,563	64,699	217,262	73.0%
20	160,592	68,104	228,696	76.8%
21	168,622	71,509	240,131	80.7%
22	176,651	74,915	251,566	84.5%
23	184,681	78,320	263,001	88.4%
24	192,711	81,725	274,436	92.2%
25	200,740	85,130	285,870	96.1%
26	208,770	88,535	297,305	99.9%
27	216,799	91,941	308,740	103.7%
28	224,829	95,346	320,175	107.6%
29	232,859	98,751	331,610	111.4%
30	240,888	102,156	343,044	115.3%
JRR Sediment Goal: 297,600 tons per year				

8A. Information & Education in the NELC

The NELC SLT has determined which Information and Education (I&E) activities are needed in the Neosho Headwaters (including Eagle Creek) and Lower Cottonwood portions of the JRR Watershed. These important activities provide watershed residents with a higher awareness of local watershed issues which leads to increased adoption rates of BMPs. All I&E activities and events are evaluated based on productivity, attendance and achievement of objectives.

A. I&E Activities and Events Scheduled in the NELC

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 **$76,050**. *It is understood that monies from non-WRAPS sources will be required to fund all activities listed in the following tables.*

Table 57. I&E: Cropland BMP Education in the NELC

Cropland BMP Implementation					
BMP	**Target Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
Riparian Buffers	Landowners and Farmers	Demonstration Projects	Annual – Spring	$5,000 per project	KAWS WRAPS Conservation Districts
		Tour/Field Day highlighting grassed buffers	Annual - Summer	$1,000 per tour	KAWS WRAPS Conservation Districts
		Tour/Field Day highlighting forestry-BMPs	Annual – Summer	$1,700 per tour	Kansas Forest Service
		One-on-One Technical Assistance for Landowners	Annual - Ongoing	No cost	NRCS Conservation Technician
Conservation Crop Rotations	Landowners and Producers	One-on-one	Annual - ongoing	No cost	NRCS, EQIP
No-Till	Farmers and Rental Operators	Scholarships for 5 farmers to attend No-Till Winter Conference	Annual – Winter	$750 ($150 per person)	No-till on the Plains
		Tour/Field Day	Annual – Summer	$1,500	
		One-on-one Technical Assistance for Farmers	Annual - Ongoing	$5,000 per year	
		Seasonal Informational Meetings (planting)	Annual – spring (plant) summer (harvest)	$5,500	
Nutrient Management Plans	Producers	One-on-one Technical Assistance for producers	Ongoing	No cost	NRCS, KSU Watershed Specialists, COOP Agronomist
Permanent Vegetation	Producers	One-on-one Technical Assistance	Ongoing	No cost	NRCS, Conservation Districts
Terraces	Farmers	Tour/Field Day	Annual – Summer	$1,500 per tour	Conservation Districts
Waterways	Farmers	Tour/Field Day	Annual – Summer	$1,500 per tour (included with terraces)	Conservation Districts

Table 58. I&E: Livestock BMP Education in the NELC

Livestock BMP Implementation					
BMP	**Target Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
Vegetative Filter Strips	Landowners and Ranchers	Demonstration Projects	Annual – Spring	Combined with riparian buffer demonstrations	Flint Hills RC&D C onservation Districts
		Tour/Field Day	Annual - Summer	Combined with riparian buffer tour	Flint Hills RC&D Conservation Districts
		One-on-One Technical Assistance for Landowners	Annual - Ongoing	No cost	NRCS Conservation Technician
Fenced-off Streams	Landowners and Ranchers	Demonstration Projects	Annual - Summer	$2,000 per project	WRAPS, NRCS, Conservation Districts
		Tour/Field Day	Annual - Summer	$2,000 per tour	Kansas Rural Center
Relocate Pasture Feeding Sites	Ranchers	Demonstration Project	Annual – Spring	$5,000 per project	WRAPS, NRCS, Conservation Districts
		Tour/Field Day	Annual - Summer	$500 per tour	WRAPS, NRCS, Conservation Districts
		Informational Meeting/ Workshop	Annual - Fall	$500 per meeting	WRAPS, NRCS, Conservation Districts
Off-stream Watering System	Ranchers	Demonstration projects for pond construction and spring developments	Annual - Fall	$10,000 per project	WRAPS, NRCS, Conservation Districts
		Tour/Field Day	Annual - Summer	$500 per tour	WRAPS, NRCS, Conservation Districts
		Informational Meeting/ Workshop	Annual - Fall	Combine with relocating pasture feeding sites meeting	WRAPS, NRCS, Conservation Districts
Rotational Grazing	Ranchers	Tour/Field Day	Annual – Spring	$500 per tour	WRAPS, NRCS, Conservation Districts

Table 59. I&E: Streambank BMP Education in the NELC

Streambank BMP Implementation					
BMP	**Target Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
Streambank Stabilization	Landowners	One-on-One Technical Assistance for Landowners	Annual – Ongoing	Varies by project	Consulting firms/agencies providing engineering/design services (TBD)
		Tour highlighting completed stabilization projects	Annual - Summer	$2,000 per tour	WRAPS funds through KAWS

Table 60. I&E: Watershed Resident Education in the NELC

General / Watershed-Wide Information and Education					
BMP	**Target Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
Education Activities Targeting Youth	Students and Educators	Day on the Farm	Annual – Spring	$500 per event	County Farm Bureaus
					Kansas FFA Organization
		Poster, essay, speech contests promoting water quality	Annual – Spring	$200	Conservation Districts
		Envirothon	Annual - Spring	$250	Conservation Districts
		Curriculum workshop for K-12 educators	Annual - Summer	$2,000 per workshop	KACEE
		Environmental education	Ongoing	$5,000 per year	Project EARTH
		Service learning project	Ongoing	$5,000 per year	Water Link
Education Activities Targeting Adults	Watershed Residents	Newspaper/newsletter articles	Annual – Ongoing	No cost	Conservation Districts
					Kansas State Research and Extension
		Presentation about water quality issues & WRAPS update at annual meetings	Annual – Winter	No cost	Conservation Districts
					Kansas State Research and Extension
					Flint Hills RC&D
		Educational campaign about leaking/failing septic systems	Ongoing	$1,500 per year	Local Environmental Protection Programs
		Healthy Ecosystems – Healthy Communities	Ongoing	$15,000 per year	Kansas PRIDE Program
Total Cost (per year) for All Information and Education Activities				**$76,050**	

B. Evaluation of Information and Education Activities

All service providers conducting I&E activities funded through the JRR 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.

8B. Information & Education in Upper Cottonwood

The Upper Cottonwood SLT has determined which Information and Education (I&E) activities are needed in the Upper Cottonwood portion of the JRR Watershed. These important activities provide watershed residents with a higher awareness of local watershed issues which leads to increased adoption rates of BMPs. All I&E activities and events are evaluated based on productivity, attendance and achievement of objectives.

A. I&E Activities and Events Scheduled in the Upper Cottonwood

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 **$138,000**. *It is understood that monies from non-WRAPS sources will be required to fund all events and activities listed in the following tables.*

Table 61. I&E: Cropland BMP Education in the Upper Cottonwood

Cropland BMP Implementation					
BMP	**Target Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
Buffers	Farmers in cropland targeted areas	Workshop/field day	Annual - spring	$5,000	Kansas State Research and Extension
					Conservation Districts
					Flint Hills RC&D
		One-on-one technical assistance	Annual - ongoing	No cost	Conservation Districts
					NRCS
		Forestry Field Day	Annual	$3,000	Kansas Forest Service
		One-on-one technical assistance for producers to implement BMPs in the targeted area	Annual	No cost	Conservation Districts
					NRCS
		One-on-one technical assistance for riparian tree planting	Annual, Ongoing	$10,000	Kansas Forest Service
Conservation Crop Rotation	Farmers in cropland targeted areas	One-on-one technical assistance for producers to implement BMPs in the targeted area.	Annual	No cost	Conservation Districts
					NRCS
		Workshop/Field Day	Annual, Spring	Included in costs above	Conservation Districts
					Kansas State Research and Extension
					Flint Hills RC&D
No-Till with Cover Crops	Farmers in cropland targeted areas	Scholarships for producers to attend No-Till on the Plains Annual Conference	Annual, Winter	5 per year, $150 per scholarship	No-Till on the Plains
		Workshop/Field Day	Annual, Spring	Included in costs above	Conservation Districts
					Kansas State Research and Extension
					Flint Hills RC&D
		One-on-one technical assistance for producers to implement BMPs in the targeted area	Annual	No cost	Conservation District
					NRCS
Nutrient Management Plans	Producers	One-on-one Technical Assistance for producers	Ongoing	No cost	NRCS, KSU Watershed Specialists, COOP Agronomist
Permanent Vegetation	Farmers in cropland targeted areas	Workshop/Field day	Annual, Spring	$2,000	Conservation Districts
					Kansas State Research and Extension
					Flint Hills RC&D
		Forestry field day	Annual	$3,000	Kansas Forest Service
Terraces	Farmers in cropland targeted areas	One-on-one technical assistance for producers to implement BMPs in the targeted area	Annual	No cost	Conservation Districts
					NRCS
		Workshop/Field Day	Annual, Spring	Included in above	Conservation Districts
					Kansas State Research and Extension
					Flint Hills RC&D
Waterways	Farmers in cropland targeted areas	One-on-one technical assistance for producers to implement BMPs in the targeted area.	Annual	No cost	Conservation Districts
					NRCS

Table 62. I&E: Livestock BMP Education in the Upper Cottonwood

Livestock BMP Implementation					
BMP	**Target Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
Fenced-off Streams	Producers in livestock targeted areas	One-on-one technical assistance	Annual	$10,000	Conservation Districts NRCS Kansas State Research and Extension
		Tour/Field Day	Annual, Summer	$2,500	Kansas Rural Center Kansas State Research and Extension Conservation Districts NRCS
Off-stream Watering Systems	Producers in livestock targeted areas	Tour/Field Day	Annual, Summer	Included in costs above	Kansas Rural Center Kansas State Research and Extension Conservation Districts NRCS
		Scholarships to Grazing Schools and Workshops	Annual, Winter	$7,000	Kansas Rural Center Kansas State Research and Extension Kansas Grazer's Association
		One-on-one technical assistance for producers to implement BMPs in the targeted area	Annual, Ongoing	Included in costs above	Kansas State Research and Extension Conservation Districts NRCS
Filter Strips	Producers in livestock targeted areas	Tour/Field Day	Annual, Summer	Included in costs above	Kansas State Research and Extension Conservation Districts NRCS
		One-on-one technical assistance for producers to implement BMPs in the targeted area	Annual, Ongoing	Included in costs above	Conservation Districts NRCS
Relocate Pasture Feeding Sites	Producers in livestock targeted areas	Tour/Field Day	Annual, Summer	$5,000	Kansas Rural Center Kansas State Research and Extension Conservation Districts NRCS
		Scholarships to Grazing Schools and Workshops	Annual, Winter	5 per year, $50 per scholarships	Kansas Rural Center Kansas State Research and Extension Kansas Grazer's Association
		One-on-one technical assistance for producers to implement BMPs in the targeted area	Annual, Ongoing	$17,500	Kansas State Research and Extension Conservation Districts NRCS
		One-on-one technical assistance to remove livestock from riparian area	Annual, Ongoing	$4,000	Kansas Forest Service
Rotational Grazing	Producers in livestock targeted areas	Tour/Field Day	Annual - summer	$2,500	Kansas Rural Center Kansas State Research and Extension Conservation Districts NRCS
		One-on-one technical assistance	Annual	$10,000	Kansas Rural Center Kansas State Research and Extension

Table 63. I&E: Streambank BMP Education in the Upper Cottonwood

Streambank BMP Implementation					
BMP	**Target Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
Streambank Stabilization	Farmers/ landowner	Workshop/Field Day	Annual, Spring	Included in cropland workshop/field day listed in previous tables.	Conservation Districts
					Kansas State Research and Extension
					FH RC&D
					TWI
					KAWS
		Forestry Field Day	Annual	$3,000	Kansas Forest Service
		One-on-one technical assistance for producers to implement BMPs in the targeted area.	Annual	No Cost	Conservation Districts
					NRCS
		One-on-one technical assistance for riparian tree planting	Annual, ongoing	Included above	Kansas Forest Service

Table 64. I&E: Watershed Resident Education in the Upper Cottonwood

General Watershed Information and Education					
BMP	**Target Audience**	**Information/Education Activity/Event**	**Time Frame**	**Estimated Costs**	**Sponsor/Responsible Agency**
Educational Activities Targeting Youth	Educators, K-12 Students	Envirothon	Annual	No cost	Conservation Districts
					KACEE
		Day on the Farm	Annual	No cost	Conservation Districts
					KACEE
		Poster, essay, and speech contests	Annual	No cost	Conservation Districts
					KACEE
		Water Festival	Annual	$5,000	Conservation Districts
					Kansas State Research and Extension
					Flint Hills RC&D
					KACEE
Educational Activities Targeting Adults	Watershed residents	BMP Auction	Annual	$10,000	Kansas State Research and Extension
					Conservation Districts
					KACEE
		River Friendly Farms	Annual	$20,000	Kansas Rural Center
		Healthy Ecosystems – Healthy Communities	Annual, Ongoing	$17,500	Kansas PRIDE
Total Cost (per year) for All Information and Education Activities				**$138,000**	

B. Evaluation of Information and Education Activities

All service providers conducting I&E activities funded through the JRR 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.

9A. NELC Implementation Costs

The NELC SLT reviewed all the recommended BMPs listed in this WRAPS plan to address the siltation and eutrophication TMDLs and determined which BMPs will receive implementation funding in each category (cropland, livestock and streambank areas). An added benefit is that most of the targeted BMPs will have positive impacts on other impairments in the JRR Watershed. Below are expenses before and after cost-share for implementing cropland, livestock and streambank BMPs. Costs can be shared with any potential funding sources (**Table 79**). Cost derivations are located in the appendix.

A. Cropland BMP Implementation Costs in the NELC

Table 65. Implementation Costs: Cropland BMP Costs Before Cost-Share

Cropland BMPs, Annual Cost Before Cost-Share								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Cost
1	$154,235	$15,133	$135,805	$22,117	$21,729	$39,577	$281,310	$669,906
2	$158,863	$15,587	$139,879	$22,780	$22,381	$40,765	$289,749	$690,003
3	$163,628	$16,054	$144,075	$23,464	$23,052	$41,988	$298,442	$710,703
4	$168,537	$16,536	$148,398	$24,168	$23,744	$43,247	$307,395	$732,024
5	$173,593	$17,032	$152,850	$24,893	$24,456	$44,545	$316,617	$753,985
6	$178,801	$17,543	$157,435	$25,639	$25,190	$45,881	$326,115	$776,604
7	$184,165	$18,069	$162,158	$26,409	$25,945	$47,257	$335,899	$799,903
8	$189,690	$18,611	$167,023	$27,201	$26,724	$48,675	$345,976	$823,900
9	$195,381	$19,169	$172,034	$28,017	$27,525	$50,135	$356,355	$848,617
10	$201,242	$19,745	$177,195	$28,857	$28,351	$51,640	$367,046	$874,075
11	$207,280	$20,337	$182,510	$29,723	$29,202	$53,189	$378,057	$900,297
12	$213,498	$20,947	$187,986	$30,615	$30,078	$54,784	$389,399	$927,306
13	$219,903	$21,575	$193,625	$31,533	$30,980	$56,428	$401,081	$955,126
14	$226,500	$22,223	$199,434	$32,479	$31,909	$58,121	$413,113	$983,779
15	$233,295	$22,889	$205,417	$33,454	$32,867	$59,864	$425,507	$1,013,293
16	$240,294	$23,576	$211,580	$34,457	$33,853	$61,660	$438,272	$1,043,691
17	$247,503	$24,283	$217,927	$35,491	$34,868	$63,510	$451,420	$1,075,002
18	$254,928	$25,012	$224,465	$36,556	$35,914	$65,415	$464,963	$1,107,252
19	$262,576	$25,762	$231,199	$37,652	$36,992	$67,378	$478,911	$1,140,470
20	$270,453	$26,535	$238,135	$38,782	$38,102	$69,399	$493,279	$1,174,684
21	$278,566	$27,331	$245,279	$39,945	$39,245	$71,481	$508,077	$1,209,924
22	$286,923	$28,151	$252,637	$41,144	$40,422	$73,626	$523,319	$1,246,222
23	$295,531	$28,996	$260,216	$42,378	$41,635	$75,834	$539,019	$1,283,609
24	$304,397	$29,865	$268,023	$43,649	$42,884	$78,109	$555,190	$1,322,117
25	$313,529	$30,761	$276,063	$44,959	$44,170	$80,453	$571,845	$1,361,781
26	$322,935	$31,684	$284,345	$46,308	$45,495	$82,866	$589,001	$1,402,634
27	$332,623	$32,635	$292,876	$47,697	$46,860	$85,352	$606,671	$1,444,713
28	$342,602	$33,614	$301,662	$49,128	$48,266	$87,913	$624,871	$1,488,055
29	$352,880	$34,622	$310,712	$50,602	$49,714	$90,550	$643,617	$1,532,696
30	$363,466	$35,661	$320,033	$52,120	$51,205	$93,267	$662,925	$1,578,677
3% Inflation							Total	$31,871,049

Table 66. Implementation Costs: Cropland BMP Costs After Cost-Share

Cropland BMPs, Annual Cost After Cost-Share								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Cost
1	$15,424	$15,133	$13,580	$2,212	$2,173	$39,577	$28,131	$116,230
2	$15,886	$15,587	$13,988	$2,278	$2,238	$40,765	$28,975	$119,716
3	$16,363	$16,054	$14,408	$2,346	$2,305	$41,988	$29,844	$123,308
4	$16,854	$16,536	$14,840	$2,417	$2,374	$43,247	$30,740	$127,007
5	$17,359	$17,032	$15,285	$2,489	$2,446	$44,545	$31,662	$130,817
6	$17,880	$17,543	$15,744	$2,564	$2,519	$45,881	$32,612	$134,742
7	$18,417	$18,069	$16,216	$2,641	$2,595	$47,257	$33,590	$138,784
8	$18,969	$18,611	$16,702	$2,720	$2,672	$48,675	$34,598	$142,948
9	$19,538	$19,169	$17,203	$2,802	$2,753	$50,135	$35,636	$147,236
10	$20,124	$19,745	$17,719	$2,886	$2,835	$51,640	$36,705	$151,653
11	$20,728	$20,337	$18,251	$2,972	$2,920	$53,189	$37,806	$156,203
12	$21,350	$20,947	$18,799	$3,061	$3,008	$54,784	$38,940	$160,889
13	$21,990	$21,575	$19,363	$3,153	$3,098	$56,428	$40,108	$165,716
14	$22,650	$22,223	$19,943	$3,248	$3,191	$58,121	$41,311	$170,687
15	$23,330	$22,889	$20,542	$3,345	$3,287	$59,864	$42,551	$175,808
16	$24,029	$23,576	$21,158	$3,446	$3,385	$61,660	$43,827	$181,082
17	$24,750	$24,283	$21,793	$3,549	$3,487	$63,510	$45,142	$186,514
18	$25,493	$25,012	$22,446	$3,656	$3,591	$65,415	$46,496	$192,110
19	$26,258	$25,762	$23,120	$3,765	$3,699	$67,378	$47,891	$197,873
20	$27,045	$26,535	$23,813	$3,878	$3,810	$69,399	$49,328	$203,809
21	$27,857	$27,331	$24,528	$3,995	$3,924	$71,481	$50,808	$209,923
22	$28,692	$28,151	$25,264	$4,114	$4,042	$73,626	$52,332	$216,221
23	$29,553	$28,996	$26,022	$4,238	$4,163	$75,834	$53,902	$222,708
24	$30,440	$29,865	$26,802	$4,365	$4,288	$78,109	$55,519	$229,389
25	$31,353	$30,761	$27,606	$4,496	$4,417	$80,453	$57,185	$236,271
26	$32,293	$31,684	$28,435	$4,631	$4,550	$82,866	$58,900	$243,359
27	$33,262	$32,635	$29,288	$4,770	$4,686	$85,352	$60,667	$250,660
28	$34,260	$33,614	$30,166	$4,913	$4,827	$87,913	$62,487	$258,179
29	$35,288	$34,622	$31,071	$5,060	$4,971	$90,550	$64,362	$265,925
30	$36,347	$35,661	$32,003	$5,212	$5,121	$93,267	$66,293	$273,903
3% Inflation							Total	$5,529,669

B. Livestock BMP Implementation Costs in the NELC

Table 67. Implementation Costs: Livestock BMPs Before Cost-Share

Livestock BMPs, Annual Cost Before Cost-Share						
Year	Filter Strip	Fence Off Streams	Relocate Pasture Feeding Site	Off-stream Watering System	Rotational Grazing	Annual Cost
1	$1,428	$8,212	$4,406	$7,590	$7,000	$28,636
2	$2,206	$0	$4,538	$7,818	$14,420	$28,982
3	$1,515	$8,712	$4,674	$8,052	$7,426	$30,380
4	$2,341	$0	$4,815	$8,294	$15,298	$30,747
5	$1,607	$9,243	$4,959	$8,543	$7,879	$32,230
6	$2,483	$0	$5,108	$8,799	$16,230	$32,620
7	$1,705	$9,806	$5,261	$9,063	$8,358	$34,193
8	$2,634	$0	$5,419	$9,335	$17,218	$34,606
9	$1,809	$10,403	$5,581	$9,615	$8,867	$36,275
10	$2,795	$0	$5,749	$9,903	$18,267	$36,714
11	$1,919	$11,036	$5,921	$10,200	$9,407	$38,484
12	$2,965	$0	$6,099	$10,506	$19,379	$38,950
13	$2,036	$11,708	$6,282	$10,822	$9,980	$40,828
14	$3,146	$0	$6,470	$11,146	$20,559	$41,322
15	$2,160	$12,421	$6,664	$11,481	$10,588	$43,315
16	$3,337	$0	$6,864	$11,825	$21,812	$43,838
17	$2,292	$13,178	$7,070	$12,180	$11,233	$45,952
18	$3,540	$0	$7,282	$12,545	$23,140	$46,508
19	$2,431	$13,980	$7,501	$12,921	$11,917	$48,751
20	$3,756	$0	$7,726	$13,309	$24,549	$49,340
21	$2,579	$14,832	$7,958	$13,708	$12,643	$51,720
22	$3,985	$0	$8,196	$14,120	$26,044	$52,345
23	$2,736	$15,735	$8,442	$14,543	$13,413	$54,870
24	$4,227	$0	$8,696	$14,980	$27,630	$55,533
25	$2,903	$16,693	$8,956	$15,429	$14,230	$58,211
26	$4,485	$0	$9,225	$15,892	$29,313	$58,915
27	$3,080	$17,710	$9,502	$16,369	$15,096	$61,756
28	$4,758	$0	$9,787	$16,860	$31,098	$62,503
29	$3,267	$18,788	$10,081	$17,365	$16,015	$65,517
30	$5,048	$0	$10,383	$17,886	$32,992	$66,309
3% Inflation					Total	$1,350,348

Table 68. Implementation Costs: Livestock BMPs After Cost-Share

Livestock BMPs, Annual Cost After Cost-Share						
Year	Filter Strip	Fence Off Streams	Relocate Pasture Feeding Site	Off-stream Watering System	Rotational Grazing	Annual Cost
1	$714	$4,106	$2,203	$3,795	$3,500	$14,318
2	$1,103	$0	$2,269	$3,909	$7,210	$14,491
3	$757	$4,356	$2,337	$4,026	$3,713	$15,190
4	$1,170	$0	$2,407	$4,147	$7,649	$15,374
5	$804	$4,621	$2,479	$4,271	$3,939	$16,115
6	$1,242	$0	$2,554	$4,399	$8,115	$16,310
7	$853	$4,903	$2,630	$4,531	$4,179	$17,096
8	$1,317	$0	$2,709	$4,667	$8,609	$17,303
9	$904	$5,201	$2,791	$4,807	$4,434	$18,138
10	$1,397	$0	$2,874	$4,952	$9,133	$18,357
11	$960	$5,518	$2,961	$5,100	$4,704	$19,242
12	$1,483	$0	$3,049	$5,253	$9,690	$19,475
13	$1,018	$5,854	$3,141	$5,411	$4,990	$20,414
14	$1,573	$0	$3,235	$5,573	$10,280	$20,661
15	$1,080	$6,211	$3,332	$5,740	$5,294	$21,657
16	$1,669	$0	$3,432	$5,912	$10,906	$21,919
17	$1,146	$6,589	$3,535	$6,090	$5,616	$22,976
18	$1,770	$0	$3,641	$6,273	$11,570	$23,254
19	$1,216	$6,990	$3,750	$6,461	$5,959	$24,375
20	$1,878	$0	$3,863	$6,655	$12,275	$24,670
21	$1,290	$7,416	$3,979	$6,854	$6,321	$25,860
22	$1,992	$0	$4,098	$7,060	$13,022	$26,172
23	$1,368	$7,868	$4,221	$7,272	$6,706	$27,435
24	$2,114	$0	$4,348	$7,490	$13,815	$27,766
25	$1,451	$8,347	$4,478	$7,714	$7,115	$29,106
26	$2,242	$0	$4,613	$7,946	$14,656	$29,457
27	$1,540	$8,855	$4,751	$8,184	$7,548	$30,878
28	$2,379	$0	$4,893	$8,430	$15,549	$31,251
29	$1,634	$9,394	$5,040	$8,683	$8,008	$32,759
30	$2,524	$0	$5,192	$8,943	$16,496	$33,155
3% Inflation					Total	$675,174

C. Streambank Restoration Costs in the NELC

Table 69. Implementation Costs: Streambank Restoration

Annual Streambank Restoration Cost		
Year	Streambank Stabilization (feet)	Cost*
1	3,234	$312,340
2	3,234	$321,710
3	3,234	$331,361
4	3,234	$341,302
5	3,234	$351,541
6	3,234	$362,087
7	3,234	$372,950
8	3,234	$384,138
9	3,234	$395,663
10	3,234	$407,532
11	3,234	$419,758
12	3,234	$432,351
13	3,234	$445,322
14	3,234	$458,681
15	3,234	$472,442
16	3,234	$486,615
17	3,234	$501,214
18	3,234	$516,250
19	3,234	$531,737
20	3,234	$547,690
21	3,234	$564,120
22	3,234	$581,044
23	3,234	$598,475
24	3,234	$616,429
25	3,234	$634,922
26	3,234	$653,970
27	3,234	$673,589
28	3,234	$693,797
29	3,234	$714,611
30	3,234	$736,049
3% Inflation	**Total**	**$14,859,692**
*$96.58 per foot		

D. Total Costs for BMP Implementation and Education in the NELC

Table 70. NELC BMP Implementation Total Costs: After Cost-Share

NELC Total Annual Cost after Cost-Share for BMPs and Education					
Year	Cropland	Livestock	Streambank	I & E	Total Cost
1	$116,230	$14,318	$312,340	$76,050	$442,888
2	$119,716	$14,491	$321,710	$78,332	$455,917
3	$123,308	$15,190	$331,361	$80,681	$469,859
4	$127,007	$15,374	$341,302	$83,102	$483,683
5	$130,817	$16,115	$351,541	$85,595	$498,473
6	$134,742	$16,310	$362,087	$88,163	$513,139
7	$138,784	$17,096	$372,950	$90,808	$528,830
8	$142,948	$17,303	$384,138	$93,532	$544,389
9	$147,236	$18,138	$395,663	$96,338	$561,037
10	$151,653	$18,357	$407,532	$99,228	$577,542
11	$156,203	$19,242	$419,758	$102,205	$595,203
12	$160,889	$19,475	$432,351	$105,271	$612,715
13	$165,716	$20,414	$445,322	$108,429	$631,452
14	$170,687	$20,661	$458,681	$111,682	$650,029
15	$175,808	$21,657	$472,442	$115,032	$669,907
16	$181,082	$21,919	$486,615	$118,483	$689,616
17	$186,514	$22,976	$501,214	$122,038	$710,704
18	$192,110	$23,254	$516,250	$125,699	$731,614
19	$197,873	$24,375	$531,737	$129,470	$753,985
20	$203,809	$24,670	$547,690	$133,354	$776,169
21	$209,923	$25,860	$564,120	$137,355	$799,903
22	$216,221	$26,172	$581,044	$141,475	$823,437
23	$222,708	$27,435	$598,475	$145,720	$848,618
24	$229,389	$27,766	$616,429	$150,091	$873,584
25	$236,271	$29,106	$634,922	$154,594	$900,299
26	$243,359	$29,457	$653,970	$159,232	$926,786
27	$250,660	$30,878	$673,589	$164,009	$955,127
28	$258,179	$31,251	$693,797	$168,929	$983,227
29	$265,925	$32,759	$714,611	$173,997	$1,013,295
30	$273,903	$33,155	$736,049	$179,217	$1,043,107
Total Cost	**$5,529,669**	**$675,174**	**$14,859,692**	**$184,593**	**$21,064,536**
3% Inflation					

9B. Upper Cottonwood Costs

The Upper Cottonwood SLT reviewed all the recommended BMPs listed in this WRAPS plan to address the siltation and eutrophication TMDLs and determined which BMPs will receive implementation funding in each category (cropland, livestock, and streambank areas). As an added benefit, most of the targeted BMPs will have positive impacts on other impairments in the JRR Watershed. Below are expenses before and after cost-share for implementing cropland, livestock, and streambank BMPs. Costs can be shared with any potential funding sources (**Table 74**). Cost derivations are located in the appendix.

A. Cropland BMP Implementation Costs in the Upper Cottonwood

Table 71. Implementation Costs: Cropland BMP Costs Before Cost-Share

Cropland BMPs, Annual Cost Before Cost-Share								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Cost
1	$168,589	$27,568	$141,375	$30,219	$19,792	$72,101	$307,490	$767,134
2	$173,647	$28,395	$145,616	$31,125	$20,386	$74,264	$316,715	$790,148
3	$178,856	$29,247	$149,984	$32,059	$20,998	$76,492	$326,216	$813,853
4	$184,222	$30,124	$154,484	$33,021	$21,628	$78,787	$336,003	$838,268
5	$189,749	$31,028	$159,118	$34,012	$22,277	$81,150	$346,083	$863,416
6	$195,441	$31,959	$163,892	$35,032	$22,945	$83,585	$356,465	$889,319
7	$201,304	$32,918	$168,809	$36,083	$23,633	$86,092	$367,159	$915,998
8	$207,344	$33,905	$173,873	$37,165	$24,342	$88,675	$378,174	$943,478
9	$213,564	$34,922	$179,089	$38,280	$25,072	$91,335	$389,519	$971,783
10	$219,971	$35,970	$184,462	$39,429	$25,825	$94,076	$401,205	$1,000,936
11	$226,570	$37,049	$189,996	$40,612	$26,599	$96,898	$413,241	$1,030,964
12	$233,367	$38,161	$195,696	$41,830	$27,397	$99,805	$425,638	$1,061,893
13	$240,368	$39,305	$201,566	$43,085	$28,219	$102,799	$438,407	$1,093,750
14	$247,579	$40,485	$207,613	$44,377	$29,066	$105,883	$451,559	$1,126,563
15	$255,006	$41,699	$213,842	$45,709	$29,938	$109,059	$465,106	$1,160,359
16	$262,657	$42,950	$220,257	$47,080	$30,836	$112,331	$479,059	$1,195,170
17	$270,536	$44,239	$226,865	$48,492	$31,761	$115,701	$493,431	$1,231,025
18	$278,652	$45,566	$233,671	$49,947	$32,714	$119,172	$508,234	$1,267,956
19	$287,012	$46,933	$240,681	$51,446	$33,695	$122,747	$523,481	$1,305,995
20	$295,622	$48,341	$247,901	$52,989	$34,706	$126,430	$539,185	$1,345,175
21	$304,491	$49,791	$255,338	$54,579	$35,747	$130,223	$555,361	$1,385,530
22	$313,626	$51,285	$262,999	$56,216	$36,820	$134,129	$572,022	$1,427,096
23	$323,035	$52,823	$270,888	$57,902	$37,924	$138,153	$589,182	$1,469,909
24	$332,726	$54,408	$279,015	$59,639	$39,062	$142,298	$606,858	$1,514,006
25	$342,707	$56,040	$287,386	$61,429	$40,234	$146,567	$625,064	$1,559,426
26	$352,989	$57,721	$296,007	$63,272	$41,441	$150,964	$643,816	$1,606,209
27	$363,578	$59,453	$304,887	$65,170	$42,684	$155,493	$663,130	$1,654,395
28	$374,486	$61,237	$314,034	$67,125	$43,965	$160,157	$683,024	$1,704,027
29	$385,720	$63,074	$323,455	$69,139	$45,284	$164,962	$703,515	$1,755,148
30	$397,292	$64,966	$333,159	$71,213	$46,642	$169,911	$724,620	$1,807,802
3% Inflation							Total	$36,496,733

Table 72. Implementation Costs: Cropland BMP Costs After Cost-Share

Cropland BMPs, Annual Cost After Cost-Share								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Cost
1	$16,859	$27,568	$14,137	$3,022	$1,979	$72,101	$30,749	$166,416
2	$17,365	$28,395	$14,562	$3,113	$2,039	$74,264	$31,671	$171,408
3	$17,886	$29,247	$14,998	$3,206	$2,100	$76,492	$32,622	$176,550
4	$18,422	$30,124	$15,448	$3,302	$2,163	$78,787	$33,600	$181,847
5	$18,975	$31,028	$15,912	$3,401	$2,228	$81,150	$34,608	$187,302
6	$19,544	$31,959	$16,389	$3,503	$2,294	$83,585	$35,647	$192,921
7	$20,130	$32,918	$16,881	$3,608	$2,363	$86,092	$36,716	$198,709
8	$20,734	$33,905	$17,387	$3,717	$2,434	$88,675	$37,817	$204,670
9	$21,356	$34,922	$17,909	$3,828	$2,507	$91,335	$38,952	$210,810
10	$21,997	$35,970	$18,446	$3,943	$2,582	$94,076	$40,120	$217,135
11	$22,657	$37,049	$19,000	$4,061	$2,660	$96,898	$41,324	$223,649
12	$23,337	$38,161	$19,570	$4,183	$2,740	$99,805	$42,564	$230,358
13	$24,037	$39,305	$20,157	$4,308	$2,822	$102,799	$43,841	$237,269
14	$24,758	$40,485	$20,761	$4,438	$2,907	$105,883	$45,156	$244,387
15	$25,501	$41,699	$21,384	$4,571	$2,994	$109,059	$46,511	$251,719
16	$26,266	$42,950	$22,026	$4,708	$3,084	$112,331	$47,906	$259,270
17	$27,054	$44,239	$22,686	$4,849	$3,176	$115,701	$49,343	$267,048
18	$27,865	$45,566	$23,367	$4,995	$3,271	$119,172	$50,823	$275,060
19	$28,701	$46,933	$24,068	$5,145	$3,370	$122,747	$52,348	$283,312
20	$29,562	$48,341	$24,790	$5,299	$3,471	$126,430	$53,919	$291,811
21	$30,449	$49,791	$25,534	$5,458	$3,575	$130,223	$55,536	$300,565
22	$31,363	$51,285	$26,300	$5,622	$3,682	$134,129	$57,202	$309,582
23	$32,303	$52,823	$27,089	$5,790	$3,792	$138,153	$58,918	$318,870
24	$33,273	$54,408	$27,902	$5,964	$3,906	$142,298	$60,686	$328,436
25	$34,271	$56,040	$28,739	$6,143	$4,023	$146,567	$62,506	$338,289
26	$35,299	$57,721	$29,601	$6,327	$4,144	$150,964	$64,382	$348,437
27	$36,358	$59,453	$30,489	$6,517	$4,268	$155,493	$66,313	$358,891
28	$37,449	$61,237	$31,403	$6,712	$4,396	$160,157	$68,302	$369,657
29	$38,572	$63,074	$32,346	$6,914	$4,528	$164,962	$70,351	$380,747
30	$39,729	$64,966	$33,316	$7,121	$4,664	$169,911	$72,462	$392,169
3% Inflation							Total	$7,917,294

B. Livestock BMP Implementation Costs in the Upper Cottonwood

Table 73. Implementation Costs: Livestock BMPs Before Cost-Share

Livestock BMPs, Annual Cost Before Cost-Share						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Annual Cost
1	$4,106	$714	$3,795	$2,203	$7,000	$17,818
2	$0	$735	$3,909	$2,269	$0	$6,913
3	$4,356	$757	$4,026	$2,337	$7,426	$18,903
4	$0	$780	$4,147	$2,407	$0	$7,334
5	$4,621	$804	$4,271	$2,479	$7,879	$20,054
6	$0	$828	$4,399	$2,554	$0	$7,781
7	$4,903	$853	$4,531	$2,630	$8,358	$21,276
8	$0	$878	$4,667	$2,709	$0	$8,255
9	$5,201	$904	$4,807	$2,791	$8,867	$22,571
10	$0	$932	$4,952	$2,874	$0	$8,758
11	$5,518	$960	$5,100	$2,961	$9,407	$23,946
12	$0	$988	$5,253	$3,049	$0	$9,291
13	$5,854	$1,018	$5,411	$3,141	$9,980	$25,404
14	$0	$1,049	$5,573	$3,235	$0	$9,857
15	$6,211	$1,080	$5,740	$3,332	$10,588	$26,951
16	$0	$1,112	$5,912	$3,432	$0	$10,457
17	$6,589	$1,146	$6,090	$3,535	$11,233	$28,593
18	$0	$1,180	$6,273	$3,641	$0	$11,094
19	$6,990	$1,216	$6,461	$3,750	$11,917	$30,334
20	$0	$1,252	$6,655	$3,863	$0	$11,770
21	$7,416	$1,290	$6,854	$3,979	$12,643	$32,181
22	$0	$1,328	$7,060	$4,098	$0	$12,486
23	$7,868	$1,368	$7,272	$4,221	$13,413	$34,141
24	$0	$1,409	$7,490	$4,348	$0	$13,247
25	$8,347	$1,451	$7,714	$4,478	$14,230	$36,220
26	$0	$1,495	$7,946	$4,613	$0	$14,053
27	$8,855	$1,540	$8,184	$4,751	$15,096	$38,426
28	$0	$1,586	$8,430	$4,893	$0	$14,909
29	$9,394	$1,634	$8,683	$5,040	$16,015	$40,766
30	$0	$1,683	$8,943	$5,192	$0	$15,817
3% inflation					Total	$579,608

Table 74. Implementation Costs: Livestock BMPs After Cost-Share

Livestock BMPs, Annual Cost After Cost-Share						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Annual Cost
1	$2,053	$357	$1,898	$1,102	$3,500	$8,909
2	$0	$368	$1,954	$1,135	$0	$3,457
3	$2,178	$379	$2,013	$1,169	$3,713	$9,452
4	$0	$390	$2,073	$1,204	$0	$3,667
5	$2,311	$402	$2,136	$1,240	$3,939	$10,027
6	$0	$414	$2,200	$1,277	$0	$3,891
7	$2,451	$426	$2,266	$1,315	$4,179	$10,638
8	$0	$439	$2,334	$1,355	$0	$4,127
9	$2,601	$452	$2,404	$1,395	$4,434	$11,286
10	$0	$466	$2,476	$1,437	$0	$4,379
11	$2,759	$480	$2,550	$1,480	$4,704	$11,973
12	$0	$494	$2,627	$1,525	$0	$4,645
13	$2,927	$509	$2,705	$1,570	$4,990	$12,702
14	$0	$524	$2,787	$1,618	$0	$4,928
15	$3,105	$540	$2,870	$1,666	$5,294	$13,476
16	$0	$556	$2,956	$1,716	$0	$5,229
17	$3,294	$573	$3,045	$1,768	$5,616	$14,296
18	$0	$590	$3,136	$1,821	$0	$5,547
19	$3,495	$608	$3,230	$1,875	$5,959	$15,167
20	$0	$626	$3,327	$1,931	$0	$5,885
21	$3,708	$645	$3,427	$1,989	$6,321	$16,091
22	$0	$664	$3,530	$2,049	$0	$6,243
23	$3,934	$684	$3,636	$2,111	$6,706	$17,071
24	$0	$705	$3,745	$2,174	$0	$6,623
25	$4,173	$726	$3,857	$2,239	$7,115	$18,110
26	$0	$747	$3,973	$2,306	$0	$7,027
27	$4,427	$770	$4,092	$2,375	$7,548	$19,213
28	$0	$793	$4,215	$2,447	$0	$7,455
29	$4,697	$817	$4,341	$2,520	$8,008	$20,383
30	$0	$841	$4,472	$2,596	$0	$7,909
3% inflation					Total	$289,804

C. Streambank Restoration Costs in the Upper Cottonwood

Table 75. Implementation Costs: Streambank Restoration

Annual Streambank Restoration Cost		
Year	Streambank Stabilization (feet)	Cost*
1	392	$37,859
2	392	$38,995
3	392	$40,165
4	392	$41,370
5	392	$42,611
6	392	$43,889
7	392	$45,206
8	392	$46,562
9	392	$47,959
10	392	$49,398
11	392	$50,880
12	392	$52,406
13	392	$53,978
14	392	$55,598
15	392	$57,266
16	392	$58,984
17	392	$60,753
18	392	$62,576
19	392	$64,453
20	392	$66,387
21	392	$68,378
22	392	$70,430
23	392	$72,542
24	392	$74,719
25	392	$76,960
26	392	$79,269
27	392	$81,647
28	392	$84,097
29	392	$86,619
30	392	$89,218
3% Inflation	**Total**	**$1,801,175**
*$96.58 per foot		

D. Total Costs for BMP Implementation and Education in the Upper Cottonwood

Table 76. Upper Cottonwood BMP Implementation Costs: After Cost-Share

Total Annual Cost after Cost-Share for BMPs and Education					
Year	Cropland	Livestock	Streambank	I & E	Total Cost
1	$166,416	$8,909	$37,859	$138,000	$351,184
2	$171,408	$3,457	$38,995	$142,140	$356,000
3	$176,550	$9,452	$40,165	$146,404	$372,571
4	$181,847	$3,667	$41,370	$150,796	$377,680
5	$187,302	$10,027	$42,611	$155,320	$395,260
6	$192,921	$3,891	$43,889	$159,980	$400,681
7	$198,709	$10,638	$45,206	$164,779	$419,332
8	$204,670	$4,127	$46,562	$169,723	$425,082
9	$210,810	$11,286	$47,959	$174,814	$444,869
10	$217,135	$4,379	$49,398	$180,059	$450,971
11	$223,649	$11,973	$50,880	$185,460	$471,962
12	$230,358	$4,645	$52,406	$191,024	$478,433
13	$237,269	$12,702	$53,978	$196,755	$500,704
14	$244,387	$4,928	$55,598	$202,658	$507,571
15	$251,719	$13,476	$57,266	$208,737	$531,198
16	$259,270	$5,229	$58,984	$215,000	$538,483
17	$267,048	$14,296	$60,753	$221,449	$563,546
18	$275,060	$5,547	$62,576	$228,093	$571,276
19	$283,312	$15,167	$64,453	$234,936	$597,868
20	$291,811	$5,885	$66,387	$241,984	$606,067
21	$300,565	$16,091	$68,378	$249,243	$634,277
22	$309,582	$6,243	$70,430	$256,721	$642,976
23	$318,870	$17,071	$72,542	$264,422	$672,905
24	$328,436	$6,623	$74,719	$272,355	$682,133
25	$338,289	$18,110	$76,960	$280,526	$713,885
26	$348,437	$7,027	$79,269	$288,941	$723,674
27	$358,891	$19,213	$81,647	$297,610	$757,361
28	$369,657	$7,455	$84,097	$306,538	$767,747
29	$380,747	$20,383	$86,619	$315,734	$803,483
30	$392,169	$7,909	$89,218	$325,206	$814,502
Total Cost	**$7,917,294**	**$289,804**	**$1,801,175**	**$334,962**	**$10,343,235**
3% Inflation					

9C. Total Costs for Implementation in the JRR Watershed

The JRR Watershed total combined costs for the NELC and Upper Cottonwood BMP implementation and education portions of the plan is shown below in **Table 77.**

Table 77. Total Costs for the Implementation of the JRR Watershed WRAPS Plan

JRR Watershed Total Annual Cost after Cost-Share for BMPs and Education					
Year	Total Cropland Costs	Total Livestock Costs	Total Streambank Costs	Total I & E Costs	Total Cost
1	$282,646	$23,227	$350,199	$214,050	$870,122
2	$291,124	$17,948	$360,705	$220,472	$890,248
3	$299,858	$24,642	$371,526	$227,086	$923,112
4	$308,854	$19,041	$382,672	$233,898	$944,465
5	$318,119	$26,142	$394,152	$240,915	$979,328
6	$327,663	$20,201	$405,976	$248,143	$1,001,983
7	$337,493	$27,734	$418,156	$255,587	$1,038,970
8	$347,618	$21,430	$430,700	$263,255	$1,063,003
9	$358,046	$29,424	$443,622	$271,152	$1,102,244
10	$368,788	$22,736	$456,930	$279,287	$1,127,741
11	$379,852	$31,215	$470,638	$287,665	$1,169,371
12	$391,247	$24,120	$484,757	$296,295	$1,196,419
13	$402,985	$33,116	$499,300	$305,184	$1,240,585
14	$415,074	$25,589	$514,279	$314,340	$1,269,282
15	$427,527	$35,133	$529,708	$323,770	$1,316,138
16	$440,352	$27,148	$545,599	$333,483	$1,346,582
17	$453,562	$37,272	$561,967	$343,487	$1,396,288
18	$467,170	$28,801	$578,826	$353,792	$1,428,589
19	$481,185	$39,542	$596,190	$364,406	$1,481,323
20	$495,620	$30,555	$614,077	$375,338	$1,515,590
21	$510,488	$41,951	$632,498	$386,598	$1,571,535
22	$525,803	$32,415	$651,474	$398,196	$1,607,888
23	$541,578	$44,506	$671,017	$410,142	$1,667,243
24	$557,825	$34,389	$691,148	$422,446	$1,705,809
25	$574,560	$47,216	$711,882	$435,120	$1,768,778
26	$591,796	$36,484	$733,239	$448,173	$1,809,692
27	$609,551	$50,091	$755,236	$461,618	$1,876,496
28	$627,836	$38,706	$777,894	$475,467	$1,919,903
29	$646,672	$53,142	$801,230	$489,731	$1,990,775
30	$666,072	$41,064	$825,267	$504,423	$2,036,826
Total Cost	**$13,446,963**	**$964,978**	**$16,660,867**	**$519,556**	**$31,592,364**
3% Inflation					

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 JRR WRAPS plan. Possible technical assistance providers and funding sources are presented in **Tables 78** and **79.**

Table 78. Potential Technical Assistance Providers for Plan Implementation

Technical Assistance to Aid in BMP Implementation		
BMPs To Be Implemented		**Technical Assistance**
Cropland	Buffers	JRR WRAPS Coordinators (NELC and Upper Cottonwood), Farm Service Agency, KDWPT, Kansas Forest Service, NRCS, Butler, Chase, Coffey, Greenwood, Harvey, Lyon, Marion, Morris, and Wabaunsee County Conservation Districts, and the KSRE Watershed Specialist
	Conservation Crop Rotations	
	No-till with Cover Crops	
	Nutrient Management Plan	
	Permanent Vegetation	
	Terraces	
	Waterways	
Livestock	Fence off Streams	
	Filter Strips	
	Off-stream Watering Systems	
	Relocate Pasture Feeding Sites	
	Rotational Grazing	
Streambank	Streambank Restoration	

Table 79. 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 goal of this JRR Watershed WRAPS plan is to restore water quality for uses that support aquatic life, domestic water supply, and recreation for the John Redmond Reservoir. The plan specifically addresses the high-priority eutrophication and siltation TMDLs for the reservoir. In order to reach the load reduction goals associated with the JRR Watershed impairments, an implementation schedule for conservation practices spanning 30 years has been developed.

The selected practices included in the plan will be implemented throughout the targeted areas within the JRR Watershed, and water quality milestones have been developed for the John Redmond Reservoir. The purpose of the milestones is to measure water quality improvements associated with the implementation schedule contained in this plan.

The phosphorus portion of the eutrophication TMDL in the watershed will be met in year 30 of the plan. Although there were no quantitative load reductions required for nitrogen, this plan will result in outstanding nitrogen load reductions by year 30. After the eutrophication TMDL is achieved, the process will become one of protection, rather than restoration.

It is estimated that the siltation TMDL in the JRR Watershed will be attained at year 27 of this WRAPS plan. After the siltation TMDL is achieved, the process will become one of protection, rather than restoration.

Implementing the BMPs outlined in this plan to achieve the eutrophication and siltation TMDLs subsequently will address many of the other impairments throughout the JRR Watershed.

A. Measurable Milestones for BMP Implementation

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

1. NELC short-, medium-, and long-term milestones

Table 80. NELC Cropland BMP Adoption Milestones

Cropland BMP Implementation Milestones (acres)									
	Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Adoption
Short-Term	1	970	388	1,358	388	194	388	970	4,656
	2	970	388	1,358	388	194	388	970	4,656
	3	970	388	1,358	388	194	388	970	4,656
	4	970	388	1,358	388	194	388	970	4,656
	5	970	388	1,358	388	194	388	970	4,656
	Subtotal	*4,850*	*1,940*	*6,790*	*1,940*	*970*	*1,940*	*4,850*	*23,281*
Medium-Term	6	970	388	1,358	388	194	388	970	4,656
	7	970	388	1,358	388	194	388	970	4,656
	8	970	388	1,358	388	194	388	970	4,656
	9	970	388	1,358	388	194	388	970	4,656
	10	970	388	1,358	388	194	388	970	4,656
	Subtotal	*9,700*	*3,880*	*13,580*	*3,880*	*1,940*	*3,880*	*9,700*	*46,562*
Long-Term	11	970	388	1,358	388	194	388	970	4,656
	12	970	388	1,358	388	194	388	970	4,656
	13	970	388	1,358	388	194	388	970	4,656
	14	970	388	1,358	388	194	388	970	4,656
	15	970	388	1,358	388	194	388	970	4,656
	16	970	388	1,358	388	194	388	970	4,656
	17	970	388	1,358	388	194	388	970	4,656
	18	970	388	1,358	388	194	388	970	4,656
	19	970	388	1,358	388	194	388	970	4,656
	20	970	388	1,358	388	194	388	970	4,656
	21	970	388	1,358	388	194	388	970	4,656
	22	970	388	1,358	388	194	388	970	4,656
	23	970	388	1,358	388	194	388	970	4,656
	24	970	388	1,358	388	194	388	970	4,656
	25	970	388	1,358	388	194	388	970	4,656
	26	970	388	1,358	388	194	388	970	4,656
	27	970	388	1,358	388	194	388	970	4,656
	28	970	388	1,358	388	194	388	970	4,656
	29	970	388	1,358	388	194	388	970	4,656
	30	970	388	1,358	388	194	388	970	4,656
	Total	***29,101***	***11,640***	***40,741***	***11,640***	***5,820***	***11,640***	***29,101***	***139,685***

Table 81. NELC Livestock BMP Adoption Milestones

Livestock BMP Milestones (projects)						
	Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing
Short-Term	1	1	2	2	2	1
	2	1	3	2	2	2
	3	1	2	2	2	1
	4	1	3	2	2	2
	5	1	2	2	2	1
	Subtotal	*5*	*12*	*10*	*10*	*7*
Medium-Term	6	1	3	2	2	2
	7	1	2	2	2	1
	8	1	3	2	2	2
	9	1	2	2	2	1
	10	1	3	2	2	2
	Subtotal	*10*	*25*	*20*	*20*	*15*
Long-Term	11	1	2	2	2	1
	12	1	3	2	2	2
	13	1	2	2	2	1
	14	1	3	2	2	2
	15	1	2	2	2	1
	16	1	3	2	2	2
	17	1	2	2	2	1
	18	1	3	2	2	2
	19	1	2	2	2	1
	20	1	3	2	2	2
	21	1	2	2	2	1
	22	1	3	2	2	2
	23	1	2	2	2	1
	24	1	3	2	2	2
	25	1	2	2	2	1
	26	1	3	2	2	2
	27	1	2	2	2	1
	28	1	3	2	2	2
	29	1	2	2	2	1
	30	1	3	2	2	2
	Total	***30***	***75***	***60***	***60***	***45***

Table 82. NELC Streambank Stabilization Milestones

Streambank Stabilization Milestones (linear feet)		
	Year	**Streambank Stabilization**
Short-Term	1	3,234
	2	3,234
	3	3,234
	4	3,234
	5	3,234
	Subtotal	*16,169*
Medium-Term	6	3,234
	7	3,234
	8	3,234
	9	3,234
	10	3,234
	Subtotal	*32,339*
Long-Term	11	3,234
	12	3,234
	13	3,234
	14	3,234
	15	3,234
	16	3,234
	17	3,234
	18	3,234
	19	3,234
	20	3,234
	21	3,234
	22	3,234
	23	3,234
	24	3,234
	25	3,234
	26	3,234
	27	3,234
	28	3,234
	29	3,234
	30	3,234
	Total	***97,016***

2. Upper Cottonwood short-, medium-, and long-term milestones

Table 83. Upper Cottonwood Cropland BMP Adoption Milestones

Cropland BMP Milestones (acres)									
	Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Adoption
Short-Term	1	1,060	707	1,414	530	177	707	1,060	5,655
	2	1,060	707	1,414	530	177	707	1,060	5,655
	3	1,060	707	1,414	530	177	707	1,060	5,655
	4	1,060	707	1,414	530	177	707	1,060	5,655
	5	1,060	707	1,414	530	177	707	1,060	5,655
	Subtotal	*5,302*	*3,534*	*7,069*	*2,651*	*884*	*3,534*	*5,302*	*28,275*
Medium-Term	6	1,060	707	1,414	530	177	707	1,060	5,655
	7	1,060	707	1,414	530	177	707	1,060	5,655
	8	1,060	707	1,414	530	177	707	1,060	5,655
	9	1,060	707	1,414	530	177	707	1,060	5,655
	10	1,060	707	1,414	530	177	707	1,060	5,655
	Subtotal	*10,603*	*7,069*	*14,137*	*5,302*	*1,767*	*7,069*	*10,603*	*56,550*
Long-Term	11	1,060	707	1,414	530	177	707	1,060	5,655
	12	1,060	707	1,414	530	177	707	1,060	5,655
	13	1,060	707	1,414	530	177	707	1,060	5,655
	14	1,060	707	1,414	530	177	707	1,060	5,655
	15	1,060	707	1,414	530	177	707	1,060	5,655
	16	1,060	707	1,414	530	177	707	1,060	5,655
	17	1,060	707	1,414	530	177	707	1,060	5,655
	18	1,060	707	1,414	530	177	707	1,060	5,655
	19	1,060	707	1,414	530	177	707	1,060	5,655
	20	1,060	707	1,414	530	177	707	1,060	5,655
	21	1,060	707	1,414	530	177	707	1,060	5,655
	22	1,060	707	1,414	530	177	707	1,060	5,655
	23	1,060	707	1,414	530	177	707	1,060	5,655
	24	1,060	707	1,414	530	177	707	1,060	5,655
	25	1,060	707	1,414	530	177	707	1,060	5,655
	26	1,060	707	1,414	530	177	707	1,060	5,655
	27	1,060	707	1,414	530	177	707	1,060	5,655
	28	1,060	707	1,414	530	177	707	1,060	5,655
	29	1,060	707	1,414	530	177	707	1,060	5,655
	30	1,060	707	1,414	530	177	707	1,060	5,655
	Total	***31,809***	***21,206***	***42,412***	***15,905***	***5,302***	***21,206***	***31,809***	***169,650***

Table 84. Upper Cottonwood Livestock BMP Adoption Milestones

Livestock BMP Milestones (projects)						
	Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing
Short-Term	1	1	1	1	1	1
	2	0	1	1	1	0
	3	1	1	1	1	1
	4	0	1	1	1	0
	5	1	1	1	1	1
	Subtotal	*3*	*5*	*5*	*5*	*3*
Medium-Term	6	0	1	1	1	0
	7	1	1	1	1	1
	8	0	1	1	1	0
	9	1	1	1	1	1
	10	0	1	1	1	0
	Subtotal	*5*	*10*	*10*	*10*	*5*
Long-Term	11	1	1	1	1	1
	12	0	1	1	1	0
	13	1	1	1	1	1
	14	0	1	1	1	0
	15	1	1	1	1	1
	16	0	1	1	1	0
	17	1	1	1	1	1
	18	0	1	1	1	0
	19	1	1	1	1	1
	20	0	1	1	1	0
	21	1	1	1	1	1
	22	0	1	1	1	0
	23	1	1	1	1	1
	24	0	1	1	1	0
	25	1	1	1	1	1
	26	0	1	1	1	0
	27	1	1	1	1	1
	28	0	1	1	1	0
	29	1	1	1	1	1
	30	0	1	1	1	0
	Total	***15***	***30***	***30***	***30***	***15***

Table 85. Upper Cottonwood Streambank Stabilization Milestones

Streambank Stabilization Milestones (linear feet)		
	Year	Streambank Stabilization
Short-Term	1	392
	2	392
	3	392
	4	392
	5	392
	Subtotal	*1,960*
Medium-Term	6	392
	7	392
	8	392
	9	392
	10	392
	Subtotal	*3,920*
Long-Term	11	392
	12	392
	13	392
	14	392
	15	392
	16	392
	17	392
	18	392
	19	392
	20	392
	21	392
	22	392
	23	392
	24	392
	25	392
	26	392
	27	392
	28	392
	29	392
	30	392
	Total	***11,760***

3. BMP milestones in the JRR Watershed, NELC and Upper Cottonwood, combined

Table 86. JRR Watershed Cumulative Cropland BMP Adoption Milestones

JRR Watershed Cropland BMP Milestones (acres)									
	Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Adoption
Short-Term	1	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	2	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	3	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	4	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	5	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	Subtotal	*10,152*	5,474	*13,859*	4,591	1,854	5,474	10,152	51,555
Medium-Term	6	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	7	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	8	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	9	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	10	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	Subtotal	*20,303*	10,949	*27,717*	9,182	3,707	10,949	20,303	103,110
Long-Term	11	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	12	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	13	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	14	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	15	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	16	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	17	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	18	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	19	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	20	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	21	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	22	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	23	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	24	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	25	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	26	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	27	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	28	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	29	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	30	2,030	1,095	2,772	918	371	1,095	2,030	10,311
	Total	***60,910***	***32,846***	***83,153***	***27,545***	***11,122***	***32,846***	***60,910***	***309,333***

Table 87. JRR Watershed Cumulative Livestock BMP Adoption Milestones

JRR Watershed Livestock BMP Milestones (projects)						
	Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing
Short-Term	1	2	3	3	3	2
	2	1	4	3	3	2
	3	2	3	3	3	2
	4	1	4	3	3	2
	5	2	3	3	3	2
	Subtotal	*8*	*17*	*15*	*15*	*10*
Medium-Term	6	1	4	3	3	2
	7	2	3	3	3	2
	8	1	4	3	3	2
	9	2	3	3	3	2
	10	1	4	3	3	2
	Subtotal	*15*	*35*	*30*	*30*	*20*
Long-Term	11	2	3	3	3	2
	12	1	4	3	3	2
	13	2	3	3	3	2
	14	1	4	3	3	2
	15	2	3	3	3	2
	16	1	4	3	3	2
	17	2	3	3	3	2
	18	1	4	3	3	2
	19	2	3	3	3	2
	20	1	4	3	3	2
	21	2	3	3	3	2
	22	1	4	3	3	2
	23	2	3	3	3	2
	24	1	4	3	3	2
	25	2	3	3	3	2
	26	1	4	3	3	2
	27	2	3	3	3	2
	28	1	4	3	3	2
	29	2	3	3	3	2
	30	1	4	3	3	2
	Total	***45***	***105***	***90***	***90***	***60***

Table 88. JRR Watershed Cumulative Streambank Stabilization Milestones

JRR Watershed Streambank Stabilization Milestones (linear feet)		
	Year	Streambank Stabilization
Short-Term	1	3,626
	2	3,626
	3	3,626
	4	3,626
	5	3,626
	Subtotal	*18,129*
Medium-Term	6	3,626
	7	3,626
	8	3,626
	9	3,626
	10	3,626
	Subtotal	*36,259*
Long-Term	11	3,626
	12	3,626
	13	3,626
	14	3,626
	15	3,626
	16	3,626
	17	3,626
	18	3,626
	19	3,626
	20	3,626
	21	3,626
	22	3,626
	23	3,626
	24	3,626
	25	3,626
	26	3,626
	27	3,626
	28	3,626
	29	3,626
	30	3,626
	Total	***108,776***

B. Benchmarks to Measure Water Quality and Social Progress

It is hoped that, over a five- to 30-year time frame, this JRR Watershed WRAPS plan will improve water quality throughout the watershed and in the John Redmond Reservoir itself. To monitor these improvements, measurements taken at John Redmond Reservoir are important because the reservoir represents the drainage endpoint of the watershed. Social indicators of success also will be examined by tracking traffic in the reservoir and park. A good example of a healthy lake ecosystem is frequent visits by the public to enjoy outdoor recreation at the reservoir and in the park.

After reviewing the criteria listed in **Table 89**, the SLTs will assess and revise the overall strategy plan for the watershed every five years. At that time, 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 SLTs will coordinate every five years to discuss benchmarks and updates to TMDL plans. The following indicator and parameter criteria shall be used to assess progress toward successful implementation to abate pollutant loads.

Table 89. Benchmarks to Measure Water Quality Progress

Benchmarks to Measure Water Quality Progress		
Impairment Addressed	**Criteria to Measure Water Quality Progress**	**Information Source**
Nutrients	**John Redmond Reservoir:** Summer Chlorophyll a concentration < 12 µg/L	KDHE
Sediment	**John Redmond Reservoir:** Secchi disc depth > 0.8 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
Impairment Addressed	**Social Indicators to Measure Water Quality Progress**	**Information Source**
Nutrients/ Sediment	Visitor traffic to John Redmond Reservoir	KDWPT
	Boating traffic on John Redmond Reservoir	KDWPT
	Trends of quantity and quality of fishing in John Redmond Reservoir	KDWPT
	Beach closing at John Redmond Reservoir	KDHE
	Taste and odor issues in public water supply from John Redmond Reservoir	KDHE
	Occurrence of algal blooms in John Redmond Reservoir	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 JRR Watershed WRAPS plan is to restore water quality for uses that support aquatic life, primary contact recreation and public water supply for the John Redmond Reservoir. This restoration plan addresses specifically the medium-priority eutrophication and siltation TMDLs in the John Redmond Reservoir. 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 the JRR Watershed WRAPS to measure water quality improvements within the watershed.

In the NELC portion of the watershed, BMP implementation will take place along the riparian corridors of cropland, livestock, and streambank areas in 40 priority HUC 12 areas. In the Upper Cottonwood portion of the JRR Watershed, BMP implementation will take place in cropland, livestock, and streambank areas throughout seven priority HUC 12 areas. BMP implementation will result in positive impacts on water quality and impairment listings throughout the JRR Watershed.

Water quality milestones have been developed for the John Redmond Reservoir, along with additional indicators of water quality. The purpose of these milestones and indicators is to measure water quality improvements associated with the BMP implementation schedule contained in this plan. These water quality indicators will enable KDHE and the JRR Watershed WRAPS to measure water quality improvements within the watershed above the reservoir, which should directly affect the water quality in the reservoir itself.

D. Water Quality Milestones for John Redmond Reservoir

In order to reach the nutrient load reduction goals for the John Redmond Reservoir, a BMP implementation schedule spanning 30 years has been developed, and several water quality milestones and indicators have been developed for John Redmond Reservoir. (The implementation schedule and water quality milestones are outlined in previous sections of this plan.) Water quality measures such as concentrations of total phosphorus, chlorophyll *a*, and Secchi disc depth measurements found at the KDHE sampling site (LM026001) will be utilized to determine the effectiveness of the BMPs implemented as part of the nutrient and sediment load reduction goals outlined in this plan.

John Redmond Reservoir is deemed to be argillotrophic, as its average chlorophyll *a* concentration is 6.53 ppb (TSI = 48.98), while its average total phosphorus concentration is 175 ppb. The reservoir had a conservation storage capacity of 82,231 acre-feet when it was constructed in 1959. Subsequent surveys, the most recent in 1993, have been taken of the lake bathymetry, and they indicate a conservation storage capacity of 57,842 acre-feet. The loss of 6,803 acre-feet of storage over a 10-year time span represents an average annual loss of 680 acre-feet per year. In 2016, the Kansas Water Office reported that the reservoir had lost 40% of its water supply due to siltation. This loss became apparent in the severe drought of 2012-2013. With the reservoir being the water source for 19 municipalities, and six industrial users downstream, reclamation was needed. In 2016, after four years of planning, Great Lakes Dredging and Dock, LLC, began dredging the lake, giving the reservoir another three years of lifespan. More than 3,000,000 cu/yds of sediment were removed and disposed of on locally leased lands.

Long term water quality goals/milestones for various parameters monitored in the John Redmond Reservoir have been calculated by KDHE in Spring, 2021 (**Tables 90** and **91**)[28]. The KDHE TMDL Section is responsible for reviewing TMDLs every 5-10 years.

[28] John Redmond Water Quality Milestones provided by KDHE in April 2021.

Table 90. Water Quality Milestones: Eutrophication in the JRR

Water Quality Milestones for JRR: Phosphorus					
Sampling Site	Current Condition	10-Year Goal		Long-Term Goal	
	1987- 2020 Median TP	Improved Condition (2021 - 2031) Median TP	Total Reduction Needed	Improved Condition Median TP	Total Reduction Needed
	Total Phosphorus (TP) (median of data collected during indicated period), ppb				
John Redmond Reservoir LM026001	211	167	44	80	131

Table 91. Water Quality Milestones: Sediment in John Redmond Reservoir

Water Quality Milestones for JRR: Sediment							
Sampling Site	Current Condition	10-Year Goal		Long-Term Goal	Current Condition	10-Year Goal	Long-Term Goal
	1990 - 2020 Chlorophyll *a*	Improved Condition (2021 - 2031) Chlorophyll *a*	Total Reduction Needed	Improved Condition Chlorophyll *a*	1990 - 2020 Secchi (Avg.)	Improved Condition (2021 - 2031) 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		
John Redmond Reservoir LM026001	26.56	21.04	5.56	Maintain Average Chlorophyll *a* ≤ 10 ppb	0.35	Secchi depth > 0.61	Maintain Secchi depth > 0.8 m

E. Water Quality Milestones for other areas in the JRR Watershed

As mentioned in Section 5 on impairments, there are several TMDLs in the JRR Watershed that are not directly targeted by this WRAPS plan but will be positively impacted by the implementation of this plan. A few of these TMDLs may be de-listed due to the implementation of this plan and include:

- Lower Cottonwood River – Total Phosphorus (TP) TMDL
- Neosho River – Total Phosphorus (TP) TMDL
- Eagle Creek, near Olpe – Dissolved Oxygen (DO) TMDL
- Allen Creek, near Emporia – Dissolved Oxygen (DO) TMDL

Long term water quality goals/milestones for various parameters monitored in the JRR Watershed have been calculated by KDHE in Spring, 2021 (**Tables 92 - 95**)[29]. The KDHE TMDL Section is responsible for reviewing TMDLs every 5-10 years.

[29] John Redmond Water Quality Milestones provided by KDHE in April 2021.

Table 92. Water Quality Milestones: TP in the Lower Cottonwood River

Water Quality Milestones for Cottonwood River					
Sampling Site	Current Condition (1990-2013)* Median TP	10-Year Goal		Long Term Goal	
		Improved Condition (2021 - 2031) Median TP	Total Reduction Needed	Improved Condition Median TP	Total Reduction Needed
	Total Phosphorus (median of data collected during indicated period), ppb				
Lower Cottonwood River SC247	396	164	**232**	121	**359**

Table 93. Water Quality Milestones: TP in the Neosho River

Water Quality Milestones for Neosho River					
	Current Condition (1990-2013)* Median TP	10-Year Goal		Long Term Goal	
		Improved Condition (2021 - 2031) Median TP	Total Reduction Needed	Improved Condition Median TP	Total Reduction Needed
Sampling Sites	Total Phosphorus (median of data collected during indicated period), ppb				
Neosho River SC273	330	164	**166**	121	**209**

Table 94. Water Quality Milestones: DO in Eagle Creek, near Olpe

Water Quality Milestones for Eagle Creek		
Sampling Sites	Current Condition (1993-2001)* Average DO	Long Term Goal
		Improved Condition DO
	Dissolved Oxygen (data collected during indicated period), ppm	
Eagle Creek, near Olpe Station 634	9	Maintain DO > 5 for all samples

Table 95. Water Quality Milestones: DO in Allen Creek, near Emporia

Water Quality Milestones for Allen Creek		
Sampling Sites	Current Condition (1992-2001)* Average DO	Long Term Goal
		Improved Condition DO
	Dissolved Oxygen (data collected during indicated period), ppm	
Allen Creek, near Emporia Station 628	9	Maintain DO > 5 for all samples

12. Monitoring Water Quality

KDHE continues to monitor water quality in the JRR Watershed by maintaining monitoring stations. **Figure 39** illustrates the locations of the monitoring sites within the JRR Watershed.

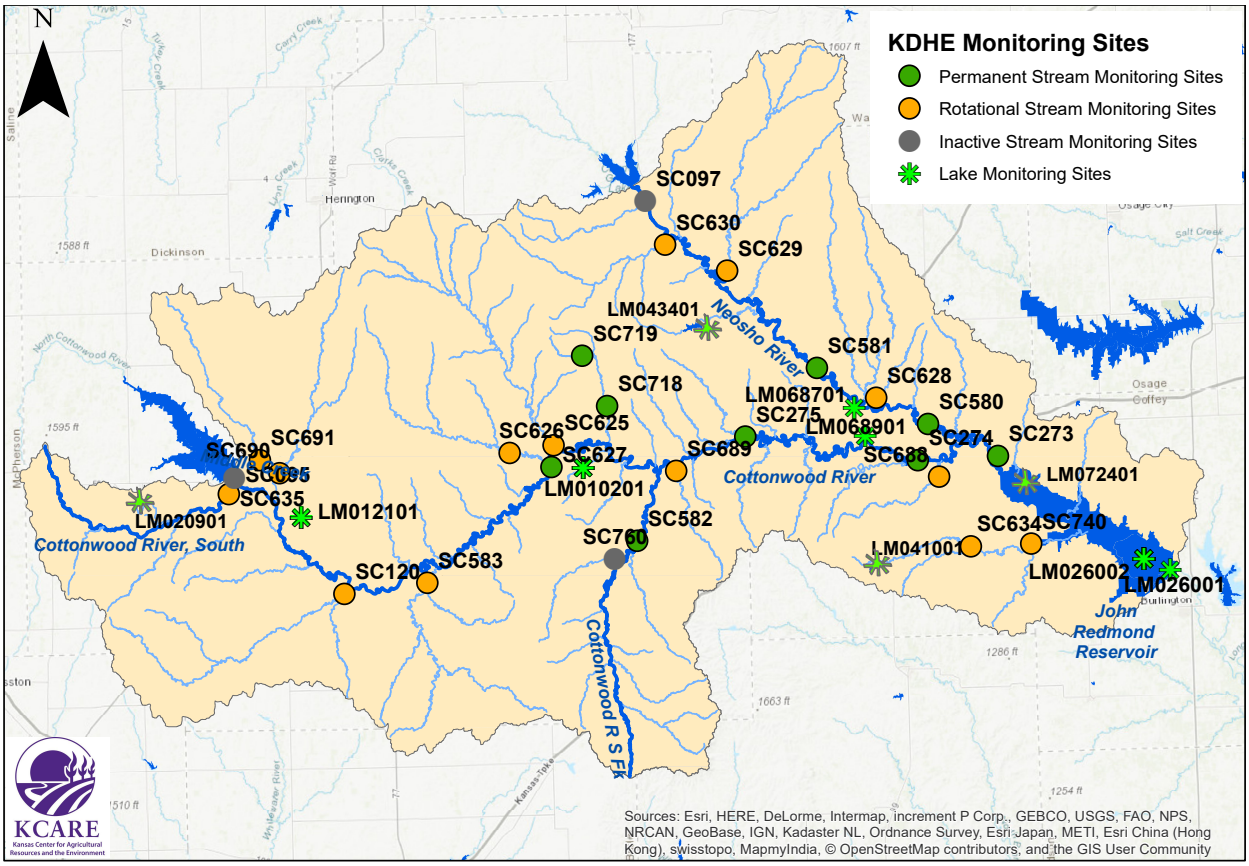


Figure 39. Monitoring Sites in the JRR Watershed

The KDHE sampling data will be reviewed by the SLTs. Data collected in the targeted areas will be of special interest. Both a composite review of implemented BMPs and monitoring data will be analyzed for effects resulting from the BMPs. Typically, monitoring takes place in May through September. 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.

There are three types of monitoring sites utilized by KDHE: permanent (nine sites), rotational (14 sites), and lake sites (10 sites). Permanent sites are continuously sampled, whereas rotational sites are only sampled every fourth year. All 33 active sites will be continued into the future. Each site is tested for nutrients, metals, ammonia, solid fractions, turbidity, alkalinity, pH, dissolved oxygen, *E. coli* bacteria and chemicals. Not all sites are tested for these pollutant indicators at each collection time. This is dependent upon the anticipated pollutant concern as well as other factors.

In addition to the KDHE monitoring sites, USGS collects spatial water quality data and makes it available for SLT review. Continuous water-quality monitors are used to measure water temperature, specific conductance, turbidity, pH, DO, chlorophyll, phycocyanin, and nitrate at 30-second intervals.

Much of the evaluative information can be obtained through the existing networks and sampling plans of both KDHE and USGS. Public engagement can be obtained through observations of reservoir clarity, ease of boating and the physical appearance of the reservoir. Some communications with the Tulsa District Corps of Engineers will supplement any information on the conditions in the Neosho River drainage and in John Redmond Reservoir. Monitoring data from all sources in the JRR 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 JRR Watershed extend through a 30-year period from 2021-2051. 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 water quality milestones have been achieved. At that time, KDHE and the SLTs can address any necessary modifications or revisions to the plan based on the data analysis. At the end of this plan in 2051, a determination will be made as to whether the water quality standards have been attained.

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

13. Review of the WRAPS Plan

In the year 2026, this WRAPS plan will be reviewed and revised according to monitoring data results. At that time, the SLTs will review the criteria listed below, in addition to any other concerns.

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

- KDHE reports on current and desired endpoints for water quality in John Redmond Reservoir regarding **eutrophication:** The desired outcome will be to maintain summer chlorophyll *a* average concentrations below 12 µg/L, with reductions focused on phosphorus. **Phosphorus must be reduced by 286,408 pounds**, which is roughly a 21% reduction;[30] even though no quantitative reduction in nitrogen is required to meet the TMDL, nitrogen load reductions will be made and the reservoir will be impacted positively.
- KDHE reports on current and desired endpoints for water quality in John Redmond Reservoir regarding **siltation:** The desired outcome will be to maintain a Secchi disc depth of greater than 0.8 meters. Sediment **must be reduced by 297,600 tons**, which is roughly a 33% reduction.[31]
- KDHE reports on 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 the John Redmond Reservoir.

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.

[30] KDHE, E TMDL, http://www.kdheks.gov/tmdl/ne/RedmondE.pdf
[31] KDHE, E TMDL, http://www.kdheks.gov/tmdl/ne/RedmondSILT.pdf

14. Appendix

A. Potential Service Providers

Table 96. Service Provider List

Organization	Programs	Purpose	Technical/ 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	www.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	

Service Provider List, Continued

Organization	Programs	Purpose	Technical or Financial Assistance	Phone	Website address
Kansas Rural Center	The Heartland Network Clean Water Farms - River Friendly Farms Sustainable Food Systems Project Cost share programs	The Center is committed to economically viable, environmentally sound and socially sustainable rural culture.	Technical and Financial	(785) 873-3431	www.kansasruralcenter.org
Kansas Rural Water Association	Technical assistance for Water Systems with Source Water Protection Planning	Provide education, technical assistance and leadership to public water and wastewater utilities to enhance the public health and to sustain Kansas' communities.	Technical	(785) 336-3760	www.krwa.net
Kansas State Research and Extension	Water Quality Programs Waste Management Programs Kansas Center for Agricultural Resources and Environment (KCARE)	Provide programs, expertise and educational materials that relate to minimizing the impact of rural and urban activities on water quality.	Technical	(785) 532-7108	www.kcare.ksu.edu
	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.ks.gov
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	Butler County Conservation District (316) 320-3549	www.butlercountyconservationdistrictks.com
	Nonpoint Source Pollution Control Fund	Provides financial assistance for nonpoint pollution control projects which help restore water quality.		Chase County Conservation District (620) 343-2812	www.govserv.org/US/Emporia/160470840825642/Lyon-Chase-County-Conservation-District
	Riparian and Wetland Protection Program	Funds to assist with wetland and riparian development and enhancement.		Coffey County Conservation District (620) 364-1190	www.landcan.org/local-resources/coffey-county-conservation-district/4139/
	Stream Rehabilitation Program	Assist with streams that have been adversely altered by channel modifications.		Greenwood County Conservation District (620) 583-6461	www.greenwoodcounty.org/conservation-district.htm
	Kansas Water Quality Buffer Initiative	Compliments Conservation Reserve Program by offering additional financial incentives for grass filters and riparian forest buffers.		Harvey County Conservation District (316) 283-0370	www.harveycounty.com/partnerships/conservation-district/conservation-district-home.html
				Lyon County Conservation District (620) 343-2812	www.govserv.org/US/Emporia/160470840825642/Lyon-Chase-County-Conservation-District
				Marion County Conservation District (620) 382-3520	www.landcan.org/local-resources/marion-county-conservation-district/4181/
				Morris County Conservation District (620) 767-5111	www.morriscountyconservationdistrict.com
	Watershed district and multipurpose lakes	Programs are available for watershed district and multipurpose small lakes.		Wabaunsee County Conservation District (785) 765-3836	https://www.landcan.org/local-resources/Wabaunsee-County-Conservation-District/4223/

Service Provider List, Continued

Organization	Programs	Purpose	Technical or Financial Assistance	Phone	Website address
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	Butler County Conservation District (316) 320-3549	www.butlercountyconservationdistrictks.com
	Conservation Operations	To provide technical assistance on private land for development and application of Resource Management Plans.		Chase County Conservation District (620) 343-2812	www.govserv.org/US/Emporia/160470840825642/Lyon-Chase-County-Conservation-District
	Watershed Planning and Operations	Primarily focused on high priority areas where agricultural improvements will meet water quality objectives.		Coffey County Conservation District (620) 364-1190	www.landcan.org/local-resources/coffey-county-conservation-district/4139/
	Wetland Reserve Program	Cost share and easements to restore wetlands.		Greenwood County Conservation District (620) 583-6461	www.greenwoodcounty.org/conservation-district.htm
				Harvey County Conservation District (316) 283-0370	www.harveycounty.com/partnerships/conservation-district/conservation-district-home.html
				Lyon County Conservation District (620) 343-2812	www.govserv.org/US/Emporia/160470840825642/Lyon-Chase-County-Conservation-District
	Wildlife Habitat Incentives Program	Cost share to establish wildlife habitat which includes wetlands and riparian areas.		Marion County Conservation District (620) 382-3520	www.landcan.org/local-resources/marion-county-conservation-district/4181/
				Morris County Conservation District (620) 767-5111	www.morriscountyconservationdistrict.com
	Grassland Reserve Program, EQIP and Conservation Reserve Program	Improve and protect rangeland resources with cost-sharing practices, rental agreements, and easement purchases.		Wabaunsee County Conservation District (785) 765-3836	https://www.landcan.org/local-resources/Wabaunsee-County-Conservation-District/4223/

B. BMP Definitions

1. Cropland BMPs

a. Buffers

- Vegetative buffers are areas of a field maintained in permanent vegetation to help reduce nutrient and sediment loss from agricultural fields, to improve runoff water quality, and to provide habitat for wildlife.
- On average for Kansas fields, a one-acre buffer treats 15 acres of cropland, and they have 50% erosion, nitrogen, and phosphorus reduction efficiencies.

b. Conservation crop rotations

- Producers using conservation crop rotation grow different crops on the same piece of land year after year in a planned, recurring sequence.
- This may include alternating row crop production with a high residue-producing crop, to a low residue-producing crop.
- Conservation crop rotations have 25% erosion, nitrogen, and phosphorus reduction efficiencies.

c. No-till with cover crops

- No-till is a management system using alternative methods instead of tillage for weed control and seedbed preparation.
- In a total no-till system, the soil surface is never disturbed, except for planting or drilling operations; this maintains nutrient levels and aids in preventing nutrients from leaving the field due to runoff events.
- A cover crop is a specific plant grown primarily for the benefit of the soil, rather than the crop yield.
- Cover crops commonly are used to suppress weeds, to manage soil erosion, to help build and improve soil fertility and quality, and to control diseases and pests.
- Cover crops are typically grasses or legumes but may be comprised of other green plants.
- Cover crops can: reduce wind and water erosion, 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.[32]
- No-till with cover crops has a 40% erosion, 25% nitrogen, and a 50% phosphorus reduction efficiency.

d. 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.
- Nutrient management plans have nitrogen, and phosphorus reduction efficiencies.

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

e. Permanent vegetation

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

f. Terraces

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

g. Waterways

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

2. Livestock BMPs

a. Fence off streams

- Exclusion fencing prevents livestock from entering into and polluting stream waters. This prevents livestock from degrading the streambanks and causing sediment sloughing into the water.
- An alternate watering system may be a necessary component with this BMP.
- Stream, or exclusion, fencing in general has a 25-year lifespan.
- Using fencing to keep livestock out of streams can have a 95% phosphorus reduction as well as unknown nitrogen and sediment load reductions.

b. 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%.

c. Off-stream watering systems

- These are watering systems designed to give livestock an alternate watering source, which discourages livestock from entering a stream or waterbody.
- Studies show cattle prefer drinking from a tank, rather than 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. Relocate pasture feeding sites

- When producers relocate pasture feeding sites, they move feeding sites in a pasture away from a stream, waterway, or body of water to increase filtration and waste removal (i.e., move bale feeders away from a stream).
- Relocation of feeding sites equates to an average of 70% phosphorus reduction efficiency.

e. Rotational grazing

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

3. Streambank stabilization

Some streambank BMPs that may be utilized are riparian buffers, field borders, bottomland timber in wetlands, and/or streambank restoration.

C. Budget Derivations[33]

1. Cropland

Summarized derivation of cropland BMP cost estimates:

- Buffer: $159 per treated acre with 90% cost-share.
- Conservation crop rotations: $39 per acre.
- No-till with cover crops: $100 per treated acre with 90% cost-share.
- Establish permanent vegetation: $112 per treated acre with 90% cost- share.
- Nutrient management plan: $57 per treated acre with 90% cost-share.
- Establish permanent vegetation: $150 per treated acre with 99% cost-share.
- Terraces: $102 per treated acre with no cost-share.
- Grassed waterway: $290 per treated acre with 90% cost-share.

2. Livestock

Summarized derivation of livestock BMP cost estimates:

- Fence off streams: Average of $4,106 per project with 50% cost-share.
- Filter strip: $714 per unit with 50% cost-share.
- Off-stream watering system: $3,795 per unit with 50% cost-share.
- Relocate pasture feeding site: $2,203 with 50% cost-share. Cost includes building ¼ mile of fence, a permeable surface, and labor.
- Rotational grazing: $7,000 with 50% cost-share. Cost includes fencing and labor.

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

3. Streambank

Summarized derivation of streambank stabilization BMP cost estimates:

Streambank stabilization and/or restoration BMPs: $96.58 per foot.

D. 30-year Project Tables by HUC 8

Note: this plan combines the Neosho Headwaters and Lower Cottonwood and refers to them collectively as the "NELC". The tables below reflect those areas *prior* to being combined into the NELC tables used throughout this WRAPS plan.

1. Cropland BMP implementation in the JRR Watershed

a. Neosho Headwaters – HUC 11070201

Neosho Headwaters Annual Adoption (treated acres), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Adoption
1	409	163	572	163	82	163	409	1,961
2	409	163	572	163	82	163	409	1,961
3	409	163	572	163	82	163	409	1,961
4	409	163	572	163	82	163	409	1,961
5	409	163	572	163	82	163	409	1,961
6	409	163	572	163	82	163	409	1,961
7	409	163	572	163	82	163	409	1,961
8	409	163	572	163	82	163	409	1,961
9	409	163	572	163	82	163	409	1,961
10	409	163	572	163	82	163	409	1,961
11	409	163	572	163	82	163	409	1,961
12	409	163	572	163	82	163	409	1,961
13	409	163	572	163	82	163	409	1,961
14	409	163	572	163	82	163	409	1,961
15	409	163	572	163	82	163	409	1,961
16	409	163	572	163	82	163	409	1,961
17	409	163	572	163	82	163	409	1,961
18	409	163	572	163	82	163	409	1,961
19	409	163	572	163	82	163	409	1,961
20	409	163	572	163	82	163	409	1,961
21	409	163	572	163	82	163	409	1,961
22	409	163	572	163	82	163	409	1,961
23	409	163	572	163	82	163	409	1,961
24	409	163	572	163	82	163	409	1,961
25	409	163	572	163	82	163	409	1,961
26	409	163	572	163	82	163	409	1,961
27	409	163	572	163	82	163	409	1,961
28	409	163	572	163	82	163	409	1,961
29	409	163	572	163	82	163	409	1,961
30	409	163	572	163	82	163	409	1,961
Total	**12,256**	**4,903**	**17,159**	**4,903**	**2,451**	**4,903**	**12,256**	**58,830**

b. Lower Cottonwood – HUC 11070203

Lower Cottonwood Annual Adoption (treated acres), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Adoption
1	561	225	786	225	112	225	561	2,695
2	561	225	786	225	112	225	561	2,695
3	561	225	786	225	112	225	561	2,695
4	561	225	786	225	112	225	561	2,695
5	561	225	786	225	112	225	561	2,695
6	561	225	786	225	112	225	561	2,695
7	561	225	786	225	112	225	561	2,695
8	561	225	786	225	112	225	561	2,695
9	561	225	786	225	112	225	561	2,695
10	561	225	786	225	112	225	561	2,695
11	561	225	786	225	112	225	561	2,695
12	561	225	786	225	112	225	561	2,695
13	561	225	786	225	112	225	561	2,695
14	561	225	786	225	112	225	561	2,695
15	561	225	786	225	112	225	561	2,695
16	561	225	786	225	112	225	561	2,695
17	561	225	786	225	112	225	561	2,695
18	561	225	786	225	112	225	561	2,695
19	561	225	786	225	112	225	561	2,695
20	561	225	786	225	112	225	561	2,695
21	561	225	786	225	112	225	561	2,695
22	561	225	786	225	112	225	561	2,695
23	561	225	786	225	112	225	561	2,695
24	561	225	786	225	112	225	561	2,695
25	561	225	786	225	112	225	561	2,695
26	561	225	786	225	112	225	561	2,695
27	561	225	786	225	112	225	561	2,695
28	561	225	786	225	112	225	561	2,695
29	561	225	786	225	112	225	561	2,695
30	561	225	786	225	112	225	561	2,695
Total	**16,830**	**6,750**	**23,580**	**6,750**	**3,360**	**6,750**	**16,830**	**80,850**

c. Upper Cottonwood – HUC 11070202

Upper Cottonwood Annual Adoption (treated acres), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Adoption
1	1,060	707	1,414	530	177	707	1,060	5,655
2	1,060	707	1,414	530	177	707	1,060	5,655
3	1,060	707	1,414	530	177	707	1,060	5,655
4	1,060	707	1,414	530	177	707	1,060	5,655
5	1,060	707	1,414	530	177	707	1,060	5,655
6	1,060	707	1,414	530	177	707	1,060	5,655
7	1,060	707	1,414	530	177	707	1,060	5,655
8	1,060	707	1,414	530	177	707	1,060	5,655
9	1,060	707	1,414	530	177	707	1,060	5,655
10	1,060	707	1,414	530	177	707	1,060	5,655
11	1,060	707	1,414	530	177	707	1,060	5,655
12	1,060	707	1,414	530	177	707	1,060	5,655
13	1,060	707	1,414	530	177	707	1,060	5,655
14	1,060	707	1,414	530	177	707	1,060	5,655
15	1,060	707	1,414	530	177	707	1,060	5,655
16	1,060	707	1,414	530	177	707	1,060	5,655
17	1,060	707	1,414	530	177	707	1,060	5,655
18	1,060	707	1,414	530	177	707	1,060	5,655
19	1,060	707	1,414	530	177	707	1,060	5,655
20	1,060	707	1,414	530	177	707	1,060	5,655
21	1,060	707	1,414	530	177	707	1,060	5,655
22	1,060	707	1,414	530	177	707	1,060	5,655
23	1,060	707	1,414	530	177	707	1,060	5,655
24	1,060	707	1,414	530	177	707	1,060	5,655
25	1,060	707	1,414	530	177	707	1,060	5,655
26	1,060	707	1,414	530	177	707	1,060	5,655
27	1,060	707	1,414	530	177	707	1,060	5,655
28	1,060	707	1,414	530	177	707	1,060	5,655
29	1,060	707	1,414	530	177	707	1,060	5,655
30	1,060	707	1,414	530	177	707	1,060	5,655
Total	**31,809**	**21,206**	**42,412**	**15,905**	**5,302**	**21,206**	**31,809**	**169,650**

d. Cumulative cropland BMP implementation in the JRR Watershed

Cropland BMP Implementation in the JRR Watershed (acres)				
Year	Neosho Headwaters	Lower Cottonwood	Upper Cottonwood	Total Adoption
1	1,961	2,695	5,655	10,311
2	1,961	2,695	5,655	10,311
3	1,961	2,695	5,655	10,311
4	1,961	2,695	5,655	10,311
5	1,961	2,695	5,655	10,311
6	1,961	2,695	5,655	10,311
7	1,961	2,695	5,655	10,311
8	1,961	2,695	5,655	10,311
9	1,961	2,695	5,655	10,311
10	1,961	2,695	5,655	10,311
11	1,961	2,695	5,655	10,311
12	1,961	2,695	5,655	10,311
13	1,961	2,695	5,655	10,311
14	1,961	2,695	5,655	10,311
15	1,961	2,695	5,655	10,311
16	1,961	2,695	5,655	10,311
17	1,961	2,695	5,655	10,311
18	1,961	2,695	5,655	10,311
19	1,961	2,695	5,655	10,311
20	1,961	2,695	5,655	10,311
21	1,961	2,695	5,655	10,311
22	1,961	2,695	5,655	10,311
23	1,961	2,695	5,655	10,311
24	1,961	2,695	5,655	10,311
25	1,961	2,695	5,655	10,311
26	1,961	2,695	5,655	10,311
27	1,961	2,695	5,655	10,311
28	1,961	2,695	5,655	10,311
29	1,961	2,695	5,655	10,311
30	1,961	2,695	5,655	10,311
Total	**58,830**	**80,850**	**169,650**	**309,330**

2. Livestock BMP implementation in the JRR Watershed

a. Neosho Headwaters – HUC 11070201

Neosho Headwaters Annual Adoption (projects), Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Total Adoption
1	1	1	1	1	0	4
2	0	1	1	1	1	4
3	1	1	1	1	0	4
4	0	1	1	1	1	4
5	1	1	1	1	0	4
6	0	1	1	1	1	4
7	1	1	1	1	0	4
8	0	1	1	1	1	4
9	1	1	1	1	0	4
10	0	1	1	1	1	4
11	1	1	1	1	0	4
12	0	1	1	1	1	4
13	1	1	1	1	0	4
14	0	1	1	1	1	4
15	1	1	1	1	0	4
16	0	1	1	1	1	4
17	1	1	1	1	0	4
18	0	1	1	1	1	4
19	1	1	1	1	0	4
20	0	1	1	1	1	4
21	1	1	1	1	0	4
22	0	1	1	1	1	4
23	1	1	1	1	0	4
24	0	1	1	1	1	4
25	1	1	1	1	0	4
26	0	1	1	1	1	4
27	1	1	1	1	0	4
28	0	1	1	1	1	4
29	1	1	1	1	0	4
30	0	1	1	1	1	4
Total	**15**	**30**	**30**	**30**	**15**	**120**

b. Lower Cottonwood – HUC 11070203

Lower Cottonwood Annual Adoption (projects), Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Total Projects
1	1	1	1	1	1	5
2	0	2	1	1	1	5
3	1	1	1	1	1	5
4	0	2	1	1	1	5
5	1	1	1	1	1	5
6	0	2	1	1	1	5
7	1	1	1	1	1	5
8	0	2	1	1	1	5
9	1	1	1	1	1	5
10	0	2	1	1	1	5
11	1	1	1	1	1	5
12	0	2	1	1	1	5
13	1	1	1	1	1	5
14	0	2	1	1	1	5
15	1	1	1	1	1	5
16	0	2	1	1	1	5
17	1	1	1	1	1	5
18	0	2	1	1	1	5
19	1	1	1	1	1	5
20	0	2	1	1	1	5
21	1	1	1	1	1	5
22	0	2	1	1	1	5
23	1	1	1	1	1	5
24	0	2	1	1	1	5
25	1	1	1	1	1	5
26	0	2	1	1	1	5
27	1	1	1	1	1	5
28	0	2	1	1	1	5
29	1	1	1	1	1	5
30	0	2	1	1	1	5
Total	**15**	**45**	**30**	**30**	**30**	**150**

c. Upper Cottonwood – HUC 11070202

Upper Cottonwood Annual Adoption (projects), Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Projects Per Year
1	1	1	1	1	1	5
2	0	1	1	1	0	3
3	1	1	1	1	1	5
4	0	1	1	1	0	3
5	1	1	1	1	1	5
6	0	1	1	1	0	3
7	1	1	1	1	1	5
8	0	1	1	1	0	3
9	1	1	1	1	1	5
10	0	1	1	1	0	3
11	1	1	1	1	1	5
12	0	1	1	1	0	3
13	1	1	1	1	1	5
14	0	1	1	1	0	3
15	1	1	1	1	1	5
16	0	1	1	1	0	3
17	1	1	1	1	1	5
18	0	1	1	1	0	3
19	1	1	1	1	1	5
20	0	1	1	1	0	3
21	1	1	1	1	1	5
22	0	1	1	1	0	3
23	1	1	1	1	1	5
24	0	1	1	1	0	3
25	1	1	1	1	1	5
26	0	1	1	1	0	3
27	1	1	1	1	1	5
28	0	1	1	1	0	3
29	1	1	1	1	1	5
30	0	1	1	1	0	3
Total	**15**	**30**	**30**	**30**	**15**	**120**

d. Cumulative livestock BMP implementation in the JRR Watershed

Livestock BMP Implementation in the JRR Watershed (projects)				
Year	Neosho Headwaters	Lower Cottonwood	Upper Cottonwood	Total Adoption
1	4	5	5	14
2	4	5	3	12
3	4	5	5	14
4	4	5	3	12
5	4	5	5	14
6	4	5	3	12
7	4	5	5	14
8	4	5	3	12
9	4	5	5	14
10	4	5	3	12
11	4	5	5	14
12	4	5	3	12
13	4	5	5	14
14	4	5	3	12
15	4	5	5	14
16	4	5	3	12
17	4	5	5	14
18	4	5	3	12
19	4	5	5	14
20	4	5	3	12
21	4	5	5	14
22	4	5	3	12
23	4	5	5	14
24	4	5	3	12
25	4	5	5	14
26	4	5	3	12
27	4	5	5	14
28	4	5	3	12
29	4	5	5	14
30	4	5	3	12
Total	**120**	**150**	**120**	**390**

3. Streambank BMP implementation in the JRR Watershed

Streambank BMP Implementation in the JRR Watershed (linear feet)				
Year	Neosho Headwaters	Lower Cottonwood	Upper Cottonwood	Total Adoption
1	1,170	2,064	392	3,626
2	1,170	2,064	392	3,626
3	1,170	2,064	392	3,626
4	1,170	2,064	392	3,626
5	1,170	2,064	392	3,626
6	1,170	2,064	392	3,626
7	1,170	2,064	392	3,626
8	1,170	2,064	392	3,626
9	1,170	2,064	392	3,626
10	1,170	2,064	392	3,626
11	1,170	2,064	392	3,626
12	1,170	2,064	392	3,626
13	1,170	2,064	392	3,626
14	1,170	2,064	392	3,626
15	1,170	2,064	392	3,626
16	1,170	2,064	392	3,626
17	1,170	2,064	392	3,626
18	1,170	2,064	392	3,626
19	1,170	2,064	392	3,626
20	1,170	2,064	392	3,626
21	1,170	2,064	392	3,626
22	1,170	2,064	392	3,626
23	1,170	2,064	392	3,626
24	1,170	2,064	392	3,626
25	1,170	2,064	392	3,626
26	1,170	2,064	392	3,626
27	1,170	2,064	392	3,626
28	1,170	2,064	392	3,626
29	1,170	2,064	392	3,626
30	1,170	2,064	392	3,626
Total	**35,100**	**61,920**	**11,760**	**108,780**

4. Phosphorus load reductions in the JRR Watershed

a. Neosho Headwaters – HUC 11070201

Neosho Headwaters Phosphorus Reduction (lbs), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	151	30	211	30	57	36	121	636
2	302	60	422	60	115	72	241	1,273
3	452	90	633	90	172	109	362	1,909
4	603	121	845	121	229	145	483	2,546
5	754	151	1,056	151	287	181	603	3,182
6	905	181	1,267	181	344	217	724	3,818
7	1,056	211	1,478	211	401	253	845	4,455
8	1,206	241	1,689	241	458	290	965	5,091
9	1,357	271	1,900	271	516	326	1,086	5,728
10	1,508	302	2,111	302	573	362	1,206	6,364
11	1,659	332	2,322	332	630	398	1,327	7,000
12	1,810	362	2,534	362	688	434	1,448	7,637
13	1,960	392	2,745	392	745	471	1,568	8,273
14	2,111	422	2,956	422	802	507	1,689	8,910
15	2,262	452	3,167	452	860	543	1,810	9,546
16	2,413	483	3,378	483	917	579	1,930	10,182
17	2,564	513	3,589	513	974	615	2,051	10,819
18	2,715	543	3,800	543	1,032	651	2,172	11,455
19	2,865	573	4,011	573	1,089	688	2,292	12,092
20	3,016	603	4,223	603	1,146	724	2,413	12,728
21	3,167	633	4,434	633	1,203	760	2,534	13,364
22	3,318	664	4,645	664	1,261	796	2,654	14,001
23	3,469	694	4,856	694	1,318	832	2,775	14,637
24	3,619	724	5,067	724	1,375	869	2,895	15,274
25	3,770	754	5,278	754	1,433	905	3,016	15,910
26	3,921	784	5,489	784	1,490	941	3,137	16,547
27	4,072	814	5,700	814	1,547	977	3,257	17,183
28	4,223	845	5,912	845	1,605	1,013	3,378	17,819
29	4,373	875	6,123	875	1,662	1,050	3,499	18,456
30	4,524	905	6,334	905	1,719	1,086	3,619	19,092

Neosho Headwaters Phosphorus Load Reduction (lbs), Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Total Load Reduction
1	30	888	25	21	0	964
2	30	1,777	50	41	7	1,905
3	59	2,665	75	62	7	2,869
4	59	3,553	100	83	15	3,810
5	89	4,442	125	103	15	4,774
6	89	5,330	151	124	22	5,715
7	118	6,218	176	145	22	6,678
8	118	7,106	201	165	30	7,620
9	148	7,995	226	186	30	8,583
10	148	8,883	251	207	37	9,525
11	177	9,771	276	227	37	10,488
12	177	10,660	301	248	44	11,430
13	207	11,548	326	269	44	12,393
14	207	12,436	351	289	52	13,335
15	236	13,325	376	310	52	14,298
16	236	14,213	401	331	59	15,240
17	266	15,101	426	351	59	16,203
18	266	15,989	452	372	66	17,145
19	295	16,878	477	393	66	18,108
20	295	17,766	502	413	74	19,050
21	325	18,654	527	434	74	20,013
22	325	19,543	552	454	81	20,955
23	354	20,431	577	475	81	21,918
24	354	21,319	602	496	89	22,860
25	384	22,208	627	516	89	23,823
26	384	23,096	652	537	96	24,765
27	413	23,984	677	558	96	25,728
28	413	24,872	702	578	103	26,670
29	443	25,761	727	599	103	27,633
30	443	26,649	753	620	111	28,575

b. Lower Cottonwood – HUC 11070203

Lower Cottonwood Phosphorus Reduction (lbs), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	192	38	269	38	73	46	153	810
2	384	77	537	77	146	92	307	1,619
3	575	115	806	115	219	138	460	2,429
4	767	153	1,074	153	292	184	614	3,238
5	959	192	1,343	192	364	230	767	4,048
6	1,151	230	1,611	230	437	276	921	4,857
7	1,343	269	1,880	269	510	322	1,074	5,667
8	1,535	307	2,148	307	583	368	1,228	6,476
9	1,726	345	2,417	345	656	414	1,381	7,286
10	1,918	384	2,686	384	729	460	1,535	8,095
11	2,110	422	2,954	422	802	506	1,688	8,905
12	2,302	460	3,223	460	875	552	1,842	9,714
13	2,494	499	3,491	499	948	599	1,995	10,524
14	2,686	537	3,760	537	1,021	645	2,148	11,333
15	2,877	575	4,028	575	1,093	691	2,302	12,143
16	3,069	614	4,297	614	1,166	737	2,455	12,952
17	3,261	652	4,565	652	1,239	783	2,609	13,762
18	3,453	691	4,834	691	1,312	829	2,762	14,571
19	3,645	729	5,103	729	1,385	875	2,916	15,381
20	3,837	767	5,371	767	1,458	921	3,069	16,190
21	4,028	806	5,640	806	1,531	967	3,223	17,000
22	4,220	844	5,908	844	1,604	1,013	3,376	17,809
23	4,412	882	6,177	882	1,677	1,059	3,530	18,619
24	4,604	921	6,445	921	1,749	1,105	3,683	19,428
25	4,796	959	6,714	959	1,822	1,151	3,837	20,238
26	4,988	998	6,983	998	1,895	1,197	3,990	21,047
27	5,179	1,036	7,251	1,036	1,968	1,243	4,143	21,857
28	5,371	1,074	7,520	1,074	2,041	1,289	4,297	22,666
29	5,563	1,113	7,788	1,113	2,114	1,335	4,450	23,476
30	5,755	1,151	8,057	1,151	2,187	1,381	4,604	24,285

Lower Cottonwood Phosphorus Load Reductions (lbs), Livestock BMPS						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Total Load Reduction
1	30	888	25	21	7	971
2	30	2,665	50	41	15	2,801
3	59	3,553	75	62	22	3,772
4	59	5,330	100	83	30	5,601
5	89	6,218	125	103	37	6,572
6	89	7,995	151	124	44	8,402
7	118	8,883	176	145	52	9,373
8	118	10,660	201	165	59	11,203
9	148	11,548	226	186	66	12,174
10	148	13,325	251	207	74	14,003
11	177	14,213	276	227	81	14,974
12	177	15,989	301	248	89	16,804
13	207	16,878	326	269	96	17,775
14	207	18,654	351	289	103	19,605
15	236	19,543	376	310	111	20,575
16	236	21,319	401	331	118	22,405
17	266	22,208	426	351	125	23,376
18	266	23,984	452	372	133	25,206
19	295	24,872	477	393	140	26,177
20	295	26,649	502	413	148	28,007
21	325	27,537	527	434	155	28,977
22	325	29,314	552	454	162	30,807
23	354	30,202	577	475	170	31,778
24	354	31,979	602	496	177	33,608
25	384	32,867	627	516	184	34,579
26	384	34,644	652	537	192	36,408
27	413	35,532	677	558	199	37,379
28	413	37,309	702	578	207	39,209
29	443	38,197	727	599	214	40,180
30	443	39,974	753	620	221	42,010

c. Upper Cottonwood – HUC 11070202

Upper Cottonwood Phosphorus Reduction (lbs), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	983	328	1,310	246	311	393	786	4,357
2	1,966	655	2,621	491	622	786	1,572	8,714
3	2,948	983	3,931	737	934	1,179	2,359	13,071
4	3,931	1,310	5,242	983	1,245	1,572	3,145	17,428
5	4,914	1,638	6,552	1,229	1,556	1,966	3,931	21,785
6	5,897	1,966	7,862	1,474	1,867	2,359	4,717	26,143
7	6,880	2,293	9,173	1,720	2,179	2,752	5,504	30,500
8	7,862	2,621	10,483	1,966	2,490	3,145	6,290	34,857
9	8,845	2,948	11,794	2,211	2,801	3,538	7,076	39,214
10	9,828	3,276	13,104	2,457	3,112	3,931	7,862	43,571
11	10,811	3,604	14,414	2,703	3,423	4,324	8,649	47,928
12	11,794	3,931	15,725	2,948	3,735	4,717	9,435	52,285
13	12,776	4,259	17,035	3,194	4,046	5,111	10,221	56,642
14	13,759	4,586	18,346	3,440	4,357	5,504	11,007	60,999
15	14,742	4,914	19,656	3,686	4,668	5,897	11,794	65,356
16	15,725	5,242	20,966	3,931	4,980	6,290	12,580	69,713
17	16,708	5,569	22,277	4,177	5,291	6,683	13,366	74,071
18	17,690	5,897	23,587	4,423	5,602	7,076	14,152	78,428
19	18,673	6,224	24,898	4,668	5,913	7,469	14,939	82,785
20	19,656	6,552	26,208	4,914	6,224	7,862	15,725	87,142
21	20,639	6,880	27,518	5,160	6,536	8,256	16,511	91,499
22	21,622	7,207	28,829	5,405	6,847	8,649	17,297	95,856
23	22,604	7,535	30,139	5,651	7,158	9,042	18,084	100,213
24	23,587	7,862	31,450	5,897	7,469	9,435	18,870	104,570
25	24,570	8,190	32,760	6,143	7,781	9,828	19,656	108,927
26	25,553	8,518	34,070	6,388	8,092	10,221	20,442	113,284
27	26,536	8,845	35,381	6,634	8,403	10,614	21,229	117,641
28	27,518	9,173	36,691	6,880	8,714	11,007	22,015	121,999
29	28,501	9,500	38,002	7,125	9,025	11,401	22,801	126,356
30	29,484	9,828	39,312	7,371	9,337	11,794	23,587	130,713

Upper Cottonwood Phosphorus Load Reductions (lbs), Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-Stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Annual Load Reduction
1	30	888	25	21	7	971
2	30	1,777	50	41	7	1,905
3	59	2,665	75	62	15	2,876
4	59	3,553	100	83	15	3,810
5	89	4,442	125	103	22	4,781
6	89	5,330	151	124	22	5,715
7	118	6,218	176	145	30	6,686
8	118	7,106	201	165	30	7,620
9	148	7,995	226	186	37	8,591
10	148	8,883	251	207	37	9,525
11	177	9,771	276	227	44	10,496
12	177	10,660	301	248	44	11,430
13	207	11,548	326	269	52	12,401
14	207	12,436	351	289	52	13,335
15	236	13,325	376	310	59	14,306
16	236	14,213	401	331	59	15,240
17	266	15,101	426	351	66	16,211
18	266	15,989	452	372	66	17,145
19	295	16,878	477	393	74	18,116
20	295	17,766	502	413	74	19,050
21	325	18,654	527	434	81	20,021
22	325	19,543	552	454	81	20,955
23	354	20,431	577	475	89	21,926
24	354	21,319	602	496	89	22,860
25	384	22,208	627	516	96	23,831
26	384	23,096	652	537	96	24,765
27	413	23,984	677	558	103	25,736
28	413	24,872	702	578	103	26,670
29	443	25,761	727	599	111	27,641
30	443	26,649	753	620	111	28,575

d. Streambank restoration phosphorus load reductions in the JRR Watershed

Streambank Stabilization Phosphorus Load Reductions (lbs) in the JRR Watershed							
Year	Neosho Headwaters		Lower Cottonwood		Upper Cottonwood		Total Phosphorus Load Reductions (lbs)
	Streambank Stabilization (feet)	Phosphorus Load Reduction (lbs)	Streambank Stabilization (feet)	Phosphorus Load Reduction (lbs)	Streambank Stabilization (feet)	Phosphorus Load Reduction (lbs)	
1	1,170	187	2,064	244	392	54	485
2	1,170	374	2,064	487	392	107	968
3	1,170	561	2,064	731	392	161	1,453
4	1,170	748	2,064	974	392	214	1,936
5	1,170	935	2,064	1,218	392	268	2,421
6	1,170	1,122	2,064	1,462	392	321	2,905
7	1,170	1,308	2,064	1,705	392	375	3,388
8	1,170	1,495	2,064	1,949	392	429	3,873
9	1,170	1,682	2,064	2,192	392	482	4,356
10	1,170	1,869	2,064	2,436	392	536	4,841
11	1,170	2,056	2,064	2,680	392	589	5,325
12	1,170	2,243	2,064	2,923	392	643	5,809
13	1,170	2,430	2,064	3,167	392	696	6,293
14	1,170	2,617	2,064	3,410	392	750	6,777
15	1,170	2,804	2,064	3,654	392	804	7,262
16	1,170	2,991	2,064	3,898	392	857	7,746
17	1,170	3,178	2,064	4,141	392	911	8,230
18	1,170	3,365	2,064	4,385	392	964	8,714
19	1,170	3,552	2,064	4,628	392	1,018	9,198
20	1,170	3,738	2,064	4,872	392	1,072	9,682
21	1,170	3,925	2,064	5,116	392	1,125	10,166
22	1,170	4,112	2,064	5,359	392	1,179	10,650
23	1,170	4,299	2,064	5,603	392	1,232	11,134
24	1,170	4,486	2,064	5,846	392	1,286	11,618
25	1,170	4,673	2,064	6,090	392	1,339	12,102
26	1,170	4,860	2,064	6,334	392	1,393	12,587
27	1,170	5,047	2,064	6,577	392	1,447	13,071
28	1,170	5,234	2,064	6,821	392	1,500	13,555
29	1,170	5,421	2,064	7,064	392	1,554	14,039
30	1,170	5,608	2,064	7,308	392	1,607	14,523

e. Cumulative phosphorus load reductions in the JRR Watershed

Cumulative Phosphorus Load Reductions (lbs) in the JRR Watershed										
Year	Neosho Headwaters			Lower Cottonwood			Upper Cottonwood			Total Phosphorus Load Reductions
	Cropland	Livestock	Streambank	Cropland	Livestock	Streambank	Cropland	Livestock	Streambank	
1	636	964	187	810	971	244	4,357	971	54	9,194
2	1,273	1,905	374	1,619	2,801	487	8,714	1,905	107	19,185
3	1,909	2,869	561	2,429	3,772	731	13,071	2,876	161	28,379
4	2,546	3,810	748	3,238	5,601	974	17,428	3,810	214	38,370
5	3,182	4,774	935	4,048	6,572	1,218	21,785	4,781	268	47,563
6	3,818	5,715	1,122	4,857	8,402	1,462	26,143	5,715	321	57,555
7	4,455	6,678	1,308	5,667	9,373	1,705	30,500	6,686	375	66,747
8	5,091	7,620	1,495	6,476	11,203	1,949	34,857	7,620	429	76,739
9	5,728	8,583	1,682	7,286	12,174	2,192	39,214	8,591	482	85,932
10	6,364	9,525	1,869	8,095	14,003	2,436	43,571	9,525	536	95,924
11	7,000	10,488	2,056	8,905	14,974	2,680	47,928	10,496	589	105,116
12	7,637	11,430	2,243	9,714	16,804	2,923	52,285	11,430	643	115,109
13	8,273	12,393	2,430	10,524	17,775	3,167	56,642	12,401	696	124,301
14	8,910	13,335	2,617	11,333	19,605	3,410	60,999	13,335	750	134,294
15	9,546	14,298	2,804	12,143	20,575	3,654	65,356	14,306	804	143,486
16	10,182	15,240	2,991	12,952	22,405	3,898	69,713	15,240	857	153,478
17	10,819	16,203	3,178	13,762	23,376	4,141	74,071	16,211	911	162,671
18	11,455	17,145	3,365	14,571	25,206	4,385	78,428	17,145	964	172,664
19	12,092	18,108	3,552	15,381	26,177	4,628	82,785	18,116	1,018	181,856
20	12,728	19,050	3,738	16,190	28,007	4,872	87,142	19,050	1,072	191,848
21	13,364	20,013	3,925	17,000	28,977	5,116	91,499	20,021	1,125	201,040
22	14,001	20,955	4,112	17,809	30,807	5,359	95,856	20,955	1,179	211,032
23	14,637	21,918	4,299	18,619	31,778	5,603	100,213	21,926	1,232	220,225
24	15,274	22,860	4,486	19,428	33,608	5,846	104,570	22,860	1,286	230,218
25	15,910	23,823	4,673	20,238	34,579	6,090	108,927	23,831	1,339	239,410
26	16,547	24,765	4,860	21,047	36,408	6,334	113,284	24,765	1,393	249,403
27	17,183	25,728	5,047	21,857	37,379	6,577	117,641	25,736	1,447	258,595
28	17,819	26,670	5,234	22,666	39,209	6,821	121,999	26,670	1,500	268,587
29	18,456	27,633	5,421	23,476	40,180	7,064	126,356	27,641	1,554	277,780
30	19,092	28,575	5,608	24,285	42,010	7,308	130,713	28,575	1,607	287,773

5. Nitrogen load reductions in the JRR Watershed

a. Neosho Headwaters – HUC 11070201

Neosho Headwaters Nitrogen Reduction (lbs), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	1,017	203	736	192	386	244	813	3,592
2	2,034	407	1,472	384	773	488	1,627	7,184
3	3,051	610	2,207	576	1,159	732	2,440	10,776
4	4,067	813	2,943	768	1,546	976	3,254	14,368
5	5,084	1,017	3,679	960	1,932	1,220	4,067	17,960
6	6,101	1,220	4,415	1,152	2,318	1,464	4,881	21,552
7	7,118	1,424	5,151	1,344	2,705	1,708	5,694	25,143
8	8,135	1,627	5,886	1,536	3,091	1,952	6,508	28,735
9	9,152	1,830	6,622	1,728	3,478	2,196	7,321	32,327
10	10,169	2,034	7,358	1,920	3,864	2,440	8,135	35,919
11	11,186	2,237	8,094	2,111	4,250	2,685	8,948	39,511
12	12,202	2,440	8,829	2,303	4,637	2,929	9,762	43,103
13	13,219	2,644	9,565	2,495	5,023	3,173	10,575	46,695
14	14,236	2,847	10,301	2,687	5,410	3,417	11,389	50,287
15	15,253	3,051	11,037	2,879	5,796	3,661	12,202	53,879
16	16,270	3,254	11,773	3,071	6,183	3,905	13,016	57,471
17	17,287	3,457	12,508	3,263	6,569	4,149	13,829	61,063
18	18,304	3,661	13,244	3,455	6,955	4,393	14,643	64,655
19	19,320	3,864	13,980	3,647	7,342	4,637	15,456	68,247
20	20,337	4,067	14,716	3,839	7,728	4,881	16,270	71,838
21	21,354	4,271	15,452	4,031	8,115	5,125	17,083	75,430
22	22,371	4,474	16,187	4,223	8,501	5,369	17,897	79,022
23	23,388	4,678	16,923	4,415	8,887	5,613	18,710	82,614
24	24,405	4,881	17,659	4,607	9,274	5,857	19,524	86,206
25	25,422	5,084	18,395	4,799	9,660	6,101	20,337	89,798
26	26,438	5,288	19,130	4,991	10,047	6,345	21,151	93,390
27	27,455	5,491	19,866	5,183	10,433	6,589	21,964	96,982
28	28,472	5,694	20,602	5,375	10,819	6,833	22,778	100,574
29	29,489	5,898	21,338	5,567	11,206	7,077	23,591	104,166
30	30,506	6,101	22,074	5,759	11,592	7,321	24,405	107,758

Neosho Headwaters Nitrogen Load Reduction (lbs), Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Total Load Reduction
1	56	1,673	47	39	0	1,815
2	56	3,346	94	78	14	3,588
3	111	5,019	142	117	14	5,403
4	111	6,692	189	156	28	7,176
5	167	8,366	236	195	28	8,991
6	167	10,039	283	233	42	10,764
7	222	11,712	331	272	42	12,579
8	222	13,385	378	311	56	14,352
9	278	15,058	425	350	56	16,167
10	278	16,731	472	389	69	17,940
11	334	18,404	520	428	69	19,755
12	334	20,077	567	467	83	21,528
13	389	21,750	614	506	83	23,343
14	389	23,424	661	545	97	25,116
15	445	25,097	709	584	97	26,931
16	445	26,770	756	623	111	28,704
17	500	28,443	803	661	111	30,519
18	500	30,116	850	700	125	32,292
19	556	31,789	898	739	125	34,107
20	556	33,462	945	778	139	35,880
21	611	35,135	992	817	139	37,695
22	611	36,808	1,039	856	153	39,468
23	667	38,482	1,087	895	153	41,283
24	667	40,155	1,134	934	167	43,056
25	723	41,828	1,181	973	167	44,871
26	723	43,501	1,228	1,012	181	46,644
27	778	45,174	1,276	1,051	181	48,459
28	778	46,847	1,323	1,089	195	50,232
29	834	48,520	1,370	1,128	195	52,047
30	834	50,193	1,417	1,167	208	53,820

b. Lower Cottonwood – HUC 11070203

Lower Cottonwood Nitrogen Reduction (lbs), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	1,269	254	888	254	482	305	1,015	4,466
2	2,538	508	1,776	508	964	609	2,030	8,932
3	3,806	761	2,664	761	1,446	914	3,045	13,399
4	5,075	1,015	3,553	1,015	1,929	1,218	4,060	17,865
5	6,344	1,269	4,441	1,269	2,411	1,523	5,075	22,331
6	7,613	1,523	5,329	1,523	2,893	1,827	6,090	26,797
7	8,882	1,776	6,217	1,776	3,375	2,132	7,105	31,263
8	10,150	2,030	7,105	2,030	3,857	2,436	8,120	35,730
9	11,419	2,284	7,993	2,284	4,339	2,741	9,135	40,196
10	12,688	2,538	8,882	2,538	4,821	3,045	10,150	44,662
11	13,957	2,791	9,770	2,791	5,304	3,350	11,165	49,128
12	15,226	3,045	10,658	3,045	5,786	3,654	12,181	53,594
13	16,494	3,299	11,546	3,299	6,268	3,959	13,196	58,061
14	17,763	3,553	12,434	3,553	6,750	4,263	14,211	62,527
15	19,032	3,806	13,322	3,806	7,232	4,568	15,226	66,993
16	20,301	4,060	14,211	4,060	7,714	4,872	16,241	71,459
17	21,570	4,314	15,099	4,314	8,196	5,177	17,256	75,925
18	22,839	4,568	15,987	4,568	8,679	5,481	18,271	80,392
19	24,107	4,821	16,875	4,821	9,161	5,786	19,286	84,858
20	25,376	5,075	17,763	5,075	9,643	6,090	20,301	89,324
21	26,645	5,329	18,651	5,329	10,125	6,395	21,316	93,790
22	27,914	5,583	19,540	5,583	10,607	6,699	22,331	98,256
23	29,183	5,837	20,428	5,837	11,089	7,004	23,346	102,723
24	30,451	6,090	21,316	6,090	11,572	7,308	24,361	107,189
25	31,720	6,344	22,204	6,344	12,054	7,613	25,376	111,655
26	32,989	6,598	23,092	6,598	12,536	7,917	26,391	116,121
27	34,258	6,852	23,980	6,852	13,018	8,222	27,406	120,587
28	35,527	7,105	24,869	7,105	13,500	8,526	28,421	125,054
29	36,795	7,359	25,757	7,359	13,982	8,831	29,436	129,520
30	38,064	7,613	26,645	7,613	14,464	9,135	30,451	133,986

Lower Cottonwood Nitrogen Reduction (lbs), Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Annual Load Reduction
1	56	1,673	47	39	14	1,829
2	56	5,019	94	78	28	5,275
3	111	6,692	142	117	42	7,104
4	111	10,039	189	156	56	10,550
5	167	11,712	236	195	69	12,379
6	167	15,058	283	233	83	15,825
7	222	16,731	331	272	97	17,654
8	222	20,077	378	311	111	21,100
9	278	21,750	425	350	125	22,929
10	278	25,097	472	389	139	26,375
11	334	26,770	520	428	153	28,204
12	334	30,116	567	467	167	31,650
13	389	31,789	614	506	181	33,479
14	389	35,135	661	545	195	36,925
15	445	36,808	709	584	208	38,754
16	445	40,155	756	623	222	42,200
17	500	41,828	803	661	236	44,029
18	500	45,174	850	700	250	47,475
19	556	46,847	898	739	264	49,304
20	556	50,193	945	778	278	52,750
21	611	51,867	992	817	292	54,579
22	611	55,213	1,039	856	306	58,025
23	667	56,886	1,087	895	320	59,854
24	667	60,232	1,134	934	334	63,300
25	723	61,905	1,181	973	347	65,129
26	723	65,251	1,228	1,012	361	68,575
27	778	66,925	1,276	1,051	375	70,404
28	778	70,271	1,323	1,089	389	73,850
29	834	71,944	1,370	1,128	403	75,679
30	834	75,290	1,417	1,167	417	79,125

c. Upper Cottonwood – HUC 11070202

Upper Cottonwood Nitrogen Reduction (lbs), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till	Nutrient Management Plan	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	5,723	1,908	3,815	1,431	1,812	2,289	4,578	21,555
2	11,445	3,815	7,630	2,861	3,624	4,578	9,156	43,110
3	17,168	5,723	11,445	4,292	5,436	6,867	13,734	64,665
4	22,890	7,630	15,260	5,723	7,249	9,156	18,312	86,221
5	28,613	9,538	19,075	7,153	9,061	11,445	22,890	107,776
6	34,336	11,445	22,890	8,584	10,873	13,734	27,468	129,331
7	40,058	13,353	26,705	10,015	12,685	16,023	32,047	150,886
8	45,781	15,260	30,521	11,445	14,497	18,312	36,625	172,441
9	51,503	17,168	34,336	12,876	16,309	20,601	41,203	193,996
10	57,226	19,075	38,151	14,307	18,122	22,890	45,781	215,551
11	62,949	20,983	41,966	15,737	19,934	25,179	50,359	237,107
12	68,671	22,890	45,781	17,168	21,746	27,468	54,937	258,662
13	74,394	24,798	49,596	18,598	23,558	29,758	59,515	280,217
14	80,116	26,705	53,411	20,029	25,370	32,047	64,093	301,772
15	85,839	28,613	57,226	21,460	27,182	34,336	68,671	323,327
16	91,562	30,521	61,041	22,890	28,995	36,625	73,249	344,882
17	97,284	32,428	64,856	24,321	30,807	38,914	77,827	366,437
18	103,007	34,336	68,671	25,752	32,619	41,203	82,405	387,993
19	108,729	36,243	72,486	27,182	34,431	43,492	86,984	409,548
20	114,452	38,151	76,301	28,613	36,243	45,781	91,562	431,103
21	120,175	40,058	80,116	30,044	38,055	48,070	96,140	452,658
22	125,897	41,966	83,932	31,474	39,867	50,359	100,718	474,213
23	131,620	43,873	87,747	32,905	41,680	52,648	105,296	495,768
24	137,342	45,781	91,562	34,336	43,492	54,937	109,874	517,323
25	143,065	47,688	95,377	35,766	45,304	57,226	114,452	538,879
26	148,788	49,596	99,192	37,197	47,116	59,515	119,030	560,434
27	154,510	51,503	103,007	38,628	48,928	61,804	123,608	581,989
28	160,233	53,411	106,822	40,058	50,740	64,093	128,186	603,544
29	165,956	55,319	110,637	41,489	52,553	66,382	132,764	625,099
30	171,678	57,226	114,452	42,920	54,365	68,671	137,342	646,654

Upper Cottonwood Nitrogen Reduction (lbs), Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Annual Load Reduction
1	56	1,673	47	39	14	1,829
2	56	3,346	94	78	14	3,588
3	111	5,019	142	117	28	5,417
4	111	6,692	189	156	28	7,176
5	167	8,366	236	195	42	9,005
6	167	10,039	283	233	42	10,764
7	222	11,712	331	272	56	12,593
8	222	13,385	378	311	56	14,352
9	278	15,058	425	350	69	16,181
10	278	16,731	472	389	69	17,940
11	334	18,404	520	428	83	19,769
12	334	20,077	567	467	83	21,528
13	389	21,750	614	506	97	23,357
14	389	23,424	661	545	97	25,116
15	445	25,097	709	584	111	26,945
16	445	26,770	756	623	111	28,704
17	500	28,443	803	661	125	30,533
18	500	30,116	850	700	125	32,292
19	556	31,789	898	739	139	34,121
20	556	33,462	945	778	139	35,880
21	611	35,135	992	817	153	37,709
22	611	36,808	1,039	856	153	39,468
23	667	38,482	1,087	895	167	41,297
24	667	40,155	1,134	934	167	43,056
25	723	41,828	1,181	973	181	44,885
26	723	43,501	1,228	1,012	181	46,644
27	778	45,174	1,276	1,051	195	48,473
28	778	46,847	1,323	1,089	195	50,232
29	834	48,520	1,370	1,128	208	52,061
30	834	50,193	1,417	1,167	208	53,820

d. Cumulative nitrogen load reductions in the JRR Watershed

Cumulative Nitrogen Load Reductions (lbs) in the JRR Watershed							
Year	Neosho Headwaters		Lower Cottonwood		Upper Cottonwood		Total Nitrogen Load Reductions
	Cropland	Livestock	Cropland	Livestock	Cropland	Livestock	
1	3,592	1,815	4,466	1,829	21,555	1,829	35,086
2	7,184	3,588	8,932	5,275	43,110	3,588	71,677
3	10,776	5,403	13,399	7,104	64,665	5,417	106,764
4	14,368	7,176	17,865	10,550	86,221	7,176	143,356
5	17,960	8,991	22,331	12,379	107,776	9,005	178,442
6	21,552	10,764	26,797	15,825	129,331	10,764	215,033
7	25,143	12,579	31,263	17,654	150,886	12,593	250,118
8	28,735	14,352	35,730	21,100	172,441	14,352	286,710
9	32,327	16,167	40,196	22,929	193,996	16,181	321,796
10	35,919	17,940	44,662	26,375	215,551	17,940	358,387
11	39,511	19,755	49,128	28,204	237,107	19,769	393,474
12	43,103	21,528	53,594	31,650	258,662	21,528	430,065
13	46,695	23,343	58,061	33,479	280,217	23,357	465,152
14	50,287	25,116	62,527	36,925	301,772	25,116	501,743
15	53,879	26,931	66,993	38,754	323,327	26,945	536,829
16	57,471	28,704	71,459	42,200	344,882	28,704	573,420
17	61,063	30,519	75,925	44,029	366,437	30,533	608,506
18	64,655	32,292	80,392	47,475	387,993	32,292	645,099
19	68,247	34,107	84,858	49,304	409,548	34,121	680,185
20	71,838	35,880	89,324	52,750	431,103	35,880	716,775
21	75,430	37,695	93,790	54,579	452,658	37,709	751,861
22	79,022	39,468	98,256	58,025	474,213	39,468	788,452
23	82,614	41,283	102,723	59,854	495,768	41,297	823,539
24	86,206	43,056	107,189	63,300	517,323	43,056	860,130
25	89,798	44,871	111,655	65,129	538,879	44,885	895,217
26	93,390	46,644	116,121	68,575	560,434	46,644	931,808
27	96,982	48,459	120,587	70,404	581,989	48,473	966,894
28	100,574	50,232	125,054	73,850	603,544	50,232	1,003,486
29	104,166	52,047	129,520	75,679	625,099	52,061	1,038,572
30	107,758	53,820	133,986	79,125	646,654	53,820	1,075,163

6. Sediment load reductions in the JRR Watershed

a. Neosho Headwaters – HUC 11070201

Neosho Headwaters Sediment Loss Reduction (tons), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	110	22	123	0	42	26	88	411
2	220	44	246	0	83	53	176	821
3	329	66	369	0	125	79	264	1,232
4	439	88	492	0	167	105	351	1,643
5	549	110	615	0	209	132	439	2,053
6	659	132	738	0	250	158	527	2,464
7	769	154	861	0	292	184	615	2,875
8	878	176	984	0	334	211	703	3,285
9	988	198	1,107	0	376	237	791	3,696
10	1,098	220	1,230	0	417	264	878	4,107
11	1,208	242	1,353	0	459	290	966	4,517
12	1,318	264	1,476	0	501	316	1,054	4,928
13	1,427	285	1,599	0	542	343	1,142	5,339
14	1,537	307	1,722	0	584	369	1,230	5,749
15	1,647	329	1,845	0	626	395	1,318	6,160
16	1,757	351	1,968	0	668	422	1,406	6,571
17	1,867	373	2,091	0	709	448	1,493	6,981
18	1,977	395	2,214	0	751	474	1,581	7,392
19	2,086	417	2,337	0	793	501	1,669	7,803
20	2,196	439	2,460	0	835	527	1,757	8,213
21	2,306	461	2,583	0	876	553	1,845	8,624
22	2,416	483	2,706	0	918	580	1,933	9,035
23	2,526	505	2,829	0	960	606	2,020	9,446
24	2,635	527	2,952	0	1,001	632	2,108	9,856
25	2,745	549	3,075	0	1,043	659	2,196	10,267
26	2,855	571	3,198	0	1,085	685	2,284	10,678
27	2,965	593	3,321	0	1,127	712	2,372	11,088
28	3,075	615	3,444	0	1,168	738	2,460	11,499
29	3,184	637	3,566	0	1,210	764	2,547	11,910
30	3,294	659	3,689	0	1,252	791	2,635	12,320

b. Lower Cottonwood – HUC 11070203

Lower Cottonwood Sediment Loss Reduction (tons), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	119	24	133	0	45	28	95	444
2	237	47	266	0	90	57	190	887
3	356	71	399	0	135	85	285	1,331
4	474	95	531	0	180	114	380	1,774
5	593	119	664	0	225	142	474	2,218
6	712	142	797	0	270	171	569	2,662
7	830	166	930	0	315	199	664	3,105
8	949	190	1,063	0	361	228	759	3,549
9	1,067	213	1,196	0	406	256	854	3,992
10	1,186	237	1,328	0	451	285	949	4,436
11	1,305	261	1,461	0	496	313	1,044	4,879
12	1,423	285	1,594	0	541	342	1,139	5,323
13	1,542	308	1,727	0	586	370	1,233	5,767
14	1,660	332	1,860	0	631	399	1,328	6,210
15	1,779	356	1,993	0	676	427	1,423	6,654
16	1,898	380	2,125	0	721	455	1,518	7,097
17	2,016	403	2,258	0	766	484	1,613	7,541
18	2,135	427	2,391	0	811	512	1,708	7,985
19	2,254	451	2,524	0	856	541	1,803	8,428
20	2,372	474	2,657	0	901	569	1,898	8,872
21	2,491	498	2,790	0	946	598	1,993	9,315
22	2,609	522	2,922	0	992	626	2,087	9,759
23	2,728	546	3,055	0	1,037	655	2,182	10,202
24	2,847	569	3,188	0	1,082	683	2,277	10,646
25	2,965	593	3,321	0	1,127	712	2,372	11,090
26	3,084	617	3,454	0	1,172	740	2,467	11,533
27	3,202	640	3,587	0	1,217	769	2,562	11,977
28	3,321	664	3,719	0	1,262	797	2,657	12,420
29	3,440	688	3,852	0	1,307	825	2,752	12,864
30	3,558	712	3,985	0	1,352	854	2,847	13,308

c. Upper Cottonwood – HUC 11070202

Upper Cottonwood Sediment Loss Reduction (tons), Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Load Reduction
1	641	214	684	0	203	257	513	2,512
2	1,283	428	1,368	0	406	513	1,026	5,025
3	1,924	641	2,053	0	609	770	1,539	7,537
4	2,566	855	2,737	0	812	1,026	2,053	10,049
5	3,207	1,069	3,421	0	1,016	1,283	2,566	12,561
6	3,849	1,283	4,105	0	1,219	1,539	3,079	15,074
7	4,490	1,497	4,789	0	1,422	1,796	3,592	17,586
8	5,131	1,710	5,474	0	1,625	2,053	4,105	20,098
9	5,773	1,924	6,158	0	1,828	2,309	4,618	22,610
10	6,414	2,138	6,842	0	2,031	2,566	5,131	25,123
11	7,056	2,352	7,526	0	2,234	2,822	5,645	27,635
12	7,697	2,566	8,210	0	2,437	3,079	6,158	30,147
13	8,339	2,780	8,895	0	2,641	3,335	6,671	32,660
14	8,980	2,993	9,579	0	2,844	3,592	7,184	35,172
15	9,621	3,207	10,263	0	3,047	3,849	7,697	37,684
16	10,263	3,421	10,947	0	3,250	4,105	8,210	40,196
17	10,904	3,635	11,631	0	3,453	4,362	8,723	42,709
18	11,546	3,849	12,316	0	3,656	4,618	9,237	45,221
19	12,187	4,062	13,000	0	3,859	4,875	9,750	47,733
20	12,829	4,276	13,684	0	4,062	5,131	10,263	50,246
21	13,470	4,490	14,368	0	4,266	5,388	10,776	52,758
22	14,112	4,704	15,052	0	4,469	5,645	11,289	55,270
23	14,753	4,918	15,736	0	4,672	5,901	11,802	57,782
24	15,394	5,131	16,421	0	4,875	6,158	12,316	60,295
25	16,036	5,345	17,105	0	5,078	6,414	12,829	62,807
26	16,677	5,559	17,789	0	5,281	6,671	13,342	65,319
27	17,319	5,773	18,473	0	5,484	6,927	13,855	67,831
28	17,960	5,987	19,157	0	5,687	7,184	14,368	70,344
29	18,602	6,201	19,842	0	5,890	7,441	14,881	72,856
30	19,243	6,414	20,526	0	6,094	7,697	15,394	75,368

d. Streambank sediment load reductions in the JRR Watershed

Cumulative Sediment Loss Reductions (tons) in the JRR Watershed							
Year	Neosho Headwaters		Lower Cottonwood		Upper Cottonwood		Total Sediment Loss Reductions (tons)
	Streambank Stabilization (feet)	Sediment Erosion Reduction (tons)	Streambank Stabilization (feet)	Sediment Erosion Reduction (tons)	Streambank Stabilization (feet)	Sediment Erosion Reduction (tons)	
1	1,170	3,115	2,064	4,060	392	3,405	10,580
2	1,170	6,231	2,064	8,120	392	6,810	21,161
3	1,170	9,346	2,064	12,180	392	10,216	31,742
4	1,170	12,461	2,064	16,240	392	13,621	42,322
5	1,170	15,577	2,064	20,300	392	17,026	52,903
6	1,170	18,692	2,064	24,360	392	20,431	63,483
7	1,170	21,807	2,064	28,420	392	23,836	74,063
8	1,170	24,923	2,064	32,480	392	27,242	84,645
9	1,170	28,038	2,064	36,540	392	30,647	95,225
10	1,170	31,154	2,064	40,600	392	34,052	105,806
11	1,170	34,269	2,064	44,660	392	37,457	116,386
12	1,170	37,384	2,064	48,720	392	40,862	126,966
13	1,170	40,500	2,064	52,780	392	44,268	137,548
14	1,170	43,615	2,064	56,840	392	47,673	148,128
15	1,170	46,730	2,064	60,900	392	51,078	158,708
16	1,170	49,846	2,064	64,960	392	54,483	169,289
17	1,170	52,961	2,064	69,020	392	57,888	179,869
18	1,170	56,076	2,064	73,080	392	61,294	190,450
19	1,170	59,192	2,064	77,140	392	64,699	201,031
20	1,170	62,307	2,064	81,200	392	68,104	211,611
21	1,170	65,422	2,064	85,260	392	71,509	222,191
22	1,170	68,538	2,064	89,320	392	74,915	232,773
23	1,170	71,653	2,064	93,380	392	78,320	243,353
24	1,170	74,768	2,064	97,440	392	81,725	253,933
25	1,170	77,884	2,064	101,500	392	85,130	264,514
26	1,170	80,999	2,064	105,560	392	88,535	275,094
27	1,170	84,115	2,064	109,620	392	91,941	285,676
28	1,170	87,230	2,064	113,680	392	95,346	296,256
29	1,170	90,345	2,064	117,740	392	98,751	306,836
30	1,170	93,461	2,064	121,800	392	102,156	317,417

e. Cumulative sediment load reductions in the JRR Watershed

Cumulative Sediment Loss Reductions (tons) in the JRR Watershed							
Year	Neosho Headwaters		Lower Cottonwood		Upper Cottonwood		Total Sediment Loss Reductions
	Cropland	Streambank	Cropland	Streambank	Cropland	Streambank	
1	411	3,115	444	4,060	2,512	893	11,435
2	821	6,231	887	8,120	5,025	1,786	22,869
3	1,232	9,346	1,331	12,180	7,537	2,679	34,305
4	1,643	12,461	1,774	16,240	10,049	3,572	45,739
5	2,053	15,577	2,218	20,300	12,561	4,465	57,174
6	2,464	18,692	2,662	24,360	15,074	5,358	68,609
7	2,875	21,807	3,105	28,420	17,586	6,250	80,043
8	3,285	24,923	3,549	32,480	20,098	7,143	91,479
9	3,696	28,038	3,992	36,540	22,610	8,036	102,913
10	4,107	31,154	4,436	40,600	25,123	8,929	114,349
11	4,517	34,269	4,879	44,660	27,635	9,822	125,782
12	4,928	37,384	5,323	48,720	30,147	10,715	137,217
13	5,339	40,500	5,767	52,780	32,660	11,608	148,654
14	5,749	43,615	6,210	56,840	35,172	12,501	160,087
15	6,160	46,730	6,654	60,900	37,684	13,394	171,522
16	6,571	49,846	7,097	64,960	40,196	14,287	182,957
17	6,981	52,961	7,541	69,020	42,709	15,180	194,391
18	7,392	56,076	7,985	73,080	45,221	16,073	205,827
19	7,803	59,192	8,428	77,140	47,733	16,966	217,262
20	8,213	62,307	8,872	81,200	50,246	17,859	228,696
21	8,624	65,422	9,315	85,260	52,758	18,751	240,130
22	9,035	68,538	9,759	89,320	55,270	19,644	251,567
23	9,446	71,653	10,202	93,380	57,782	20,537	263,001
24	9,856	74,768	10,646	97,440	60,295	21,430	274,435
25	10,267	77,884	11,090	101,500	62,807	22,323	285,871
26	10,678	80,999	11,533	105,560	65,319	23,216	297,305
27	11,088	84,115	11,977	109,620	67,831	24,109	308,741
28	11,499	87,230	12,420	113,680	70,344	25,002	320,175
29	11,910	90,345	12,864	117,740	72,856	25,895	331,610
30	12,320	93,461	13,308	121,800	75,368	26,788	343,045

7. JRR Watershed BMP implementation: Costs before cost-share

a. Neosho Headwaters – HUC 11070201

Neosho Headwaters Implementation Cost Before Cost-Share, Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Annual Cost
1	$64,958	$6,373	$57,196	$9,315	$9,151	$16,669	$118,478	$282,140
2	$66,907	$6,564	$58,912	$9,594	$9,426	$17,169	$122,032	$290,604
3	$68,914	$6,761	$60,679	$9,882	$9,709	$17,684	$125,693	$299,322
4	$70,982	$6,964	$62,500	$10,179	$10,000	$18,214	$129,464	$308,302
5	$73,111	$7,173	$64,375	$10,484	$10,300	$18,761	$133,347	$317,551
6	$75,305	$7,388	$66,306	$10,798	$10,609	$19,323	$137,348	$327,077
7	$77,564	$7,610	$68,295	$11,122	$10,927	$19,903	$141,468	$336,890
8	$79,891	$7,838	$70,344	$11,456	$11,255	$20,500	$145,712	$346,996
9	$82,287	$8,073	$72,454	$11,800	$11,593	$21,115	$150,084	$357,406
10	$84,756	$8,316	$74,628	$12,154	$11,940	$21,749	$154,586	$368,129
11	$87,299	$8,565	$76,867	$12,518	$12,299	$22,401	$159,224	$379,172
12	$89,918	$8,822	$79,173	$12,894	$12,668	$23,073	$164,001	$390,548
13	$92,615	$9,087	$81,548	$13,281	$13,048	$23,765	$168,921	$402,264
14	$95,394	$9,359	$83,994	$13,679	$13,439	$24,478	$173,988	$414,332
15	$98,255	$9,640	$86,514	$14,089	$13,842	$25,213	$179,208	$426,762
16	$101,203	$9,929	$89,110	$14,512	$14,258	$25,969	$184,584	$439,565
17	$104,239	$10,227	$91,783	$14,947	$14,685	$26,748	$190,122	$452,752
18	$107,366	$10,534	$94,536	$15,396	$15,126	$27,551	$195,825	$466,334
19	$110,587	$10,850	$97,372	$15,858	$15,580	$28,377	$201,700	$480,324
20	$113,905	$11,176	$100,294	$16,334	$16,047	$29,228	$207,751	$494,734
21	$117,322	$11,511	$103,302	$16,824	$16,528	$30,105	$213,984	$509,576
22	$120,842	$11,856	$106,401	$17,328	$17,024	$31,008	$220,403	$524,863
23	$124,467	$12,212	$109,594	$17,848	$17,535	$31,939	$227,015	$540,609
24	$128,201	$12,578	$112,881	$18,384	$18,061	$32,897	$233,826	$556,828
25	$132,047	$12,956	$116,268	$18,935	$18,603	$33,884	$240,840	$573,532
26	$136,008	$13,344	$119,756	$19,503	$19,161	$34,900	$248,066	$590,738
27	$140,089	$13,745	$123,348	$20,088	$19,736	$35,947	$255,508	$608,460
28	$144,291	$14,157	$127,049	$20,691	$20,328	$37,026	$263,173	$626,714
29	$148,620	$14,582	$130,860	$21,312	$20,938	$38,136	$271,068	$645,516
30	$153,079	$15,019	$134,786	$21,951	$21,566	$39,281	$279,200	$664,881
3% Inflation							Total	$13,422,923

Neosho Headwaters Implementation Cost Before Cost-Share, Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Annual Cost
1	$4,106	$714	$3,795	$2,203	$0	$10,818
2	$0	$735	$3,909	$2,269	$7,210	$14,123
3	$4,356	$757	$4,026	$2,337	$0	$11,476
4	$0	$780	$4,147	$2,407	$7,649	$14,983
5	$4,621	$804	$4,271	$2,479	$0	$12,175
6	$0	$828	$4,399	$2,554	$8,115	$15,896
7	$4,903	$853	$4,531	$2,630	$0	$12,917
8	$0	$878	$4,667	$2,709	$8,609	$16,863
9	$5,201	$904	$4,807	$2,791	$0	$13,703
10	$0	$932	$4,952	$2,874	$9,133	$17,891
11	$5,518	$960	$5,100	$2,961	$0	$14,539
12	$0	$988	$5,253	$3,049	$9,690	$18,980
13	$5,854	$1,018	$5,411	$3,141	$0	$15,424
14	$0	$1,049	$5,573	$3,235	$10,280	$20,137
15	$6,211	$1,080	$5,740	$3,332	$0	$16,363
16	$0	$1,112	$5,912	$3,432	$10,906	$21,362
17	$6,589	$1,146	$6,090	$3,535	$0	$17,360
18	$0	$1,180	$6,273	$3,641	$11,570	$22,664
19	$6,990	$1,216	$6,461	$3,750	$0	$18,417
20	$0	$1,252	$6,655	$3,863	$12,275	$24,045
21	$7,416	$1,290	$6,854	$3,979	$0	$19,539
22	$0	$1,328	$7,060	$4,098	$13,022	$25,508
23	$7,868	$1,368	$7,272	$4,221	$0	$20,729
24	$0	$1,409	$7,490	$4,348	$13,815	$27,062
25	$8,347	$1,451	$7,714	$4,478	$0	$21,990
26	$0	$1,495	$7,946	$4,613	$14,656	$28,710
27	$8,855	$1,540	$8,184	$4,751	$0	$23,330
28	$0	$1,586	$8,430	$4,893	$15,549	$30,458
29	$9,394	$1,634	$8,683	$5,040	$0	$24,751
30	$0	$1,683	$8,943	$5,192	$16,496	$32,314
3% inflation					Total	$584,527

Streambank implementation costs before cost-share are the same as those after cost-share; they are listed in the next section.

b. Lower Cottonwood – HUC 11070203

Lower Cottonwood Implementation Cost Before Cost-Share, Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Cost
1	$89,277	$8,759	$78,609	$12,802	$12,577	$22,909	$162,833	$387,766
2	$91,955	$9,022	$80,967	$13,186	$12,955	$23,596	$167,717	$399,399
3	$94,714	$9,293	$83,396	$13,582	$13,343	$24,304	$172,749	$411,381
4	$97,556	$9,571	$85,898	$13,989	$13,744	$25,033	$177,931	$423,722
5	$100,482	$9,859	$88,475	$14,409	$14,156	$25,784	$183,269	$436,434
6	$103,497	$10,154	$91,129	$14,841	$14,581	$26,558	$188,767	$449,527
7	$106,602	$10,459	$93,863	$15,286	$15,018	$27,354	$194,431	$463,013
8	$109,800	$10,773	$96,679	$15,745	$15,469	$28,175	$200,263	$476,903
9	$113,094	$11,096	$99,579	$16,217	$15,933	$29,020	$206,271	$491,210
10	$116,486	$11,429	$102,567	$16,704	$16,411	$29,891	$212,459	$505,947
11	$119,981	$11,772	$105,644	$17,205	$16,903	$30,788	$218,833	$521,125
12	$123,580	$12,125	$108,813	$17,721	$17,410	$31,711	$225,398	$536,759
13	$127,288	$12,489	$112,077	$18,253	$17,932	$32,663	$232,160	$552,862
14	$131,106	$12,863	$115,440	$18,800	$18,470	$33,642	$239,125	$569,447
15	$135,040	$13,249	$118,903	$19,364	$19,024	$34,652	$246,299	$586,531
16	$139,091	$13,647	$122,470	$19,945	$19,595	$35,691	$253,688	$604,127
17	$143,264	$14,056	$126,144	$20,543	$20,183	$36,762	$261,298	$622,251
18	$147,561	$14,478	$129,928	$21,160	$20,789	$37,865	$269,137	$640,918
19	$151,988	$14,912	$133,826	$21,795	$21,412	$39,001	$277,211	$660,146
20	$156,548	$15,359	$137,841	$22,448	$22,055	$40,171	$285,528	$679,950
21	$161,244	$15,820	$141,976	$23,122	$22,716	$41,376	$294,094	$700,348
22	$166,082	$16,295	$146,236	$23,815	$23,398	$42,617	$302,916	$721,359
23	$171,064	$16,784	$150,623	$24,530	$24,100	$43,896	$312,004	$743,000
24	$176,196	$17,287	$155,141	$25,266	$24,823	$45,213	$321,364	$765,290
25	$181,482	$17,806	$159,795	$26,024	$25,567	$46,569	$331,005	$788,248
26	$186,926	$18,340	$164,589	$26,805	$26,334	$47,966	$340,935	$811,896
27	$192,534	$18,890	$169,527	$27,609	$27,124	$49,405	$351,163	$836,253
28	$198,310	$19,457	$174,613	$28,437	$27,938	$50,887	$361,698	$861,340
29	$204,260	$20,041	$179,851	$29,290	$28,776	$52,414	$372,549	$887,180
30	$210,387	$20,642	$185,247	$30,169	$29,639	$53,986	$383,725	$913,796
3% Inflation							Total	$18,448,128

Lower Cottonwood Implementation Cost Before Cost-Share, Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotation Grazing	Annual Cost
1	$4,106	$714	$3,795	$2,203	$7,000	$17,818
2	$0	$1,471	$3,909	$2,269	$7,210	$14,859
3	$4,356	$757	$4,026	$2,337	$7,426	$18,903
4	$0	$1,560	$4,147	$2,407	$7,649	$15,764
5	$4,621	$804	$4,271	$2,479	$7,879	$20,054
6	$0	$1,655	$4,399	$2,554	$8,115	$16,724
7	$4,903	$853	$4,531	$2,630	$8,358	$21,276
8	$0	$1,756	$4,667	$2,709	$8,609	$17,742
9	$5,201	$904	$4,807	$2,791	$8,867	$22,571
10	$0	$1,863	$4,952	$2,874	$9,133	$18,823
11	$5,518	$960	$5,100	$2,961	$9,407	$23,946
12	$0	$1,977	$5,253	$3,049	$9,690	$19,969
13	$5,854	$1,018	$5,411	$3,141	$9,980	$25,404
14	$0	$2,097	$5,573	$3,235	$10,280	$21,185
15	$6,211	$1,080	$5,740	$3,332	$10,588	$26,951
16	$0	$2,225	$5,912	$3,432	$10,906	$22,475
17	$6,589	$1,146	$6,090	$3,535	$11,233	$28,593
18	$0	$2,360	$6,273	$3,641	$11,570	$23,844
19	$6,990	$1,216	$6,461	$3,750	$11,917	$30,334
20	$0	$2,504	$6,655	$3,863	$12,275	$25,296
21	$7,416	$1,290	$6,854	$3,979	$12,643	$32,181
22	$0	$2,657	$7,060	$4,098	$13,022	$26,837
23	$7,868	$1,368	$7,272	$4,221	$13,413	$34,141
24	$0	$2,818	$7,490	$4,348	$13,815	$28,471
25	$8,347	$1,451	$7,714	$4,478	$14,230	$36,220
26	$0	$2,990	$7,946	$4,613	$14,656	$30,205
27	$8,855	$1,540	$8,184	$4,751	$15,096	$38,426
28	$0	$3,172	$8,430	$4,893	$15,549	$32,044
29	$9,394	$1,634	$8,683	$5,040	$16,015	$40,766
30	$0	$3,365	$8,943	$5,192	$16,496	$33,996
3% inflation					Total	$765,818

Streambank implementation costs before cost-share are the same as after cost-share; they are listed in the next section.

c. Upper Cottonwood – HUC 11070202

Upper Cottonwood Implementation Cost Before Cost-Share, Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Cost
1	$168,589	$27,568	$141,375	$30,219	$19,792	$72,101	$307,490	$767,134
2	$173,647	$28,395	$145,616	$31,125	$20,386	$74,264	$316,715	$790,148
3	$178,856	$29,247	$149,984	$32,059	$20,998	$76,492	$326,216	$813,853
4	$184,222	$30,124	$154,484	$33,021	$21,628	$78,787	$336,003	$838,268
5	$189,749	$31,028	$159,118	$34,012	$22,277	$81,150	$346,083	$863,416
6	$195,441	$31,959	$163,892	$35,032	$22,945	$83,585	$356,465	$889,319
7	$201,304	$32,918	$168,809	$36,083	$23,633	$86,092	$367,159	$915,998
8	$207,344	$33,905	$173,873	$37,165	$24,342	$88,675	$378,174	$943,478
9	$213,564	$34,922	$179,089	$38,280	$25,072	$91,335	$389,519	$971,783
10	$219,971	$35,970	$184,462	$39,429	$25,825	$94,076	$401,205	$1,000,936
11	$226,570	$37,049	$189,996	$40,612	$26,599	$96,898	$413,241	$1,030,964
12	$233,367	$38,161	$195,696	$41,830	$27,397	$99,805	$425,638	$1,061,893
13	$240,368	$39,305	$201,566	$43,085	$28,219	$102,799	$438,407	$1,093,750
14	$247,579	$40,485	$207,613	$44,377	$29,066	$105,883	$451,559	$1,126,563
15	$255,006	$41,699	$213,842	$45,709	$29,938	$109,059	$465,106	$1,160,359
16	$262,657	$42,950	$220,257	$47,080	$30,836	$112,331	$479,059	$1,195,170
17	$270,536	$44,239	$226,865	$48,492	$31,761	$115,701	$493,431	$1,231,025
18	$278,652	$45,566	$233,671	$49,947	$32,714	$119,172	$508,234	$1,267,956
19	$287,012	$46,933	$240,681	$51,446	$33,695	$122,747	$523,481	$1,305,995
20	$295,622	$48,341	$247,901	$52,989	$34,706	$126,430	$539,185	$1,345,175
21	$304,491	$49,791	$255,338	$54,579	$35,747	$130,223	$555,361	$1,385,530
22	$313,626	$51,285	$262,999	$56,216	$36,820	$134,129	$572,022	$1,427,096
23	$323,035	$52,823	$270,888	$57,902	$37,924	$138,153	$589,182	$1,469,909
24	$332,726	$54,408	$279,015	$59,639	$39,062	$142,298	$606,858	$1,514,006
25	$342,707	$56,040	$287,386	$61,429	$40,234	$146,567	$625,064	$1,559,426
26	$352,989	$57,721	$296,007	$63,272	$41,441	$150,964	$643,816	$1,606,209
27	$363,578	$59,453	$304,887	$65,170	$42,684	$155,493	$663,130	$1,654,395
28	$374,486	$61,237	$314,034	$67,125	$43,965	$160,157	$683,024	$1,704,027
29	$385,720	$63,074	$323,455	$69,139	$45,284	$164,962	$703,515	$1,755,148
30	$397,292	$64,966	$333,159	$71,213	$46,642	$169,911	$724,620	$1,807,802
3% Inflation							Total	$36,496,733

Upper Cottonwood Implementation Cost Before Cost-Share, Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Annual Cost
1	$4,106	$714	$3,795	$2,203	$7,000	$17,818
2	$0	$735	$3,909	$2,269	$0	$6,913
3	$4,356	$757	$4,026	$2,337	$7,426	$18,903
4	$0	$780	$4,147	$2,407	$0	$7,334
5	$4,621	$804	$4,271	$2,479	$7,879	$20,054
6	$0	$828	$4,399	$2,554	$0	$7,781
7	$4,903	$853	$4,531	$2,630	$8,358	$21,276
8	$0	$878	$4,667	$2,709	$0	$8,255
9	$5,201	$904	$4,807	$2,791	$8,867	$22,571
10	$0	$932	$4,952	$2,874	$0	$8,758
11	$5,518	$960	$5,100	$2,961	$9,407	$23,946
12	$0	$988	$5,253	$3,049	$0	$9,291
13	$5,854	$1,018	$5,411	$3,141	$9,980	$25,404
14	$0	$1,049	$5,573	$3,235	$0	$9,857
15	$6,211	$1,080	$5,740	$3,332	$10,588	$26,951
16	$0	$1,112	$5,912	$3,432	$0	$10,457
17	$6,589	$1,146	$6,090	$3,535	$11,233	$28,593
18	$0	$1,180	$6,273	$3,641	$0	$11,094
19	$6,990	$1,216	$6,461	$3,750	$11,917	$30,334
20	$0	$1,252	$6,655	$3,863	$0	$11,770
21	$7,416	$1,290	$6,854	$3,979	$12,643	$32,181
22	$0	$1,328	$7,060	$4,098	$0	$12,486
23	$7,868	$1,368	$7,272	$4,221	$13,413	$34,141
24	$0	$1,409	$7,490	$4,348	$0	$13,247
25	$8,347	$1,451	$7,714	$4,478	$14,230	$36,220
26	$0	$1,495	$7,946	$4,613	$0	$14,053
27	$8,855	$1,540	$8,184	$4,751	$15,096	$38,426
28	$0	$1,586	$8,430	$4,893	$0	$14,909
29	$9,394	$1,634	$8,683	$5,040	$16,015	$40,766
30	$0	$1,683	$8,943	$5,192	$0	$15,817
3% inflation					Total	$579,608

Streambank Implementation costs before cost-share are the same as after cost-share and are listed in the next section.

d. Cumulative Costs Before Cost-Share in the JRR Watershed

Cumulative Costs Befote Cost-Share in the JRR Watershed										
Year	Neosho Headwaters Costs			Lower Cottonwood Costs			Upper Cottonwood Costs			Total Costs Before Cost-Share
	Cropland	Livestock	Streambank	Cropland	Livestock	Streambank	Cropland	Livestock	Streambank	
1	$282,140	$10,818	$112,999	$387,766	$17,818	$199,327	$767,134	$17,818	$37,859	$1,833,679
2	$290,604	$14,123	$116,389	$399,399	$14,859	$205,307	$790,148	$6,913	$38,995	$1,876,737
3	$299,322	$11,476	$119,880	$411,381	$18,903	$211,466	$813,853	$18,903	$40,165	$1,945,349
4	$308,302	$14,983	$123,477	$423,722	$15,764	$217,810	$838,268	$7,334	$41,370	$1,991,030
5	$317,551	$12,175	$127,181	$436,434	$20,054	$224,344	$863,416	$20,054	$42,611	$2,063,820
6	$327,077	$15,896	$130,996	$449,527	$16,724	$231,075	$889,319	$7,781	$43,889	$2,112,284
7	$336,890	$12,917	$134,926	$463,013	$21,276	$238,007	$915,998	$21,276	$45,206	$2,189,509
8	$346,996	$16,863	$138,974	$476,903	$17,742	$245,147	$943,478	$8,255	$46,562	$2,240,920
9	$357,406	$13,703	$143,143	$491,210	$22,571	$252,502	$971,783	$22,571	$47,959	$2,322,848
10	$368,129	$17,891	$147,438	$505,947	$18,823	$260,077	$1,000,936	$8,758	$49,398	$2,377,397
11	$379,172	$14,539	$151,861	$521,125	$23,946	$267,879	$1,030,964	$23,946	$50,880	$2,464,312
12	$390,548	$18,980	$156,416	$536,759	$19,969	$275,915	$1,061,893	$9,291	$52,406	$2,522,177
13	$402,264	$15,424	$161,109	$552,862	$25,404	$284,193	$1,093,750	$25,404	$53,978	$2,614,388
14	$414,332	$20,137	$165,942	$569,447	$21,185	$292,718	$1,126,563	$9,857	$55,598	$2,675,779
15	$426,762	$16,363	$170,921	$586,531	$26,951	$301,500	$1,160,359	$26,951	$57,266	$2,773,604
16	$439,565	$21,362	$176,048	$604,127	$22,475	$310,545	$1,195,170	$10,457	$58,984	$2,838,733
17	$452,752	$17,360	$181,330	$622,251	$28,593	$319,861	$1,231,025	$28,593	$60,753	$2,942,518
18	$466,334	$22,664	$186,769	$640,918	$23,844	$329,457	$1,267,956	$11,094	$62,576	$3,011,612
19	$480,324	$18,417	$192,373	$660,146	$30,334	$339,341	$1,305,995	$30,334	$64,453	$3,121,717
20	$494,734	$24,045	$198,144	$679,950	$25,296	$349,521	$1,345,175	$11,770	$66,387	$3,195,022
21	$509,576	$19,539	$204,088	$700,348	$32,181	$360,007	$1,385,530	$32,181	$68,378	$3,311,828
22	$524,863	$25,508	$210,211	$721,359	$26,837	$370,807	$1,427,096	$12,486	$70,430	$3,389,597
23	$540,609	$20,729	$216,517	$743,000	$34,141	$381,931	$1,469,909	$34,141	$72,542	$3,513,519
24	$556,828	$27,062	$223,013	$765,290	$28,471	$393,389	$1,514,006	$13,247	$74,719	$3,596,025
25	$573,532	$21,990	$229,703	$788,248	$36,220	$405,191	$1,559,426	$36,220	$76,960	$3,727,490
26	$590,738	$28,710	$236,594	$811,896	$30,205	$417,347	$1,606,209	$14,053	$79,269	$3,815,021
27	$608,460	$23,330	$243,692	$836,253	$38,426	$429,867	$1,654,395	$38,426	$81,647	$3,954,496
28	$626,714	$30,458	$251,003	$861,340	$32,044	$442,763	$1,704,027	$14,909	$84,097	$4,047,355
29	$645,516	$24,751	$258,533	$887,180	$40,766	$456,046	$1,755,148	$40,766	$86,619	$4,195,325
30	$664,881	$32,314	$266,289	$913,796	$33,996	$469,727	$1,807,802	$15,817	$89,218	$4,293,840
Totals	$13,422,921	$584,527	$5,375,959	$18,448,128	$765,818	$9,483,067	$36,496,731	$579,606	$1,801,174	$86,957,931

8. JRR BMP implementation: Costs after cost-share

a. Neosho Headwaters – HUC 11070201

Neosho Headwaters Implementation Cost After Cost-Share, Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Cost
1	$6,496	$6,373	$5,720	$931	$915	$16,669	$11,848	$48,952
2	$6,691	$6,564	$5,891	$959	$943	$17,169	$12,203	$50,420
3	$6,891	$6,761	$6,068	$988	$971	$17,684	$12,569	$51,933
4	$7,098	$6,964	$6,250	$1,018	$1,000	$18,214	$12,946	$53,491
5	$7,311	$7,173	$6,437	$1,048	$1,030	$18,761	$13,335	$55,096
6	$7,530	$7,388	$6,631	$1,080	$1,061	$19,323	$13,735	$56,748
7	$7,756	$7,610	$6,830	$1,112	$1,093	$19,903	$14,147	$58,451
8	$7,989	$7,838	$7,034	$1,146	$1,126	$20,500	$14,571	$60,204
9	$8,229	$8,073	$7,245	$1,180	$1,159	$21,115	$15,008	$62,010
10	$8,476	$8,316	$7,463	$1,215	$1,194	$21,749	$15,459	$63,871
11	$8,730	$8,565	$7,687	$1,252	$1,230	$22,401	$15,922	$65,787
12	$8,992	$8,822	$7,917	$1,289	$1,267	$23,073	$16,400	$67,761
13	$9,262	$9,087	$8,155	$1,328	$1,305	$23,765	$16,892	$69,793
14	$9,539	$9,359	$8,399	$1,368	$1,344	$24,478	$17,399	$71,887
15	$9,826	$9,640	$8,651	$1,409	$1,384	$25,213	$17,921	$74,044
16	$10,120	$9,929	$8,911	$1,451	$1,426	$25,969	$18,458	$76,265
17	$10,424	$10,227	$9,178	$1,495	$1,469	$26,748	$19,012	$78,553
18	$10,737	$10,534	$9,454	$1,540	$1,513	$27,551	$19,583	$80,910
19	$11,059	$10,850	$9,737	$1,586	$1,558	$28,377	$20,170	$83,337
20	$11,390	$11,176	$10,029	$1,633	$1,605	$29,228	$20,775	$85,837
21	$11,732	$11,511	$10,330	$1,682	$1,653	$30,105	$21,398	$88,412
22	$12,084	$11,856	$10,640	$1,733	$1,702	$31,008	$22,040	$91,064
23	$12,447	$12,212	$10,959	$1,785	$1,753	$31,939	$22,702	$93,796
24	$12,820	$12,578	$11,288	$1,838	$1,806	$32,897	$23,383	$96,610
25	$13,205	$12,956	$11,627	$1,894	$1,860	$33,884	$24,084	$99,509
26	$13,601	$13,344	$11,976	$1,950	$1,916	$34,900	$24,807	$102,494
27	$14,009	$13,745	$12,335	$2,009	$1,974	$35,947	$25,551	$105,569
28	$14,429	$14,157	$12,705	$2,069	$2,033	$37,026	$26,317	$108,736
29	$14,862	$14,582	$13,086	$2,131	$2,094	$38,136	$27,107	$111,998
30	$15,308	$15,019	$13,479	$2,195	$2,157	$39,281	$27,920	$115,358
3% Inflation							Total	$2,328,895

Neosho Headwaters Implementation Cost After Cost-Share, Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Total Cost
1	$2,053	$357	$1,898	$1,102	$0	$5,410
2	$0	$368	$1,954	$1,135	$3,605	$7,062
3	$2,178	$379	$2,013	$1,169	$0	$5,739
4	$0	$390	$2,073	$1,204	$3,825	$7,492
5	$2,311	$402	$2,136	$1,240	$0	$6,089
6	$0	$414	$2,200	$1,277	$4,057	$7,948
7	$2,451	$426	$2,266	$1,315	$0	$6,458
8	$0	$439	$2,334	$1,355	$4,305	$8,433
9	$2,601	$452	$2,404	$1,395	$0	$6,852
10	$0	$466	$2,476	$1,437	$4,567	$8,946
11	$2,759	$480	$2,550	$1,480	$0	$7,269
12	$0	$494	$2,627	$1,525	$4,845	$9,491
13	$2,927	$509	$2,705	$1,570	$0	$7,711
14	$0	$524	$2,787	$1,618	$5,140	$10,069
15	$3,105	$540	$2,870	$1,666	$0	$8,181
16	$0	$556	$2,956	$1,716	$5,453	$10,681
17	$3,294	$573	$3,045	$1,768	$0	$8,680
18	$0	$590	$3,136	$1,821	$5,785	$11,332
19	$3,495	$608	$3,230	$1,875	$0	$9,208
20	$0	$626	$3,327	$1,931	$6,137	$12,021
21	$3,708	$645	$3,427	$1,989	$0	$9,769
22	$0	$664	$3,530	$2,049	$6,511	$12,754
23	$3,934	$684	$3,636	$2,111	$0	$10,365
24	$0	$705	$3,745	$2,174	$6,908	$13,532
25	$4,173	$726	$3,857	$2,239	$0	$10,995
26	$0	$747	$3,973	$2,306	$7,328	$14,354
27	$4,427	$770	$4,092	$2,375	$0	$11,664
28	$0	$793	$4,215	$2,447	$7,775	$15,230
29	$4,697	$817	$4,341	$2,520	$0	$12,375
30	$0	$841	$4,472	$2,596	$8,248	$16,157
3% Inflation					Total	$292,266

Neosho Headwaters Streambank Stabilization Costs		
Year	Streambank Stabilization (feet)	Cumulative Cost*
1	1,170	$112,999
2	1,170	$116,389
3	1,170	$119,880
4	1,170	$123,477
5	1,170	$127,181
6	1,170	$130,996
7	1,170	$134,926
8	1,170	$138,974
9	1,170	$143,143
10	1,170	$147,438
11	1,170	$151,861
12	1,170	$156,416
13	1,170	$161,109
14	1,170	$165,942
15	1,170	$170,921
16	1,170	$176,048
17	1,170	$181,330
18	1,170	$186,769
19	1,170	$192,373
20	1,170	$198,144
21	1,170	$204,088
22	1,170	$210,211
23	1,170	$216,517
24	1,170	$223,013
25	1,170	$229,703
26	1,170	$236,594
27	1,170	$243,692
28	1,170	$251,003
29	1,170	$258,533
30	1,170	$266,289
3% Inflation		
*$96.58 per foot		

b. Lower Cottonwood – HUC 11070203

Lower Cottonwood Implementation Cost After Cost-Share, Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Cost
1	$8,928	$8,759	$7,861	$1,280	$1,258	$22,909	$16,283	$67,278
2	$9,196	$9,022	$8,097	$1,319	$1,295	$23,596	$16,772	$69,296
3	$9,471	$9,293	$8,340	$1,358	$1,334	$24,304	$17,275	$71,375
4	$9,756	$9,571	$8,590	$1,399	$1,374	$25,033	$17,793	$73,516
5	$10,048	$9,859	$8,847	$1,441	$1,416	$25,784	$18,327	$75,722
6	$10,350	$10,154	$9,113	$1,484	$1,458	$26,558	$18,877	$77,994
7	$10,660	$10,459	$9,386	$1,529	$1,502	$27,354	$19,443	$80,333
8	$10,980	$10,773	$9,668	$1,574	$1,547	$28,175	$20,026	$82,743
9	$11,309	$11,096	$9,958	$1,622	$1,593	$29,020	$20,627	$85,226
10	$11,649	$11,429	$10,257	$1,670	$1,641	$29,891	$21,246	$87,782
11	$11,998	$11,772	$10,564	$1,720	$1,690	$30,788	$21,883	$90,416
12	$12,358	$12,125	$10,881	$1,772	$1,741	$31,711	$22,540	$93,128
13	$12,729	$12,489	$11,208	$1,825	$1,793	$32,663	$23,216	$95,922
14	$13,111	$12,863	$11,544	$1,880	$1,847	$33,642	$23,913	$98,800
15	$13,504	$13,249	$11,890	$1,936	$1,902	$34,652	$24,630	$101,764
16	$13,909	$13,647	$12,247	$1,995	$1,960	$35,691	$25,369	$104,817
17	$14,326	$14,056	$12,614	$2,054	$2,018	$36,762	$26,130	$107,961
18	$14,756	$14,478	$12,993	$2,116	$2,079	$37,865	$26,914	$111,200
19	$15,199	$14,912	$13,383	$2,179	$2,141	$39,001	$27,721	$114,536
20	$15,655	$15,359	$13,784	$2,245	$2,205	$40,171	$28,553	$117,972
21	$16,124	$15,820	$14,198	$2,312	$2,272	$41,376	$29,409	$121,511
22	$16,608	$16,295	$14,624	$2,382	$2,340	$42,617	$30,292	$125,157
23	$17,106	$16,784	$15,062	$2,453	$2,410	$43,896	$31,200	$128,911
24	$17,620	$17,287	$15,514	$2,527	$2,482	$45,213	$32,136	$132,779
25	$18,148	$17,806	$15,980	$2,602	$2,557	$46,569	$33,100	$136,762
26	$18,693	$18,340	$16,459	$2,680	$2,633	$47,966	$34,094	$140,865
27	$19,253	$18,890	$16,953	$2,761	$2,712	$49,405	$35,116	$145,091
28	$19,831	$19,457	$17,461	$2,844	$2,794	$50,887	$36,170	$149,444
29	$20,426	$20,041	$17,985	$2,929	$2,878	$52,414	$37,255	$153,927
30	$21,039	$20,642	$18,525	$3,017	$2,964	$53,986	$38,373	$158,545
3% Inflation							Total	$3,200,773

Lower Cottonwood Implementation Cost After Cost-Share, Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Annual Cost
1	$2,053	$357	$1,898	$1,102	$3,500	$8,909
2	$0	$735	$1,954	$1,135	$3,605	$7,429
3	$2,178	$379	$2,013	$1,169	$3,713	$9,452
4	$0	$780	$2,073	$1,204	$3,825	$7,882
5	$2,311	$402	$2,136	$1,240	$3,939	$10,027
6	$0	$828	$2,200	$1,277	$4,057	$8,362
7	$2,451	$426	$2,266	$1,315	$4,179	$10,638
8	$0	$878	$2,334	$1,355	$4,305	$8,871
9	$2,601	$452	$2,404	$1,395	$4,434	$11,286
10	$0	$932	$2,476	$1,437	$4,567	$9,411
11	$2,759	$480	$2,550	$1,480	$4,704	$11,973
12	$0	$988	$2,627	$1,525	$4,845	$9,984
13	$2,927	$509	$2,705	$1,570	$4,990	$12,702
14	$0	$1,049	$2,787	$1,618	$5,140	$10,593
15	$3,105	$540	$2,870	$1,666	$5,294	$13,476
16	$0	$1,112	$2,956	$1,716	$5,453	$11,238
17	$3,294	$573	$3,045	$1,768	$5,616	$14,296
18	$0	$1,180	$3,136	$1,821	$5,785	$11,922
19	$3,495	$608	$3,230	$1,875	$5,959	$15,167
20	$0	$1,252	$3,327	$1,931	$6,137	$12,648
21	$3,708	$645	$3,427	$1,989	$6,321	$16,091
22	$0	$1,328	$3,530	$2,049	$6,511	$13,418
23	$3,934	$684	$3,636	$2,111	$6,706	$17,071
24	$0	$1,409	$3,745	$2,174	$6,908	$14,235
25	$4,173	$726	$3,857	$2,239	$7,115	$18,110
26	$0	$1,495	$3,973	$2,306	$7,328	$15,102
27	$4,427	$770	$4,092	$2,375	$7,548	$19,213
28	$0	$1,586	$4,215	$2,447	$7,775	$16,022
29	$4,697	$817	$4,341	$2,520	$8,008	$20,383
30	$0	$1,683	$4,472	$2,596	$8,248	$16,998
3% inflation					Total	$382,909

Lower Cottonwood Streambank Stabilization Costs		
Year	Streambank Stabilization (feet)	Cumulative Cost*
1	2,064	$199,327
2	2,064	$205,307
3	2,064	$211,466
4	2,064	$217,810
5	2,064	$224,344
6	2,064	$231,075
7	2,064	$238,007
8	2,064	$245,147
9	2,064	$252,502
10	2,064	$260,077
11	2,064	$267,879
12	2,064	$275,915
13	2,064	$284,193
14	2,064	$292,718
15	2,064	$301,500
16	2,064	$310,545
17	2,064	$319,861
18	2,064	$329,457
19	2,064	$339,341
20	2,064	$349,521
21	2,064	$360,007
22	2,064	$370,807
23	2,064	$381,931
24	2,064	$393,389
25	2,064	$405,191
26	2,064	$417,347
27	2,064	$429,867
28	2,064	$442,763
29	2,064	$456,046
30	2,064	$469,727
3% Inflation		
*$96.58 per foot		

c. Upper Cottonwood – HUC 11070202

Upper Cottonwood Implementation Cost After Cost-Share, Cropland BMPs								
Year	Buffers	Conservation Crop Rotation	No-Till with Cover Crops	Nutrient Management Plans	Permanent Vegetation	Terraces	Waterways	Total Cost
1	$16,859	$27,568	$14,137	$3,022	$1,979	$72,101	$30,749	$166,416
2	$17,365	$28,395	$14,562	$3,113	$2,039	$74,264	$31,671	$171,408
3	$17,886	$29,247	$14,998	$3,206	$2,100	$76,492	$32,622	$176,550
4	$18,422	$30,124	$15,448	$3,302	$2,163	$78,787	$33,600	$181,847
5	$18,975	$31,028	$15,912	$3,401	$2,228	$81,150	$34,608	$187,302
6	$19,544	$31,959	$16,389	$3,503	$2,294	$83,585	$35,647	$192,921
7	$20,130	$32,918	$16,881	$3,608	$2,363	$86,092	$36,716	$198,709
8	$20,734	$33,905	$17,387	$3,717	$2,434	$88,675	$37,817	$204,670
9	$21,356	$34,922	$17,909	$3,828	$2,507	$91,335	$38,952	$210,810
10	$21,997	$35,970	$18,446	$3,943	$2,582	$94,076	$40,120	$217,135
11	$22,657	$37,049	$19,000	$4,061	$2,660	$96,898	$41,324	$223,649
12	$23,337	$38,161	$19,570	$4,183	$2,740	$99,805	$42,564	$230,358
13	$24,037	$39,305	$20,157	$4,308	$2,822	$102,799	$43,841	$237,269
14	$24,758	$40,485	$20,761	$4,438	$2,907	$105,883	$45,156	$244,387
15	$25,501	$41,699	$21,384	$4,571	$2,994	$109,059	$46,511	$251,719
16	$26,266	$42,950	$22,026	$4,708	$3,084	$112,331	$47,906	$259,270
17	$27,054	$44,239	$22,686	$4,849	$3,176	$115,701	$49,343	$267,048
18	$27,865	$45,566	$23,367	$4,995	$3,271	$119,172	$50,823	$275,060
19	$28,701	$46,933	$24,068	$5,145	$3,370	$122,747	$52,348	$283,312
20	$29,562	$48,341	$24,790	$5,299	$3,471	$126,430	$53,919	$291,811
21	$30,449	$49,791	$25,534	$5,458	$3,575	$130,223	$55,536	$300,565
22	$31,363	$51,285	$26,300	$5,622	$3,682	$134,129	$57,202	$309,582
23	$32,303	$52,823	$27,089	$5,790	$3,792	$138,153	$58,918	$318,870
24	$33,273	$54,408	$27,902	$5,964	$3,906	$142,298	$60,686	$328,436
25	$34,271	$56,040	$28,739	$6,143	$4,023	$146,567	$62,506	$338,289
26	$35,299	$57,721	$29,601	$6,327	$4,144	$150,964	$64,382	$348,437
27	$36,358	$59,453	$30,489	$6,517	$4,268	$155,493	$66,313	$358,891
28	$37,449	$61,237	$31,403	$6,712	$4,396	$160,157	$68,302	$369,657
29	$38,572	$63,074	$32,346	$6,914	$4,528	$164,962	$70,351	$380,747
30	$39,729	$64,966	$33,316	$7,121	$4,664	$169,911	$72,462	$392,169
3% Inflation							Total	$7,917,294

Upper Cottonwood Implementation Cost After Cost-Share, Livestock BMPs						
Year	Fence Off Streams	Filter Strip	Off-stream Watering System	Relocate Pasture Feeding Site	Rotational Grazing	Total Cost
1	$2,053	$357	$1,898	$1,102	$3,500	$8,909
2	$0	$368	$1,954	$1,135	$0	$3,457
3	$2,178	$379	$2,013	$1,169	$3,713	$9,452
4	$0	$390	$2,073	$1,204	$0	$3,667
5	$2,311	$402	$2,136	$1,240	$3,939	$10,027
6	$0	$414	$2,200	$1,277	$0	$3,891
7	$2,451	$426	$2,266	$1,315	$4,179	$10,638
8	$0	$439	$2,334	$1,355	$0	$4,127
9	$2,601	$452	$2,404	$1,395	$4,434	$11,286
10	$0	$466	$2,476	$1,437	$0	$4,379
11	$2,759	$480	$2,550	$1,480	$4,704	$11,973
12	$0	$494	$2,627	$1,525	$0	$4,645
13	$2,927	$509	$2,705	$1,570	$4,990	$12,702
14	$0	$524	$2,787	$1,618	$0	$4,928
15	$3,105	$540	$2,870	$1,666	$5,294	$13,476
16	$0	$556	$2,956	$1,716	$0	$5,229
17	$3,294	$573	$3,045	$1,768	$5,616	$14,296
18	$0	$590	$3,136	$1,821	$0	$5,547
19	$3,495	$608	$3,230	$1,875	$5,959	$15,167
20	$0	$626	$3,327	$1,931	$0	$5,885
21	$3,708	$645	$3,427	$1,989	$6,321	$16,091
22	$0	$664	$3,530	$2,049	$0	$6,243
23	$3,934	$684	$3,636	$2,111	$6,706	$17,071
24	$0	$705	$3,745	$2,174	$0	$6,623
25	$4,173	$726	$3,857	$2,239	$7,115	$18,110
26	$0	$747	$3,973	$2,306	$0	$7,027
27	$4,427	$770	$4,092	$2,375	$7,548	$19,213
28	$0	$793	$4,215	$2,447	$0	$7,455
29	$4,697	$817	$4,341	$2,520	$8,008	$20,383
30	$0	$841	$4,472	$2,596	$0	$7,909
3% inflation					Total	$289,804

Upper Cottonwood Streambank Stabilization Cost		
Year	Streambank Stabilization (feet)	Cumulative Cost*
1	392	$37,859
2	392	$38,995
3	392	$40,165
4	392	$41,370
5	392	$42,611
6	392	$43,889
7	392	$45,206
8	392	$46,562
9	392	$47,959
10	392	$49,398
11	392	$50,880
12	392	$52,406
13	392	$53,978
14	392	$55,598
15	392	$57,266
16	392	$58,984
17	392	$60,753
18	392	$62,576
19	392	$64,453
20	392	$66,387
21	392	$68,378
22	392	$70,430
23	392	$72,542
24	392	$74,719
25	392	$76,960
26	392	$79,269
27	392	$81,647
28	392	$84,097
29	392	$86,619
30	392	$89,218
3% Inflation	**Total**	**$1,801,175**
*$96.58 per foot		

d. Cumulative costs after cost-share in the JRR Watershed

Cumulative Costs After Cost-Share in the JRR Watershed										
Year	Neosho Headwaters Costs			Lower Cottonwood Costs			Upper Cottonwood Costs			Total Costs After Cost-Share
	Cropland	Livestock	Streambank	Cropland	Livestock	Streambank	Cropland	Livestock	Streambank	
1	$48,952	$5,410	$112,999	$67,278	$8,909	$199,327	$166,416	$8,909	$37,859	$656,059
2	$50,420	$7,062	$116,389	$69,296	$7,429	$205,307	$171,408	$3,457	$38,995	$669,763
3	$51,933	$5,739	$119,880	$71,375	$9,452	$211,466	$176,550	$9,452	$40,165	$696,012
4	$53,491	$7,492	$123,477	$73,516	$7,882	$217,810	$181,847	$3,667	$41,370	$710,552
5	$55,096	$6,089	$127,181	$75,722	$10,027	$224,344	$187,302	$10,027	$42,611	$738,399
6	$56,748	$7,948	$130,996	$77,994	$8,362	$231,075	$192,921	$3,891	$43,889	$753,824
7	$58,451	$6,458	$134,926	$80,333	$10,638	$238,007	$198,709	$10,638	$45,206	$783,366
8	$60,204	$8,433	$138,974	$82,743	$8,871	$245,147	$204,670	$4,127	$46,562	$799,731
9	$62,010	$6,852	$143,143	$85,226	$11,286	$252,502	$210,810	$11,286	$47,959	$831,074
10	$63,871	$8,946	$147,438	$87,782	$9,411	$260,077	$217,135	$4,379	$49,398	$848,437
11	$65,787	$7,269	$151,861	$90,416	$11,973	$267,879	$223,649	$11,973	$50,880	$881,687
12	$67,761	$9,491	$156,416	$93,128	$9,984	$275,915	$230,358	$4,645	$52,406	$900,104
13	$69,793	$7,711	$161,109	$95,922	$12,702	$284,193	$237,269	$12,702	$53,978	$935,379
14	$71,887	$10,069	$165,942	$98,800	$10,593	$292,718	$244,387	$4,928	$55,598	$954,922
15	$74,044	$8,181	$170,921	$101,764	$13,476	$301,500	$251,719	$13,476	$57,266	$992,347
16	$76,265	$10,681	$176,048	$104,817	$11,238	$310,545	$259,270	$5,229	$58,984	$1,013,077
17	$78,553	$8,680	$181,330	$107,961	$14,296	$319,861	$267,048	$14,296	$60,753	$1,052,778
18	$80,910	$11,332	$186,769	$111,200	$11,922	$329,457	$275,060	$5,547	$62,576	$1,074,773
19	$83,337	$9,208	$192,373	$114,536	$15,167	$339,341	$283,312	$15,167	$64,453	$1,116,894
20	$85,837	$12,021	$198,144	$117,972	$12,648	$349,521	$291,811	$5,885	$66,387	$1,140,226
21	$88,412	$9,769	$204,088	$121,511	$16,091	$360,007	$300,565	$16,091	$68,378	$1,184,912
22	$91,064	$12,754	$210,211	$125,157	$13,418	$370,807	$309,582	$6,243	$70,430	$1,209,666
23	$93,796	$10,365	$216,517	$128,911	$17,071	$381,931	$318,870	$17,071	$72,542	$1,257,074
24	$96,610	$13,532	$223,013	$132,779	$14,235	$393,389	$328,436	$6,623	$74,719	$1,283,336
25	$99,509	$10,995	$229,703	$136,762	$18,110	$405,191	$338,289	$18,110	$76,960	$1,333,629
26	$102,494	$14,354	$236,594	$140,865	$15,102	$417,347	$348,437	$7,027	$79,269	$1,361,489
27	$105,569	$11,664	$243,692	$145,091	$19,213	$429,867	$358,891	$19,213	$81,647	$1,414,847
28	$108,736	$15,230	$251,003	$149,444	$16,022	$442,763	$369,657	$7,455	$84,097	$1,444,407
29	$111,998	$12,375	$258,533	$153,927	$20,383	$456,046	$380,747	$20,383	$86,619	$1,501,011
30	$115,358	$16,157	$266,289	$158,545	$16,998	$469,727	$392,169	$7,909	$89,218	$1,532,370
Totals	**$2,328,896**	**$292,266**	**$5,375,959**	**$3,200,773**	**$382,909**	**$9,483,067**	**$7,917,294**	**$289,806**	**$1,801,174**	**$31,072,144**