# Upper Walnut/El Dorado Lake Nine Element Plan

# Watershed Restoration and Protection Strategy (WRAPS)



# August 2012

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# Introduction

In 1918, Rolla Clymer moved his young family to El Dorado, Kansas, where he became editor and manager of the El Dorado Republican, (now known as the El Dorado Times). He served Butler County, El Dorado and the Flint Hills in that capacity for 59 years. In his later years Clymer devoted much of his time to efforts to preserve the Kansas Flint Hills region which he dearly loved. In addition to newspaper editorials, he wrote and published numerous widely circulated articles and poems about the Flint Hills. Perhaps his best known tribute was his poem "Majesty of the Hills."

*"The Flint Hills are changeless and unchanging-and have so stood since their limestone ridges first broke from beneath the surface of prehistoric seas. All modern development, the growing complexity of civilization's advance have surrounded and hemmed them in but have failed to alter their essential character. They vie not in grandeur with the mighty Rockies, nor do they aspire to eminence among the nation's fondly cherished landmarks. Yet they possess unique glory and appeal, which stems from their gentle and healing moods. For ones bowed by worldly discouragement and disillusion, they offer spiritual enchantment through eyes opened to their beauty and constancy."*

# Statement of Goals:

Keeping in mind farmers and ranchers living in this watershed have an enduring connection to this region of the Flint Hills, make their living off the land and its' resources and wish to pass on this way of life to their sons and daughters; knowing they have a responsibility to others to manage their resources wisely for their families as well as all the families who rely on El Dorado Lake and their tributaries for their water supply; it is our mission to provide long term support through conservation education and information to assist them in decision making and offer technical and financial assistance for practices that reduce sediment and nutrients; with the ultimate goal of guaranteeing their way of life is protected while we work to assure water from El Dorado Lake is available for our children and their children and beyond.

This Watershed Plan will address El Dorado Lake and its tributaries as a high priority watershed in this region and offer ways to reduce sediment and eutrophication which are currently identified as impairments in the watershed. As pollutant reductions are achieved, the Plan will address ways to maintain those reductions to meet current water quality standards. This Plan will remain flexible to allow for changes that may take place in the watershed in addition to providing updates and revisions as new information on water quality, impairments or improvements occur.

## A. Watershed Map/Stream Network and HUC 12 Boundaries

The Upper Walnut Watershed (HUC 11030017) is part of the Walnut Basin Watershed, the smallest of the 12 major river basins in Kansas.
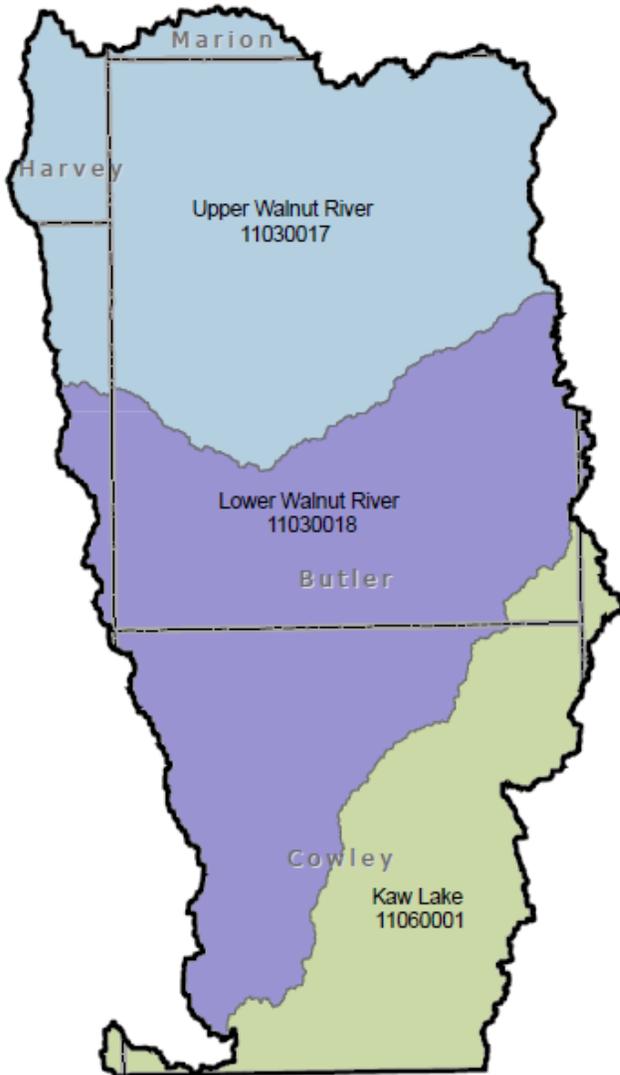


Nestled in the beautiful Flint Hills Region of Kansas, the Upper Walnut/El Dorado Lake Watershed is located in the northeast corner of the Walnut Basin. The Upper Walnut/El Dorado Lake Watershed, which drains into El Dorado Lake, covers 242 square miles and includes a small portion of Chase County.

# Walnut Basin



El Dorado Lake Watershed

Marion

Harvey

Sedgwick

Butler

Elk

Sumner

Cowley

WHITEWATER R

WALNUT R

LITTLE WALNUT R

WALNUT R

GROUSE CR

El Dorado

Winfield

El Dorado Reservoir

N
W    E
S

DATA SOURCES:

Hydrology: EPA RF 1
Political Boundaries: KCD
Towns: GNIS/USGS
Roads: 100K DLG/USGS/DASC

This map intended for planning purposes only.

Kansas Water Office, May 1999

5    0    5    10 Miles

● County Seat
/\ Highway
/\ Hydrology
■ Reservoir
☐ County Boundary

There are six sub-watersheds (HUC 12) located in the Upper Walnut Watershed. They include Shady Creek, Bemis Creek and Harrison Creek, (HUC 110300170305) Satchel Creek (HUC 110300170304), Durechen Creek (HUC 110300170303), Walnut River and School Branch (HUC 110300170301), Cole Creek and Gilmore Branch (HUC 110300170302) and El Dorado Lake, (HUC 110300170306).
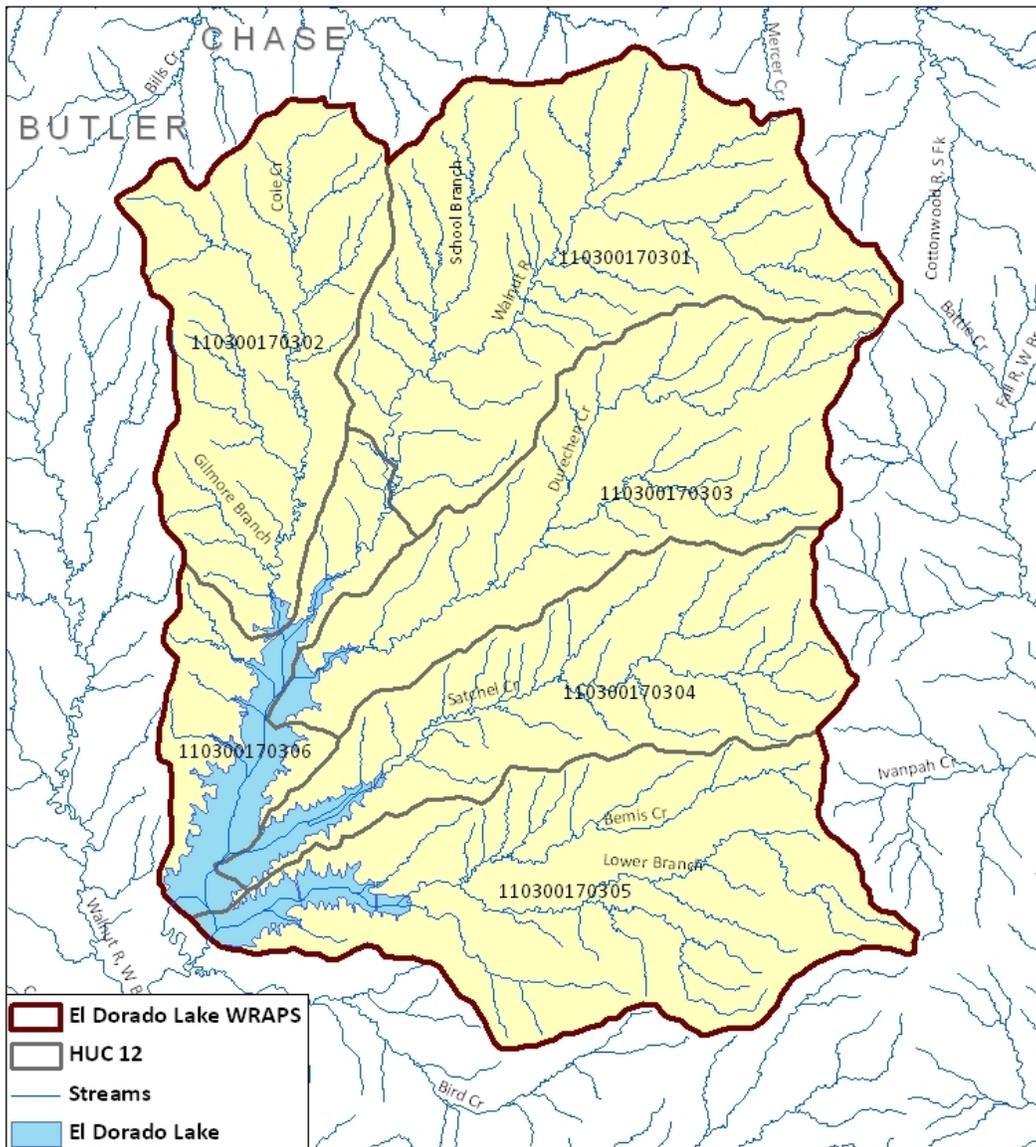


The purpose of this publication is to illustrate general watershed conditions in the state of Kansas. This map product is provided without representation or implied or expressed warranty of accuracy and is intended for watershed planning purposes only. The originating agency is not responsible for publication or use of this product for any other purpose. This product may be corrected or updated as necessary without prior notification.

## B.  General Description of Plan Area

**Demographics**

The 2010 Census Bureau population estimate for Butler County is 64,084.  El Dorado Lake is a main source of water for Butler County residents.

There are approximately 372 homes scattered throughout the watershed.  The population of Cassoday is 95; Rosalia is 87.  Fox Lake has approximately 34 weekend cabins and summer homes, but there are a few people who live there year round.  There are many absentee landowners in the watershed as well. From Butler County Mapping Department's parcels data, there are 1,132 separate parcels in the UWW. These parcels are owned by 541 different landowners.  Fifty seven (57) landowners are out of state and 97 landowners are out of county and do not actually live on the property they own.   These landowners (28%) are considered absentee landowners.
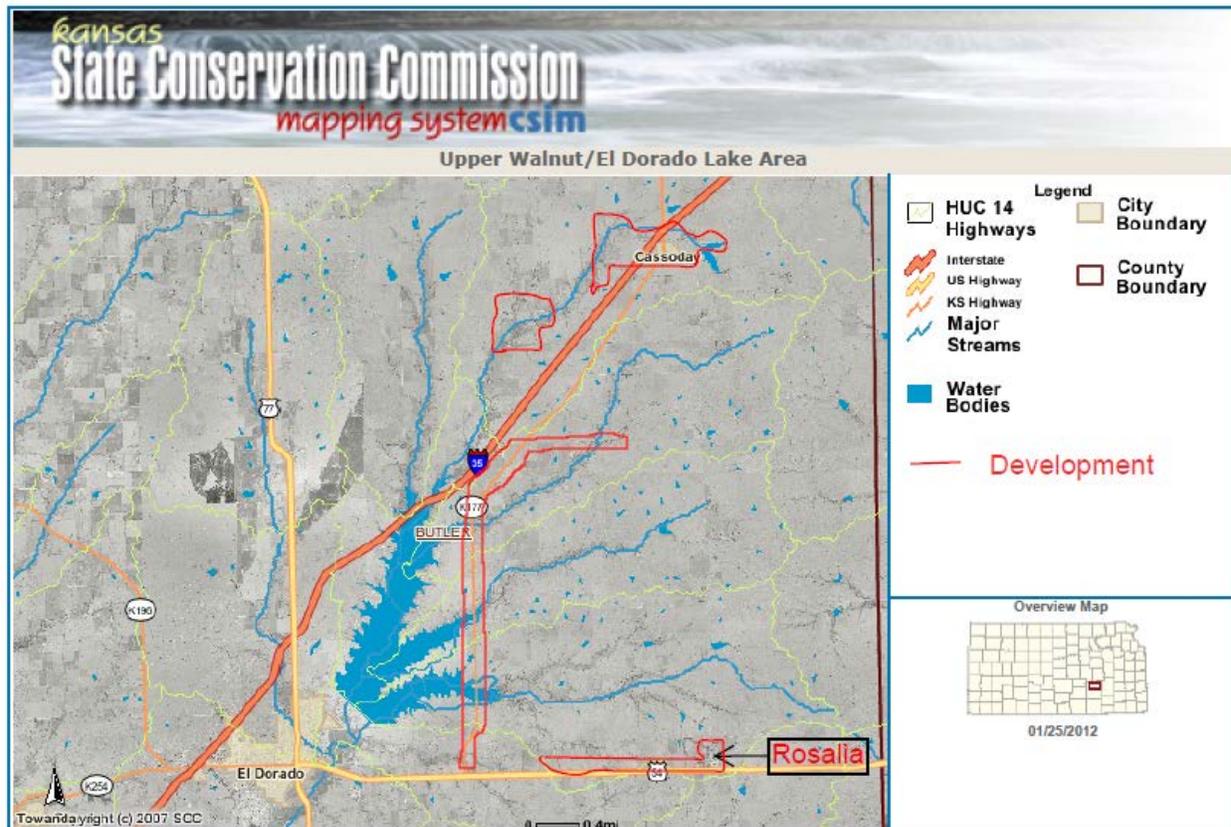
**Geology**

Butler County is located almost entirely in the Flint Hills physiographic region. The Flint Hills were formed by the erosion of Permian-age limestone and shale. Much of the limestone in the Flint Hills contains numerous bands of chert, or flint. Because chert is much less soluble than the limestone around it, the weathering of the limestone has left behind clayey hilltops in this region that are capped with cherty gravel. Such residual chert is responsible for maintaining high topographic relief and gives the Flint Hills their name. Unconsolidated sediments are common, especially within river valleys and on some upland areas. Soils are developed in residual (weathered) bedrock material, alluvial deposits, and loess sediment. The Flint Hills includes the largest region of native tall-grass prairie remaining in North America, and the surface geology and geomorphology are readily visible in the landscape.

**Soil Characteristics** *(From the Butler County Soil Survey (1975) General Soil Map):*

The majority of soils in the UWW fall into the Dwight-Labette Association:  Nearly level to sloping, moderately deep soils that have a silt loam or silty clay loam surface layer and a silty clay subsoil; on uplands.

The second most prominent soil association is Irwin-Ladysmith:  Nearly level to sloping, deep soils that have a silty clay loam surface layer and a silty clay subsoil; on uplands.

The third most prominent soil association is Florence-Benfield:  Gently sloping to strongly sloping, moderately deep and deep soils that have a cherty silty clay loam or cherty silt loam surface layer and a cherty silty clay or cherty clay supsoil; on uplands.

Fourth is Verdigris-Brewer-Norge Association:  Nearly level to sloping, deep soils that have a silt loam or silty clay loam surface layer and a silty clay loam or silty clay subsoil; on flood plains and terraces.

Fifth is Labette-Sogn Association:  Gently sloping to sloping, moderately deep soils that have a silty clay loam surface layer and a silty clay subsoil, and shallow soils that are silty clay loam throughout; on uplands.

**El Dorado Lake Characteristics**

El Dorado Lake is a multi-purpose facility with the major uses of flood control, water supply, fish and wildlife management and recreation.  The U. S. Government owns the dam, and the operation and regulation of the facility is the responsibility of the U. S. Army Corps of Engineers, Tulsa District.  El Dorado Lake is operated for optimal flood control benefits as part of the Arkansas River System.  It has 98 miles of shoreline with an average depth of 19 feet.  The deepest part of the Lake is 63 feet.  Kansas Department of Wildlife and Parks maintain the 3,891 acres surrounding El Dorado Lake, making it the largest state park in Kansas.

The City of El Dorado holds a contract with the USACE, Tulsa District, for 142,900 acre feet of storage from the conservation pool of the Lake.  Water is treated by the City of El Dorado Water Treatment Plant and provided to City of El Dorado residents and sold to Rural Water Districts.  Raw water is sold to the City of Augusta and treated at their water treatment plant.

**Public Water Supply (PWS) Information** – Besides El Dorado Lake which the City of El Dorado Water Treatment Plant uses as their public water supply for its residents and several rural water districts and the City of Augusta in Butler County, there are no other public water supply systems in the Upper Walnut/El Dorado Lake Watershed.



## Walnut Basin
### Federal Lake Storage Customers

Legend:
- Stream
- Federal Lake
- Walnut Basin

**Other Contract Customers***
- Cheney Lake
- El Dorado Lake

* There are no Water Marketing Lakes or Water Assurance Districts in the Walnut Basin.

20   10   0        20 Miles

Kansas Water Office, February 2008
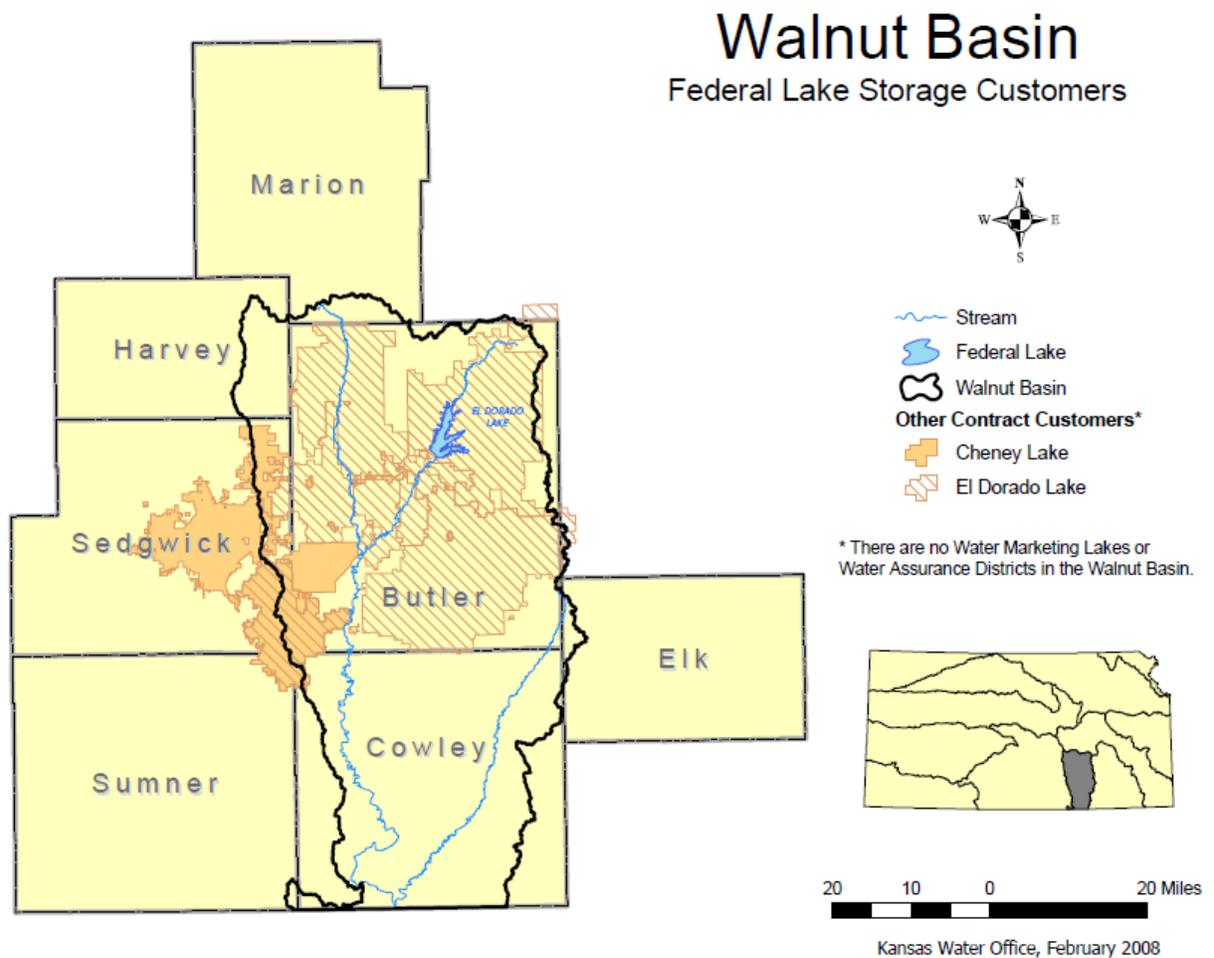
## C. Land Use/Cover

Agriculture is the leading land use in the Upper Walnut Watershed above El Dorado Lake. Rangeland activities rank #1 followed by pasture and hayland then row crops; small grains rank 6[th.] Approximately 12% of the watershed is currently being farmed (KDHE, 2002). The majority of cropland in the Upper Walnut Watershed is located adjacent to tributaries that drain into El Dorado Lake.

| El Dorado Lake Watershed Land-Cover | | |
|---|---|---|
| Land Use/Cover | Acres | Percent Cover |
| Open Water | 9,372.6 | 5.98 |
| Low Density Residential | 65.2 | 0.04 |
| High Density Residential | 26.0 | 0.02 |
| Commercial/Industrial Transportation | 572.7 | 0.37 |
| Bare Rock/Sand/Clay | 19.4 | 0.01 |
| Quarries/Strip Mines/Gravel Pits | 20.2 | 0.01 |
| Deciduous Forest | 371.0 | 0.58 |
| Evergreen Forest | 21.1 | 0.01 |
| Mixed Forest | 64.1 | 0.04 |
| Shrubland | 4,169.8 | 2.66 |
| Grasslands/Herbaceous | 113,970.7 | 72.69 |
| Pasture/Hay | 16,556.9 | 10.55 |
| Row Crops | 8,306.5 | 5.30 |
| Small Grains | 1,236.3 | 0.79 |
| Urban/Recreational Grasses | 197.5 | 0.13 |
| Woody Emergents | 30.3 | 0.02 |
| Emergent Herbaceous Wetlands | 1,263.8 | 0.81 |
| Total | 156,780.1 | 100.10 |

(El Dorado Lake Watershed SWAT model, 2006)

# El Dorado Lake WRAPS Land Cover (KLCP 2005)
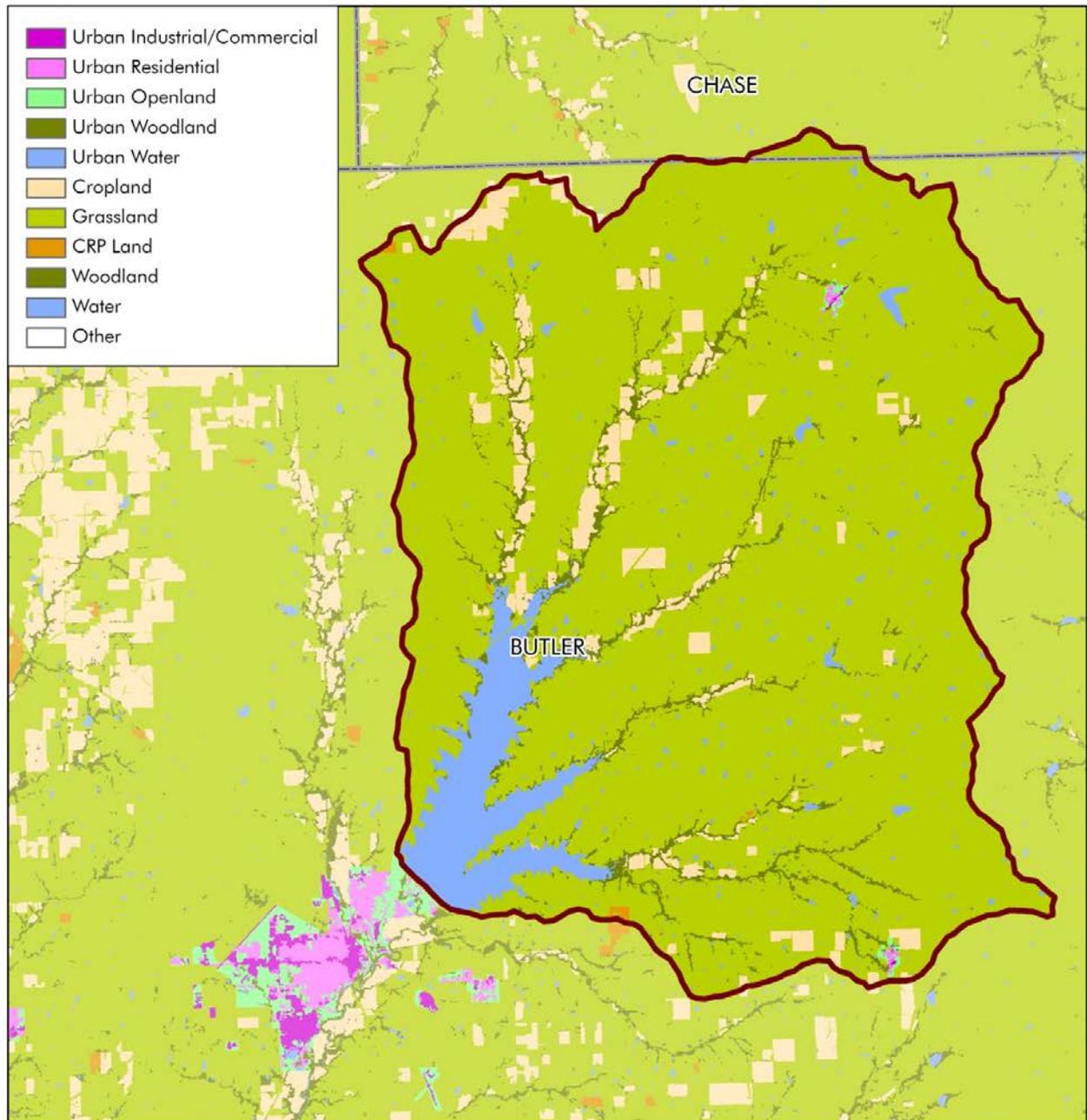


Legend:
- Urban Industrial/Commercial
- Urban Residential
- Urban Openland
- Urban Woodland
- Urban Water
- Cropland
- Grassland
- CRP Land
- Woodland
- Water
- Other

CHASE

BUTLER

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Kansas
Department of Health and Environment
April 2011

# D. Description of Potential NPS Sources and Water Quality Impacts

Cropland Sources of NPS Pollution:

- Conventional tillage operations – these operations leave minimal residue on the soil surface causing an increase in soil erosion/sediment runoff during a hard rain or runoff event.
- Lack of any conservation practices on fields – conservation practices such as waterways, terraces and grade stabilization structures help control erosion by water.  Soil loss is greater on fields where no conservation practices are installed or implemented.
- Maintenance of installed conservation practices – conservation practices must be properly maintained in order for them to control erosion.  Practices that are not maintained or practices that have come to the end of their useful lifespan can begin to erode thus causing extensive gullies or erosion problems allowing additional sediment into water sources.
- Gullies formed in No-till fields due to no-till operations – the creation of gullies in no-till fields due to the fact they are not "farmed in" causes gullies that farm equipment cannot go through anymore.  Conservation practices are needed for these gullies to control erosion and sediment loss.
- Farming too close to riparian areas – farming practices that encroach on riparian areas allows sediment and nutrients to flow into tributaries because of the reduced filter area.
- Lack of nutrient management plans for spreading livestock/commercial waste – livestock producers who don't have a nutrient management plan that includes soil/manure testing do not know how much manure or commercial fertilizer they are actually applying to the land.  Land application rates may be too high causing additional runoff of nutrients.  Also, with manure applications, manure should be tested to determine nutrient value for proper application rates.

Rangeland Sources of NPS Pollution:

- Cattle allowed in sensitive riparian areas – applies to cattle drinking water from tributaries and also loafing by cattle during the summer months or using riparian areas for winter protection.  Degradation of streambanks is one concern, increase in nutrients and fecal coliform bacteria is another concern.  In addition, animals congregating under trees can be a source of erosion especially when grasses are shaded or trampled out.
- Cattle trailing – Cattle trails along fence lines or in sensitive riparian areas can become large gullies if not addressed by the rancher.  Large amounts of sediment can enter tributaries as a result of gully erosion.
- Overgrazing – overgrazing pastures allows additional nutrients to wash off the area as well as increases gully erosion, weed and noxious weed pressure and ultimately makes the pasture less productive.
- Brush Control – Noxious weeds such as sericea lespedeza, hedge, locust and cedar trees decrease a pasture's productivity as well as use nutrients and water needed for forage production.  Handling of chemicals used in brush control is important.  If chemicals are not used properly, they have the potential to impact aquatic life.

Urban
- Failing on-site waste systems – on-site waste systems that don't function properly can contribute nutrients and fecal coliform bacteria to water sources, especially if they are within 500 feet of the tributary.
- Illegal dumping – household trash and large items such as refrigerators, washing machines, furniture, etc. are sometimes dumped in sensitive riparian areas or off bridges. Some of these items contain harmful substances such as Freon which can enter tributaries. Household trash such as spoiled food or soiled diapers can be a source of bacteria.
- Improper disposal of household hazardous waste or farm chemicals in or near tributaries can pollute the water source.

Wildlife and Parks/Lake
- Shoreline erosion – shorelines not protected by rock or vegetation contribute sediment directly to El Dorado Lake. Shorelines that are south facing are the most susceptible due to the prevailing wind.
- Noxious weeds – sericea lespedeza and other noxious weeds are a concern in go back filter strips along riparian areas because they out complete more desirable filtering and soil stabilizing vegetation.

Woodland/Riparian Areas
- Improper woodland management – woodland along streams that is not managed properly can cause problems in the tributary including log jams and stream bank erosion. Timber that has reached maturity is an income farmers and ranchers don't always think about.

Livestock
- Livestock manure management – improperly stored manure has the potential to run off into water sources causing nutrient loading.
- Runoff from confined animal operations, particularly older operations, has the potential to reach water sources causing nutrient loading and an increase in fecal coliforms and ecoli bacteria.
- Outdated livestock waste systems that don't meet current standards have the potential to pollute water sources.
- Livestock allowed complete stream access for water causes degradation of stream banks and denuding of riparian vegetation.
- Cattle allowed in sensitive riparian areas to provide shade in the summer and protection from the wind in winter causes denuding of vegetation, degradation of the streambanks and nutrient loading.

Streambank Erosion
- Erosion of stream banks due to cattle access, tillage operations that create hard pan and reduce filter widths along riparian areas, improper woodland management or by watershed dams that allow for longer duration higher flows can dramatically increase sediment loading into El Dorado Lake.

# E. Other Relevant Assessment Information as it Pertains to Identification of Sources and Targeting

## Assessment Needs – Completed

### 1. Kansas Water Office, El Dorado Lake Watershed Streambank Erosion Assessment, June 2011

The Kansas Water Office (KWO) completed an assessment for the El Dorado Lake Watershed Restoration and Protection Strategy (WRAPS) Stakeholder Leadership Team (SLT) in 2011. This comparison study was designed to guide prioritization of streambank restoration by identifying reaches of streams where erosion is most severe in the watershed above El Dorado Lake.

Land use has considerable effect on sediment loading in a reservoir. Intense agricultural use in the watershed, with limited or ineffective erosion prevention methods, can contribute large loads of sediment along with contaminants (such as phosphorus) to downstream reservoirs (Mau, 2001).

The El Dorado Lake Watershed streambank erosion assessment was performed using ArcGIS® software. The purpose of the assessment is to identify locations of streambank instability to prioritize restoration needs and slow sedimentation rates into El Dorado Lake through implementation of streambank stabilization projects. The streambank erosion assessment was performed by overlaying 2008 NAIP county aerial imagery onto 1991 DASC county aerial imagery. Using ArcMap® tools, only those areas having "aggressive movement" of the streambank between 1991 DASC and 2008 NAIP aerial photos were identified, at a 1:6,000 scale, as a site of streambank erosion. "Aggressive movement" represents an area of roughly 1,500 sq. feet or more of streambank movement based on changes from 1991 DASC and 2008 NAIP aerial photos. Ninety-six percent of the identified streambank erosion sites were identified as having a poor riparian condition (riparian area identified as having cropland or grass/crop streamside vegetation).

The assessment quantifies annual tons of sediment eroding from the El Dorado Lake Watershed over a 17 year period between 1991 and 2008 within the upper Walnut basin in southeastern Kansas. Streambank erosion sites were analyzed by stream reach. A total of 15 streambank erosion sites covering an area of 1500 square feet or more were identified, amounting to 3,772 linear feet of unstable streambank. This assessment shows that these 15 sites alone are transporting 740 tons of sediment downstream per year; accounting for roughly 0.47 acre-feet per year of sediment accumulation in El Dorado Lake each year. A substantial quantity of the identified eroded sediment in the watershed is transported annually from the School Branch, accounting for roughly 1,591 tons of sediment annually or 42 percent of sediment eroding from all identified streambank erosion sites.

Based on the calculated sedimentation rate from the bathymetric survey, sediment from the identified streambank erosion sites contributes roughly 0.2 percent of the estimated 219 acre-feet/yr. It is probable that high flow event runoffs from rangelands and agricultural lands via ephemeral gullies, and bridge crossings that are continually undercut by high flow events could be contributing to the sedimentation rate. These occurrences were not a part of this assessment but should be assessed in the future.

The SLT also identified PL566 and State Funded Watershed Dams constructed through organized watershed districts as also contributing to an increase in streambank erosion below these dams.

See Appendix A for the entire report completed by the Kansas Water Office, "El Dorado Lake Watershed Streambank Erosion Assessment, June 2011"

## 2.  Kansas Rural Center River Friendly Farm Environmental Assessment

On March 8, 2011, a River Friendly Farm Workshop was held at the Butler County Conservation District Office.  Dale Kirkham of the Kansas Rural Center introduced the River Friendly Farm Environmental Assessment notebook to 28 people from above El Dorado Lake who attended the workshop.  Developed by Kansas State University and the Kansas Rural Center to assist farmers and ranchers in assessing the environmental strengths and weaknesses on their farms, the notebook helps identify family and farm goals, problems or potential problems and helps prioritize a plan of action to address the identified concerns.  The assessment consists of a series of worksheets with questions to help farmers assess and score the status of soil conservation, nutrient management, pest management and livestock waste utilization on their farm.

On March 29, 2011, Dale and I met with 14 landowners to review their notebooks and set up field visits.  Of those 14, eleven have completed their notebooks.  We have been in contact with 11 other landowners who still have some work to do to complete their notebooks, but intend to do so when their schedules allow.   Field visits were made to these 11 landowners to see erosion and other conservation issues they have on their farms.

Our field visits around the watershed listening to landowner concerns and seeing the effects of erosion first hand has confirmed for us; gully erosion and stream bank erosion continue to be key issues for landowners and definite contributors to sediment loading in Upper Walnut streams and El Dorado Lake.   Soil erosion is the most mentioned issue landowners deal with. Soil erosion is not only a factor in crop fields but native grass pastures as well.  Erosion in native grass pastures is not something we have addressed much in the past but should be looked at more closely in the future.

During our field visits, we asked landowners what factors persuaded them to follow through on the completion of their notebooks. Many said the extra $250 incentive from the City of El Dorado made them take a closer look at the notebook in the first place and made it worth the effort to complete. Several mentioned it opened up communication between family members on how their farm operation was run. With the notebook, they were able to work through each aspect of their farming operation and come up with an action plan that will help them prioritize erosion issues or other natural resource concerns they have on their farm. Others said the notebook provided education, awareness and a deeper understanding of how farm management decisions can impact and affect their neighbors and those living downstream. Ultimately, by completing the Environmental Assessment, they will be able to prioritize best management practices that will protect water quality and benefit their farming operation.

## 3. El Dorado Lake Ecosystem Restoration and Protection Feasibility Study

The U S Army Corps of Engineers-Tulsa District, Kansas Water Office and City of El Dorado provided funding for a feasibility study on the Upper Walnut/El Dorado Lake Watershed. The study was completed in January 2007.

### SWAT Model

A Soil and Water Assessment Tool (SWAT) basin scale model was used to predict the impact of land management practices on water and soil. The SWAT model shows:

Highest sediment export rates are estimated for subbasin 13 (1.07 t/ha, Walnut river Arm), subbasin 24 (0.99 t/ha, Cole Creek Arm), and subbasin 19 (0.91 t/ha, Walnut River Arm). Ranking of all subbasins (51) based on sediment export rate shows that of the ten highest rates six are attributed to subbasins in the Walnut River Arm (subbasins 13,19, 4, 18, 17, and 9) of the watershed, three in the Cole/Gilmore Creek Arm (subbasins 24, 16, and 7), and one in the Durechen Creek Arm (subbasin 32) .
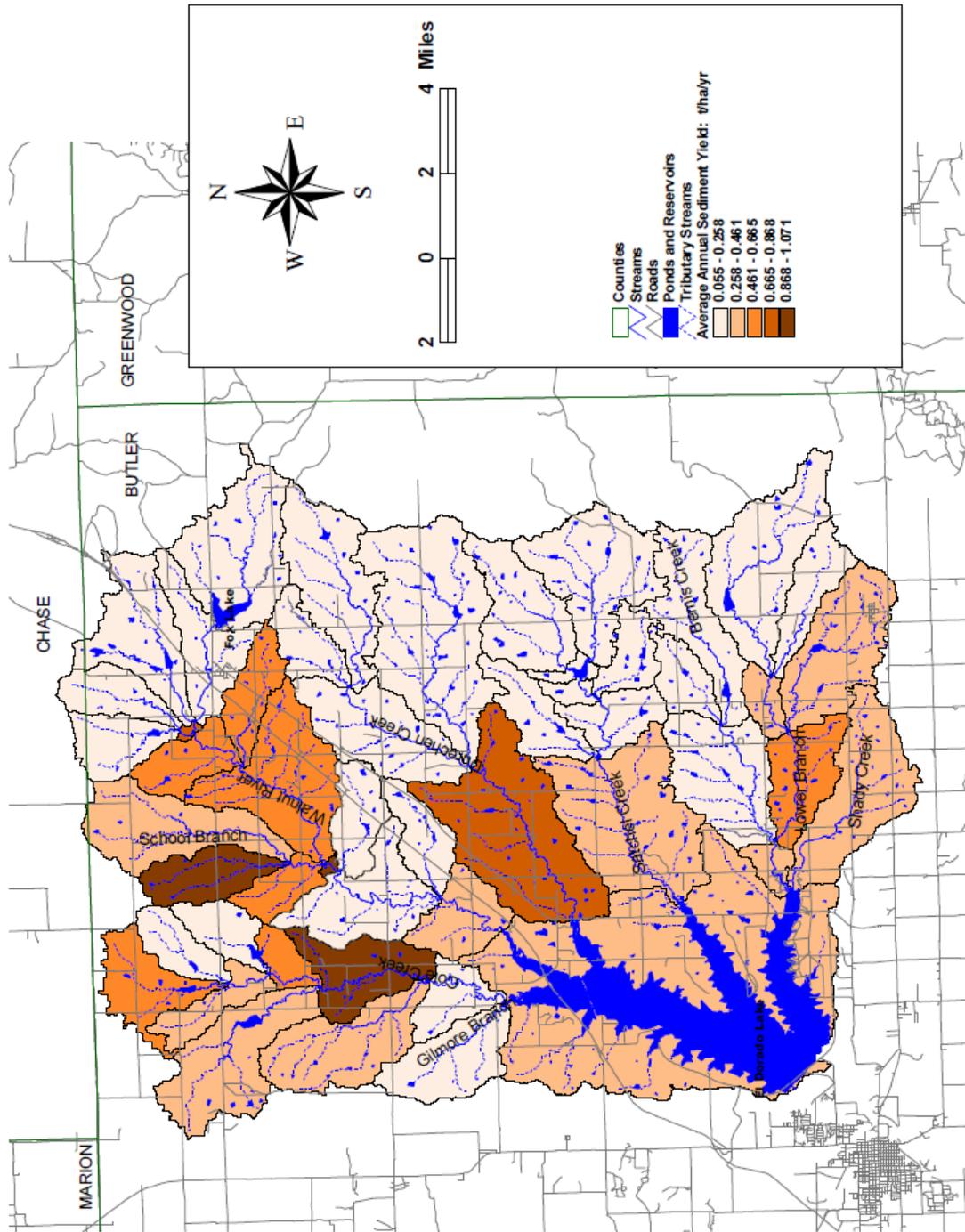
**Figure 13.**     Simulated average annual sediment export rate in metric tons per hectare (t/ha) by subbasin.

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Highest rates of sediment and nutrient yields are predicted for row crop agriculture (3.88 t/ha sediment, 13.72 kg/ha total nitrogen, and 2.93 kg/ha total phosphorus) and urban commercial/industrial/transportation (1.40 t/ha sediment, 5.30 kg/ha total nitrogen, and 1.23 kg/ha total phosphorus) land uses. Lowest export rates for sediment and nutrients are predicted for forested areas and wetlands. Land uses receiving fertilizers as either manure or commercial fertilizers contribute significant quantities of soluble nutrients (nitrate and soluble phosphorus).
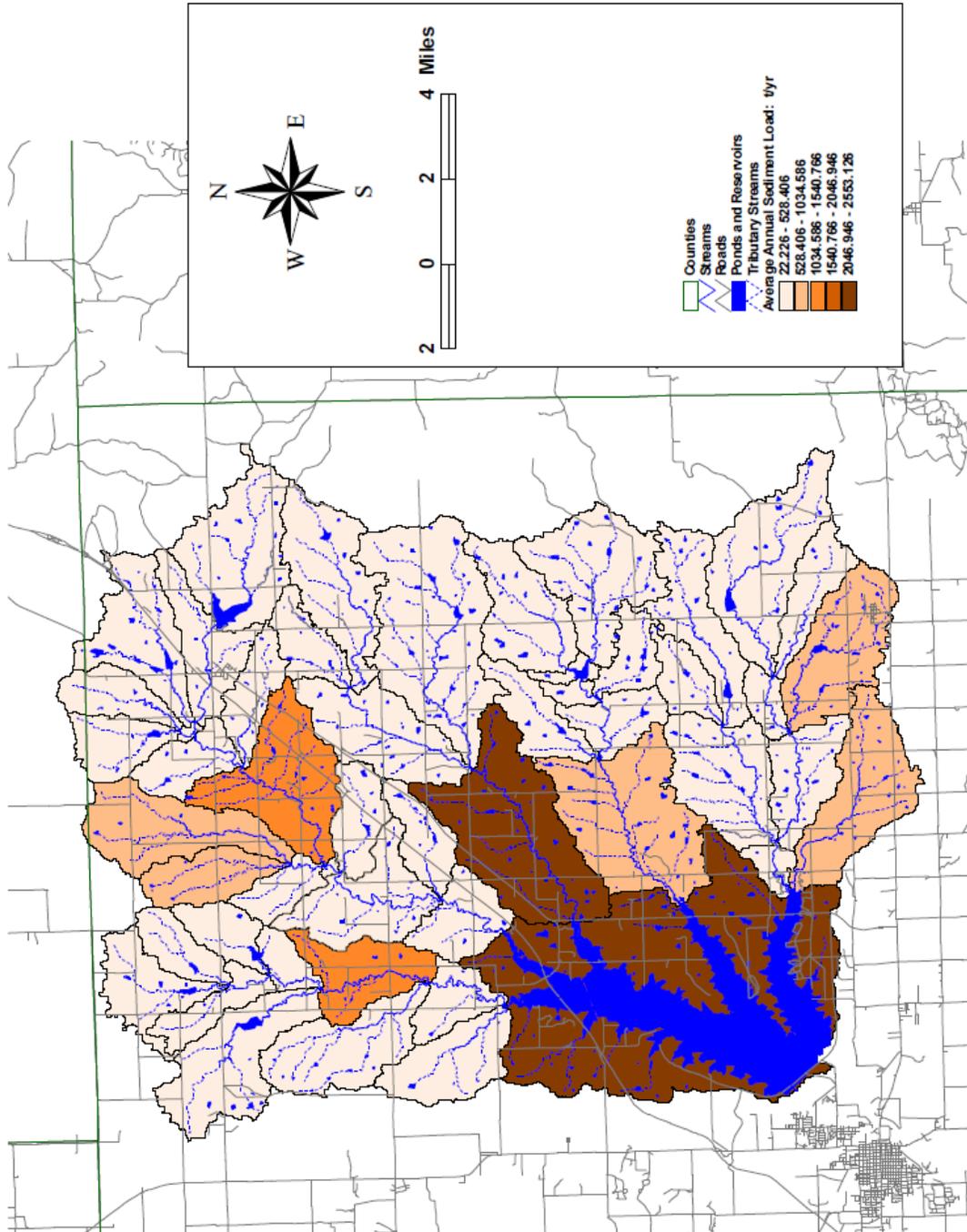


**Simulated average annual sediment load in metric tons per year (t/yr) by subbasin.**

The SWAT model allows extraction of estimated sediment and nutrient export rates by land use for each individual subbasin. The simulated highest ten sediment export rates by subbasin and land use are all row crop agriculture, with two in the Walnut River Arm (subbasins 13, and 26), two in the Cole Creek Arm (subbasins 24 and 30), one in the Durechen Creek Arm (subbasin 32), three in the Satchel Creek Arm (subbasins 33, 35, and 40), the El Dorado Lake subbasin (48), and one in the Bemis Creek Arm (subbasin 51).

Average annual loads are calculated as export rate multiplied by area of the land use within the watershed. Highest average annual sediment loads are estimated from row crop agriculture (13,111 t/yr or 69% of the total watershed upland sediment load) and range (4,833 t/yr, 25% of the total watershed upland sediment load). Average annual loads of sediment and nutrients were calculated for each subbasin. The highest average annual subbasin sediment load is 2,555 t/yr for subbasin 48, the subbasin including El Dorado Lake and adjacent area. The next highest average annual sediment load is attributed to subbasin 32 (2,062 t/yr, at the mouth of the Durechen Creek Arm). The third highest average annual sediment load, 1,081 t/yr, is attributed to subbasin 24 in the Cole Creek Arm. Based on average annual subbasin loading calculations, the Walnut River Arm delivers 5,475 t/yr sediment to El Dorado Lake from upland sources; the Cole Creek Arm delivers 3,570 t/yr; the Durechen Creek Arm delivers 2,895 t/yr; Bemis Creek Arm 2,723 t/yr; Satchel Creek Arm 1,819 t/yr; and the El Dorado Lake area 2,555 t/yr.
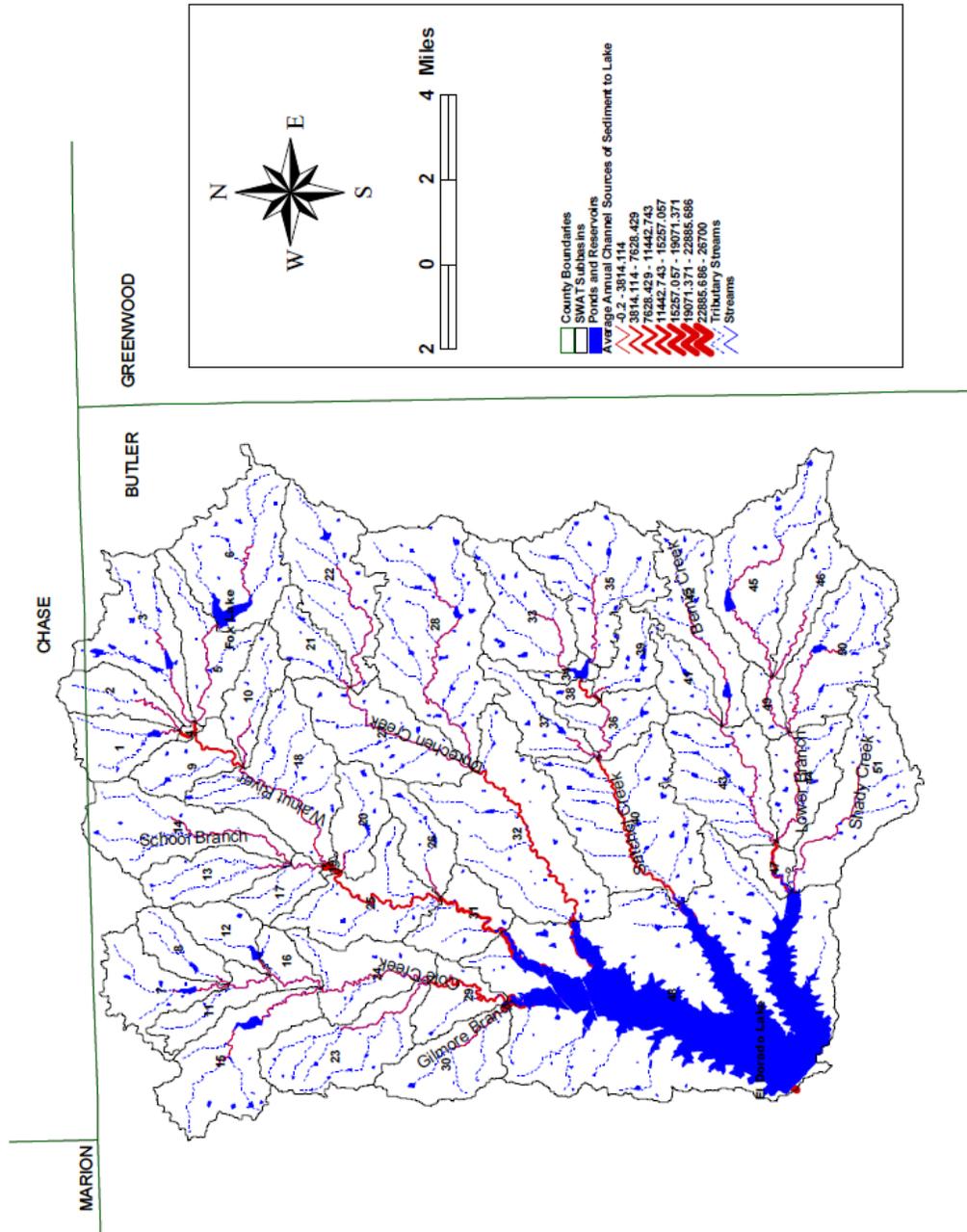
Model estimated annual average reach (channel) sediment contribution (t/yr) to average annual sediment load delivered to El Dorado Lake.

The model predicts an average annual sediment load of 19,037 t/yr delivered to El Dorado Lake from upland areas in the watershed with 28.75% from the Walnut River Arm, 18.76% from the Cole Creek Arm, 15.21% from the Durechen Creek Arm, 14.32 % from the Bemis Creek Arm, 9.56% from the Satchel Creek Arm, and the remaining 13.41% from the El Dorado Lake subbasin. The highest sediment load contributing land use, by subbasin, is row crop agriculture in subbasin 32 (1,845 t/yr in the Durechen Creek Arm) followed closely row crop agriculture in subbasin 48 (1,555 t/yr in the El Dorado Lake subbasin). Nine of the highest ten average annual sediment load contributions by land use, by subbasin, are from row crop agriculture. The single exception is range land in subbasin 48 (El Dorado Lake area) contributing 881 t/yr.

**Filter Strips on Cropland**

The effect of various filter-strip widths around crop lands, the land uses with the highest estimated sediment yield per unit area (3.6 t/ha), was modeled to estimate the potential reduction of net sediment load to the lake. The SWAT model assumes these filter strips are standard grass buffer areas capable of filtering out a fraction of pollutant loads passing over/through them with trapping efficiency varying with width. Based on conversations with local and national NRCS personnel, filter (buffer) strip widths likely to be implemented in the El Dorado Lake watershed range from 30 to 120 feet. SWAT model runs were implemented using 30, 60, 90, and 120 foot filter strip widths around crop land uses and results of each were compared to the base-case scenario of net sediment load delivered to the lake. The modeled effect of filter strips around crop lands showed a fairly dramatic reduction of the rate of sediment and nutrient yields. Thirty (30) foot filter strips were predicted to reduce cropland sediment yield by about 70% (3.62 t/ha in the base scenario to 1.07 t/ha with 30 ft. filter strips). Nutrient export rates from crop land were similarly reduced with 30 ft filter strips (Table 22). Applying filter strips to crop lands was predicted to reduce sediment mass delivered to El Dorado Lake, with greater reductions given wider filter strip widths. Modeled reductions of sediment loads to the lake for filter strip widths of 30, 60, 90, and 120 feet were 4.10%, 5.05%, 5.72%, and 5.85%, respectively. Included in Table 23 are estimates of El Dorado Lake conservation volume storage loss under each of these scenarios, and estimates of extended reservoir life compared to USACE 100 year life design. Maximum annual average conservation volume storage loss reduction (~ 7 ac-ft) and extended reservoir life (~7 years) were associated with 120 foot filter strip widths.

A notable effect of modeling the variable filter width strips was that while upland sediment load contribution to lake sediment loading was dramatically reduced with increasing filter strip width (19,039 t/yr in the base scenario compared to 5,344 t/yr with 120 foot filter strips), channel sediment (degradation) contributions to lake sediment load increased, both in proportion and mass delivered to the lake. As surface runoff sediment concentration is reduced via effective application of filter strips, water reaching the stream channel is capable of carrying more sediment, and channel degradation occurs. Sediment basin location and design would require intensive study to determine physical characteristics of the sediment, hydraulic characteristics of the basin(s), inflow sediment graph, inflow hydrograph, basin geometry, and chemistry of the water and sediment. A host of factors can affect sediment basin performance including particle size distribution, basin hydraulic response, detention storage time, basin shape, dead storage, basin type (permanent or non-permanent pool), water chemistry, and sediment scour (Haan et al., 1994).

**Assessment of water quantity, quality and aquatic life impacts of sedimentation in El Dorado Lake.**

The water quantity estimates were updated by the 2004 bathymetric survey. This survey provides the most accurate estimate of water supply (conservation pool) storage to date. The 2004 survey shows virtually no impact to water supply storage. The differences in storage estimating techniques and the differences in estimated volumes among the volume estimating methodologies make it impractical to revise the rate of sedimentation until an additional bathymetric survey (or in-lake sediment sampling) is completed.

The conservation pool storage volume measured by the 2004 survey was found to be slightly greater than the volume estimated during project design. Therefore revising the sedimentation rate will not be possible until an additional bathymetric survey is conducted (following subsequent measurable sediment accumulation) or until other sedimentation studies are conducted that will allow a determination of the volume of sediment deposited in El Dorado Lake. Until additional sediment studies are complete the TMDL siltation reduction rate has a high uncertainty because the siltation rate has a high uncertainty. The recommended siltation reduction implementation activities include three agricultural best management practices which are applicable regardless of the sedimentation rate. All soil erosion increased by agricultural practices (farming and ranching) should be minimized through the use of best management practices. Grass filter strips are especially effective in filtering soil from upland runoff.

The Kansas Biological Survey did sediment core sampling in El Dorado Lake in the summer of 2011; however, not all the samples have been analyzed to date. The map below shows where core samples were taken in El Dorado Lake:

## El Dorado Reservoir - Sediment Coring Sites 2011
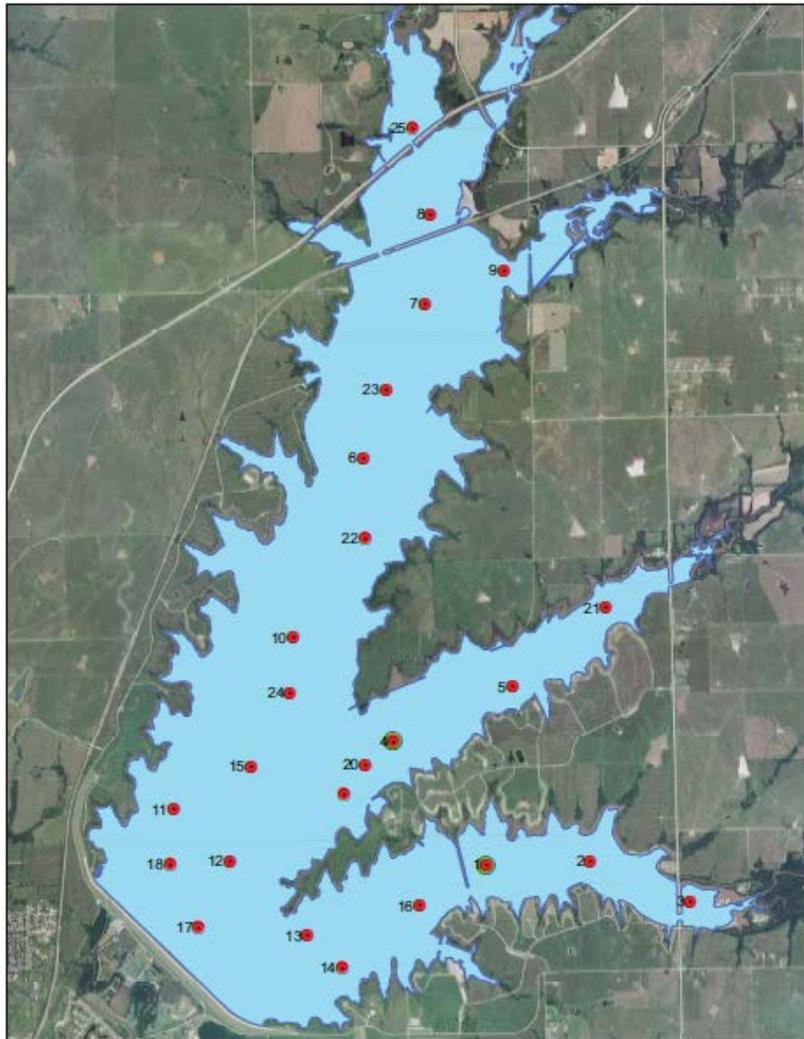
This data will be useful in determining amount of sediment deposited since the last study was completed in 2000. The data may also be useful in comparing to the bathymetric survey completed by the US Army Corps of Engineers in 2004 for a more accurate account of sediment accumulation in El Dorado Lake since recently completed data cannot be compared to old data when the Lake was built.

**Dredging options for managing sediment accumulation in and around
El Dorado Lake**

Several dredging options were examined through the Feasibility Study:

Dredging sediment from the conservation pool would restore water supply storage for the benefit of the City of El Dorado who has contracted with the government for the storage.

Dredging would restore the lost aquatic habitat for the benefit of the environment and public recreation. The dredging project costs would include: planning, permits and studies, land acquisition, dredged material disposal area and dewatering area construction, dredging, and disposal area management. The cost of dredging using 24 to 30 inch dredges would range from $2 to $4 per cubic yard or $3,200 to $6,500 per acre foot. Problem contaminants could increase the cost range by one or two orders of magnitude – i.e., $20 to $40 per cubic yard or $200 to $400 per cubic yard.

Dredging to restore shorelines was found to be technically viable but is not recommended because the potential volume of conservation pool storage that could be recovered would be minor compared to total reservoir sedimentation. This concept also has the negative benefit of reducing flood control storage.

Dredging of upper reservoir arms was found to be impractical for reducing sedimentation in the conservation pool.

## Other Sediment Reducing Practices

Low flow sediment traps were suggested early in the formulation process as a concept to trap sediments just upstream of the reservoir pool. The concept would use a "created wetland" to simulate the sediment trapping function of a natural wetland. As the study progressed a general review of sediment load versus stream flow data (for other reservoirs with sediment flow data) showed that low stream flows transport only a small portion of the total sediment load that enters a reservoir. Although the ecosystem value of created wetlands could be beneficial, low flow sediment traps were not recommended because there would be minimal reservoir sediment reduction. The relatively small storage capacity compared to the large volume of flood waters carrying the sediment load would make the concept infeasible. Natural or created wetlands distributed throughout the El Dorado Lake watershed would typically occur within riparian areas and would be below small drainage areas. In this more natural situation wetlands are very effective in retaining eroded soils and nutrients.

Sediment storage reservoirs (watershed dams) were reviewed as a management concept but were not specifically sited or designed as part of the management plan. The Soil and Water Assessment Tool developed for the management plan provides initial information for use in locating potential sediment storage reservoirs. While a few small reservoirs could effectively trap large volumes of sediment, those reservoirs will eventually be filled. Determining whether building additional sediment trap reservoirs or dealing with sedimentation issues at El Dorado Lake is the more viable course of action will require additional sediment source and sediment transport rate data. The Natural Resources Conservation Service may be able to assist with additional data.

Restoration of altered stream banks is supported by the state's Kansas Water Plan position on wetland and riparian management. Specifically, "The primary policy of the state regarding wetland and riparian management is to facilitate the protection of these areas from conversion or channel modifications, and to stabilize streams which have been adversely affected by channel modification activities." Application of this policy through the implementation of the best management practices has the potential to reduce higher erosion caused by agricultural practices in or near the stream and riparian areas.

Shoreline erosion was suspected to be a source of sediment that was impacting the conservation pool storage. Preliminary field investigations were made of erosion areas around the lake.  Subsequently an evaluation of the potential volume of shoreline material was conducted. The average annual volume of shoreline erosion was found to be less than 5 acre-feet, using assumptions that resulted in higher volume estimates. One estimate of average annual total sediment transported to the lake (including shoreline erosion) is about 180 acre-feet per year. The shoreline contribution (a conservatively high estimate) is minimal compared to the total estimated sediment load to the lake. However, there are a number of other justifications for minimizing shoreline erosion. The park areas, access roads, project utilities, camping facilities, and a variety of recreation facilities are important Federal investments in public recreation resources. Shoreline erosion alters and may often degrade the local terrestrial and aquatic environment. The loss of park lands from erosion and reduction in the quality of the recreation experience represents a quantifiable loss of a public resource. The loss of native shoreline vegetation due to erosion from wave action decreases the value of recreation activities and impacts the aesthetic qualities of the lake and park facilities. To the extent possible, the destructive impacts of shoreline erosion should be minimized.

See Appendix B for more information on the El Dorado Lake Ecosystem Restoration and Protection Feasibility Study.

4. **Innovative Green Infrastructure Project Proposal, 2009 - El Dorado Lake Identification of Stream Bank Restoration Needs in the Watershed**

A proposal was submitted to Kansas Department of Health and Environment for funds through the Innovative Green Infrastructure Project in 2009 for stream bank restoration projects above El Dorado Lake.  The proposal was a cooperative effort between the City of El Dorado and Butler County Conservation District with assistance from Wildhorse Riverworks for survey and design costs and cost estimates for rock, rock placement, shaping, reseeding and planting trees. Although our project was not funded, we did come up with additional assessment information on stream banks above El Dorado Lake.   The Project Description was to: Reduce erosion coming from unstable stream banks to decrease sediment load in El Dorado Lake, a public water supply. Stream bank restoration measures would include rock veins, riprap, rock chutes and bioengineering (vegetation), hardened crossings across streams and alternative watering supplies for livestock.

This was an in-office survey.  We used Arc View mapping through the Natural Resources Conservation Service to identify sites with evident stream bank erosion.  A measurement tool on Arc View was used to determine length of erosion and bank height was estimated based on prior observation and work in the field.  Phil Balch with Wildhorse Riverworks inputted that information onto a spreadsheet to come up with quantities and then he was able to provide cost estimates for each site.  The cost estimates included surveying and engineering services for each site, rock veins, riprap, rock chutes or other approved practices, bioengineering (vegetation), hardened crossings and alternative watering supplies for livestock.

The primary water quality benefit to be achieved through this project was the reduction of sediment in El Dorado Lake with a secondary benefit of reducing nutrients (eutrophication).

Long term benefits included extending the useable life of El Dorado Lake and reducing water treatment costs.

The creeks highlighted in red were deemed highest priorities for the Innovative Grant; however there were additional sites identified which are also in need of stabilization and are included in the table below:

| Creek/River | Construction Costs | Surveying/Design/ Checkout Costs | Permit Fees | Total Cost |
|---|---|---|---|---|
| Cole Creek #1 | $ 13,557.12 | $5,207.00 | $ 200.00 | $ 18,964.12 |
| Cole Creek #2 | $ 3,435.50 | $3,914.00 | $ 200.00 | $ 7,549.50 |
| Cole Creek #3 | $ 15,501.04 | $5,207.00 | $ 200.00 | $ 20,908.04 |
| Cole Creek #4 | $ 5,752.63 | $5,207.00 | $ 200.00 | $ 11,159.63 |
| Cole Creek #5 | $ 24,141.40 | $5,643.00 | $ 200.00 | $ 29,984.40 |
| Cole Creek #6 | $ 33,723.01 | $6,143.00 | $ 200.00 | $ 40,066.01 |
| Cole Creek #7 | $ 33,342.39 | $5,643.00 | $ 200.00 | $ 39,185.39 |
| Cole Creek #8 | $ 2,582.19 | $3,914.00 | $ 200.00 | $ 6,696.19 |
| Cole Creek #9 | $ 7,687.13 | $4,057.00 | $ 200.00 | $ 11,944.13 |
| Cole Creek #10 | $ 9,856.27 | $4,057.00 | $ 200.00 | $ 14,113.27 |
| Cole - Hardened Crossings - 1 | $ 7,500.00 | $ - | $ 200.00 | $ 7,700.00 |
| Cole - Alternative Watering Facilities - 3 | $ 12,750.00 | $ - | $ - | $ 12,750.00 |
| | | | | |
| Walnut River #1 | $ 26,417.55 | $5,850.00 | $ 200.00 | $ 32,467.55 |
| Walnut River #2 | $ 37,107.20 | $5,850.00 | $ 200.00 | $ 43,157.20 |
| Walnut River #3 | $ 40,920.54 | $5,350.00 | $ 200.00 | $ 46,470.54 |
| Walnut River #4 | $ 63,622.44 | $7,500.00 | $ 200.00 | $ 71,322.44 |
| Walnut River #5 | $ 16,981.73 | $4,707.00 | $ 200.00 | $ 21,888.73 |
| Walnut River #6 | $ 22,881.33 | $4,707.00 | $ 200.00 | $ 27,788.33 |
| Walnut River #7 | $ 27,092.09 | $5,207.00 | $ 200.00 | $ 32,499.09 |
| Walnut River #8 | $ 12,871.77 | $5,850.00 | $ 200.00 | $ 18,921.77 |
| Walnut River #9 | $ 18,657.76 | $5,207.00 | $ 200.00 | $ 24,064.76 |
| Walnut River #10 | $ 7,659.85 | $5,207.00 | $ 200.00 | $ 13,066.85 |
| Walnut River #11 | $ 8,452.76 | $5,207.00 | $ 200.00 | $ 13,859.76 |
| Walnut River #12 | $ 21,193.65 | $5,207.00 | $ 200.00 | $ 26,600.65 |
| Walnut River #13 | $ 26,484.48 | $5,207.00 | $ 200.00 | $ 31,891.48 |
| Walnut River #14 | $ 39,535.75 | $5,850.00 | $ 200.00 | $ 45,585.75 |
| Walnut River #15 | $ 13,605.05 | $4,564.00 | $ 200.00 | $ 18,369.05 |
| Walnut River #16 | $ 10,048.69 | $4,564.00 | $ 200.00 | $ 14,812.69 |
| Walnut River #17 | $ 33,665.17 | $5,207.00 | $ 200.00 | $ 39,072.17 |
| Walnut River #18 | $ 43,165.40 | $5,207.00 | $ 200.00 | $ 48,572.40 |
| Walnut River #19 | $ 26,528.22 | $5,850.00 | $ 200.00 | $ 32,578.22 |
| Walnut - Hardened Crossings - 2 | $ 15,000.00 | 0 | $ 200.00 | $ 15,200.00 |
| Walnut - Alternative Watering Facilities - 3 | $ 12,750.00 | 0 | 0 | $ 12,750.00 |

| | | | | |
|---|---|---|---|---|
| Durechen Creek #1 | $ 13,101.02 | $4,414.00 | $ 200.00 | $ 17,715.02 |
| Durechen Creek #2 | $ 18,542.76 | $5,993.00 | $ 200.00 | $ 24,735.76 |
| Durechen Creek #3 | $ 12,648.77 | $4,057.00 | $ 200.00 | $ 16,905.77 |
| Durechen Creek #4 | $ 20,823.04 | $5,493.00 | $ 200.00 | $ 26,516.04 |
| Durechen Creek #5 | $ 30,452.00 | $5,493.00 | $ 200.00 | $ 36,145.00 |
| Durechen Creek #6 | $ 13,222.66 | $4,850.00 | $ 200.00 | $ 18,272.66 |
| Durechen Creek #7 | $ 17,272.01 | $5,350.00 | $ 200.00 | $ 22,822.01 |
| Durechen Creek #8 | $ 7,804.79 | $3,914.00 | $ 200.00 | $ 11,918.79 |
| Durechen Creek #9 | $ 18,544.06 | $5,350.00 | $ 200.00 | $ 24,094.06 |
| Durechen Creek #10 | $ 36,279.63 | $5,993.00 | $ 200.00 | $ 42,472.63 |
| Durechen Creek #11 | $ 39,795.35 | $5,493.00 | $ 200.00 | $ 45,488.35 |
| Durechen Creek #12 | $ 17,267.10 | $4,850.00 | $ 200.00 | $ 22,317.10 |
| Durechen Creek #13 | $ 10,090.29 | $4,207.00 | $ 200.00 | $ 14,497.29 |
| Durechen Creek #14 | $ 13,442.04 | $5,350.00 | $ 200.00 | $ 18,992.04 |
| Durechen - Hardened Crossings - 7 | $ 52,500.00 | 0 | $ 200.00 | $ 52,700.00 |
| Durechen - Alternative Watering Facilities - 3 | $ 12,750.00 | 0 | 0 | $ 12,750.00 |
| | | | | |
| Bemis/Harrison Creek #1 | $ 2,855.08 | $3,914.00 | $ 200.00 | $ 6,969.08 |
| Bemis/Harrison Creek #2 | $ 2,931.07 | $3,914.00 | $ 200.00 | $ 7,045.07 |
| Bemis/Harrison Creek #3 | $ 4,341.60 | $3,914.00 | $ 200.00 | $ 8,455.60 |
| Bemis/Harrison Creek #4 | $ 5,234.61 | $3,914.00 | $ 200.00 | $ 9,348.61 |
| Bemis/Harrison Creek #5 | $ 7,896.12 | $3,914.00 | $ 200.00 | $ 12,010.12 |
| Bemis/Harrison Creek #6 | $ 5,483.89 | $4,707.00 | $ 200.00 | $ 10,390.89 |
| Bemis/Harrison Creek #7 | $ 16,460.17 | $5,493.00 | $ 200.00 | $ 22,153.17 |
| Bemis/Harrison Creek #8 | $ 7,475.09 | $4,850.00 | $ 200.00 | $ 12,525.09 |
| Bemis/Harrison Creek #9 | $ 8,958.35 | $5,350.00 | $ 200.00 | $ 14,508.35 |
| Bemis/Harrison Creek #10 | $ 2,212.21 | $2,914.00 | $ 200.00 | $ 5,326.21 |
| | | | | |
| Bemis/Harrison - Hardened Crossings - 4 | $ 30,000.00 | $ - | $ 200.00 | $ 30,200.00 |
| Bemis/Harrison - Alternative Watering Facilities - 0 | $ - | | $ - | |
| | | | | |
| Satchel Creek #1 | $ 17,918.40 | $4,850.00 | $ 200.00 | $ 22,968.40 |

| | | | | | |
|---|---|---|---|---|---|
| Satchel Creek #2 | $ 17,543.39 | $5,350.00 | $ 200.00 | $ | 23,093.39 |
| Satchel Creek #3 | $ 14,428.46 | $5,350.00 | $ 200.00 | $ | 19,978.46 |
| Satchel Creek #4 | $ 3,268.37 | $4,414.00 | $ 200.00 | $ | 7,882.37 |
| Satchel Creek #5 | $ 6,959.99 | $5,350.00 | $ 200.00 | $ | 12,509.99 |
| Satchel Creek #6 | $ 6,986.08 | $5,350.00 | $ 200.00 | $ | 12,536.08 |
| Satchel Creek #7 | $ 9,505.36 | $5,350.00 | $ 200.00 | $ | 15,055.36 |
| Satchel Creek #8 | $ 2,781.36 | $4,414.00 | $ 200.00 | $ | 7,395.36 |
| Satchel Creek #9 | $ 6,935.97 | $5,207.00 | $ 200.00 | $ | 12,342.97 |
| Satchel - Hardened Crossings - 5 | $ 37,500.00 | $ - | $ 200.00 | $ | 37,700.00 |
| Satchel - Alternative Watering Facilities - 2 | $ 8,500.00 | $ - | $ - | $ | 8,500.00 |
| | | | | | |
| Shady Creek #1 | $ 7,398.58 | $5,350.00 | $ 200.00 | $ | 12,948.58 |
| Shady Creek #2 | $ 41,227.92 | $7,429.00 | $ 200.00 | $ | 48,856.92 |
| Shady - Hardened Crossings - 0 | $ - | 0 | 0 | | |
| Shady - Alternative Watering Facilities - 0 | $ - | 0 | 0 | | |

|  | $ 1,303,807.70 | $323,395.00 | $ 13,800.00 | $ 1,641,002.70 |
|---|---|---|---|---|

The total cost of this project is $1,641,002.70.

The following maps show locations of stream sites identified in the data above:

Shady/Harrison/Bemis Creek Stream Restoration Sites
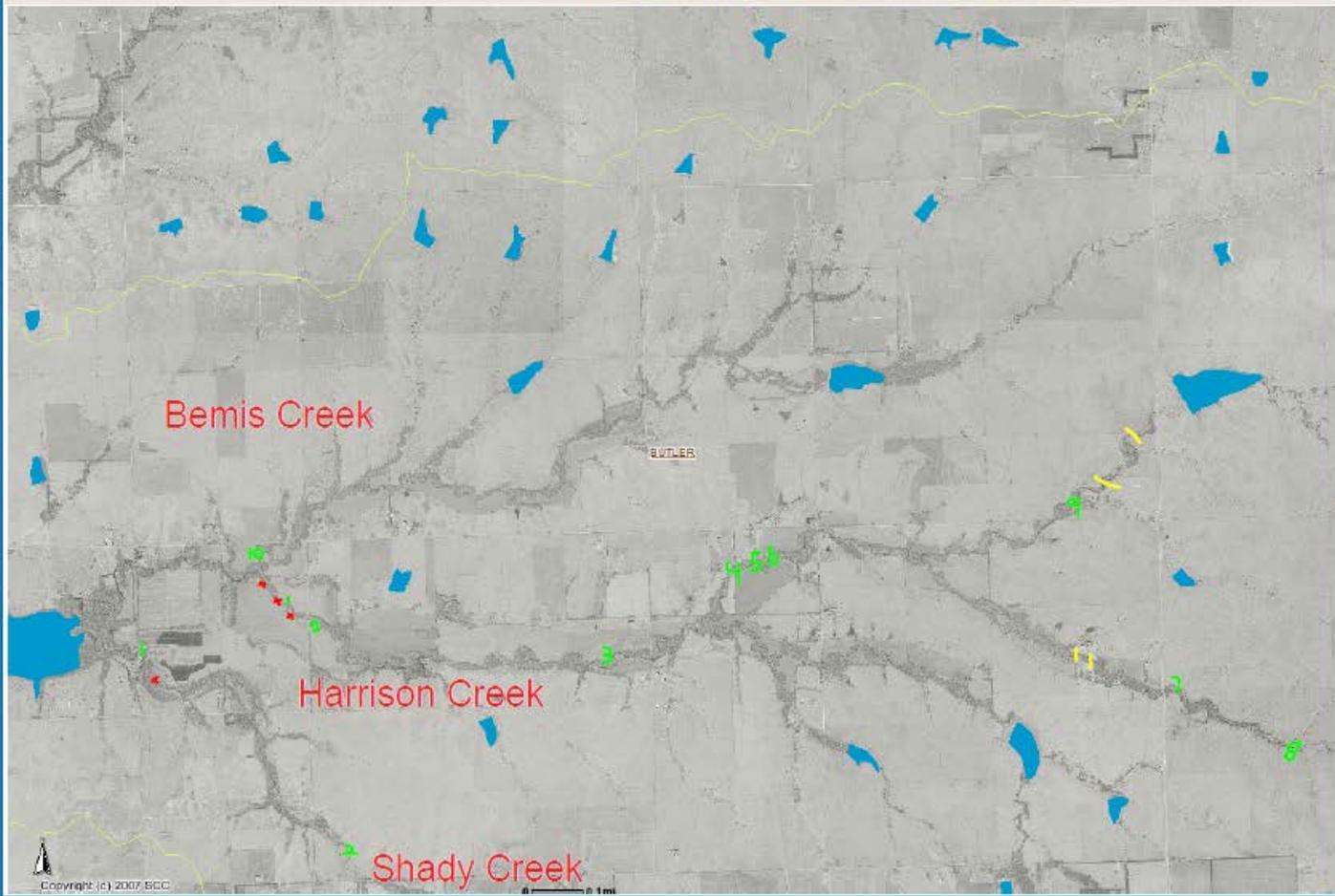
Satchel Creek Stream Restoration Sites
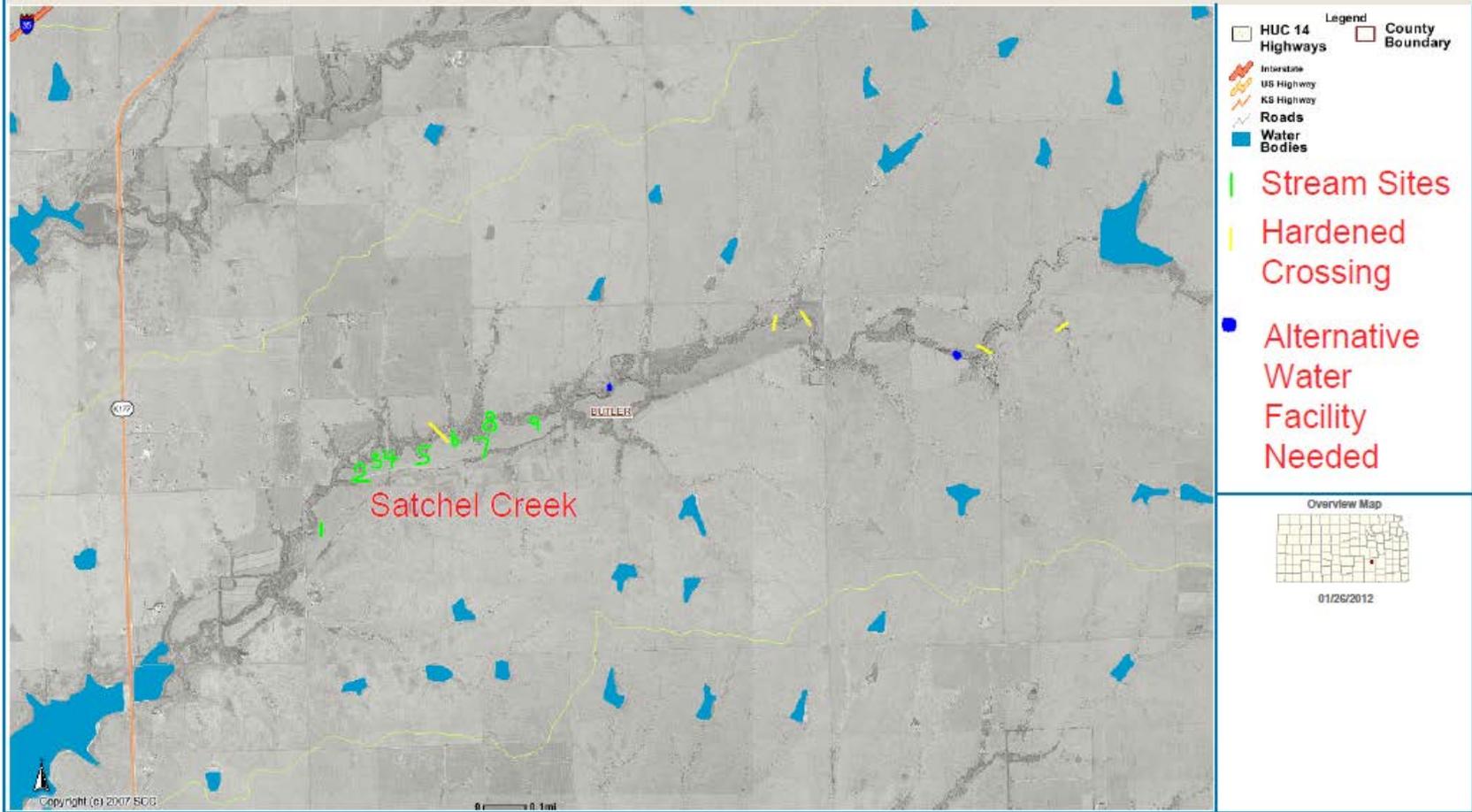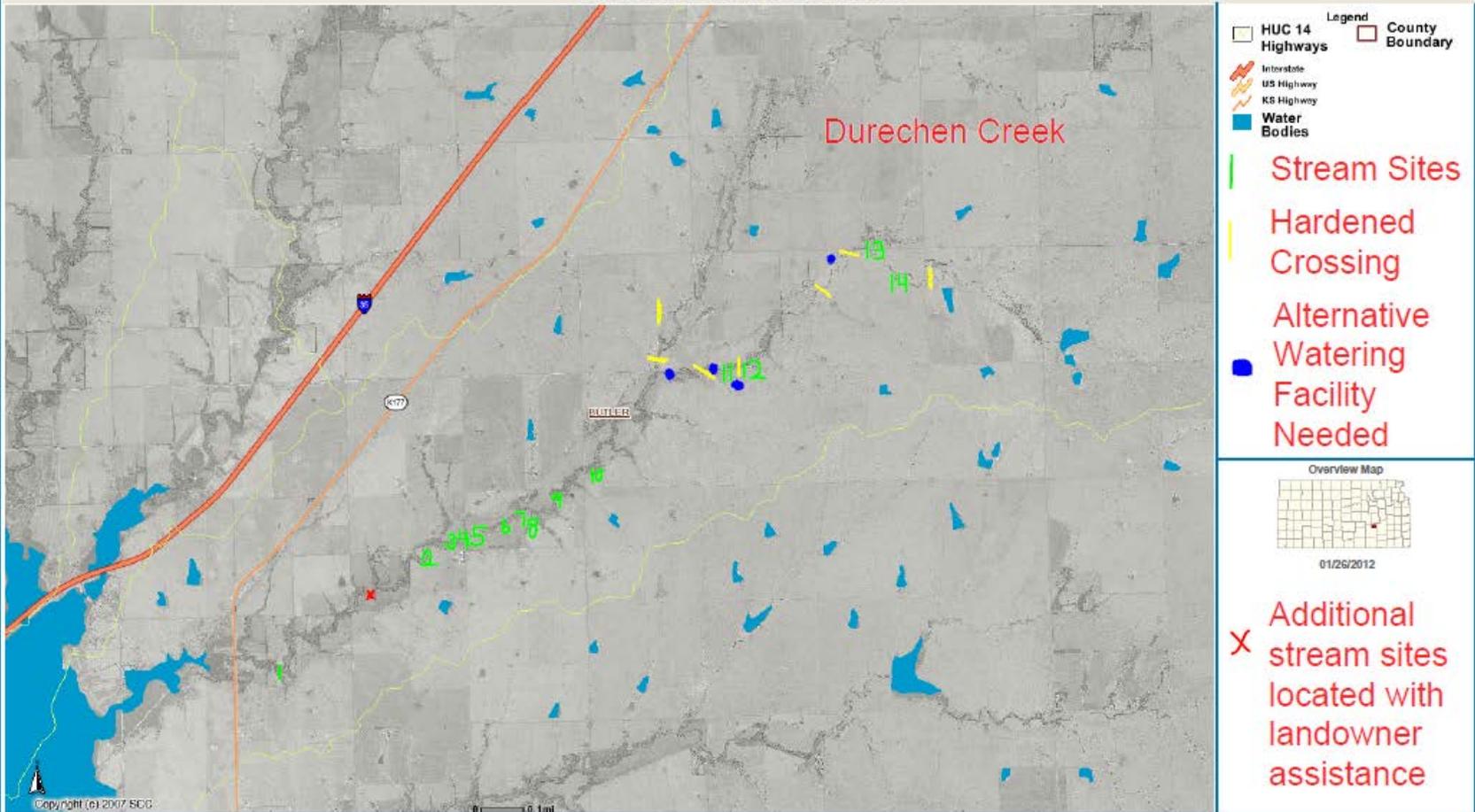
Walnut River Stream Restoration Sites
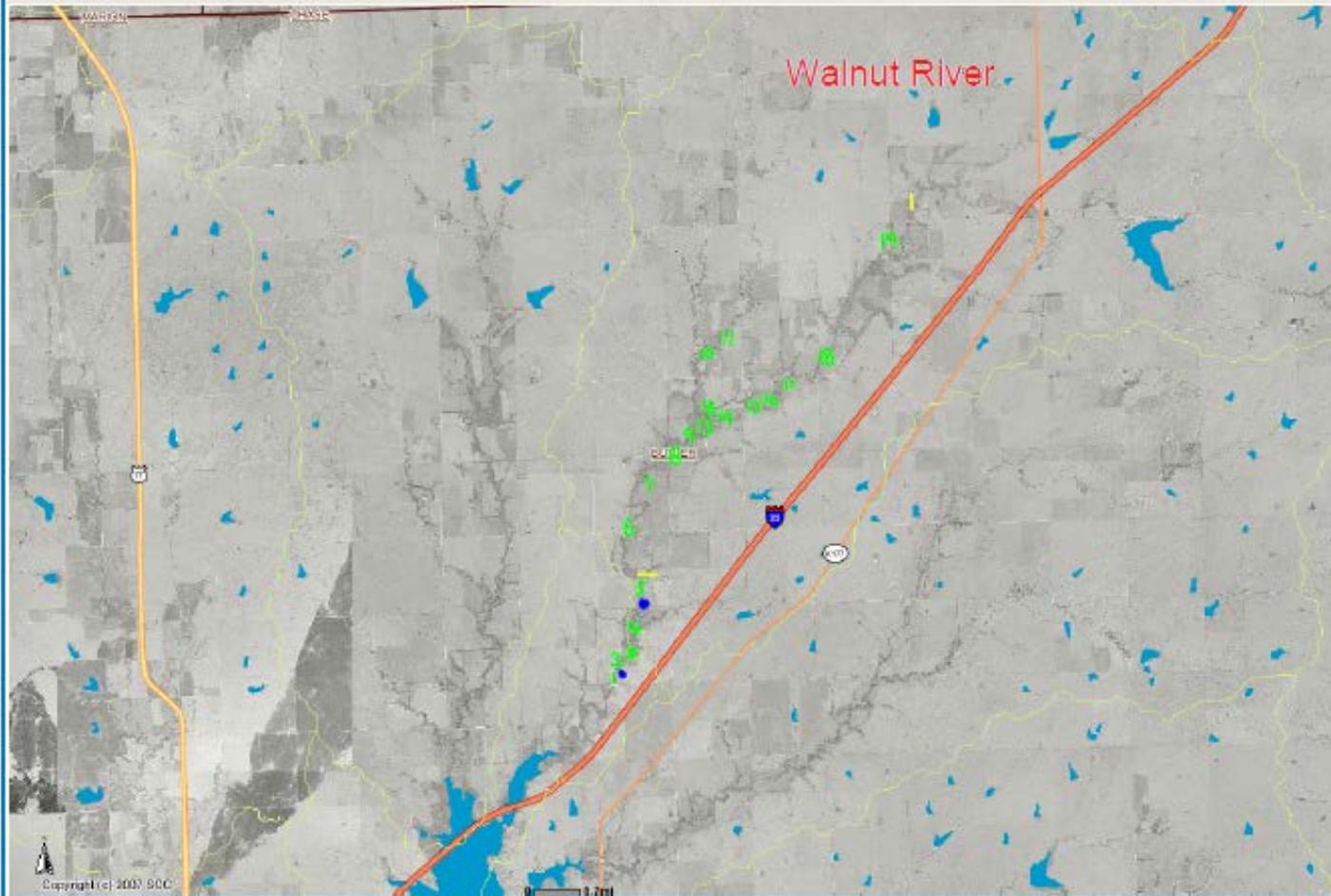
Cole Creek Stream Restoration Sites
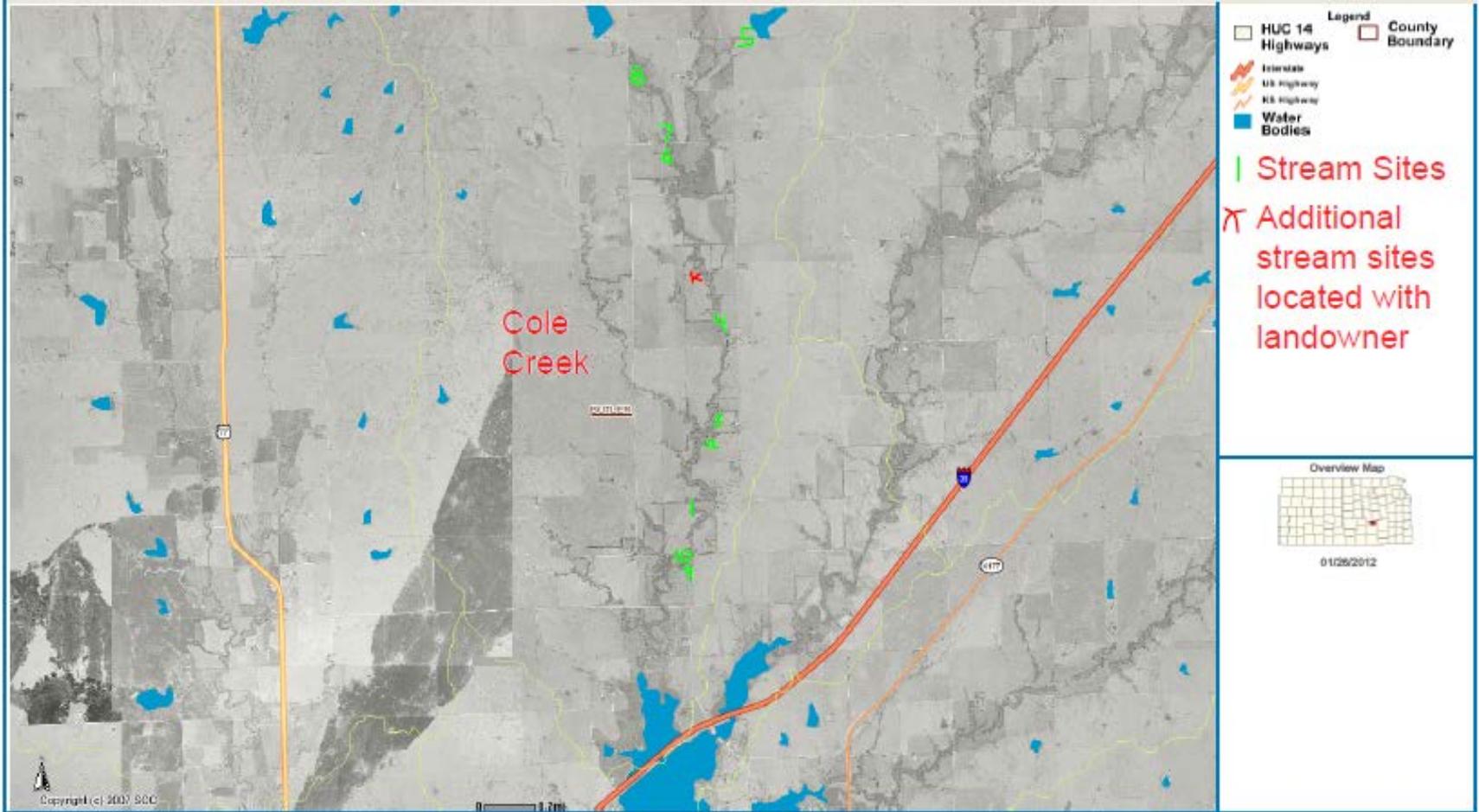
## 5. Americorps Riparian Buffer Inventory

In 1994, an Americorps Team color-coded riparian areas in Butler County on maps to show land uses adjacent to riparian areas. In January 2004, Butler County Conservation District staff compiled the color-coded data in a more useable format for the Upper Walnut Watershed. Americorps broke down the riparian areas in 7 different categories; 1. Forestland, 2. Forest/Grass Mix, 3. Forest/Crop Mix, 4. Forest/Urban Mix, 5. Grassland, 6. Cropland, 7. Urban Land. Conservation District staff compiled the Americorps data by stream name, legal description (to the quarter section when possible), number of feet of stream that could use treatment, land use and USGS Map number. It was determined cropland and forestland/cropland mix would have the most impact on the Upper Walnut Watershed as far as impacting El Dorado Lake with sediment and nutrients. From the maps, staff estimated the length in feet from forest/cropland mix and then cropland mix. Based on those estimates, it was determined there were 54 miles of forestland/cropland mix adjacent to streams above El Dorado Lake and 60 miles of cropland adjacent to streams above El Dorado Lake.

## 6. State Conservation Commission TMDL Inventory on livestock, cropland, and on site waste systems.

In January/February 2003, the State Conservation Commission requested that an inventory be completed to help them target Kansas Water Plan Funds for high priority TMDL areas.

Livestock Waste Systems – a windshield survey was completed in February 2003 to estimate livestock waste systems in the Upper Walnut Watershed. A total of 84 livestock operations were identified in the watershed.

A cropland survey was completed using in-office data. Total estimated cropland in the Upper Walnut Watershed is 18,516 acres. The percent cropland needing treatment was estimated at 52%. Structural practices needed such as terraces and waterways are estimated at 36%.

On Site Septic Systems – A survey was conducted using data from Butler County Planning and Environmental Services and Butler County Mapping Department. It was determined there were 208 households in the Upper Walnut Watershed that used private wastewater systems.

## 7. Selling Water to Wichita

Currently, over 51,000 people rely on El Dorado Lake for their water supply. That number will continue to grow as urbanization and population increases. As such, El Dorado Lake is of major importance to Butler County and surrounding areas. In fact, The City of El Dorado and The City of Wichita have begun to discuss the possibility of El Dorado selling water to Wichita. Some preliminary studies have already been done.

As reported in *The El Dorado Times*, June 14, 2011, with excerpts included here, *"The city has already had an Oasis Model completed for the lake, which predicts what the lake will produce over a period of time, looking at precipitation, evaporation, inflow and outflow. The model looks at the lake in the year 2050, taking into account continued sedimentation. For the purpose of the study, the Kansas Water Office needed to know the maximum amount the city would allow the lake to drop, which the city decided to provide as five feet. Five feet was an arbitrary number used for the purpose of the model.*

*According to the model, in the year 2050 after another 40 years of sedimentation, the lake could yield and the city sell 50 million gallons per day (MGD) of additional water 63 percent of the time, 40 MGD 69 percent of the time, 25 MGD 78 percent of the time and 10 MGD 88 percent of the time without dropping lake levels more than five feet. The model also assumed a base use of 12.2 MGD for the City of El Dorado's existing customers. According to the model, in the last 60 years, there were about a dozen times when they would not have been able to meet a 30 to 40 MGD water demand, which is what they would expect from Wichita."* Kurt Bookout, City Public Works Director, *"Explained that Corp lakes were built with a life of 100 years, but with work, he thought they could extend that. He said they could come up with multiple long-term strategies to extend the life of the lake. Bookout said they were already putting some money back for such work, but additional money would be beneficial. It also would guarantee a revenue stream to pay off the lake. Bookout also addressed the amount they would draw down the lake. He said rather than looking at drawing the lake down five feet, he gave an example of how selling additional water would only drop lake levels four inches over the course of a month. That was figured using the fact the lake covers 8,000 acres at conservation pool. There is about 325,800 gallons in one acre of water, one foot deep, which totals 2.6 billion gallons in one foot of water over 8,000 acres. Bookout said if they sold 30 million gallons a day for 30 days, that's 900 million gallons, which would be four inches of water a month."*

El Dorado Lake is located on the optimal site in this region. There are no plans for another lake when El Dorado Lake is full of sediment and no longer able to supply water for the population. Future generations will rely on the water El Dorado Lake supplies provided actions are taken now to protect the Lake and its watershed from pollutants, erosion and sedimentation. Our generation has the opportunity and the potential to extend the life of El Dorado Lake far beyond its anticipated lifespan.

**F. Map of Classified Streams in the Upper Walnut/El Dorado Lake Watershed**



El Dorado Lake WRAPS
Classified Streams
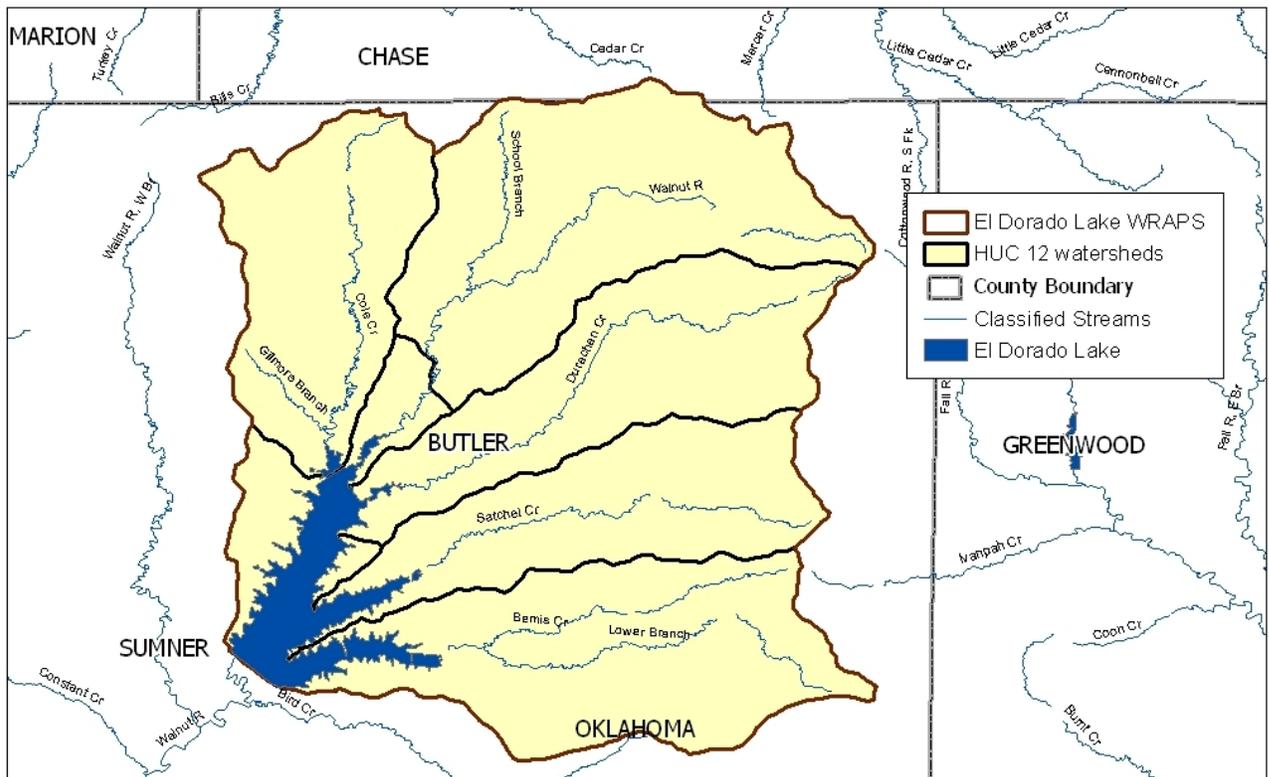
The purpose of this publication is to illustrate general watershed conditions in the state of Kansas. This map product is provided without representation or implied or expressed warranty of accuracy and is intended for watershed planning purposes only. The originating agency is not responsible for publication or use of this product for any other purpose. This product may be corrected or updated as necessary without prior notification.

January 2012

# G. Table of Designated Uses for All Classified Streams and El Dorado Lake

**Explanation of Designated Uses for Surface Waters**

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

There are no Special Aquatic Life Use Waters (SALU), Exceptional State Waters (ESW) or Outstanding National Resource Waters (ONRW) in the Upper Walnut/El Dorado Lake Watershed.

| STREAM SEGMENT NAME | LATITUDE/LONGITUDE UPPER LOWER | SEG | CLASS | AL | CR | DS | FP | GR | IW | IR | LW |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| Bemis Cr | 37.8856 96.5870 37.8504 96.7327 | 8 | GP | E | b | X | X | X | X | X | X |
| Cole Cr | 38.0789 96.7543 37.9387 96.7856 | 15 | GP | E | c | X | X | X | X | X | X |
| Durechen Cr | 38.0125 96.5597 37.9202 96.7532 | 12 | GP | E | c | X | X | X | X | X | X |
| Gilmore Branch | 37.9775 96.8192 37.9455 96.7851 | 39 | GP | E | a | X | X | X | X | X | X |
| Satchel Cr | 37.9058 96.5766 37.8800 96.7500 | 10 | GP | E | a | X | O | X | X | X | X |
| School Branch | 38.0829 96.7070 38.0061 96.7234 | 45 | GP | E | b | O | O | O | O | O | X |
| Walnut River | 38.0215 96.5533 37.9427 96.7589 | 14 | GP | E | B | X | X | X | X | X | X |

Designations apply only to unimpounded reaches of the specified stream segments. Use designations assigned
to classified streams not listed in this table are determined by the Department on a case-by-case basis
in accordance with K.A.R. 28-16-28d(d).
Abbreviations:
HUC = hydrologic unit code
SEG = stream segment
CLASS = antidegradation category
GP = general purpose waters
EX = exceptional state waters
ON = outstanding national resource waters
AL = designated for aquatic life use
S = special aquatic life use water
E = expected aquatic life use water
R = restricted aquatic life use water
CR = designated for contact recreational use
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
C = Primary contact recreation stream segment is not open to and accessible by the public
under Kansas law
a = Secondary contact recreation stream segment is by law or written permission of the
landowner open to and accessible by the public
b = Secondary contact recreation stream segment is not open to and accessible by the public
under Kansas law
DS = designated for domestic water supply use
FP = designated for food procurement use
GR = designated for ground water recharge
IW = designated for industrial water supply use
IR = designated for irrigation use
LW = designated for livestock watering use
X = referenced stream segment is assigned the indicated designated use
O = referenced stream segment does not support the indicated designated use
blank = capacity of the referenced stream segment to support the indicated designated use has
not been determined by use attainability analysis
Br = branch
Cr = creek
Fk = fork
M = middle
R = river

| Lake Name | Project Name | Type | Class | AL | CR | DS | FP | GR | IW | IR |
|---|---|---|---|---|---|---|---|---|---|---|
| El Dorado Lake (Butler County) | LM033001 | L | GP | E | A | X | X | X | X | X |

**Abbreviations:**

HUC = hydrologic unit code

CLASS = antidegradation category

GP = general purpose waters

EX = exceptional state waters

ON = outstanding national resource waters

AL = designated for aquatic life use

S = special aquatic life use water

E = expected aquatic life use water

R = restricted aquatic life use water

CR = designated for contact recreational use

A = Primary contact recreation lakes that have a posted public swimming area

B = Primary contact recreation lakes that are by law or written permission of the landowner
  open to and accessible by the public

C = Primary contact recreation lakes that are not open to and accessible by the public under
  Kansas law

a = Secondary contact recreation lakes that are by law or written permission of the
  landowner open to and accessible by the public

b = Secondary contact recreation lakes that are not open to and accessible by the public
  under Kansas law

DS = designated for domestic water supply use

FP = designated for food procurement use

GR = designated for ground water recharge

IW = designated for industrial water supply use

IR = designated for irrigation use

LW = designated for livestock watering use

X = referenced lake is assigned the indicated designated use

O = referenced lake does not support the indicated designated use

blank = capacity of the referenced lake to support the indicated designated use has not been
  determined by use attainability analysis.

KWP = Kansas Wildlife and Parks

LK/ L = lake

NWR = National Wildlife Refuge

RES = reservoir

SFL = State Fishing Lake

W = wetland

W.A. = Wildlife Area

Kansas Department of
Health and Environment   KANSAS SURFACE WATER REGISTER   December 15, 2010

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# H. Explanation of Designated Uses and Relevance to the Plan

**Designated Uses – El Dorado Lake:** Primary and Secondary Contact Recreation; Expected Aquatic Life Support; Drinking Water; Industrial Water Supply Use; Food Procurement.

**Impaired Use (Eutrophication):** Primary and Secondary Contact Recreation; Expected Aquatic Life Support; Drinking Water; Industrial Water Supply Use; Food Procurement are all impaired to a degree by eutrophication.

Bioassays preformed by the Kansas Biological Survey indicate the lake is co-limited by phosphorus and nitrogen. The chlorophyll a to total phosphorus yield is low; the algal production is reduced because light cannot penetrate through the turbid water. The chlorophyll a levels will rise when the turbidity decreases and the Secchi disc depth increases, if current phosphorus and nitrogen levels in the lake are not reduced simultaneously. Because the nutrient concentrations in the lake are so elevated, algal blooms may form as the clarity improves even though measures are being taken to decrease the nutrient load. If the clarity (Secchi Disc Depth) of the lake does not improve, then a gradual decline in the chlorophyll a concentration will be seen.

**Impaired Use (Siltation):** Expected Aquatic Life Support and Primary and Secondary Contact Recreation are impaired by siltation.

Sediment accumulation in the lake reduces the reservoir volume and limits accessibility to portions of the lake which have silted in. Additionally, accumulated sediment contributes to recycling of nutrients within the lake. Surface water in El Dorado Lake has high turbidity and is dominated by inorganic materials because the lake receives a steady inflow of silt. Therefore, reduction of the sediment accumulation rate improves the quality of the lake and extends the utility as a water supply and recreation facility.

Aquatic life impacts are not expected to vary greatly unless large nutrient or sediment loadings occur.

**Designated Uses – Shady Creek, Bemis/Harrison Creek, Satchel Creek, Durechen Creek, Walnut River/School Branch and Cole Creek:** Primary and Secondary Contact Recreation; Expected Aquatic Life Support; Drinking Water; Industrial Water Supply Use; Food Procurement; Livestock Watering. Note: School Branch only supports Expected Aquatic Life Support, Secondary Contact Recreation and Livestock Watering.

**Impaired Use (Not Determined):** No data from KDHE is available on impaired uses of tributaries above El Dorado Lake; however, the water monitoring program through Butler Community College/Butler County Conservation District show fecal coliform bacteria counts as well as nutrients increasing in the tributaries above El Dorado Lake over the past few years. The SWAT Model provided through the US Army Corps of Engineer's Feasibility Study also indicates sediment and nutrients as targeted pollutants from upland sub-basins above El Dorado Lake.

This plan will directly address siltation, eutrophication and fecal coliform bacteria pollutants by implementing best management practices that reduce the impacts of these non-point source pollutants.

# I. Description of Impaired Streams and El Dorado Lake

**Impaired Waters - 303(d) Listed Waters**

Under section 303(d) of the 1972 Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. Impaired waters are those that do not meet water quality standards that have been set for them by states, territories, and authorized tribes, even after point sources of pollution have been controlled by the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop Total Maximum Daily Loads (TMDL) for these waters. A TMDL specifies the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and allocates pollutant loadings among point and nonpoint pollutant sources. By law, EPA must approve or disapprove lists and TMDLs established by states, territories, and authorized tribes.   In response, Kansas prepared lists of water quality impaired stream segments, wetlands, and lakes in 1994, 1996, 1998, 2002, 2004, 2008 and 2010.

There are no monitoring stations available on tributaries above El Dorado Lake; therefore, it is impossible to determine which streams are contributing to the sediment and eutrophication TMDL's in El Dorado Lake.  Consequently, there are no TMDLs or 303d impairments credited to those tributaries.

## J. Description and Map of Impaired Lake

According to the 303 (d) Report, aquatic life is impaired by eutrophication and water supply is impaired by siltation in El Dorado Lake, making them both high priorities for TMDL implementation.

Walnut Basin (HUC 110300170300)  2010 303(d) List of All Impaired/
Upper Walnut River  Potentially Impaired Waters

| Stream/Lake | Impaired Use | Impairment | Station | County | Body Type | Priority | Comment |
|---|---|---|---|---|---|---|---|
| El Dorado Lake | Aquatic Life | Eutrophication | LM033001 | BU | Lake | High | TMDL Approved on 9/30/2002 |
| El Dorado Lake | Water Supply | Siltation | LM033001 | BU | Lake | High | TMDL Approved on 9/30/2002 |

Thursday, September 23, 2010



Lakes and Wildlife Areas with TMDLs in the Walnut River Basin
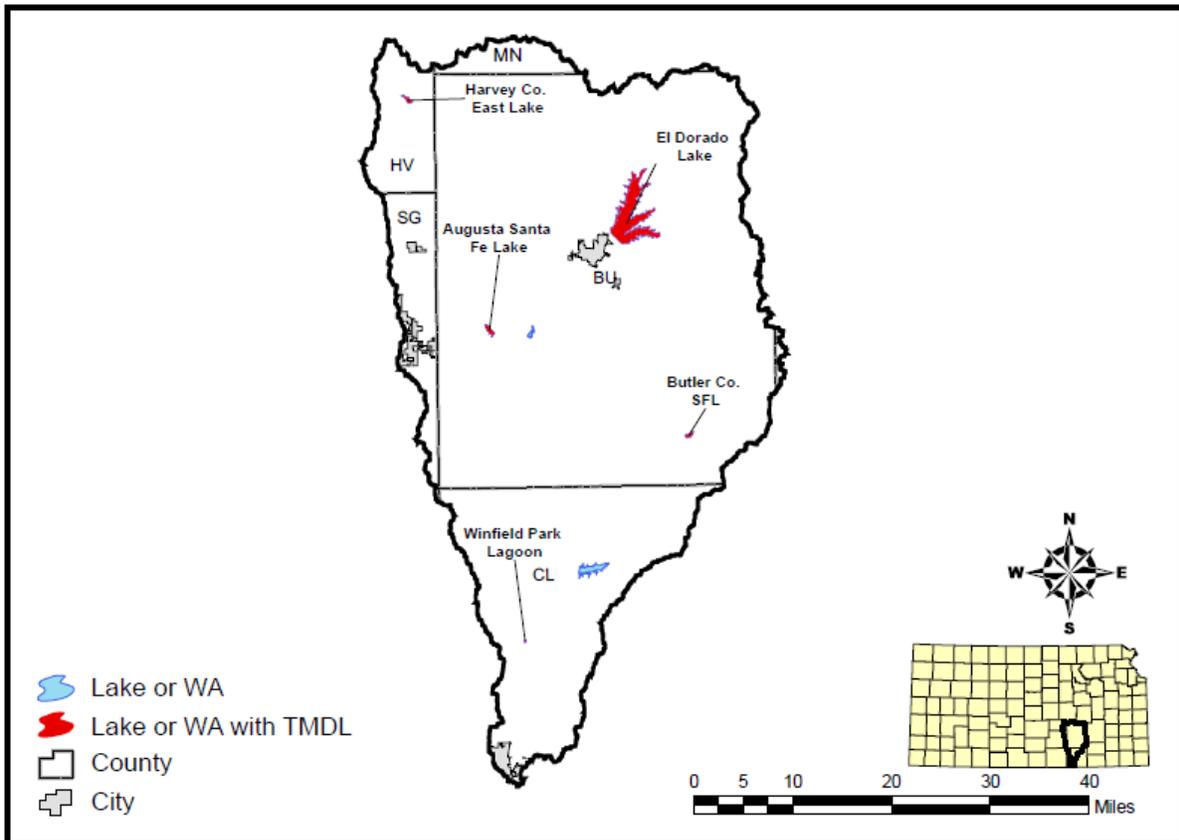
KDHE.BOW.WPS.051407

45

## K. Identification of TMDL's and High Priority Waters to be Directly Addressed in the Upper Walnut/El Dorado Lake Watershed

According to the Kansas Department of Health and Environmental (KDHE) Walnut River Basin TMDL report approved September 30, 2002, El Dorado Lake is classified as impaired for sedimentation and eutrophication. KDHE conducted five surveys during 1987 through 1999 and the Kansas Biological Survey conducted monthly surveys during 2000 at designated monitoring stations on El Dorado Lake. As of 2002, El Dorado Lake was argillotrophic with a chlorophyll a concentration of 3.45 ppb corresponding to a trophic state of 42.7. Sampling conducted by KDHE indicates total phosphorus concentrations increased during the survey period with light being the primary limiting factor due to high inorganic turbidity caused by the steady inflow of silt into the lake. Bioassays performed by the Kansas Biological Survey in 2000 indicate the lake is co-limited by phosphorus and nitrogen.



## KBS Sampling Sites on El Dorado Lake
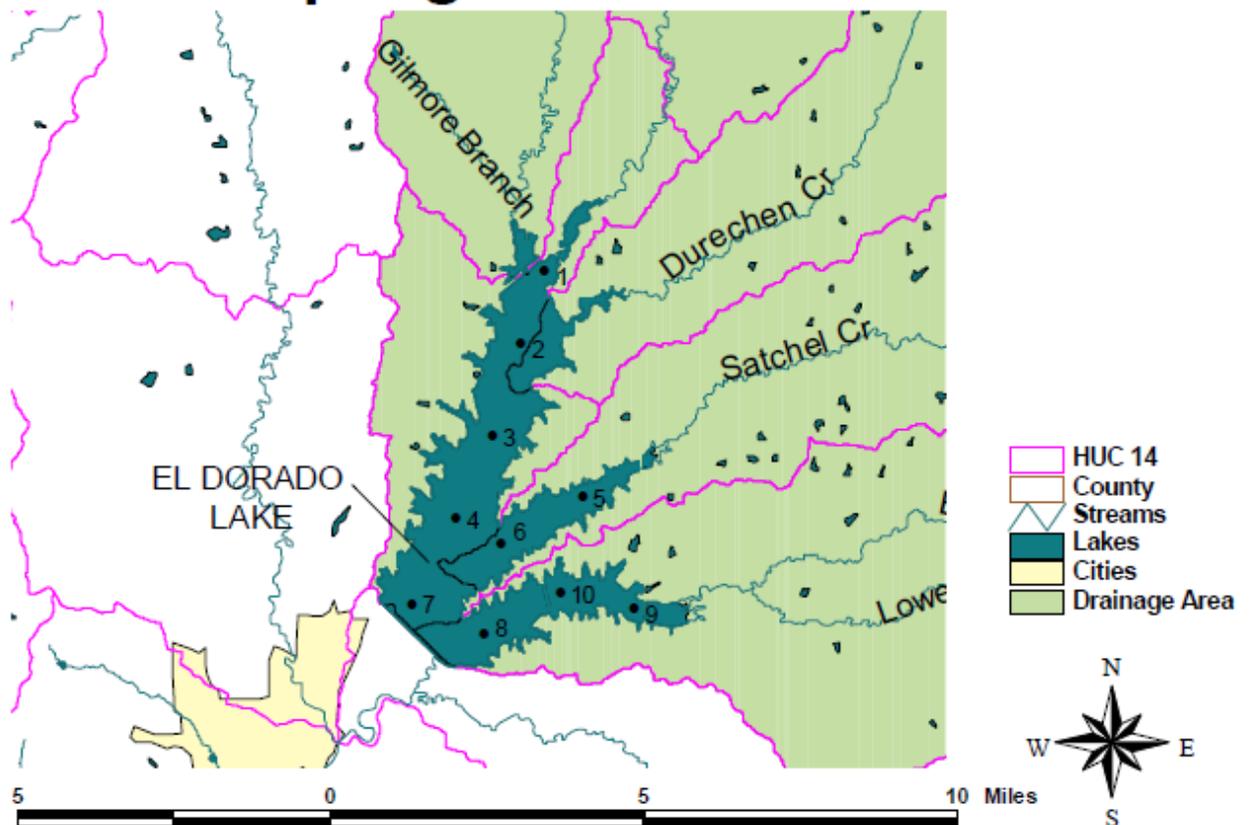
Sediment accumulation in the lake reduces the conservation storage for water supply and aquatic habitat and limits accessibility to portions of the lake which have silted in. Reservoir construction was completed in 1981 and had a conservation storage capacity of 163,929 acre-feet. A survey was taken of the lake bathymetry in 1989, indicating a conservation storage capacity of 161,929 acre-feet. The loss of 2,000 acre-feet of storage over 8 years represents an average annual loss of 250 acre-feet per year.

The Tulsa District of the Corps of Engineers indicates the sediment storage of the lake is 17,400 acre-feet, designed to be filled over 100 years. At the initial rate of sedimentation, the sediment storage will be filled in 70 years.

In 2008, TMDL's were reviewed. No revisions or changes were recommended because no improvement or further degradation of water quality had occurred; therefore, sedimentation and eutrophication remain high priorities in the Upper Walnut/El Dorado Lake Watershed.

The water monitoring program through Butler Community College/Butler County Conservation District show fecal coliform bacteria counts as well as nutrients increasing in the tributaries above El Dorado Lake over the past few years. The SWAT Model provided through the US Army Corps of Engineer's Feasibility Study also indicates sediment and nutrients as targeted pollutants from upland sub-basins above El Dorado Lake.

See Appendix C for the complete TMDL report from KDHE.

## Prioritization

Assessments mentioned in Section E above are the basis for prioritization in addressing erosion, sediment and eutrophication issues in the Upper Walnut Watershed.

The Kansas Water Office's Streambank Erosion Assessment shows the 15 sites studied in that assessment are transporting 740 tons of sediment downstream per year; accounting for roughly 0.47 acre-feet per year of sediment accumulation in El Dorado Lake each year. The study concluded that it is probable that high flow event runoffs from rangelands and agricultural lands via ephemeral gullies, and bridge crossings that are continually undercut by high flow events could be contributing to the sedimentation rate and this is verified by landowner contacts as well as from observation of aerial photographs and personal visits. The SLT also identified PL566 and State Funded Watershed Dams constructed through organized watershed districts as also contributing to an increase in streambank erosion below these dams.

The Innovative Green Project Proposal also confirms the need for streambank restoration measures to reduce erosion coming from unstable stream banks and decrease sediment load in El Dorado Lake. The primary water quality benefit to be achieved through this project was the reduction of sediment in El Dorado Lake with a secondary benefit of reducing nutrients (eutrophication). Long term benefits included extending the useable life of El Dorado Lake and reducing water treatment costs.

The Kansas Rural Center's River Friendly Farm Environmental Assessment also validates the Kansas Water Office Assessment. Our field visits around the watershed listening to landowner concerns and seeing the effects of erosion first hand has confirmed for us; gully erosion and stream bank erosion continue to be key issues for landowners and definite contributors to sediment loading in Upper Walnut streams and El Dorado Lake.

Soil erosion is the most mentioned issue landowners deal with.  Soil erosion is not only a factor in crop fields but native grass pastures as well.  Erosion in native grass pastures is not something we have addressed much in the past but should be looked at more closely in the future.

Finally, the Corps Feasibility Study provided us with a SWAT model to help target those areas where best management practices should be implemented to do the most good in reducing sediment and nutrients from entering El Dorado Lake.

To identify high priority areas for BMP implementation, data was gleaned from the *Walnut River Basin, Kansas - Feasibility Report – El Dorado Lake, Kansas - Watershed Management Plan – January 2007.*  Information was also used from the Butler Community College/Butler County Conservation District Water Monitoring Program.

Prioritization was determined using data from the Feasibility Study:

Sub-basins were prioritized using Tables 18, 19 and 21 from the Feasibility Study SWAT model. Table 18 refers to average annual sediment and nutrient loads; Table 19 refers to distribution of estimated annual upland sediment loads within tributary arms; Table 21 refers to estimates of annual average contributions of sediment loads to El Dorado Lake from upland and channel sources.  From each table, sub-basins were ranked based upon highest sediment loss and highest nutrient loading for each pollutant.  Those sub-basins that ranked highest in all 3 categories (based upon the tables) are considered highest priority followed by sub-basins placing in 2 categories and then those sub-basins that placed in 1 category.

The SWAT model divided the watershed into 51 sub-basins.  Using the data from Tables 18, 19 and 21, the sub-basins were further prioritized based upon the highest contribution of pollutants in tons/yr of sediment or kg/ha of nitrogen, nitrate and phosphorus.  This ranking is identified on the map as P1, P2, etc.

## L. Map of TMDL's/HP Waters in the Upper Walnut Watershed to be Directly Addressed by the Plan

### Sub-watersheds in the Upper Walnut/El Dorado Lake Watershed

Below is a base map showing the Upper Walnut/El Dorado Lake area sub-basins used in the Feasibility Study.  The next color coded map highlights sub-basins which are high priority followed by the second and third priorities.  Corresponding data from the Feasibility Study is highlighted in yellow in the pages that follow the maps for each pollutant.

For the sediment TMDL, sub-basins 7, 9, 10, 11, 13, 14, 15, 18, 19, 22, 23, 24, 25, 27, 29, 30, 31, 32, 33, 35, 36, 39, 40, 43, 44, 47, 48, 49, 50 and 51 are priority areas for best management practices.

For the eutrophication TMDL, sub-basins 7, 13, 14, 18, 23, 24, 28, 29, 32, 35, 40, 43, 44, 45, 48, 50 and 51 are the priority areas for best management practices.
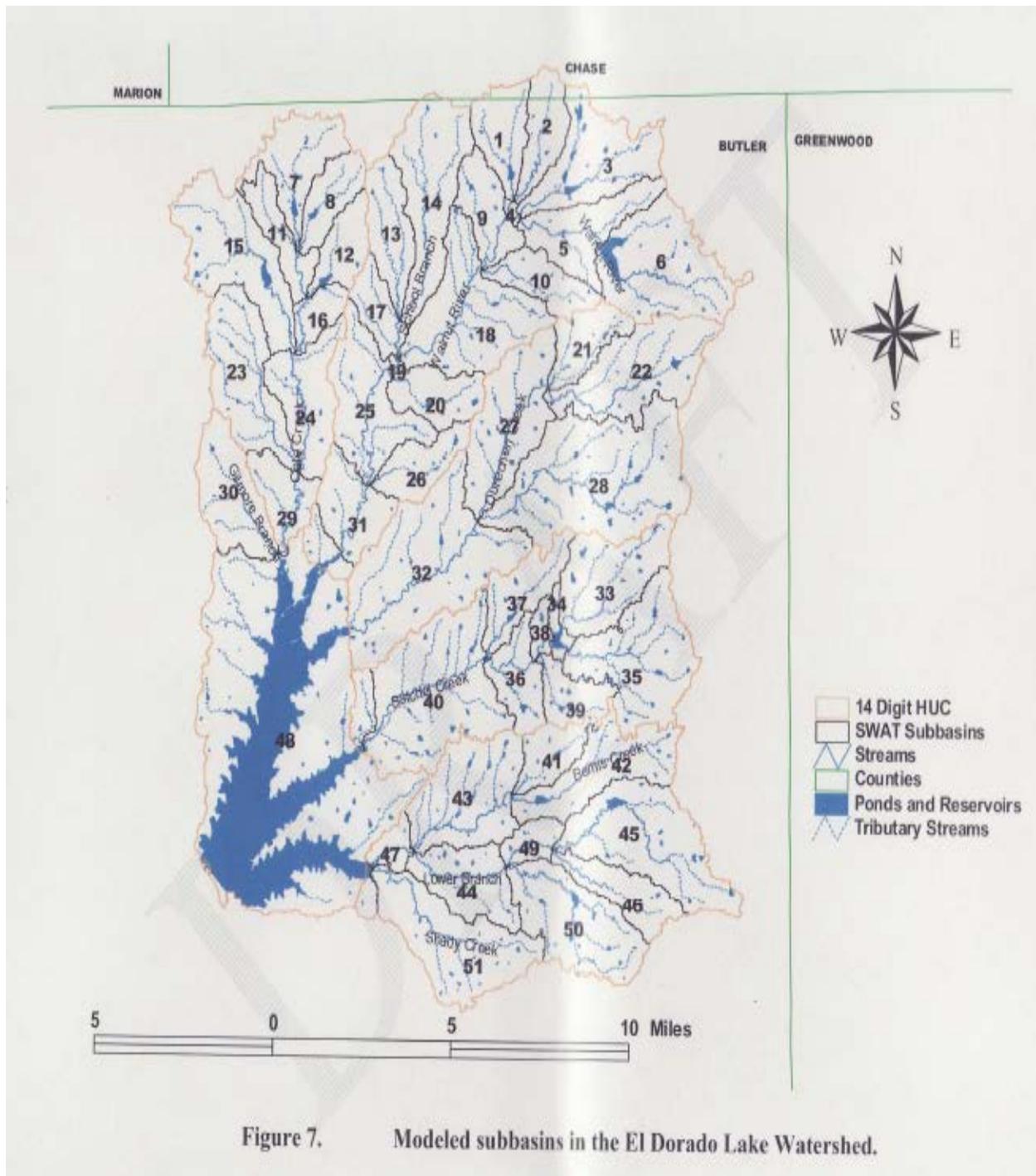
Figure 7.    Modeled subbasins in the El Dorado Lake Watershed.
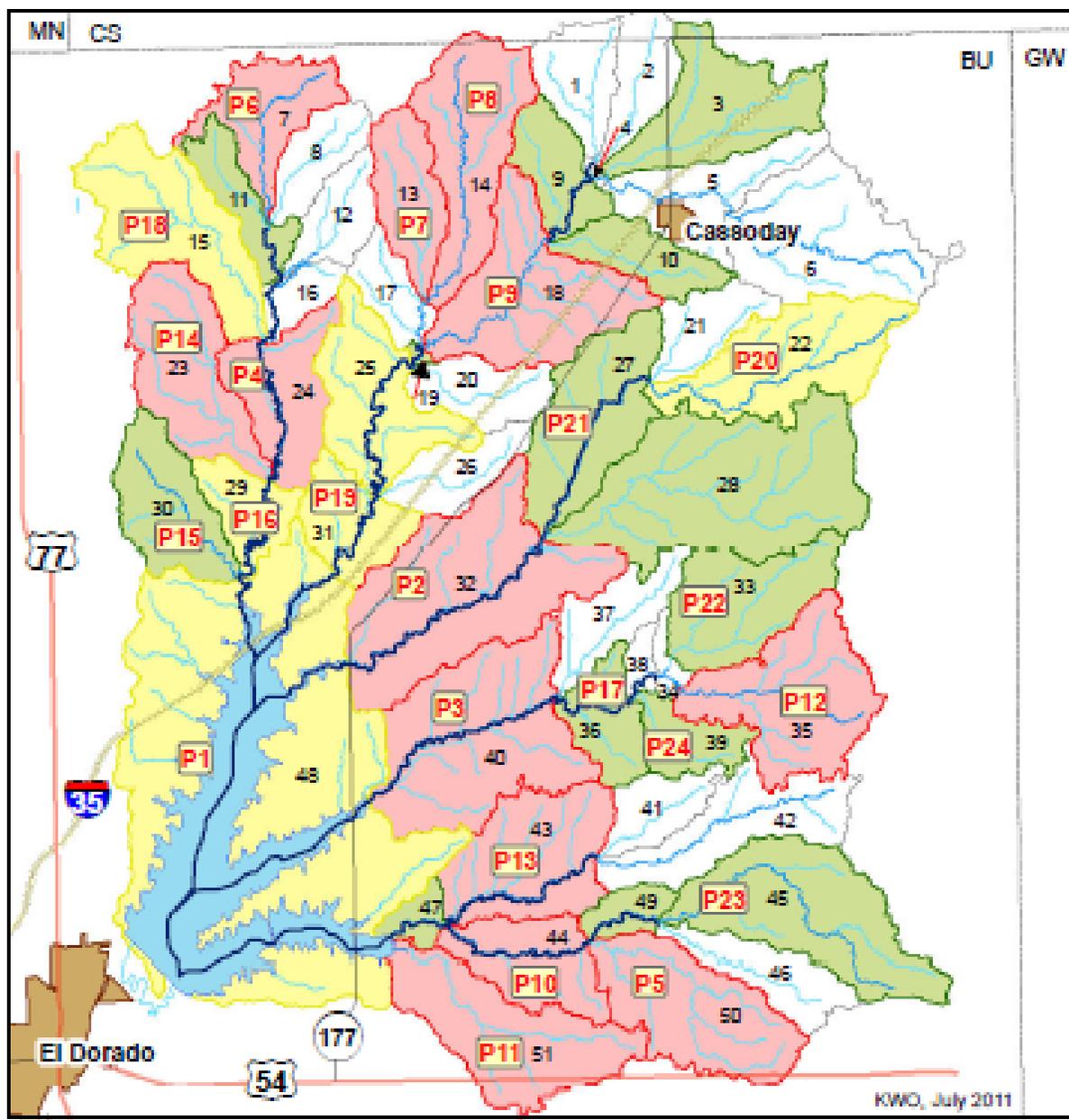
El Dorado WRAPS Sub-basin Priority Ranking. KWO, July 2011
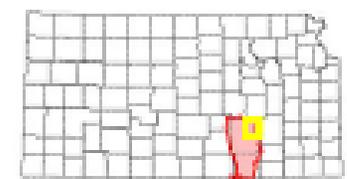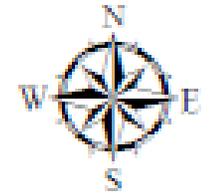
**Table 18.** Model predicted average annual sediment and nutrient loads for the El Dorado Lake Watershed by subbasin.

| Tributary Arm | Subbasin # | Area ha | Runoff m³/yr | Sediment t/ha | Org. N kg/ha | Org. P kg/ha | Sed. P kg/ha | Nitrate kg/ha | Sol. P kg/ha |
|---|---|---|---|---|---|---|---|---|---|
| WR | 1 | 713.79 | 10,430 | 81 | 305 | 39 | 9 | 476 | 2 |
| WR | 2 | 667.16 | 9,080 | 90 | 391 | 62 | 14 | 597 | 7 |
| WR | 3 | 1,442.52 | 21,410 | 360 | 1,215 | 193 | 59 | 971 | 13 |
| WR | 4 | 42.94 | 390 | 33 | 143 | 24 | 8 | 31 | 1 |
| WR | 5 | 1,031.58 | 14,960 | 263 | 913 | 156 | 44 | 941 | 17 |
| WR | 6 | 1,879.47 | 27,390 | 125 | 563 | 83 | 14 | 1,718 | 12 |
| CC | 7 | 961.65 | 17,110 | 520 | 1,921 | 279 | 98 | 899 | 15 |
| CC | 8 | 570.95 | 9,890 | 145 | 592 | 86 | 22 | 575 | 5 |
| WR | 9 | 691.84 | 8,020 | 364 | 1,348 | 223 | 75 | 541 | 13 |
| WR | 10 | 664.30 | 9,340 | 344 | 1,161 | 203 | 67 | 632 | 10 |
| CC | 11 | 573.84 | 9,440 | 234 | 948 | 156 | 48 | 734 | 13 |
| CC | 12 | 563.31 | 8,610 | 62 | 301 | 39 | 5 | 463 | 3 |
| WR | 13 | 821.17 | 9,560 | 879 | 3,253 | 542 | 180 | 699 | 13 |
| WR | 14 | 1,610.24 | 18,860 | 577 | 2,320 | 387 | 124 | 1,314 | 24 |
| CC | 15 | 1,695.14 | 29,490 | 471 | 1,738 | 260 | 73 | 1,554 | 13 |
| CC | 16 | 354.15 | 5,390 | 227 | 844 | 135 | 41 | 401 | 6 |
| WR | 17 | 486.99 | 5,620 | 271 | 929 | 159 | 53 | 423 | 6 |
| WR | 18 | 1,917.61 | 22,030 | 1,074 | 3,768 | 634 | 225 | 1,413 | 24 |
| WR | 19 | 37.27 | 230 | 34 | 131 | 21 | 8 | 17 | 1 |
| WR | 20 | 707.84 | 10,540 | 95 | 347 | 56 | 14 | 567 | 5 |
| DC | 21 | 637.56 | 9,430 | 80 | 330 | 54 | 14 | 619 | 11 |
| DC | 22 | 1,686.22 | 25,460 | 327 | 1,232 | 203 | 61 | 1,531 | 19 |
| CC | 23 | 1,488.96 | 27,860 | 397 | 1,547 | 249 | 67 | 1,817 | 17 |
| CC | 24 | 1,095.58 | 14,950 | 1,081 | 3,613 | 616 | 204 | 1,201 | 29 |
| WR | 25 | 1,420.73 | 14,490 | 364 | 1,347 | 218 | 69 | 940 | 12 |
| WR | 26 | 662.31 | 10,130 | 140 | 458 | 76 | 20 | 523 | 6 |
| DC | 27 | 1,558.70 | 20,970 | 251 | 1,002 | 154 | 42 | 1,118 | 13 |
| DC | 28 | 3,148.78 | 44,230 | 174 | 722 | 103 | 18 | 2,348 | 22 |
| CC | 29 | 631.81 | 8,060 | 149 | 600 | 99 | 29 | 615 | 20 |
| CC | 30 | 1,129.33 | 19,180 | 285 | 1,082 | 172 | 43 | 1,398 | 19 |
| WR | 31 | 837.55 | 8,700 | 379 | 1,508 | 250 | 82 | 615 | 12 |
| DC | 32 | 2,937.98 | 38,760 | 2,062 | 6,188 | 1,066 | 337 | 2,502 | 32 |
| SC | 33 | 1,340.56 | 18,440 | 252 | 920 | 150 | 40 | 1,144 | 12 |
| SC | 34 | 158.76 | 2,520 | 22 | 91 | 13 | 2 | 149 | 1 |
| SC | 35 | 1,837.79 | 29,870 | 335 | 1,351 | 219 | 50 | 1,954 | 27 |
| SC | 36 | 665.08 | 10,460 | 112 | 476 | 72 | 15 | 639 | 7 |
| SC | 37 | 771.75 | 11,780 | 61 | 251 | 36 | 6 | 661 | 5 |
| SC | 38 | 164.98 | 2,860 | 24 | 105 | 15 | 2 | 171 | 1 |
| SC | 39 | 536.75 | 8,890 | 122 | 488 | 81 | 22 | 533 | 10 |
| SC | 40 | 2,566.17 | 41,180 | 892 | 2,930 | 484 | 134 | 2,293 | 36 |
| BC | 41 | 554.58 | 8,910 | 54 | 247 | 40 | 9 | 568 | 14 |
| BC | 42 | 1,318.78 | 20,640 | 84 | 341 | 44 | 7 | 986 | 11 |
| BC | 43 | 1,604.61 | 27,060 | 324 | 1,184 | 188 | 45 | 1,581 | 21 |
| BC | 44 | 992.42 | 15,610 | 485 | 1,693 | 280 | 82 | 825 | 15 |
| BC | 45 | 2,031.20 | 30,760 | 140 | 657 | 89 | 11 | 1,660 | 14 |
| BC | 46 | 751.59 | 11,900 | 62 | 404 | 61 | 8 | 828 | 13 |
| BC | 47 | 259.92 | 3,090 | 117 | 447 | 73 | 21 | 203 | 4 |
| ED | 48 | 9,526.68 | 98,160 | 2,555 | 9,603 | 1,574 | 418 | 7,036 | 106 |
| BC | 49 | 326.86 | 4,250 | 116 | 409 | 70 | 22 | 256 | 6 |
| BC | 50 | 1,649.53 | 27,370 | 539 | 1,853 | 293 | 83 | 1,220 | 24 |
| BC | 51 | 1,801.52 | 31,500 | 804 | 2,613 | 448 | 134 | 1,954 | 37 |

**Table 19.**     Distribution of estimated average annual upland sediment loads within tributary arms and the full El Dorado Lake Watershed.

| Tributary Arm | Subbasin # | Sediment t/yr | Tributary Arm Total | % Tributary Arm Total | % Watershed Total | % Watershed From Tributary Arm | |
|---|---|---|---|---|---|---|---|
| Bemis Creek | 41 | 54.3 | 2,726.0 | 1.99% | 0.29% | 14.32% | |
| | 42 | 84.4 | | 3.10% | 0.44% | | # 4 Rank |
| | 43 | 324.1 | | 11.89% | 1.70% | | |
| | 44 | 485.3 | | 17.80% | 2.55% | | |
| | 45 | 140.2 | | 5.14% | 0.74% | | |
| | 46 | 62.4 | | 2.29% | 0.33% | | |
| | 47 | 116.4 | | 4.27% | 0.61% | | |
| | 49 | 116.0 | | 4.26% | 0.61% | | |
| | 50 | 539.4 | | 19.79% | 2.83% | | |
| | 51 | 803.5 | | 29.47% | 4.22% | | |
| Cole Creek | 7 | 520.3 | 3,570.8 | 14.57% | 2.73% | 18.76% | |
| | 8 | 144.5 | | 4.05% | 0.76% | | # 2 Rank |
| | 11 | 234.7 | | 6.57% | 1.23% | | |
| | 12 | 62.0 | | 1.74% | 0.33% | | |
| | 15 | 471.2 | | 13.20% | 2.48% | | |
| | 16 | 227.0 | | 6.36% | 1.19% | | |
| | 23 | 396.1 | | 11.09% | 2.08% | | |
| | 24 | 1,080.3 | | 30.25% | 5.67% | | |
| | 29 | 149.1 | | 4.18% | 0.78% | | |
| | 30 | 285.7 | | 8.00% | 1.50% | | |
| Durechen Creek | 21 | 80.3 | 2,895.8 | 2.77% | 0.42% | 15.21% | |
| | 22 | 328.8 | | 11.35% | 1.73% | | # 3 Rank |
| | 27 | 251.0 | | 8.67% | 1.32% | | |
| | 28 | 173.2 | | 5.98% | 0.91% | | |
| | 32 | 2,062.5 | | 71.22% | 10.83% | | |
| El Dorado Lake | 48 | 2,553.1 | 2,553.1 | 100.00% | 13.41% | 13.41% | # 5 Rank |
| Satchel Creek | 33 | 252.0 | 1,820.1 | 13.85% | 1.32% | 9.56% | |
| | 34 | 22.2 | | 1.22% | 0.12% | | # 6 Rank |
| | 35 | 334.5 | | 18.38% | 1.76% | | |
| | 36 | 112.4 | | 6.18% | 0.59% | | |
| | 37 | 60.2 | | 3.31% | 0.32% | | |
| | 38 | 23.9 | | 1.31% | 0.13% | | |
| | 39 | 121.8 | | 6.69% | 0.64% | | |
| | 40 | 893.0 | | 49.06% | 4.69% | | |
| Walnut River | 1 | 80.7 | 5,473.0 | 1.47% | 0.42% | 28.75% | |
| | 2 | 90.1 | | 1.65% | 0.47% | | # 1 Rank |
| | 3 | 359.2 | | 6.56% | 1.89% | | |
| | 4 | 33.4 | | 0.61% | 0.18% | | |
| | 5 | 263.1 | | 4.81% | 1.38% | | |
| | 6 | 125.9 | | 2.30% | 0.66% | | |
| | 9 | 363.9 | | 6.65% | 1.91% | | |
| | 10 | 344.1 | | 6.29% | 1.81% | | |
| | 13 | 879.5 | | 16.07% | 4.62% | | |
| | 14 | 576.5 | | 10.53% | 3.03% | | |
| | 17 | 271.2 | | 4.96% | 1.42% | | |
| | 18 | 1,073.9 | | 19.62% | 5.64% | | |
| | 19 | 34.1 | | 0.62% | 0.18% | | |
| | 20 | 95.6 | | 1.75% | 0.50% | | |
| | 25 | 363.7 | | 6.65% | 1.91% | | |
| | 26 | 139.7 | | 2.55% | 0.73% | | |
| | 31 | 378.6 | | 6.92% | 1.99% | | |
| **Totals** | | 19,039 | 19,039 | | 100% | 100% | |

**Table 21.** Estimates of annual average contributions of sediment loads to El Dorado Lake from upland and channel sources by modeled subbasin/reach.

| Tributary Arm | Subbasin/ Reach # | Upland Sediment t/yr | Channel Sediment t/yr | Tributary Arm Total t/yr | % Lake Input from Tributary Arm |
|---|---|---|---|---|---|
| Bemis Creek | 41 | 54 | 0 | 21,633 | 14.5% #3 Rank |
| | 42 | 84 | 0 | | |
| | 43 | 324 | 1,855 | | |
| | 44 | 485 | 3,254 | | |
| | 45 | 140 | 0 | | |
| | 46 | 62 | 0 | | |
| | 47 | 116 | 10,901 | | |
| | 49 | 116 | 2,899 | | |
| | 50 | 539 | 0 | | |
| | 51 | 803 | 0 | | |
| Cole Creek | 7 | 520 | 0 | 17,096 | 11.4% #4 Rank |
| | 8 | 144 | 0 | | |
| | 11 | 235 | 2,754 | | |
| | 12 | 62 | 0 | | |
| | 15 | 471 | 0 | | |
| | 16 | 227 | 2,381 | | |
| | 23 | 396 | 0 | | |
| | 24 | 1,080 | 3,146 | | |
| | 29 | 149 | 5,240 | | |
| | 30 | 286 | 0 | | |
| Durechen Creek | 21 | 80 | 0 | 9,212 | 6.2% #6 Rank |
| | 22 | 329 | 0 | | |
| | 27 | 251 | 2,154 | | |
| | 28 | 173 | 0 | | |
| | 32 | 2,062 | 4,163 | | |
| El Dorado Lake | 48 | 2,553 | 26,676 | 29,229 | 19.5% #2 Rank |
| Satchel Creek | 33 | 252 | 0 | 16,190 | 10.8% #5 Rank |
| | 34 | 22 | -1,337 | | |
| | 35 | 334 | 0 | | |
| | 36 | 112 | 3,514 | | |
| | 37 | 60 | 0 | | |
| | 38 | 24 | 7,286 | | |
| | 39 | 122 | 0 | | |
| | 40 | 893 | 4,907 | | |
| Walnut River | 1 | 81 | 0 | 56,340 | 37.6% #1 Rank |
| | 2 | 90 | 0 | | |
| | 3 | 359 | 0 | | |
| | 4 | 33 | 10,173 | | |
| | 5 | 263 | 1,922 | | |
| | 6 | 126 | 0 | | |
| | 9 | 364 | 4,100 | | |
| | 10 | 344 | 0 | | |
| | 13 | 879 | 0 | | |
| | 14 | 576 | 0 | | |
| | 17 | 271 | 2,067 | | |
| | 18 | 1,074 | 3,130 | | |
| | 19 | 34 | 17,000 | | |
| | 20 | 96 | 0 | | |
| | 25 | 364 | 3,960 | | |
| | 26 | 140 | 0 | | |
| | 31 | 379 | 8,530 | | |
| **Totals** | | 19,039 | 130,661 | 149,700 | 100% |

## Fecal Coliform Bacteria (Data from Butler CC/BCCD Water Monitoring Program)

Fecal Coliform bacteria found in the water are serious since fecal coliform bacteria are considered an indicator of the level of pathogenic (disease causing) bacteria in the water.

The water monitoring program through Butler Community College/Butler County Conservation District shows bacteria counts increasing over the past few years. The increase may be due to more cattle in the area, manure being spread in different areas or at increased application rates or possibly an increase in rainfall amounts during peak cattle grazing season.

Tributaries affected by fecal coliform bacteria include:
> Shady Creek
> Bemis Creek/Harrison Creek
> Satchel Creek
> Durechen Creek
> Walnut River/School Branch
> Cole Creek/Gilmore Branch
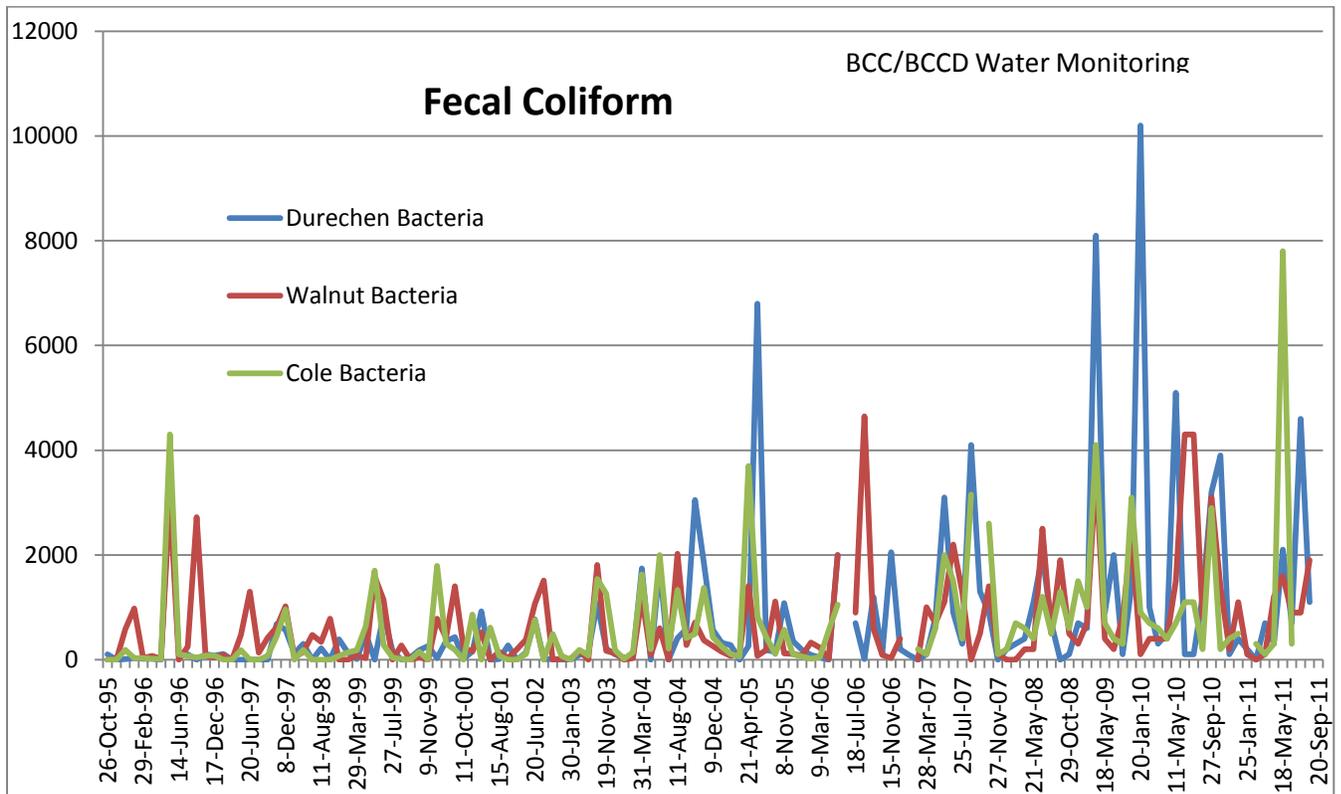
## M. Description of NPDES, Point and Non-Point Source (NPS) Pollution Sources Applicable to the Selected TMDL's/High Priority Waters and Determination of BMP Needs Within Watersheds of Priority Waters

### National Pollutant Discharge Elimination Systems (NPDES)

Seven NPDES permitted facilities are located in the Upper Walnut Watershed. Three are non-overflowing lagoons for the City of Cassoday, Butler Rural Sewer District #9 (Rosalia) and Sewer District #16. Four others are located around El Dorado Lake and are managed by Kansas Department of Wildlife and Parks. These sites are used mainly during spring, summer and fall with peak use during the summer months and holidays.



El Dorado Lake WRAPS NPDES Facilities
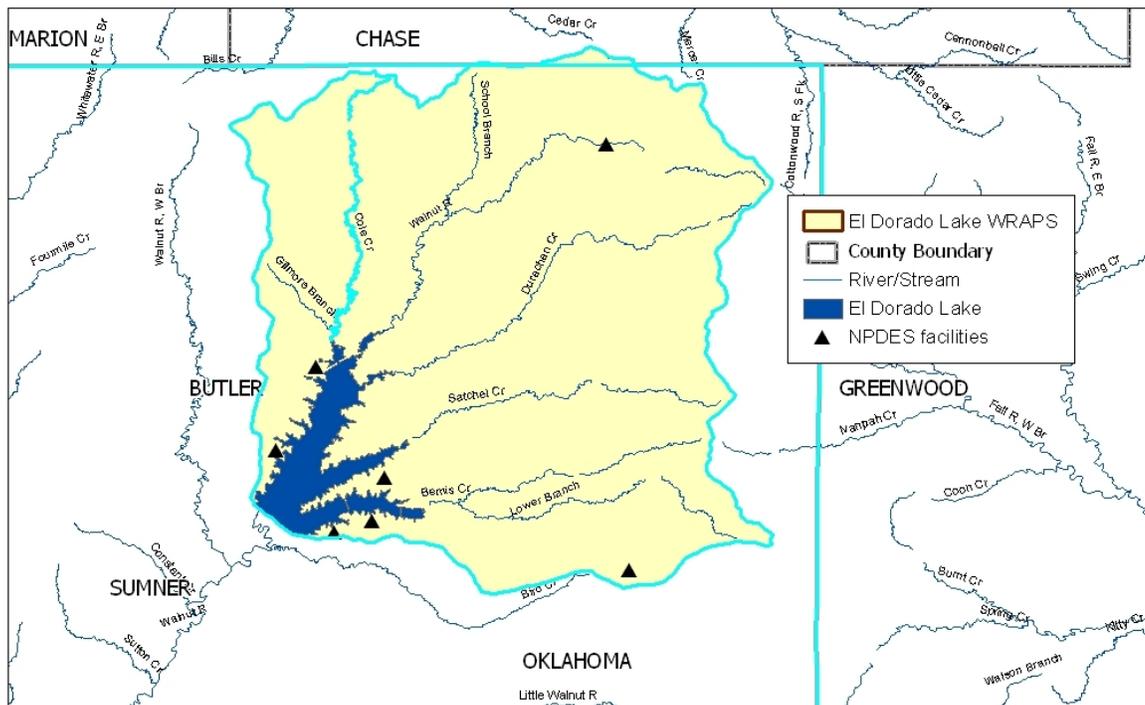
The purpose of this publication is to illustrate general watershed conditions in the state of Kansas. This map product is provided without representation or implied or expressed warranty of accuracy and is intended for watershed planning purposes only. The originating agency is not responsible for publication or use of this product for any other purpose. This product may be corrected or updated as necessary without prior notification.

January 2012

## Point Sources

Point sources of pollution fall under different permitting requirements and regulations. Livestock facilities of 1,000 animal units or more, known as Confined Animal Feeding Operations (CAFOs), must obtain an NPDES Livestock Waste Management Permit and then are federally regulated. Those sources will not be addressed with this plan.

## Non Point Sources

Anything that does not require a federal permit to discharge is considered a Nonpoint Source (as defined in the Kansas Surface Water Quality Standards K.A.R. 28-16-28 (oo)). The following categories fall under Non-Point Sources and will be addressed in this plan:

### 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 the Kansas Department of Health and Environment (KDHE). Any facility, no matter what animal capacity, is required to register if KDHE investigates them due to a complaint and the facility is found to pose a significant pollution potential. Facilities which register with KDHE will be site-inspected for significant pollution potential. If facility is found to not be a significant pollution potential by KDHE, they can be certified if they follow management practices recommended and approved by KDHE. These include but are not limited to: regular cleaning of stalls, managing manure storage areas, etc. Facilities with 300 animal units up to 999 (known as Confined Feeding Facilities (CFFs) identified with a significant pollution potential must obtain a State of Kansas Livestock Waste Management Permit. Operations with a daily discharge, such as a dairy operation that generate an outflow from the milking barn on a daily basis, are required to have a permit.

There are two confined livestock facilities located in the Upper Walnut Watershed; a certified beef facility on Cole Creek and a state permitted hog facility on Durechen Creek. There are no dairies in the Upper Walnut Watershed.

# El Dorado Lake WRAPS
## Active CAFOs
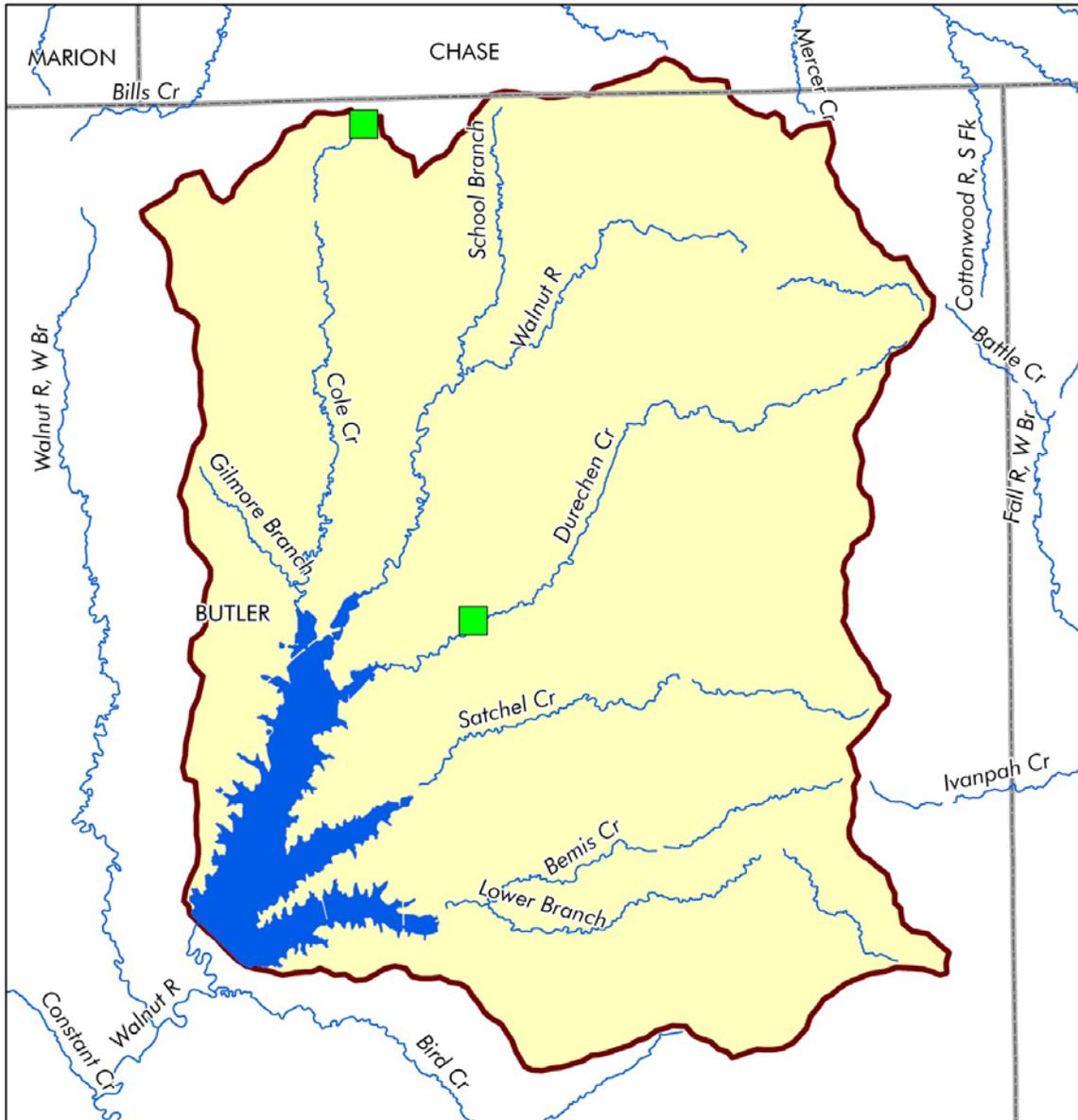


The purpose of this publication is to illustrate general watershed conditions in the state of Kansas. This map product is provided without representation or implied or expressed warranty of accuracy and is intended for watershed planning purposes only. The originating agency is not responsible for publication or use of this product for any other purpose. This product may be corrected or updated as necessary without prior notification.

Kansas
Department of Health
and Environment
June 2011

**Unconfined Concentrated Animal Areas**

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

## Determination of BMP Needs Within Watersheds of Priority Waters

### Eutrophication *(From the KDHE TMDL Report, Walnut Basin, El Dorado Lake)*
**Desired Implementation Activities:**

There is a very good potential that agricultural best management practices will allow full use support to take place in El Dorado Lake. Some of the recommended agricultural practices are:

    a. Nutrient management – crop fields, rangeland and riparian areas.
    b. Apply conservation farming practices, including terraces and waterways, sediment control   basins, and constructed wetlands.
    c. Provide sediment control practices to minimize erosion and sediment and nutrient transport.
    d. Implement soil sampling to recommend appropriate fertilizer applications on cropland
    e. Maintain conservation tillage and contour farming to minimize cropland erosion.
    f. Establish or re-establish natural riparian systems, including vegetative filter strips and streambank vegetation.
    g. Develop riparian restoration projects.
    h. Reduce activities within riparian areas.
    i. Promote wetland construction to assimilate nutrient loadings.
    j. Install grass buffer strips near streams.
    k. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

### Sediment *(From the KDHE TMDL Report, Walnut Basin, El Dorado Lake)*
**Desired Implementation Activities:**

There is a very good potential that agricultural best management practices will improve the water quality in El Dorado Lake. Some of the recommended agricultural practices are:

    a. Maintain conservation tillage and contour farming to minimize cropland erosion.
    b. Install grass buffer strips along streams.
    c. Reduce activities within riparian areas.
    d. Nutrient management - crop fields, rangeland and riparian areas.

    e.   Apply conservation farming practices, including terraces and waterways, sediment control basins and constructed wetlands.

    f.   Provide sediment control practices to minimize erosion and sediment and nutrient transport.

    g.   Establish or reestablish natural riparian systems, including vegetative filter strips and streambank vegetation.

    h.   Develop riparian restoration projects.

    i.   Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

**Fecal Coliform Bacteria** *(From Stakeholder Leadership Team)*

**Desired Implementation Activities:**

Activities to reduce fecal pollution should be directed toward the smaller, unpermitted livestock operations and rural homesteads and farmsteads along the tributaries above El Dorado Lake.

Implementation of non-point source pollution control practices should be taken within one mile of the listed stream segments.

## N. NPS Load Reduction Targets to Meet Water Quality Goals for Each Selected TMDL or High Priority Water

## Eutrophication - Allocation of Pollutant Reduction Responsibility

*From the (KDHE) Walnut River Basin TMDL report:* While light is the limiting factor in El Dorado Lake, Total Phosphorus is allocated under this TMDL because a phosphorus reduction will have a large effect on managing the algal community. The Load Capacity is 70,798 pounds per year of phosphorus and was calculated using the CNET model. Because of atmospheric deposition, initial allocations of nitrogen will be based on a proportional decrease in nitrogen between the current condition and the desired endpoint. The assessment suggests that cropland and animal waste contribute to the elevated total phosphorus concentrations in the lake. Generally, a Load Allocation of 63,718 pounds of total phosphorus per year, leading to an 80.8% reduction, is necessary to reach the endpoint. A proportional decrease of 6% in nitrogen loading will allow the total nitrogen endpoint to be achieved. The margin of safety will be 7,080 pounds per year of total phosphorus taken from the load capacity subtracted to compensate for the lack of knowledge about the relationship between the allocated loadings and the resulting water quality.

Phosphorus
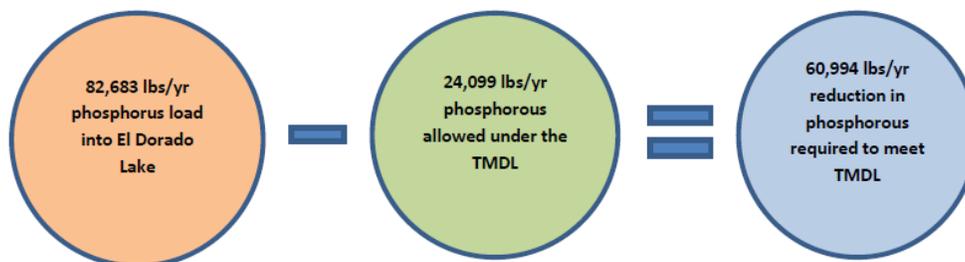


Total Phosphorus reduction in El Dorado Lake
(KDHE, 2002, El Dorado Lake Eutrophication TMDL)

|  | Total Phosphorus (lb/year) |
|---|---|
| 2011 CNET Re-Model with '02 TMDL Data | |
| Current Condition | 82,683 |
| Load Allocation | 21,689 |
| Margin of Safety | 2,410 |
| TMDL | 24,099 |
| Reduction Needed | 60,994 |
| Percent Reduction Needed | 73.80% |

## Sedimentation - Allocation of Pollutant Reduction Responsibility

From the (KDHE) Walnut River Basin TMDL report:   The goal of this TMDL is to reduce the current sedimentation rate to its original design rate, and therefore the Load Capacity of El Dorado Lake, will be reduced from 250 acre-feet per year to 174 acre-feet. Assuming a bulk density of the sediment of 58 pounds per cubic foot, the load capacity is about 220,000 tons per year. Siltation loading comes predominantly from nonpoint sources. Given the runoff characteristics of the watershed, overland runoff can easily carry sediment into the lake. The Load Allocation will be set at 220,000 tons per year, a 30 percent reduction from the initial sediment loading seen between 1981-1989.

Sediment



Sediment reduction in El Dorado Lake
(KDHE, 2002, El Dorado Lake Siltation TMDL)

|  | Sediment (ton/year) |
|---|---|
| Current Condition | 315,767 |
| Load Allocation | 220,000 |
| Margin of Safety | Implicit |
| TMDL | 220,000 |
| Reduction Needed | 95,767 |
| Percent Reduction Needed | 30% |

It can be anticipated that reduction in sediment loading to the lake will be most prevalent during the spring runoff events. This endpoint can be reached as a result of expected reductions in loading from the various sources in the watershed resulting from implementation of corrective actions and Best Management Practices, as directed by this TMDL.  Because of the unknown relationship between actual sediment loading and resulting in-lake water clarity and because the annual loading rate will vary greatly over time, the Margin of Safety will be implicit based on the assumption that watershed treatment will effect a 30% reduction over the long term, but will be more effective during the moderate or low rainfall years and this should offset the occasional major runoff event.

## Fecal Coliform Bacteria - Allocation of Pollutant Reduction Responsibility

Fecal coliform bacteria has been identified by the Butler Community College/Butler County Conservation District Water Monitoring Program as a pollutant in the tributaries above El Dorado Lake. Although no TMDL or pollutant reduction has been established for fecal coliform bacteria specifically, the best management practices used for eutrophication will also reduce fecal coliform bacteria counts.

## O. Identification and Justification of Priority Sub-Basins in HUC 12s (w/map) for Focused BMP Implementation to Address El Dorado Lake TMDL.

According to the map on page 65, sub-basins colored in pink are 1st priority, in yellow, second priority and in green third priority (from the US Army Corps of Engineers Feasibility Study partially funded by Kansas Water Office). Therefore in this plan, the pink colored sub-basins will be the top priority sub-basins. Efforts to implement BMPs in these areas will be exhausted at which point the yellow colored sub-basins will become the focus of BMP implementation. And finally the last years of the plan will be spent implementing BMPs in the green colored sub-basins. Therefore, generally speaking, the plan efforts will focus on the pink colored sub-basins and will be the 1st priority for at least the first 5 years of the project. See list below:

**For Eutrophication: (Phosphorus and Nitrogen)**

**1st Priority Area**

> HUC 12 110300170304 -Satchel Creek-
> Sub-basin 40; Sub-basin 35
> HUC 12   110300170305 - Shady Creek, Bemis and Harrison Creeks
> Sub-basin 50; Sub-basin 44; Sub-basin 51; Sub-basin 43
> HUC 12   110300170303- Durechen Creek
> Sub-basin 32
> HUC 12   110300170302- Cole Creek, Gilmore Branch
> Sub-basin 23; Sub-basin 24; Sub-basin 7
> HUC 12  110300170301- Walnut River, School Branch
> Sub-basin 14; sub-basin 18

**2nd Priority Area**

> HUC 12  110300170306- El Dorado Lake perimeter
>  Sub-basin 48; Sub-basin 31
> HUC 12   110300170303- Durechen Creek
> Sub-basin 22
> HUC 12   110300170302- Cole Creek, Gilmore Branch

Sub-basin 29; Sub-basin 15; Possibly Sub-basin 30 (even though map shows green, proximity to lake raises priority)
HUC 12  110300170301- Walnut River, School Branch
Sub-basin 25; Sub-basin 19

**3rd Priority Area**
HUC 12 110300170304-Satchel Creek-
Sub-basin 36; Sub-basin 39; Sub-basin 33;
HUC 12   110300170305- Shady Creek, Bemis and Harrison Creeks
Sub-basin 47; Sub-basin 49; Sub-basin 45
HUC 12   110300170303- Durechen Creek
Sub-basin 28; Sub-basin 27
HUC 12   110300170302- Cole Creek, Gilmore Branch
Sub-basin 11; Sub-basin 30
HUC 12  110300170301- Walnut River, School Branch
Sub-basin 10; Sub-basin 9; Sub-basin 3

Deviation will only occur if new data or significant land use changes reveals the goal would be achieved faster by realigning priorities. For example if the area (yellow sub-basin 48) land use makes its sub-basin much more likely to contribute pollutants directly to the lake, it may need to have a higher priority. The other aspect this plan recognizes is that the areas around the lake (including the shoreline and operations) are owned by the US Army Corps of Engineers. The land use practices and water level manipulation, (which may lead to accelerated shoreline erosion and siltation), are outside the framework and ability for the SLT to make an impact through BMP implementation. This is not to say the SLT cannot play a role in assisting and persuading the US Army Corps of Engineers to change their management practices or operations.  However, BMP implementation through the traditional and proven cost share, technical assistance services, may not be feasible.

Other results from the SWAT model prioritization includes the following and may be utilized for further targeting if goals aren't following earlier prioritization scheme.

**For Streambank/Channel Stabilization:**

Sub-basin 4; Sub-basin 9; Sub-basin 11; Sub-basin 16; Sub-basin 19; Sub-basin 24; Sub-basin 25; Sub-basin 27; Sub-basin 29; Sub-basin 31; Sub-basin 32; Sub-basin 36; Sub-basin 38; Sub-basin 40; Sub-basin 43; Sub-basin 44; Sub-basin 47; Sub-basin 48; Sub-basin 49.

For all pollutants combined based upon total tons/yr and kg/ha (greatest pollutant loading to least): Sub-basin 48; Sub-basin 32; Sub-basin 40; Sub-basin 24; Sub-basin 50; Sub-basin 7; Sub-basin 13; Sub-basin 14; Sub-basin 18; Sub-basin 44; Sub-basin 51; Sub-basin 35; Sub-basin 43; Sub-basin 23; Sub-basin 30; Sub-basin 29; Sub-basin 36; Sub-basin 15; Sub-basin 31; Sub-basin 22; Sub-basin 27; Sub-basin 33; Sub-basin 45; Sub-basin 39.
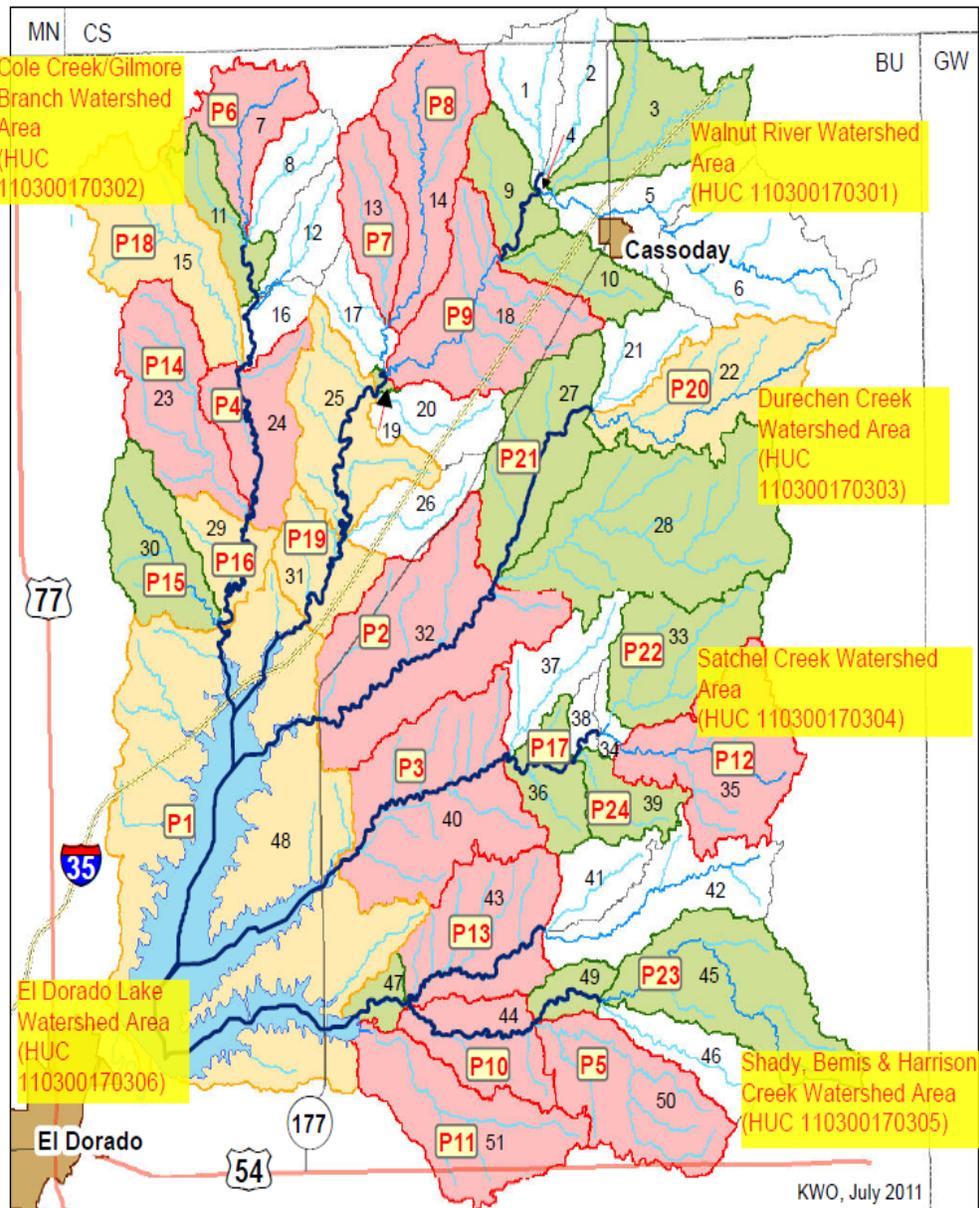
El Dorado WRAPS Sub-basin Priority Ranking
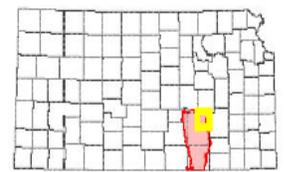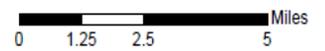
## P. Determination and Description of BMP's to be Implemented Within Watersheds of Priority Waters

Best management practices recommended by the Walnut River Basin, Kansas - Feasibility Report – El Dorado Lake, Kansas - Watershed Management Plan – January 2007:

1. Erosion in the watershed from cropland – Nutrients such as phosphorus and nitrogen originating from applied chemicals are transported by runoff and stream flow. A portion of these and other nutrients are trapped with sediments deposited in El Dorado Lake. The SWAT (Soil and Water Assessment Tool) model shows in most cases, row crop agriculture in the watershed contributes the most sediment into El Dorado Lake.  Tillage practices have evolved over the years from deep plowing to conservation tillage and now to no-till farming. Not all farmers no-till; however, the practice is becoming more popular since no till requires less passes through a field thereby reducing fuel costs.  One tradeoff with no-till requires the use of more herbicides for weed control; however, with more residue left on the ground, runoff of pollutants is minimized.  One concern with no-till is the problem of gullies forming in no-till fields that can increase sediment load into tributaries.

2. Erosion in the watershed from stream channels - The SWAT model determined that a majority of the sediment that reaches El Dorado Lake is due to channel degradation.  Of the estimated 149,700 t/yr sediment reaching El Dorado Lake, 130,660 t/yr or (87.3%) is attributed to degradation of the stream channels themselves.  Upland sources contribute an estimated 19,040 t/yr (12.7%) to El Dorado Lake.

3. Erosion in the watershed from rangeland - Nutrients such as phosphorus and nitrogen originating from animal wastes are transported by runoff and stream flow. A portion of these and other nutrients are trapped with sediments deposited in El Dorado Lake. Fecal coliform bacteria are also present in runoff from livestock operations.  Pastures may be over grazed and/or associated with easily eroded cattle trails. Over grazed pasture is susceptible to higher runoff rates and erosion, and is also more susceptible to field cuts (short disconnected areas of erosion). The initial formation of field cuts is often related to cattle trails. Worst case conditions occur when over grazed pasture adjoins riparian areas subjected to cattle browsing, water access, and over wintering. Reduced pasture and riparian vegetation allows eroded soil and cattle wastes to flow directly across fields, through the riparian area, and into streams.  Cattle trailing in rangeland areas can cause gullies to form and increase sediment load into tributaries of El Dorado Lake. Backgrounding cattle is still a popular practice in the watershed.  In some areas, cattle are allowed access to sensitive riparian areas, year round in some cases.  In winter, cattle are fed in riparian areas for protection from the weather.  Watering cattle from creeks is also a common practice.  Concentrated "hoof action" by livestock in areas such as stream banks, trails, watering points, salting and feeding sites causes compaction of wet soils and mechanically disrupts dry and exposed soils. Compacted and/or impermeable soils can have decreased infiltration rates, and therefore increased volume and velocity of runoff. Soils loosened by livestock during the dry season are a source of sediments.   Some suggested best management practices include:  Fencing to exclude cattle from a continuous riparian corridor including a 120-foot grass filter strip, stock tanks for watering or limited, fenced, stream access points, reduced cattle stock density and conservation of grazing lands.

4. Livestock Operations - Nutrients such as phosphorus and nitrogen originating from animal wastes are transported by runoff and stream flow. A portion of these and other nutrients are trapped with sediments deposited in El Dorado Lake. Fecal coliform bacteria are also present in runoff from livestock operations.  Along with this, nutrient management planning is needed to assist farm operators with proper placement, timing and amount of manure spread on cropland fields.

5. Grass Buffers/Filter Strips. From the stream bank outward, grass buffers were modeled using SWAT for 30, 60, 90, and 120 foot filter strips for all crop lands combined. The 120 foot filter strips would keep about 72% of the eroded sediment from leaving the property. However, that crop land erosion reduction does not translate into an equivalent sediment reduction at El Dorado Lake. As the surface runoff sediment concentration is reduced by filter strips, water reaching the stream channel is capable of carrying more sediment. The sediment carrying capacity is then met by sediments scoured from the stream channel (bank or channel bottom). The condition is sometimes called "sediment hungry" flow.  Filter strips serve the following purposes:
    • Field runoff rates are restored to a slower and more natural condition that tends to result in lower peak flows downstream; and lower peak flows causes less channel erosion and flooding.
    • Applied agricultural nutrients are captured and utilized within the filter strip instead of being carried downstream and stored in El Dorado Lake. The rate of capture is dependent on the slope and width of the filter strip and the vegetation types and soil infiltration rates.
    • The capture rate for total suspended solids can range from 40% to 90%. The effectiveness also depends on the slope and width of the filter strip and the vegetation types and soil infiltration rates.
    • Filter strips can also be designed to effectively restore the terrestrial ecosystem functions of lost natural buffers.  Existing state and Federal programs financially support the implementation of filter strips along crop lands meeting multi-year requirements.

6. Stream Bank Restoration.   In many cases land use changes in the watershed (such as urbanization or agricultural practices) will increase runoff rates and upland erosion. Consequently the upland changes will tend to result in accelerated stream bank erosion. However, stream bank erosion is only a symptom of the greater runoff rate. The most appropriate and effective response would be the application of best management practices at the site of the land use changes or between the land use changes and the nearest waterway. When land use changes cause a higher rate of runoff the collector streams will gain a higher level of power. It is important to evaluate the potential impacts of bank restoration (or any other stream changes that affect water resources) when considering actions that would alter the natural erosion and sediment transport processes in a watershed.

7. Reservoir Management Measures.

   Management measures are presented in the order of identification during the study. No ranking or prioritization is implied. The evaluated reservoir management measures consist of:

   For the purpose of reducing sedimentation, the financial, material, and human resources required for shoreline restoration would be more effectively applied to other sediment reduction efforts in the watershed.  While having identified that the sediment contribution from shoreline erosion is a limited contributor to the total sediment in El Dorado Lake, there are a number of justifications for minimizing shoreline erosion.
   - The park areas, access roads, project utilities, camping facilities, and a variety of recreation facilities are important Federal investments in public recreation resources.
   - Shoreline erosion alters and may often degrade the local terrestrial and aquatic environment.
   - The loss of park lands from erosion and reduction in the quality of the recreation experience represents a quantifiable loss of a public resource.
   - The loss of native shoreline vegetation due to erosion from wave action decreases the value of recreation activities and impacts the aesthetic qualities of the lake and park facilities.
8. Sediment reservoirs.  Sedimentation reservoirs upstream of El Dorado Lake, similar to NRCS multiple purpose reservoirs, were identified as an option for consideration to intercept sediment. The construction of one or more dams on the tributaries of El Dorado Lake would reduce sedimentation in the Lake.  The Watershed Protection and Flood Prevention Act (PL 83-566), August 4, 1954, as amended, authorized NRCS to cooperate with states and local agencies to carry out works of improvement for soil conservation and for other purposes including flood prevention; conservation, development, utilization and disposal of water; and conservation and proper utilization of land.  The Walnut River tributary is forecast by the SWAT model to contribute about 37.6% of the total watershed sediments that are transported to El Dorado Lake. An NRCS type reservoir located on the Walnut River would capture a percentage of the total sediment load. The percentage of captured sediment would be dependent on the location and storage volume of the reservoir, the type and operation of primary outlet works, and the type and operation of emergency spillway outlets.  The SWAT model developed in this watershed management plan would be a valuable tool in the evaluation of those reservoirs.  While the sedimentation reservoirs would be effective in prolonging the storage available for water supply in El Dorado Lake (and the flood control storage), the sediment reservoirs will eventually fill. Decisions and issues similar to those discussed for El Dorado Lake would in due course apply to sedimentation reservoirs.

9. Operational opportunity to reduce sedimentation.   Flood flows are known to transport a large percentage of the sediment that is trapped by a reservoir. An ongoing evaluation of data collected for a study of the Oologah Lake Watershed, Oklahoma and Kansas, suggests that sediment laden flood flows do not immediately mix upon entering Oologah Lake with stored water. The higher density of the flood waters (due to the sediment load and possibly lower water temperature) may cause the flood waters to run along the bottom of the reservoir to the reservoir's dam. A portion of the sediment that would otherwise be deposited in a lake might be released to flow downstream if the outlet works included a low level intake. Transporting sediments downstream would also partially restore the natural function of stream sediment transport.  Further study at Oologah Lake is required, but there may be an opportunity to modify project operations (flood water releases) at many reservoirs.  The outlet works at El Dorado Lake were designed and constructed to release flows from low in the pool. If sediment laden flood flows do reach the El Dorado dam, then they have been (and will continue to be) released as part of normal flood operations. The in-lake studies at Oologah Lake were possible because continuous stream flow and sediment load data had been collected in that basin. No such data exists for the El Dorado Lake watershed. If sediment stream flow gauges were installed in the watershed, further studies might determine operational changes that could better balance the project purposes of flood damage reduction and water supply storage.

## Q. Estimate of BMP Needs for the Priority HUC 12s Identified for Each TMDL/HP Water Addressed in the Plan

The Natural Resources Conservation Service Field Office Technical Guide lists practices which, when installed to standards and specifications, will reduce erosion and runoff of nutrients. *See Appendix D for additional information on Natural Resources Conservation Service Conservation Practices.*

BMP's were selected for implementation as a result of the conclusions of the Feasibility Study as well as local NRCS Staff and Conservation District input.   To determine the quantity of BMP's needed in the watershed, each section of land in the watershed was reviewed by using aerial photos available through NRCS's ArcView program.  Personal contacts, field visits and NRCS office staff expertise were used to verify numbers from the aerial photos where applicable.  The Natural Resources Conservation Service provided advice on types of BMP's to add to the list that would assist in sediment, fecal coliform bacteria and nutrient reduction.  Urban practices are also listed.

The following list provides examples of best management practices needed to reduce sediment, fecal coliform bacteria and nutrients in El Dorado Lake.

Cropland, Rangeland and Livestock practices that help reduce erosion, fecal coliform bacteria and runoff of nutrients:

- NRCS Code No. 342, 512 and 550 – Permanent Vegetation – 3487 acres
- NRCS Code No. 412 and 468 – Grassed/Lined Waterways – 340 acres

- NRCS Code No. 329A, 340 and 595 – No-Till and Reduced Tillage –  13854 acres
- NRCS Code No. 356, 362, 600 and 620 – Terraces – 753,470 feet
- NRCS Code No. 590 – Nutrient Management Plans – 13331 acres
- NRCS Code No. 410 and 587 – Grade Stabilization/Water Control Structures – 268
- NRCS Code No. 332, 386, 391 and 393   – Buffers and Field Borders – 607 acres
- NRCS Code No. 635 – Vegetative Filter Strip – 22 acres
- NRCS Code No. 312, 466 and 561 – Relocation of Feeding Pens – 5
- NRCS Code No. 312, 466 and 561 – Relocation of Pasture Feeding Sites – 27
- NRCS Code No. 378, 516, 533, 574, 614 and 642 – Off Stream Watering Systems – 411
- NRCS Code No. 382 and 528 – Rotational Grazing – 108,527 acres
- NRCS Code No. 382, 561 and 578 – Livestock Exclusion from Ponds/Streams – 156,680 feet
- NRCS Code No. 314, 315, 338, 528, 561, 595 – Grazing Management Plans – 127,215 acres
- NRCS Code No. 322, 326, 395, 484, 578, 580, 666 – Streambank Protection/Shoreline Protection – 2,530 acres
- NRCS Code No. 332, 342, 386, 391, 393, 412 and 512 – Cropland Reduction – 1538 acres
- NRCS Code No. 410 and 587 and 638  – Rangeland Gully Repair 63,360 feet
- NRCS Code No. 410 and 587 and 638 – Cropland Gully Repair – 21,120 feet
- NRCS Code No. 402 – Installation of Watershed Dams – 8
- NRCS Code No. 110 – On Site Wastewater Systems – 187
- NRCS Code No. 120 – Unpermitted Dump Site Remediation – 6

## R. Annual BMP Implementation Schedule for Each TMDL/HP Water with Short, Mid and Long Term Milestones Including Associated Load Reductions to Meet the Load Reduction Targets Established.

### Cropland Scenario

| Eldorado WRAPS, Targeted Area BMP Scenario | | Priority Area | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Total |
| **Acres of Cropland** | | 5,286 | 1,975 | 1,290 | **8,551** |
| **BMP Implementation (treated acres)** | **Increased Adoption** | | | | **Total** |
| Permanent Vegetation | 10% | 529 | 198 | 129 | **855** |
| Grassed Waterways | 5% | 264 | 99 | 65 | **428** |
| No-Till | 20% | 1,057 | 395 | 258 | **1,710** |
| Terraces | 15% | 793 | 296 | 194 | **1,283** |
| Nutrient Mgmt Plan | 5% | 264 | 99 | 65 | **428** |
| Buffers/Field Borders | 10% | 529 | 198 | 129 | 855 |
| Grade Stabilization Structures | 15% | 793 | 296 | 194 | **1,283** |
| Total | 80% | 4,229 | 1,580 | 1,032 | **6,841** |
| **Estimated Cost** | | | | | **Total** |
| Total Investment Cost | | $549,075 | $205,150 | $133,997 | **$888,222** |
| Available Cost-Share | | $282,900 | $105,699 | $69,039 | **$457,638** |
| Net Cost | | $266,175 | $99,451 | $64,958 | **$430,584** |
| **Estimated Annual Runoff Reduction** | | | | | **Total** |
| Soil Erosion (tons) | | 3,983 | 1,411 | 831 | **6,226** |
| Phosphorus (pounds) | | 4,969 | 1,789 | 1,096 | **7,854** |
| Nitrogen (pounds) | | 20,133 | 7,159 | 4,447 | **31,739** |
| **Estimated Average Annual Runoff** | | | | | |
| Soil Erosion (tons/acre) | | 1.68 | 1.60 | 1.44 | |
| Phosphorus (pounds/acre) | | 2.49 | 2.40 | 2.25 | |
| Nitrogen (pounds/acre) | | 11.81 | 11.24 | 10.69 | |
| **Percent Reduction** | | | | | **Average** |
| Soil Erosion | | 45% | 45% | 45% | 45% |
| Phosphorus | | 38% | 38% | 38% | 38% |
| Nitrogen | | 32% | 32% | 32% | 32% |

**Eldorado WRAPS Livestock BMPs, Costs, and Estimated Phosphorous Reduction.**

| BMP | Approximate P Reduction Efficiency | Unit Cost | After Cost Share* | Estimated P Reduction (Pounds) | Average Annual Installations | Total Additional Installations | Total Estimated P Reduction | Total Estimated N Reduction |
|---|---|---|---|---|---|---|---|---|
| Vegetative Filter Strip (acres) | 50% | $714 | $357 | 638 | 2.0 | 50 | 31,894 | 60,072 |
| Relocate Feeding Pens | 95% | $6,621 | $3,311 | 1276 | 0.2 | 5 | 6,380 | 12,017 |
| Relocate Pasture Feeding Site | 50-90% | $2,203 | $1,102 | 60 | 2.0 | 50 | 3,000 | 5,651 |
| Off-Stream Watering System | 85% | $3,795 | $1,898 | 60 | 2.0 | 50 | 3,000 | 5,651 |
| Rotational Grazing | 25% | $7,000 | $3,500 | 140 | 1.0 | 25 | 3,500 | 6,592 |
| Fence off Stream/Pond | 95% | $6,000 | $3,000 | 80 | 0.2 | 5 | 400 | 753 |
| Grazing Mgmt Plan | 25% | $1,600 | $800 | 281 | 2.0 | 50 | 14,050 | 26,463 |

| | |
|---|---|
| **Total Cost After Cost Share** | $326,853 |
| **Year 1 Cost** | $13,074.10 |
| **Year 25 Cost** | $27,374 |

| | |
|---|---|
| **Total Estimate of P Reduction (lbs.)** | 47,774 |

**Cost of P Reduction over Project Life (25 Years)**

| | |
|---|---|
| **Dollars per pound of P** | $0.49 |

*50% Cost-Share from EQIP*

**Eldorado WRAPS Cropland BMPs, Costs, and Reduction Efficiencies**

| Best Management Practice | Cost per Acre | Available Cost-Share | Erosion Reduction Efficiency | Phosphorous Reduction Efficiency | Nitrogen Reduction Efficiency |
|---|---|---|---|---|---|
| Permanent Vegetation | $150 | 50% | 95% | 95% | 95% |
| Grassed Waterways* | $160 | 50% | 40% | 40% | 40% |
| No-Till | $78 | 39% | 75% | 40% | 25% |
| Terraces** | $100 | 50% | 30% | 30% | 30% |
| Nutrient Mgmt Plan | $57 | 25% | 25% | 25% | 25% |
| Buffers/Field Borders*** | $100 | 90% | 50% | 50% | 25% |
| Grade Stabilization Structures**** | $250 | 50% | 50% | 50% | 50% |

*10 treated acres/acre of waterway*
**100 linear feet of terrace/acre*
*** 15 treated acres/acre of buffer
****One structure treats 40 acres

**Annual Adoption (treated acres), Cropland BMPs**

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total Adoption |
|---|---|---|---|---|---|---|---|---|
| 1 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 2 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 3 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 4 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 5 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 6 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 7 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 8 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 9 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 10 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 11 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 12 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 13 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 14 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 15 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 16 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 17 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 18 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 19 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 20 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 21 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 22 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 23 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 24 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| 25 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |

**Annual Adoption (treated acres), Cropland BMPs**

| | Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total Adoption |
|---|---|---|---|---|---|---|---|---|---|
| **Short Term** | 1 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 2 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 3 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 4 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 5 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| *Total* | | *171* | *86* | *342* | *257* | *86* | *171* | *257* | *1,368* |
| **Medium Term** | 6 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 7 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 8 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 9 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 10 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| *Total* | | *342* | *171* | *684* | *513* | *171* | *342* | *513* | *2,736* |
| **Long Term** | 11 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 12 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 13 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 14 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 15 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 16 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 17 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 18 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 19 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 20 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 21 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 22 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 23 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 24 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| | 25 | 34 | 17 | 68 | 51 | 17 | 34 | 51 | 274 |
| *Total* | | *855* | *428* | *1,710* | *1,283* | *428* | *855* | *1,283* | *6,841* |

**Annual Soil Erosion Reduction**

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | 53 | 11 | 83 | 25 | 7 | 28 | 42 | 249 |
| 2 | 106 | 22 | 167 | 50 | 14 | 56 | 83 | 498 |
| 3 | 159 | 33 | 250 | 75 | 21 | 83 | 125 | 747 |
| 4 | 211 | 45 | 334 | 100 | 28 | 111 | 167 | 996 |
| 5 | 264 | 56 | 417 | 125 | 35 | 139 | 209 | 1,245 |
| 6 | 317 | 67 | 501 | 150 | 42 | 167 | 250 | 1,494 |
| 7 | 370 | 78 | 584 | 175 | 49 | 195 | 292 | 1,743 |
| 8 | 423 | 89 | 668 | 200 | 56 | 223 | 334 | 1,992 |
| 9 | 476 | 100 | 751 | 225 | 63 | 250 | 376 | 2,241 |
| 10 | 529 | 111 | 835 | 250 | 70 | 278 | 417 | 2,490 |
| 11 | 582 | 122 | 918 | 275 | 77 | 306 | 459 | 2,739 |
| 12 | 634 | 134 | 1,002 | 301 | 83 | 334 | 501 | 2,988 |
| 13 | 687 | 145 | 1,085 | 326 | 90 | 362 | 543 | 3,237 |
| 14 | 740 | 156 | 1,169 | 351 | 97 | 390 | 584 | 3,486 |
| 15 | 793 | 167 | 1,252 | 376 | 104 | 417 | 626 | 3,736 |
| 16 | 846 | 178 | 1,336 | 401 | 111 | 445 | 668 | 3,985 |
| 17 | 899 | 189 | 1,419 | 426 | 118 | 473 | 710 | 4,234 |
| 18 | 952 | 200 | 1,503 | 451 | 125 | 501 | 751 | 4,483 |
| 19 | 1,004 | 211 | 1,586 | 476 | 132 | 529 | 793 | 4,732 |
| 20 | 1,057 | 223 | 1,670 | 501 | 139 | 557 | 835 | 4,981 |
| 21 | 1,110 | 234 | 1,753 | 526 | 146 | 584 | 876 | 5,230 |
| 22 | 1,163 | 245 | 1,836 | 551 | 153 | 612 | 918 | 5,479 |
| 23 | 1,216 | 256 | 1,920 | 576 | 160 | 640 | 960 | 5,728 |
| 24 | 1,269 | 267 | 2,003 | 601 | 167 | 668 | 1,002 | 5,977 |
| 25 | 1,322 | 278 | 2,087 | 626 | 174 | 696 | 1,043 | 6,226 |

**Annual Phosphorus Runoff Reduction**

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | 79 | 17 | 67 | 37 | 10 | 42 | 62 | 314 |
| 2 | 158 | 33 | 133 | 75 | 21 | 83 | 125 | 628 |
| 3 | 237 | 50 | 200 | 112 | 31 | 125 | 187 | 942 |
| 4 | 316 | 67 | 266 | 150 | 42 | 166 | 250 | 1,257 |
| 5 | 395 | 83 | 333 | 187 | 52 | 208 | 312 | 1,571 |
| 6 | 474 | 100 | 399 | 225 | 62 | 250 | 374 | 1,885 |
| 7 | 553 | 117 | 466 | 262 | 73 | 291 | 437 | 2,199 |
| 8 | 632 | 133 | 533 | 300 | 83 | 333 | 499 | 2,513 |
| 9 | 712 | 150 | 599 | 337 | 94 | 374 | 562 | 2,827 |
| 10 | 791 | 166 | 666 | 374 | 104 | 416 | 624 | 3,142 |
| 11 | 870 | 183 | 732 | 412 | 114 | 458 | 687 | 3,456 |
| 12 | 949 | 200 | 799 | 449 | 125 | 499 | 749 | 3,770 |
| 13 | 1,028 | 216 | 865 | 487 | 135 | 541 | 811 | 4,084 |
| 14 | 1,107 | 233 | 932 | 524 | 146 | 583 | 874 | 4,398 |
| 15 | 1,186 | 250 | 999 | 562 | 156 | 624 | 936 | 4,712 |
| 16 | 1,265 | 266 | 1,065 | 599 | 166 | 666 | 999 | 5,026 |
| 17 | 1,344 | 283 | 1,132 | 637 | 177 | 707 | 1,061 | 5,341 |
| 18 | 1,423 | 300 | 1,198 | 674 | 187 | 749 | 1,123 | 5,655 |
| 19 | 1,502 | 316 | 1,265 | 712 | 198 | 791 | 1,186 | 5,969 |
| 20 | 1,581 | 333 | 1,331 | 749 | 208 | 832 | 1,248 | 6,283 |
| 21 | 1,660 | 350 | 1,398 | 786 | 218 | 874 | 1,311 | 6,597 |
| 22 | 1,739 | 366 | 1,465 | 824 | 229 | 915 | 1,373 | 6,911 |
| 23 | 1,818 | 383 | 1,531 | 861 | 239 | 957 | 1,436 | 7,225 |
| 24 | 1,897 | 399 | 1,598 | 899 | 250 | 999 | 1,498 | 7,540 |
| 25 | 1,976 | 416 | 1,664 | 936 | 260 | 1,040 | 1,560 | 7,854 |

**Annual Nitrogen Runoff Reduction**

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | 374 | 79 | 197 | 177 | 49 | 98 | 295 | 1,270 |
| 2 | 748 | 157 | 394 | 354 | 98 | 197 | 591 | 2,539 |
| 3 | 1,122 | 236 | 591 | 531 | 148 | 295 | 886 | 3,809 |
| 4 | 1,496 | 315 | 787 | 709 | 197 | 394 | 1,181 | 5,078 |
| 5 | 1,870 | 394 | 984 | 886 | 246 | 492 | 1,476 | 6,348 |
| 6 | 2,244 | 472 | 1,181 | 1,063 | 295 | 591 | 1,772 | 7,617 |
| 7 | 2,618 | 551 | 1,378 | 1,240 | 344 | 689 | 2,067 | 8,887 |
| 8 | 2,992 | 630 | 1,575 | 1,417 | 394 | 787 | 2,362 | 10,157 |
| 9 | 3,366 | 709 | 1,772 | 1,594 | 443 | 886 | 2,657 | 11,426 |
| 10 | 3,740 | 787 | 1,968 | 1,772 | 492 | 984 | 2,953 | 12,696 |
| 11 | 4,114 | 866 | 2,165 | 1,949 | 541 | 1,083 | 3,248 | 13,965 |
| 12 | 4,488 | 945 | 2,362 | 2,126 | 591 | 1,181 | 3,543 | 15,235 |
| 13 | 4,862 | 1,024 | 2,559 | 2,303 | 640 | 1,279 | 3,838 | 16,504 |
| 14 | 5,236 | 1,102 | 2,756 | 2,480 | 689 | 1,378 | 4,134 | 17,774 |
| 15 | 5,610 | 1,181 | 2,953 | 2,657 | 738 | 1,476 | 4,429 | 19,044 |
| 16 | 5,984 | 1,260 | 3,149 | 2,834 | 787 | 1,575 | 4,724 | 20,313 |
| 17 | 6,358 | 1,338 | 3,346 | 3,012 | 837 | 1,673 | 5,019 | 21,583 |
| 18 | 6,732 | 1,417 | 3,543 | 3,189 | 886 | 1,772 | 5,315 | 22,852 |
| 19 | 7,106 | 1,496 | 3,740 | 3,366 | 935 | 1,870 | 5,610 | 24,122 |
| 20 | 7,480 | 1,575 | 3,937 | 3,543 | 984 | 1,968 | 5,905 | 25,392 |
| 21 | 7,854 | 1,653 | 4,134 | 3,720 | 1,033 | 2,067 | 6,200 | 26,661 |
| 22 | 8,228 | 1,732 | 4,330 | 3,897 | 1,083 | 2,165 | 6,496 | 27,931 |
| 23 | 8,602 | 1,811 | 4,527 | 4,074 | 1,132 | 2,264 | 6,791 | 29,200 |
| 24 | 8,976 | 1,890 | 4,724 | 4,252 | 1,181 | 2,362 | 7,086 | 30,470 |
| 25 | 9,350 | 1,968 | 4,921 | 4,429 | 1,230 | 2,460 | 7,381 | 31,739 |

**Total Annual Cost Before Cost-Share, Cropland BMPs**

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | $5,131 | $2,736 | $5,315 | $5,131 | $970 | $3,420 | $12,827 | $35,529 |
| 2 | $5,285 | $2,818 | $5,474 | $5,285 | $999 | $3,523 | $13,211 | $36,595 |
| 3 | $5,443 | $2,903 | $5,638 | $5,443 | $1,029 | $3,629 | $13,608 | $37,693 |
| 4 | $5,606 | $2,990 | $5,807 | $5,606 | $1,060 | $3,738 | $14,016 | $38,823 |
| 5 | $5,775 | $3,080 | $5,982 | $5,775 | $1,092 | $3,850 | $14,436 | $39,988 |
| 6 | $5,948 | $3,172 | $6,161 | $5,948 | $1,124 | $3,965 | $14,869 | $41,188 |
| 7 | $6,126 | $3,267 | $6,346 | $6,126 | $1,158 | $4,084 | $15,316 | $42,423 |
| 8 | $6,310 | $3,365 | $6,536 | $6,310 | $1,193 | $4,207 | $15,775 | $43,696 |
| 9 | $6,499 | $3,466 | $6,732 | $6,499 | $1,229 | $4,333 | $16,248 | $45,007 |
| 10 | $6,694 | $3,570 | $6,934 | $6,694 | $1,265 | $4,463 | $16,736 | $46,357 |
| 11 | $6,895 | $3,677 | $7,142 | $6,895 | $1,303 | $4,597 | $17,238 | $47,748 |
| 12 | $7,102 | $3,788 | $7,357 | $7,102 | $1,343 | $4,735 | $17,755 | $49,180 |
| 13 | $7,315 | $3,901 | $7,577 | $7,315 | $1,383 | $4,877 | $18,288 | $50,656 |
| 14 | $7,534 | $4,018 | $7,805 | $7,534 | $1,424 | $5,023 | $18,836 | $52,175 |
| 15 | $7,760 | $4,139 | $8,039 | $7,760 | $1,467 | $5,174 | $19,401 | $53,741 |
| 16 | $7,993 | $4,263 | $8,280 | $7,993 | $1,511 | $5,329 | $19,983 | $55,353 |
| 17 | $8,233 | $4,391 | $8,528 | $8,233 | $1,556 | $5,489 | $20,583 | $57,013 |
| 18 | $8,480 | $4,523 | $8,784 | $8,480 | $1,603 | $5,653 | $21,200 | $58,724 |
| 19 | $8,735 | $4,658 | $9,048 | $8,735 | $1,651 | $5,823 | $21,836 | $60,486 |
| 20 | $8,997 | $4,798 | $9,319 | $8,997 | $1,701 | $5,998 | $22,491 | $62,300 |
| 21 | $9,266 | $4,942 | $9,599 | $9,266 | $1,752 | $6,178 | $23,166 | $64,169 |
| 22 | $9,544 | $5,090 | $9,887 | $9,544 | $1,804 | $6,363 | $23,861 | $66,094 |
| 23 | $9,831 | $5,243 | $10,183 | $9,831 | $1,858 | $6,554 | $24,577 | $68,077 |
| 24 | $10,126 | $5,400 | $10,489 | $10,126 | $1,914 | $6,750 | $25,314 | $70,119 |
| 25 | $10,429 | $5,562 | $10,804 | $10,429 | $1,972 | $6,953 | $26,074 | $72,223 |

**Total Annual Cost After Cost-Share, Cropland BMPs**

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | $2,565 | $1,368 | $3,242 | $2,565 | $727 | $342 | $6,413 | $17,223 |
| 2 | $2,642 | $1,409 | $3,339 | $2,642 | $749 | $352 | $6,606 | $17,740 |
| 3 | $2,722 | $1,451 | $3,439 | $2,722 | $772 | $363 | $6,804 | $18,272 |
| 4 | $2,803 | $1,495 | $3,543 | $2,803 | $795 | $374 | $7,008 | $18,820 |
| 5 | $2,887 | $1,540 | $3,649 | $2,887 | $819 | $385 | $7,218 | $19,385 |
| 6 | $2,974 | $1,586 | $3,758 | $2,974 | $843 | $397 | $7,435 | $19,967 |
| 7 | $3,063 | $1,634 | $3,871 | $3,063 | $869 | $408 | $7,658 | $20,566 |
| 8 | $3,155 | $1,683 | $3,987 | $3,155 | $895 | $421 | $7,887 | $21,183 |
| 9 | $3,250 | $1,733 | $4,107 | $3,250 | $921 | $433 | $8,124 | $21,818 |
| 10 | $3,347 | $1,785 | $4,230 | $3,347 | $949 | $446 | $8,368 | $22,473 |
| 11 | $3,448 | $1,839 | $4,357 | $3,448 | $978 | $460 | $8,619 | $23,147 |
| 12 | $3,551 | $1,894 | $4,488 | $3,551 | $1,007 | $473 | $8,877 | $23,841 |
| 13 | $3,658 | $1,951 | $4,622 | $3,658 | $1,037 | $488 | $9,144 | $24,556 |
| 14 | $3,767 | $2,009 | $4,761 | $3,767 | $1,068 | $502 | $9,418 | $25,293 |
| 15 | $3,880 | $2,069 | $4,904 | $3,880 | $1,100 | $517 | $9,701 | $26,052 |
| 16 | $3,997 | $2,132 | $5,051 | $3,997 | $1,133 | $533 | $9,992 | $26,833 |
| 17 | $4,117 | $2,195 | $5,202 | $4,117 | $1,167 | $549 | $10,291 | $27,638 |
| 18 | $4,240 | $2,261 | $5,358 | $4,240 | $1,202 | $565 | $10,600 | $28,468 |
| 19 | $4,367 | $2,329 | $5,519 | $4,367 | $1,238 | $582 | $10,918 | $29,322 |
| 20 | $4,498 | $2,399 | $5,685 | $4,498 | $1,275 | $600 | $11,246 | $30,201 |
| 21 | $4,633 | $2,471 | $5,855 | $4,633 | $1,314 | $618 | $11,583 | $31,107 |
| 22 | $4,772 | $2,545 | $6,031 | $4,772 | $1,353 | $636 | $11,931 | $32,041 |
| 23 | $4,915 | $2,622 | $6,212 | $4,915 | $1,394 | $655 | $12,288 | $33,002 |
| 24 | $5,063 | $2,700 | $6,398 | $5,063 | $1,436 | $675 | $12,657 | $33,992 |
| 25 | $5,215 | $2,781 | $6,590 | $5,215 | $1,479 | $695 | $13,037 | $35,012 |

**Eldorado WRAPS Annual Cropland Gully Repair From Grade Stabilization**

| Year | Gully Repair | Soil Load Reduction (tons) | Cumulative Erosion Reduction (tons) | Phosphorus Reduction (lbs) | Cumulative P Load Reduction (lbs) |
|---|---|---|---|---|---|
| 1 | 1 | 325 | 325 | 20 | 20 |
| 2 | 2 | 650 | 975 | 39 | 59 |
| 3 | 1 | 325 | 1,300 | 20 | 78 |
| 4 | 2 | 650 | 1,950 | 39 | 117 |
| 5 | 1 | 325 | 2,275 | 20 | 137 |
| 6 | 2 | 650 | 2,925 | 39 | 176 |
| 7 | 1 | 325 | 3,250 | 20 | 195 |
| 8 | 2 | 650 | 3,900 | 39 | 234 |
| 9 | 1 | 325 | 4,225 | 20 | 254 |
| 10 | 2 | 650 | 4,875 | 39 | 293 |
| 11 | 1 | 325 | 5,200 | 20 | 312 |
| 12 | 2 | 650 | 5,850 | 39 | 351 |
| 13 | 1 | 325 | 6,175 | 20 | 371 |
| 14 | 2 | 650 | 6,825 | 39 | 410 |
| 15 | 1 | 325 | 7,150 | 20 | 429 |
| 16 | 2 | 650 | 7,800 | 39 | 468 |
| 17 | 1 | 325 | 8,125 | 20 | 488 |
| 18 | 2 | 650 | 8,775 | 39 | 527 |
| 19 | 1 | 325 | 9,100 | 20 | 546 |
| 20 | 2 | 650 | 9,750 | 39 | 585 |
| 21 | 1 | 325 | 10,075 | 20 | 605 |
| 22 | 2 | 650 | 10,725 | 39 | 644 |
| 23 | 1 | 325 | 11,050 | 20 | 663 |
| 24 | 2 | 650 | 11,700 | 39 | 702 |
| 25 | 1 | 325 | 12,025 | 20 | 722 |

*3% Inflation*

#### Eldorado WRAPS Rangeland Gully Repair by Sub-Watershed

| Priority Area | Gully Repair (Number) | Cumulative Erosion Reduction (tons) | Cumulative P Load Reduction (lbs) | Cost* |
|---|---|---|---|---|
| 1 | 83 | 13,944 | 837 | $249,000 |
| 2 | 83 | 13,944 | 837 | $249,000 |
| 3 | 84 | 14,112 | 847 | $252,000 |
| **Total** | **250** | **42,000** | **2520** | **$750,000** |

*2011 Dollars

#### Eldorado WRAPS Annual Streambank Load Reductions and Cost

| Year | Streambank Stabilization (feet) | Soil Load Reduction (tons) | Cumulative Erosion Reduction (tons) | Phosphorus Reduction (lbs) | Cumulative P Load Reduction (lbs) | Cost* |
|---|---|---|---|---|---|---|
| 1 | 1,000 | 500 | 500 | 30 | 30 | $96,580 |
| 2 | 1,000 | 500 | 1,000 | 30 | 60 | $99,477 |
| 3 | 1,000 | 500 | 1,500 | 30 | 90 | $102,462 |
| 4 | 1,000 | 500 | 2,000 | 30 | 120 | $105,536 |
| 5 | 1,000 | 500 | 2,500 | 30 | 150 | $108,702 |
| 6 | 1,000 | 500 | 3,000 | 30 | 180 | $111,963 |
| 7 | 1,000 | 500 | 3,500 | 30 | 210 | $115,322 |
| 8 | 1,000 | 500 | 4,000 | 30 | 240 | $118,781 |
| 9 | 1,000 | 500 | 4,500 | 30 | 270 | $122,345 |
| 10 | 1,000 | 500 | 5,000 | 30 | 300 | $126,015 |
| 11 | 1,000 | 500 | 5,500 | 30 | 330 | $129,795 |
| 12 | 1,000 | 500 | 6,000 | 30 | 360 | $133,689 |
| 13 | 1,000 | 500 | 6,500 | 30 | 390 | $137,700 |
| 14 | 1,000 | 500 | 7,000 | 30 | 420 | $141,831 |
| 15 | 1,000 | 500 | 7,500 | 30 | 450 | $146,086 |
| 16 | 1,000 | 500 | 8,000 | 30 | 480 | $150,468 |
| 17 | 1,000 | 500 | 8,500 | 30 | 510 | $154,983 |
| 18 | 1,000 | 500 | 9,000 | 30 | 540 | $159,632 |
| 19 | 1,000 | 500 | 9,500 | 30 | 570 | $164,421 |
| 20 | 1,000 | 500 | 10,000 | 30 | 600 | $169,354 |
| 21 | 1,000 | 500 | 10,500 | 30 | 630 | $174,434 |
| 22 | 1,000 | 500 | 11,000 | 30 | 660 | $179,667 |
| 23 | 1,000 | 500 | 11,500 | 30 | 690 | $185,057 |
| 24 | 1,000 | 500 | 12,000 | 30 | 720 | $190,609 |
| 25 | 1,000 | 500 | 12,500 | 30 | 750 | $196,327 |

*3% Inflation

## Annual Livestock BMP Adoption

| Year | Vegetative Filter Strip | Relocate Feeding Pens | Relocate Pasture Feeding Site | Off Stream Watering System | Rotational Grazing | Fence off Stream or Pond | Grazing Mgmt Plan |
|------|------|------|------|------|------|------|------|
| 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 |
| 2 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| 3 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| 4 | 2 | 0 | 2 | 2 | 1 | 1 | 2 |
| 5 | 2 | 1 | 2 | 2 | 1 | 0 | 2 |
| 6 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| 7 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| 8 | 2 | 0 | 2 | 2 | 1 | 1 | 2 |
| 9 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| 10 | 2 | 1 | 2 | 2 | 1 | 0 | 2 |
| 11 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| 12 | 2 | 0 | 2 | 2 | 1 | 1 | 2 |
| 13 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| 14 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| 15 | 2 | 1 | 2 | 2 | 1 | 0 | 2 |
| 16 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| 17 | 2 | 0 | 2 | 2 | 1 | 1 | 2 |
| 18 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| 19 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| 20 | 2 | 1 | 2 | 2 | 1 | 0 | 2 |
| 21 | 2 | 0 | 2 | 2 | 1 | 1 | 2 |
| 22 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| 23 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| 24 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| 25 | 2 | 0 | 2 | 2 | 1 | 0 | 2 |
| **Total** | **50** | **5** | **50** | **50** | **25** | **6** | **50** |

**Annual Cost\* Before Cost-Share of Implementing Livestock BMPs**

| Year | Vegetative Filter Strip | Relocate Feeding Pens | Relocate Pasture Feeding Site | Off Stream Watering System | Rotational Grazing | Fence off Stream or Pond | Grazing Mgmt Plan | Annual Cost |
|---|---|---|---|---|---|---|---|---|
| 1 | $714 | $3,311 | $2,203 | $3,795 | $3,500 | $3,000 | $1,600 | **$18,123** |
| 2 | $735 | $0 | $2,269 | $3,909 | $3,605 | $0 | $1,648 | **$12,166** |
| 3 | $757 | $0 | $2,337 | $4,026 | $3,713 | $0 | $1,697 | **$12,531** |
| 4 | $780 | $0 | $2,407 | $4,147 | $3,825 | $3,278 | $1,748 | **$16,185** |
| 5 | $804 | $3,726 | $2,479 | $4,271 | $3,939 | $0 | $1,801 | **$17,021** |
| 6 | $828 | $0 | $2,554 | $4,399 | $4,057 | $0 | $1,855 | **$13,693** |
| 7 | $853 | $0 | $2,630 | $4,531 | $4,179 | $0 | $1,910 | **$14,104** |
| 8 | $878 | $0 | $2,709 | $4,667 | $4,305 | $3,690 | $1,968 | **$18,217** |
| 9 | $904 | $0 | $2,791 | $4,807 | $4,434 | $0 | $2,027 | **$14,963** |
| 10 | $932 | $4,319 | $2,874 | $4,952 | $4,567 | $0 | $2,088 | **$19,731** |
| 11 | $960 | $0 | $2,961 | $5,100 | $4,704 | $0 | $2,150 | **$15,874** |
| 12 | $988 | $0 | $3,049 | $5,253 | $4,845 | $4,153 | $2,215 | **$20,503** |
| 13 | $1,018 | $0 | $3,141 | $5,411 | $4,990 | $0 | $2,281 | **$16,841** |
| 14 | $1,049 | $0 | $3,235 | $5,573 | $5,140 | $0 | $2,350 | **$17,346** |
| 15 | $1,080 | $5,007 | $3,332 | $5,740 | $5,294 | $0 | $2,420 | **$22,874** |
| 16 | $1,112 | $0 | $3,432 | $5,912 | $5,453 | $0 | $2,493 | **$18,403** |
| 17 | $1,146 | $0 | $3,535 | $6,090 | $5,616 | $4,814 | $2,568 | **$23,769** |
| 18 | $1,180 | $0 | $3,641 | $6,273 | $5,785 | $0 | $2,645 | **$19,523** |
| 19 | $1,216 | $0 | $3,750 | $6,461 | $5,959 | $0 | $2,724 | **$20,109** |
| 20 | $1,252 | $5,805 | $3,863 | $6,655 | $6,137 | $0 | $2,806 | **$26,517** |
| 21 | $1,290 | $0 | $3,979 | $6,854 | $6,321 | $5,418 | $2,890 | **$26,752** |
| 22 | $1,328 | $0 | $4,098 | $7,060 | $6,511 | $0 | $2,976 | **$21,974** |
| 23 | $1,368 | $0 | $4,221 | $7,272 | $6,706 | $0 | $3,066 | **$22,633** |
| 24 | $1,409 | $0 | $4,348 | $7,490 | $6,908 | $0 | $3,158 | **$23,312** |
| 25 | $1,451 | $0 | $4,478 | $7,714 | $7,115 | $0 | $3,252 | **$24,011** |

*3% Annual Cost Inflation*

**Annual Cost\* After Cost-Share of Implementing Livestock BMPs**

| Year | Vegetative Filter Strip | Relocate Feeding Pens | Relocate Pasture Feeding Site | Off Stream Watering System | Rotational Grazing | Fence off Stream or Pond | Grazing Mgmt Plan | Annual Cost |
|---|---|---|---|---|---|---|---|---|
| 1 | $357 | $1,655 | $1,102 | $1,898 | $1,750 | $1,500 | $800 | **$9,061** |
| 2 | $368 | $0 | $1,135 | $1,954 | $1,803 | $0 | $824 | **$6,083** |
| 3 | $379 | $0 | $1,169 | $2,013 | $1,857 | $0 | $849 | **$6,266** |
| 4 | $390 | $0 | $1,204 | $2,073 | $1,912 | $1,639 | $874 | **$8,093** |
| 5 | $402 | $1,863 | $1,240 | $2,136 | $1,970 | $0 | $900 | **$8,510** |
| 6 | $414 | $0 | $1,277 | $2,200 | $2,029 | $0 | $927 | **$6,847** |
| 7 | $426 | $0 | $1,315 | $2,266 | $2,090 | $0 | $955 | **$7,052** |
| 8 | $439 | $0 | $1,355 | $2,334 | $2,152 | $1,845 | $984 | **$9,108** |
| 9 | $452 | $0 | $1,395 | $2,404 | $2,217 | $0 | $1,013 | **$7,482** |
| 10 | $466 | $2,160 | $1,437 | $2,476 | $2,283 | $0 | $1,044 | **$9,866** |
| 11 | $480 | $0 | $1,480 | $2,550 | $2,352 | $0 | $1,075 | **$7,937** |
| 12 | $494 | $0 | $1,525 | $2,627 | $2,422 | $2,076 | $1,107 | **$10,252** |
| 13 | $509 | $0 | $1,570 | $2,705 | $2,495 | $0 | $1,141 | **$8,421** |
| 14 | $524 | $0 | $1,618 | $2,787 | $2,570 | $0 | $1,175 | **$8,673** |
| 15 | $540 | $2,504 | $1,666 | $2,870 | $2,647 | $0 | $1,210 | **$11,437** |
| 16 | $556 | $0 | $1,716 | $2,956 | $2,726 | $0 | $1,246 | **$9,201** |
| 17 | $573 | $0 | $1,768 | $3,045 | $2,808 | $2,407 | $1,284 | **$11,884** |
| 18 | $590 | $0 | $1,821 | $3,136 | $2,892 | $0 | $1,322 | **$9,762** |
| 19 | $608 | $0 | $1,875 | $3,230 | $2,979 | $0 | $1,362 | **$10,055** |
| 20 | $626 | $2,902 | $1,931 | $3,327 | $3,069 | $0 | $1,403 | **$13,259** |
| 21 | $645 | $0 | $1,989 | $3,427 | $3,161 | $2,709 | $1,445 | **$13,376** |
| 22 | $664 | $0 | $2,049 | $3,530 | $3,256 | $0 | $1,488 | **$10,987** |
| 23 | $684 | $0 | $2,111 | $3,636 | $3,353 | $0 | $1,533 | **$11,317** |
| 24 | $705 | $0 | $2,174 | $3,745 | $3,454 | $0 | $1,579 | **$11,656** |
| 25 | $726 | $0 | $2,239 | $3,857 | $3,557 | $0 | $1,626 | **$12,006** |

*3% Annual Cost Inflation*

| | | | Annual Phosphorus Load Reductions (lbs) | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Vegetative Filter Strip | Relocate Feeding Pens | Relocate Pasture Feeding Site | Off Stream Watering System | Rotational Grazing | Fence off Stream or Pond | Grazing Mgmt Plan | Annual Load Reduction |
| 1 | 1,276 | 1,276 | 120 | 120 | 140 | 80 | 562 | **3,574** |
| 2 | 2,552 | 1,276 | 240 | 240 | 280 | 80 | 1,124 | **5,792** |
| 3 | 3,827 | 1,276 | 360 | 360 | 420 | 80 | 1,686 | **8,009** |
| 4 | 5,103 | 1,276 | 480 | 480 | 560 | 160 | 2,248 | **10,307** |
| 5 | 6,379 | 2,552 | 600 | 600 | 700 | 160 | 2,810 | **13,801** |
| 6 | 7,655 | 2,552 | 720 | 720 | 840 | 160 | 3,372 | **16,019** |
| 7 | 8,930 | 2,552 | 840 | 840 | 980 | 160 | 3,934 | **18,236** |
| 8 | 10,206 | 2,552 | 960 | 960 | 1,120 | 240 | 4,496 | **20,534** |
| 9 | 11,482 | 2,552 | 1,080 | 1,080 | 1,260 | 240 | 5,058 | **22,752** |
| 10 | 12,758 | 3,828 | 1,200 | 1,200 | 1,400 | 240 | 5,620 | **26,246** |
| 11 | 14,033 | 3,828 | 1,320 | 1,320 | 1,540 | 240 | 6,182 | **28,463** |
| 12 | 15,309 | 3,828 | 1,440 | 1,440 | 1,680 | 320 | 6,744 | **30,761** |
| 13 | 16,585 | 3,828 | 1,560 | 1,560 | 1,820 | 320 | 7,306 | **32,979** |
| 14 | 17,861 | 3,828 | 1,680 | 1,680 | 1,960 | 320 | 7,868 | **35,197** |
| 15 | 19,136 | 5,104 | 1,800 | 1,800 | 2,100 | 320 | 8,430 | **38,690** |
| 16 | 20,412 | 5,104 | 1,920 | 1,920 | 2,240 | 320 | 8,992 | **40,908** |
| 17 | 21,688 | 5,104 | 2,040 | 2,040 | 2,380 | 400 | 9,554 | **43,206** |
| 18 | 22,964 | 5,104 | 2,160 | 2,160 | 2,520 | 400 | 10,116 | **45,424** |
| 19 | 24,239 | 5,104 | 2,280 | 2,280 | 2,660 | 400 | 10,678 | **47,641** |
| 20 | 25,515 | 6,380 | 2,400 | 2,400 | 2,800 | 400 | 11,240 | **51,135** |
| 21 | 26,791 | 6,380 | 2,520 | 2,520 | 2,940 | 480 | 11,802 | **53,433** |
| 22 | 28,067 | 6,380 | 2,640 | 2,640 | 3,080 | 480 | 12,364 | **55,651** |
| 23 | 29,342 | 6,380 | 2,760 | 2,760 | 3,220 | 480 | 12,926 | **57,868** |
| 24 | 30,618 | 6,380 | 2,880 | 2,880 | 3,360 | 480 | 13,488 | **60,086** |
| 25 | 31,894 | 6,380 | 3,000 | 3,000 | 3,500 | 480 | 14,050 | **62,304** |

| | | | | | | Annual Nitrogen Load Reduction (lbs) | | |
|---|---|---|---|---|---|---|---|---|
| Year | Vegetative Filter Strip | Relocate Feeding Pens | Relocate Pasture Feeding Site | Off Stream Watering System | Rotational Grazing | Fence off Stream or Pond | Grazing Mgmt Plan | Annual Load Reduction |
| 1 | 2,403 | 2,403 | 226 | 226 | 264 | 151 | 1,059 | **6,731** |
| 2 | 4,806 | 2,403 | 452 | 452 | 527 | 151 | 2,117 | **10,908** |
| 3 | 7,209 | 2,403 | 678 | 678 | 791 | 151 | 3,176 | **15,085** |
| 4 | 9,612 | 2,403 | 904 | 904 | 1,055 | 301 | 4,234 | **19,413** |
| 5 | 12,014 | 4,807 | 1,130 | 1,130 | 1,318 | 301 | 5,293 | **25,994** |
| 6 | 14,417 | 4,807 | 1,356 | 1,356 | 1,582 | 301 | 6,351 | **30,171** |
| 7 | 16,820 | 4,807 | 1,582 | 1,582 | 1,846 | 301 | 7,410 | **34,348** |
| 8 | 19,223 | 4,807 | 1,808 | 1,808 | 2,110 | 452 | 8,468 | **38,676** |
| 9 | 21,626 | 4,807 | 2,034 | 2,034 | 2,373 | 452 | 9,527 | **42,853** |
| 10 | 24,029 | 7,210 | 2,260 | 2,260 | 2,637 | 452 | 10,585 | **49,433** |
| 11 | 26,432 | 7,210 | 2,486 | 2,486 | 2,901 | 452 | 11,644 | **53,611** |
| 12 | 28,835 | 7,210 | 2,712 | 2,712 | 3,164 | 603 | 12,702 | **57,938** |
| 13 | 31,237 | 7,210 | 2,938 | 2,938 | 3,428 | 603 | 13,761 | **62,115** |
| 14 | 33,640 | 7,210 | 3,164 | 3,164 | 3,692 | 603 | 14,819 | **66,293** |
| 15 | 36,043 | 9,613 | 3,390 | 3,390 | 3,955 | 603 | 15,878 | **72,873** |
| 16 | 38,446 | 9,613 | 3,616 | 3,616 | 4,219 | 603 | 16,936 | **77,050** |
| 17 | 40,849 | 9,613 | 3,842 | 3,842 | 4,483 | 753 | 17,995 | **81,378** |
| 18 | 43,252 | 9,613 | 4,068 | 4,068 | 4,746 | 753 | 19,053 | **85,555** |
| 19 | 45,655 | 9,613 | 4,294 | 4,294 | 5,010 | 753 | 20,112 | **89,732** |
| 20 | 48,058 | 12,017 | 4,520 | 4,520 | 5,274 | 753 | 21,171 | **96,313** |
| 21 | 50,460 | 12,017 | 4,746 | 4,746 | 5,537 | 904 | 22,229 | **100,641** |
| 22 | 52,863 | 12,017 | 4,972 | 4,972 | 5,801 | 904 | 23,288 | **104,818** |
| 23 | 55,266 | 12,017 | 5,198 | 5,198 | 6,065 | 904 | 24,346 | **108,995** |
| 24 | 57,669 | 12,017 | 5,424 | 5,424 | 6,329 | 904 | 25,405 | **113,172** |
| 25 | 60,072 | 12,017 | 5,651 | 5,651 | 6,592 | 904 | 26,463 | **117,349** |

**Eldorado WRAPS Annual Rangeland Gully Repair Load Reductions and Cost**

| Year | Gully Repair | Soil Load Reduction (tons) | Cumulative Erosion Reduction (tons) | Phosphorus Reduction (lbs) | Cumulative P Load Reduction (lbs) | Cost* |
|---|---|---|---|---|---|---|
| 1 | 10 | 1,680 | 1,680 | 101 | 101 | $30,000 |
| 2 | 10 | 1,680 | 3,360 | 101 | 202 | $30,900 |
| 3 | 10 | 1,680 | 5,040 | 101 | 302 | $31,827 |
| 4 | 10 | 1,680 | 6,720 | 101 | 403 | $32,782 |
| 5 | 10 | 1,680 | 8,400 | 101 | 504 | $33,765 |
| 6 | 10 | 1,680 | 10,080 | 101 | 605 | $34,778 |
| 7 | 10 | 1,680 | 11,760 | 101 | 706 | $35,822 |
| 8 | 10 | 1,680 | 13,440 | 101 | 806 | $36,896 |
| 9 | 10 | 1,680 | 15,120 | 101 | 907 | $38,003 |
| 10 | 10 | 1,680 | 16,800 | 101 | 1,008 | $39,143 |
| 11 | 10 | 1,680 | 18,480 | 101 | 1,109 | $40,317 |
| 12 | 10 | 1,680 | 20,160 | 101 | 1,210 | $41,527 |
| 13 | 10 | 1,680 | 21,840 | 101 | 1,310 | $42,773 |
| 14 | 10 | 1,680 | 23,520 | 101 | 1,411 | $44,056 |
| 15 | 10 | 1,680 | 25,200 | 101 | 1,512 | $45,378 |
| 16 | 10 | 1,680 | 26,880 | 101 | 1,613 | $46,739 |
| 17 | 10 | 1,680 | 28,560 | 101 | 1,714 | $48,141 |
| 18 | 10 | 1,680 | 30,240 | 101 | 1,814 | $49,585 |
| 19 | 10 | 1,680 | 31,920 | 101 | 1,915 | $51,073 |
| 20 | 10 | 1,680 | 33,600 | 101 | 2,016 | $52,605 |
| 21 | 10 | 1,680 | 35,280 | 101 | 2,117 | $54,183 |
| 22 | 10 | 1,680 | 36,960 | 101 | 2,218 | $55,809 |
| 23 | 10 | 1,680 | 38,640 | 101 | 2,318 | $57,483 |
| 24 | 10 | 1,680 | 40,320 | 101 | 2,419 | $59,208 |
| 25 | 10 | 1,680 | 42,000 | 101 | 2,520 | $60,984 |

*3% Inflation*

**Eldorado WRAPS Rangeland Gully Repair by Sub-Watershed**

| Priority Area | Gully Repair (Number) | Cumulative Erosion Reduction (tons) | Cumulative P Load Reduction (lbs) | Cost* |
|---|---|---|---|---|
| 1 | 83 | 13,944 | 837 | $249,000 |
| 2 | 83 | 13,944 | 837 | $249,000 |
| 3 | 84 | 14,112 | 847 | $252,000 |
| **Total** | **250** | **42,000** | **2520** | **$750,000** |

*2011 Dollars*

# Total Phosphorus Reduction

| Year | Cropland Reduction | Livestock Reduction | Rangeland Gully Repair | Cropland Gully Repair | Streambank Stabilization | WS Dams (8) | Total Reduction (lbs) | % of TMDL |
|---|---|---|---|---|---|---|---|---|
| 1 | 314 | 3,574 | 101 | 20 | 30 | 2,133 | 6,171 | 10% |
| 2 | 628 | 5,792 | 202 | 59 | 60 | 4,266 | 11,006 | 18% |
| 3 | 942 | 8,009 | 302 | 78 | 90 | 6,399 | 15,821 | 26% |
| 4 | 1,257 | 10,307 | 403 | 117 | 120 | 8,532 | 20,736 | 34% |
| 5 | 1,571 | 13,801 | 504 | 137 | 150 | 10,665 | 26,827 | 44% |
| 6 | 1,885 | 16,019 | 605 | 176 | 180 | 12,798 | 31,662 | 52% |
| 7 | 2,199 | 18,236 | 706 | 195 | 210 | 14,931 | 36,477 | 60% |
| 8 | 2,513 | 20,534 | 806 | 234 | 240 | 17,064 | 41,392 | 68% |
| 9 | 2,827 | 22,752 | 907 | 254 | 270 | 17,064 | 44,074 | 72% |
| 10 | 3,142 | 26,246 | 1,008 | 293 | 300 | 17,064 | 48,052 | 79% |
| 11 | 3,456 | 28,463 | 1,109 | 312 | 330 | 17,064 | 50,734 | 83% |
| 12 | 3,770 | 30,761 | 1,210 | 351 | 360 | 17,064 | 53,515 | 88% |
| 13 | 4,084 | 32,979 | 1,310 | 371 | 390 | 17,064 | 56,198 | 92% |
| 14 | 4,398 | 35,197 | 1,411 | 410 | 420 | 17,064 | 58,899 | 97% |
| 15 | 4,712 | 38,690 | 1,512 | 429 | 450 | 17,064 | 62,858 | 103% |
| 16 | 5,026 | 40,908 | 1,613 | 468 | 480 | 17,064 | 65,559 | 107% |
| 17 | 5,341 | 43,206 | 1,714 | 488 | 510 | 17,064 | 68,321 | 112% |
| 18 | 5,655 | 45,424 | 1,814 | 527 | 540 | 17,064 | 71,023 | 116% |
| 19 | 5,969 | 47,641 | 1,915 | 546 | 570 | 17,064 | 73,705 | 121% |
| 20 | 6,283 | 51,135 | 2,016 | 585 | 600 | 17,064 | 77,683 | 127% |
| 21 | 6,597 | 53,433 | 2,117 | 605 | 630 | 17,064 | 80,445 | 132% |
| 22 | 6,911 | 55,651 | 2,218 | 644 | 660 | 17,064 | 83,147 | 136% |
| 23 | 7,225 | 57,868 | 2,318 | 663 | 690 | 17,064 | 85,829 | 141% |
| 24 | 7,540 | 60,086 | 2,419 | 702 | 720 | 17,064 | 88,531 | 145% |
| 25 | 7,854 | 62,304 | 2,520 | 722 | 750 | 17,064 | 91,213 | 150% |

**Phosphorous TMDL:**       **60,994**    **Pounds**

# Total Sediment Reduction

| Year | Cropland Reduction | Rangeland Gully Repair | Cropland Gully Repair | Streambank Stabilization | WS Dams (8) | Total Reduction (tons) | % of TMDL |
|---|---|---|---|---|---|---|---|
| 1 | 249 | 1,680 | 325 | 500 | 1,407 | **4,161** | 4% |
| 2 | 498 | 3,360 | 975 | 1,000 | 2,814 | **8,647** | 9% |
| 3 | 747 | 5,040 | 1,300 | 1,500 | 4,221 | **12,808** | 13% |
| 4 | 996 | 6,720 | 1,950 | 2,000 | 5,628 | **17,294** | 18% |
| 5 | 1,245 | 8,400 | 2,275 | 2,500 | 7,035 | **21,455** | 22% |
| 6 | 1,494 | 10,080 | 2,925 | 3,000 | 8,442 | **25,941** | 27% |
| 7 | 1,743 | 11,760 | 3,250 | 3,500 | 9,849 | **30,102** | 31% |
| 8 | 1,992 | 13,440 | 3,900 | 4,000 | 11,256 | **34,588** | 36% |
| 9 | 2,241 | 15,120 | 4,225 | 4,500 | 11,256 | **37,342** | 39% |
| 10 | 2,490 | 16,800 | 4,875 | 5,000 | 11,256 | **40,421** | 42% |
| 11 | 2,739 | 18,480 | 5,200 | 5,500 | 11,256 | **43,175** | 45% |
| 12 | 2,988 | 20,160 | 5,850 | 6,000 | 11,256 | **46,254** | 48% |
| 13 | 3,237 | 21,840 | 6,175 | 6,500 | 11,256 | **49,008** | 51% |
| 14 | 3,486 | 23,520 | 6,825 | 7,000 | 11,256 | **52,087** | 54% |
| 15 | 3,736 | 25,200 | 7,150 | 7,500 | 11,256 | **54,842** | 57% |
| 16 | 3,985 | 26,880 | 7,800 | 8,000 | 11,256 | **57,921** | 60% |
| 17 | 4,234 | 28,560 | 8,125 | 8,500 | 11,256 | **60,675** | 63% |
| 18 | 4,483 | 30,240 | 8,775 | 9,000 | 11,256 | **63,754** | 67% |
| 19 | 4,732 | 31,920 | 9,100 | 9,500 | 11,256 | **66,508** | 69% |
| 20 | 4,981 | 33,600 | 9,750 | 10,000 | 11,256 | **69,587** | 73% |
| 21 | 5,230 | 35,280 | 10,075 | 10,500 | 11,256 | **72,341** | 76% |
| 22 | 5,479 | 36,960 | 10,725 | 11,000 | 11,256 | **75,420** | 79% |
| 23 | 5,728 | 38,640 | 11,050 | 11,500 | 11,256 | **78,174** | 82% |
| 24 | 5,977 | 40,320 | 11,700 | 12,000 | 11,256 | **81,253** | 85% |
| 25 | 6,226 | 42,000 | 12,025 | 12,500 | 11,256 | **84,007** | 88% |

**Sediment TMDL:**     95,767     **Tons**

# S. Description and Table of Estimated annual Financial and Technical Assistance Costs for BMP Implementation Including Anticipated Sources of Assistance

## Additional Assessment Work

### Kansas Water Office, El Dorado Lake Watershed Streambank Erosion Assessment

The Kansas Water Office (KWO) completed an assessment for the El Dorado Lake Watershed Restoration and Protection Strategy (WRAPS) Stakeholder Leadership Team (SLT) in 2011. The study identified reaches of streams where erosion is most severe in the watershed above El Dorado Lake. This comparison study was designed to guide prioritization of streambank restoration. The study concluded probable high flow event runoffs from rangelands and agricultural lands via ephemeral gullies, and bridge crossings that are continually undercut by high flow events could be contributing to the sedimentation rate. The study concluded these occurrences were not a part of this assessment but should be assessed in the future.

Assessment Need: Surveying of ephemeral gullies in rangeland, cropland and bridge crossings to estimate sediment loss from these areas. Identify 2 sites in each sub-basin for a total of 12 sites, surveying sites, calculating soil loss. Propose surveying for baseline data first year, then re-surveying at least once a year for 5 years provided a flood event occurs.

### Stream Bank Erosion

The SWAT model (From the *Walnut River Basin, Kansas - Feasibility Report – El Dorado Lake, Kansas - Watershed Management Plan – January 2007)* details information for each reach in the watershed and indicates that a majority of the sediment that reaches El Dorado Lake is due to channel degradation. Of the estimated annual average 149,700 t/yr sediment reaching El Dorado Lake, 130,660 t/yr (87.3%) is attributed, in the SWAT modeling effort, to sediment transport within (degradation of) stream channels. The model, as constructed, is not capable of precisely identifying locations where degradation occurs, but can identify approximate subbasin reaches susceptible to degradation.

As a result of the SWAT model findings, a stream channel sediment survey/assessment was initiated in the WRAPS 2010 grant for the purpose of verifying the SWAT model prediction as well as to determine whether sediment is coming from stream banks and/or channels and determining the tons of sediment/year that can be attributed to stream banks and channels. Seven surveys were completed in the watershed; however, no significant rainfall has occurred since October 2010 for us to return to the sites to re-survey for the calculations.

Need: Hire Phil Balch to return to Watershed to re-survey sites after several flood events, then calculate soil loss from channel and streambanks.
$5,000.00 for time, travel and lodging expenses. 50 hours x $100/hour
Need: Students to assist with resurveying.
15 students training/surveying – total hours=240 at $12/hr = $2,880.00.

**Sediment survey of El Dorado Lake.** (From the *Walnut River Basin, Kansas - Feasibility Report –
El Dorado Lake, Kansas - Watershed Management Plan – January 2007*)

One of the objectives of the Feasibility Study was to determine the amount and location of sediment accumulation and evaluate if the sedimentation rate is higher or lower than the design rate projection.   That update could not be accomplished during the study period. The November/December 2004 bathymetric survey utilized a different and more accurate method of determining the sediment surface in the reservoir when compared to previous sediment surveys. The results of the survey indicate that the conservation pool volume originally estimated for the reservoir prior to construction was still available in 2004.  While the updated storage estimate is encouraging, the results do not provide information useful for updating the sedimentation rate or projecting points in time where sedimentation will impact water supply or other project purposes. The purposes of conducting a new survey include determining the current reservoir volume and updating the projection of the sedimentation rate. A future bathymetric survey or other sediment assessment will be required before the sedimentation rate can be updated. The 2004 data will be the baseline for estimating a sedimentation rate in the future.


The timing of the next survey is important.  If conducted prior to the occurrence of several large flood events, the survey will not provide information useful in forecasting sedimentation because the depth of additional sediment will likely be less than the accuracy of a bathymetric survey (current technology). For a survey to be effective in aiding in the forecasting of sedimentation rates, the deposition of sediment above the 2004 sediment surface should exceed a minimum of one foot in depth across a majority of the reservoir area. Most of the sediment that enters a reservoir occurs during flood events. Therefore, several large flood events would have to occur before an additional foot of sediment would be deposited. The overall thickness of the sediment layer is also influenced by the weight of the water column, the characteristics of the sediment particles, and compaction of the sediment layer.  To be economically mindful, a resurvey would be conducted when enough sediment was deposited so that a measurable change in lake volume would be meaningful for monitoring and forecasting water supply storage.  Resurvey schedules based solely on time intervals pose risks of conducting surveys (too soon) that provide minimal information and of conducting surveys (too late) where sediment volumes have accumulated faster than expected and may be impacting project purposes. To be reliable an additional accumulation of sediment that exceeded one to two foot of depth and covered a large percentage of the reservoir area would be required. (Note: A two foot layer of sediment uniformly deposited in the conservation pool would represent about a 10 percent reduction in conservation pool storage based on the 2004 bathymetric survey.)  The Oklahoma Water Resources Board recommended a ten year survey period or a large interim flood event.   According to the Tulsa Corps of Engineers rainfall and elevation data at El Dorado dam, there were 4 months where water behind the dam was 5' or more above conservation pool, August 2005, September 2008, and April and May 2009.  This data would indicate major flooding in the watershed above the Lake.

Need:  To determine whether enough sediment has accumulated, flood data could be further researched by Kansas Biological Survey to assure at least one foot of sediment has entered the Lake since December 2004, AND/OR periodic sampling by KBS at defined lake locations would provide an economical approach to monitor sediment accumulation and plan for the next bathymetric resurvey.  Core samples provide a method to gauge the accumulation of sediment.  The Kansas Biological Survey (KBS) conducts core sampling in association with state bathymetric surveys to estimate pre-survey sediment accumulations and to aid in scheduling resurveys. The KBS concurs with the general approach of bathymetric resurvey only after one to two feet of additional sediment have been deposited.  For about $3,000 (a one day effort), a series of sediment cores could be acquired and measured by KBS staff.

**Sediment Source Evaluation**

Another evaluation that can guide watershed planning and help in calibration of the SWAT model (From the *Walnut River Basin, Kansas - Feasibility Report – El Dorado Lake, Kansas - Watershed Management Plan – January 2007)* is a sediment source evaluation. The purpose of the evaluation is to estimate how much of the sediment being transported in a stream (or to a reservoir) originated from surface erosion (fields, crops, pasture, and prairie) and how much is contributed from channel erosion (channel sides and channel bottom). A sediment source evaluation requires that soil and sediment samples from fields, streams banks, and reservoir sediments be collected at several locations within the watershed. Using laboratory tests the sources of reservoir sediments can be determined and the relative amounts contributed from surface soil or channel erosion can be estimated.

Need:  Although this option may be duplicating efforts with the stream bank erosion assessment proposal for which Phil Balch, Wildhorse Riverworks is recruited, it may help to more accurately calibrate the SWAT model to test upland and channel sediments as well.  According to the Feasibility Study, a study of the El Dorado Lake watershed could be conducted by the USGS. No cost proposal has been prepared by the USGS, but a cost range of $200,000 to $300,000 is estimated for a similar study of sediment source evaluation of the El Dorado Lake watershed. Supporting funds from the USGS may be available to assist in conducting this type of evaluation.

**Determine reasonable levels of reduction for suspended sediments entering the lake from the watershed and from in lake erosion.**

Calibration of the SWAT model (From the *Walnut River Basin, Kansas - Feasibility Report – El Dorado Lake, Kansas - Watershed Management Plan – January 2007)* relied on an estimate of the sedimentation rate in El Dorado Lake. Because the sedimentation rate could not be updated using the latest bathymetric survey, the value used to calibrate the model was the original 1960's sedimentation forecast. When the sedimentation rate is eventually updated following another bathymetric survey the SWAT model can also be updated. Having a revised sedimentation rate will appreciably improve the reliability of watershed forecasting for upland and stream erosion rates. In general the model will reflect similar relative contributions from the five reservoir arms whether future sedimentation rates are higher or lower than the design sedimentation rate used to calibrate the model.

Results from the SWAT model indicate that grass filter strips could reduce a high percentage of sediments from lands used for row crop agriculture. However the model indicates that channel erosion would tend to offset the sediment reduction provided by grass buffers. If reducing reservoir sedimentation were the only concern, then the investment in grass buffers might not be viewed as justified. Grass buffers provide many other beneficial functions that are highly valuable.

Need:  Update the SWAT model using latest assessment information collected since 2010.

# Service Providers/Estimated Costs

| Service Provider | Technical Assistance Needs | Assessment Need | Estimated Costs/Year | Total Costs |
|---|---|---|---|---|
| Kansas Rural Center | River Friendly Farm Workshops/Field Visits | KRC will assist the Eldorado Lake WRAPS Watershed in the identification/implementation of Best Management Practices in Livestock Management and Cropland Management in identified targeted sub-watersheds, and assist producers with RFFP completions. 12 Workshops in 25 years. | $ 4,000.00 | $ 48,000.00 |
| Wildhorse Riverworks - Phil Balch | Stream Erosion Assessment Survey | As a result of the SWAT model findings, a stream channel sediment survey/assessment was initiated in the WRAPS 2010 grant for the purpose of verifying the SWAT model prediction as well as to determine whether sediment is coming from stream banks and/or channels and determining the tons of sediment/year that can be attributed to stream banks and channels. Seven surveys were completed in the watershed; however, no significant rainfall has occurred since October 2010 for us to return to the sites to re-survey for the calculations. One assessment every 5 years. | $ 5,500.00 | $ 27,500.00 |
| United States Geological Survey | Sediment Source Evaluation | A sediment source evaluation would guide watershed planning and help in calibration of the SWAT model to show which areas are contributing the most sediment. It requires that soil and sediment samples from fields, streams banks, channel sides, channel bottoms and reservoir sediments be collected at several locations within the watershed then laboratory tested to estimate sediment contributed from surface soil or channel erosion. Although this option may be duplicating efforts with the stream bank erosion assessment proposal for which Phil Balch, Wildhorse Riverworks is recruited, it may help to more accurately calibrate the SWAT model to test upland and channel sediments as well. | $ 300,000.00 | $300,000.00 |
| Kansas Biological Survey | Core Sampling | Core Sampling and Bathymetric Survey update. The City of El Dorado had KBS conduct another Bathymetric survey in 2010. Not all the samples have been tested to date. Data from the most recent survey needs to be completed then correlated to the 2004 survey to determine a more accurate sedimentation rate. | $ 2,500.00 | $ 2,500.00 |
| Kansas Water Office/KDHE | Update SWAT Model | Update the SWAT model using latest assessment information collected since 2010. | $ 5,500.00 | $ 5,500.00 |
| Natural Resources Conservation Service | Technical/Financial Assistance to Farmers and Ranchers | Provide technical and surveying assistance to farmers and ranchers on cropland and rangeland conservation/erosion issues in the watershed and provide information on available USDA finanical assistance programs. | NA | NA |
| Farm Services Agency | USDA Program Assistance | Provide assistance with Conservation Reserve Program (CRP) and other USDA programs offered to farmers and ranchers in the watershed. | NA | NA |
| City of El Dorado | Water Testing | Provide assistance with the Water Quality Monitoring Program by testing water samples collected monthly by the WRAPS Coordinator. Tests to be run: nitrogen, phosphorus, fecal coliform or e-coli bacteria and total suspended solids. Three major streams tested once/month = 144 tests per year at $15/test. | $2,160.00 | $ 54,000.00 |
| K-State Research and Extension | Education/Information | Provide landowners and operators the latest educational information to help them run their operations as effectively as possible. | NA | NA |
| Kansas State University/City of El Dorado | Dredged Material Land Application Research Project | Research project to determine best suited land application of dredged material taken from upper ends of El Dorado Lake when lake level is low and material can be excavated. | $ 7,900.00 | $ 7,900.00 |
| Kansas Forest Service | Riparian/Forestland Management | Provide landowners advice on riparian management, tree harvesting and riparian buffers. | NA | NA |
| Kansas Department of Wildlife, Parks and Tourism | Wildlife/Habitat Management and management of Corps owned property around El | Assist landowners with wildlife/habitat management and assist farm operators of Corps owned property around the lake to implement brush management measures, establish buffers, control erosion and control noxious weeds. | NA | NA |
| US Army Corps of Engineers | Provide information regarding El Dorado Lake, Feasibiltiy Study and SWAT model Update. | Background information needed to update or incorporate into other assessments conducted through the grant period. | NA | NA |
| | | Total Service Provider Costs for 25 Years | | $445,400.00 |

## Assessment Needs, Additional Costs

| Assessment Need | Technical Assistance Needed | Financial Assistance Needed | Associated Costs | Total Cost |
|---|---|---|---|---|
| Surveying of ephemeral gullies in rangeland, cropland and bridge crossings to estimate sediment loss from these areas. | 36 hours/year for 5 years | $720.00 per year | Mileage - $350.00 | $3,950.00 |
| As a result of the SWAT model findings, a stream channel sediment survey/assessment was initiated in the WRAPS 2010 grant for the purpose of verifying the SWAT model prediction as well as to determine whether sediment is coming from stream banks and/or channels and determining the tons of sediment/year that can be attributed to stream banks and channels. Seven surveys were completed in the watershed; however, no significant rainfall has occurred since October 2010 for us to return to the sites to re-survey for the calculations. | 1. Hire Phil Balch to return to Watershed to re-survey sites after several flood events, then calculate soil loss from channel and streambanks.  2. Hire students to assist with re-surveying. | Students' Time - 15 students; training/surveying - 240 hours x $12/hour = $2,880.00 | Surveying Equipment Rental - $300.00, Misc. Supplies - $250.00 | $ 17,150.00 |

## T. Description of I and E Activities and Estimated I and E Costs

## Development of an Information and Education Program

Education and Information – Most residents of Butler County don't live in the Upper Walnut Watershed; however a majority of those residents rely on El Dorado Lake for the water that comes out of their faucet at home.   A drop of water goes on an incredible journey from the time it drops out of the sky until it reaches the faucet at home, but there is an environmental disconnect between the water supply and the quality of water that comes out of our taps. Even though the majority of us don't live in the watershed where our water supply comes from, we all benefit from practices that reduce sediment and pollutants in our water supply, including cheap and good tasting water.  It stands to reason then, that all of us should take ownership in the water we drink.  The challenge for those who must portray this message is this:   what relationship should we cultivate to bring together the landowners and homeowners who live in the watershed to the rest of us who don't but who benefit from (or pay for) a safe, clean, dependable and long lived water supply.  The responsibility belongs to all of us.   We can choose to not do anything and hope there's water for our kids and grandkids in 40 years, or we can be realistic and insist that practices and programs be put in place now to protect our water supply for future generations.  The problem with informing and educating everyone is that each of us learns differently.  A newsletter or brochure for one individual is great, but another individual likes the one on one contact to discuss programs or options.  Others prefer tours or workshops or field days to learn how practices protect water quality. Still others prefer their information come from a different agency or association before they will really start to listen.  Sometimes change in thinking occurs because a child has learned something at school or on a field trip and the child teaches the parents.  There will always be those who are complacent no matter what the issue.   Many times a crisis has to occur before anyone takes action.   With water, that is not a good option.  The goal should be to inform and educate as many people as possible by whichever methods work best. Below are methods used in previous grant s with some additions to inform and educate the general public.   It will be important to include partner agencies in this program to assure that all services are offered:  Partner agencies include NRCS, K-State Research and Extension, Farm Services Agency, City of El Dorado, Kansas Rural Center, Farm Bureau, Kansas Livestock Association.

## U. Information and Education For General Project Awareness

| Information and Educational Activity | Time Frame | Estimated Cost | Target Audience | Cooperators |
|---|---|---|---|---|
| One on One Contacts | Ongoing | Mileage $300/year | Farmers and Ranchers | Stakeholder Leadership Team, Natural Resources Conservation Service, K-State Research and Extension, Kansas Rural Center, Butler County Conservation District, City of El Dorado |
| Newsletter | Quarterly | $650/ Newsletter | All Residents | Natural Resources Conservation Service, K-State Research and Extension, Kansas Rural Center, Butler County Conservation District, City of El Dorado |
| Educational Brochures, Pamphlets, etc | As Needed | $100/year | All Residents | Natural Resources Conservation Service, K-State Research and Extension, Kansas Rural Center, Butler County Conservation District, City of El Dorado |
| River Friendly Farm Workshops | Odd Years | $500/ Workshop | Farmers and Ranchers | Stakeholder Leadership Team, Natural Resources Conservation Service, K-State Research and Extension, Kansas Rural Center, Butler County Conservation District, City of El Dorado |
| Walnut River Water Festival | Yearly | None | 4th and 5th Graders | Natural Resources Conservation Service, K-State Research and Extension, Kansas Rural Center, Butler County Conservation District, City of El Dorado |
| Educational Presentations | Yearly | Mileage $300/year | All Residents | Natural Resources Conservation Service, K-State Research and Extension, Kansas Rural Center, Butler County Conservation District, City of El Dorado |
| Show me the Money Workshop – to highlight cost share programs, resources available. | Even Years | $200/ Workshop | All Residents | Stakeholder Leadership Team, Natural Resources Conservation Service, K-State Research and Extension, Kansas Rural Center, Butler County Conservation District, City of El Dorado |
| Tours and watershed events for non-watershed residents such as a water quality geocaching search, bicycle/5k race/run, journey of water fair, day on the farm. | Yearly | $1000/Event | All Residents | Stakeholder Leadership Team, Natural Resources Conservation Service, K-State Research and Extension, Kansas Rural Center, Butler County Conservation District, City of El Dorado |
| Special Events such as Women's Breakfast and Donuts and Coffee in Cassoday or Rosalia to talk about cost share programs, etc. | Quarterly | $150/ Quarter | All Residents | Stakeholder Leadership Team, Natural Resources Conservation Service, K-State Research and Extension, Kansas Rural Center, Butler County Conservation District, City of El Dorado |

## V. Information and Education Activities to Address Adoption, Operation and Maintenance of Rangeland, Cropland, Livestock and Stream Bank Activities

| General BMP Addressed | BMP Specific Practices | Information and Educational Activity | Time Frame | Estimated Cost | Target Audience | Cooperators |
|---|---|---|---|---|---|---|
| Cropland | Permanent Vegetation, Grassed Waterways, No-Till and Reduced Till, Terraces, Nutrient Management Plans, Grade Stabilization Structures, Buffers and Field Borders, Cropland Gully Erosion, Cropland Reduction | No-till, Cropland Management Tour, Workshop or Field Day | Odd Years | $725 per event | Farmers and Ranchers | Natural Resources Conservation Service, K-State Research and Extension, Kansas Rural Center, Butler County Conservation District, City of El Dorado |
| Rangeland and Livestock | Vegetative Filter Strips, Relocation of Feeding Pens, Relocation of Pasture Feeding Sites, Off Stream Watering Systems, Rotational Grazing, Livestock Exclusion from Ponds and Streams, Grazing management Plans, Rangeland Gully Repair | Rangeland Management and/or Livestock/Nutrient Management Tour, Workshop or Field Day | Even Years | $675.00 per event | Farmers and Ranchers | Natural Resources Conservation Service, K-State Research and Extension, Kansas Rural Center, Butler County Conservation District, City of El Dorado |
| Streambank and Shoreline Protection | Streambank Stabilization, Shoreline Protection, Riparian Area Management | Stream Bank Stabilization Tour, Workshop or Field Day | Every 3 Years (odd) | $350 per event | Farmers, Ranchers and General I & E | Natural Resources Conservation Service, K-State Research and Extension, Kansas Rural Center, Butler County Conservation District, City of El Dorado |

**Financial and Technical Assistance Needed for Information and Education Program (25 Year Estimates)**

| Information and Education | Technical Assistance Needed | Financial Assistance Needed | Associated Costs | Total Costs |
|---|---|---|---|---|
| Education and Information - Promotion of BMP's, Cost Share Programs, Tours, Workshops, Field Days | Implementation of Rangeland, No-till, Stream Bank Stabilization and Livestock Management Tours, Workshops and Field Days for the 25 year plan. | $24,400.00 for tours, workshops and field days | WRAPS Coordinator Time - 632 hours/year @ $20/hr x 25 years = $316,000.00; Mileage - 500 miles/year x 25 yrs @ $0.55/mile = $6,875.00 | $347,275.00 |
| One on One Contacts | NRCS, Kansas Rural Center | Mileage $300 miles/year x 25 years = $4,125.00 | WRAPS Coordinator Time - 150 hours/year @ $20/hr x 25 years = $75,000.00 | $79,125.00 |
| Newsletter | None | Four newsletters/yr = 100 newsletters x $650/newsletter = $65,000.00 | WRAPS Coordinator Time - 96 hours/year @ $20/hr x 25 years = $48,000.00 | $113,000.00 |
| Brochures, Pamphlets, etc | None | $100/year x 24 years = $2,500.00 | None | $2,500.00 |
| River Friendly Farm Workshops | Kansas Rural Center Field Coordinator Time and Mileage - $2,500.00 x 12 years = $30,000.00 | $500/Workshop every other year (12 workshops) = $6,000.00; Six Incentive Payments/Workshop @ $250 each x 12 years = $18,000.00 | Water Quality Coordinator Time - 70 hours/year @ $20/yr x 12 workshops = $16,800.00; Mileage = 400 miles/year x 12 years x $0.55/mile = $2,640.00 | $73,440.00 |
| Walnut River Water Festival | None | None | None | None |
| Educational Presentations | None | Educational Supplies - $300/yr x 25 years = $7,500.00 | Coordinator Time - 40 hours/year @ $20/hr x 25 years = $20,000.00 | $27,500.00 |

## Financial and Technical Assistance Needed for Information and Education Program (Continued)

| Information and Education | Technical Assistance Needed | Financial Assistance Needed | Associated Costs | Total Costs |
|---|---|---|---|---|
| Show me the Money Workshop – to highlight cost share programs, resources available. | NRCS, FSA, Kansas Rural Center, K-State Research and Extension, City of El Dorado, etc. to explain cost share and other finanical assistance programs available. | $200/ Workshop x 12 workshops = $2,400.00 | Water Quality Coordinator Time - 20 hours/year x $20/hr x 12 years = $4,800.00 | $7,200.00 |
| Tours and watershed events for non-watershed residents such as a water quality geocaching search, bicycle/5k race/run, journey of water fair, day on the farm. | None | $1,000/Event x 25 years = $25,000.00 | Water Quality Coordinator Time - 60 hours/year x $20/hr x 25 years = $30,000.00 | $55,000.00 |
| Special Events such as Women's Breakfast and Donuts and Coffee in Cassoday or Rosalia to talk about cost share programs, etc. | Representatives from NRCS, FSA, Kansas Rural Center, K-State Research and Extension, City of El Dorado, etc. to explain cost share and other finanical assistance programs available. | $50/ Quarter x 25 years = $5,000.00 | Water Quality Coordinator Time - 32 hours/year x $20/hr x 25 years = $16,000.00; Mileage = 400 miles/year x 25 years = 10,000 miles x $0.55/mile = $5,500.00 | $26,500.00 |
| **Totals** | **$45,000.00** | **$140,725.00** | **541,615.00** | **$731,540.00** |

## Estimated Financial and Technical Assistance Table

### Total Annual WRAPS Cost after Cost-Share

| Year | Cropland | Livestock | Streambank | Range Gullies | I&E | Technical Assistance | Total Annual Cost |
|---|---|---|---|---|---|---|---|
| 1 | $17,223 | $9,061 | $96,580 | $30,000 | $22,248 | $8,492 | $183,605 |
| 2 | $17,740 | $6,083 | $99,477 | $30,900 | $22,915 | $8,747 | $185,863 |
| 3 | $18,272 | $6,266 | $102,462 | $31,827 | $23,603 | $9,009 | $191,439 |
| 4 | $18,820 | $8,093 | $105,536 | $32,782 | $24,311 | $9,279 | $198,821 |
| 5 | $19,385 | $8,510 | $108,702 | $33,765 | $25,040 | $9,558 | $204,960 |
| 6 | $19,967 | $6,847 | $111,963 | $34,778 | $25,792 | $9,845 | $209,190 |
| 7 | $20,566 | $7,052 | $115,322 | $35,822 | $26,565 | $10,140 | $215,466 |
| 8 | $21,183 | $9,108 | $118,781 | $36,896 | $27,362 | $10,444 | $223,775 |
| 9 | $21,818 | $7,482 | $122,345 | $38,003 | $28,183 | $10,757 | $228,588 |
| 10 | $22,473 | $9,866 | $126,015 | $39,143 | $29,029 | $11,080 | $237,605 |
| 11 | $23,147 | $7,937 | $129,795 | $40,317 | $29,899 | $11,413 | $242,509 |
| 12 | $23,841 | $10,252 | $133,689 | $41,527 | $30,796 | $11,755 | $251,860 |
| 13 | $24,556 | $8,421 | $137,700 | $42,773 | $31,720 | $12,108 | $257,278 |
| 14 | $25,293 | $8,673 | $141,831 | $44,056 | $32,672 | $12,471 | $264,996 |
| 15 | $26,052 | $11,437 | $146,086 | $45,378 | $33,652 | $12,845 | $275,450 |
| 16 | $26,833 | $9,201 | $150,468 | $46,739 | $34,662 | $13,230 | $281,134 |
| 17 | $27,638 | $11,884 | $154,983 | $48,141 | $35,702 | $13,627 | $291,975 |
| 18 | $28,468 | $9,762 | $159,632 | $49,585 | $36,773 | $14,036 | $298,255 |
| 19 | $29,322 | $10,055 | $164,421 | $51,073 | $37,876 | $14,457 | $307,203 |
| 20 | $30,201 | $13,259 | $169,354 | $52,605 | $39,012 | $14,891 | $319,322 |
| 21 | $31,107 | $13,376 | $174,434 | $54,183 | $40,182 | $15,337 | $328,621 |
| 22 | $32,041 | $10,987 | $179,667 | $55,809 | $41,388 | $15,798 | $335,689 |
| 23 | $33,002 | $11,317 | $185,057 | $57,483 | $42,629 | $16,272 | $345,760 |
| 24 | $33,992 | $11,656 | $190,609 | $59,208 | $43,908 | $16,760 | $356,132 |
| 25 | $35,012 | $12,006 | $196,327 | $60,984 | $45,226 | $17,262 | $366,816 |

## W. Water Quality Milestones to Determine Improvements

The primary goal that is focused on within the El Dorado Lake WRAPS Watershed Plan is restoration of water quality of El Dorado Lake for designated uses supportive of aquatic life, domestic water supply, recreation, and other designated uses for the El Dorado Lake watershed. The plan specifically addresses TMDLs and 303(d) listings for El Dorado Lake. The following is a list of the impairments being directly addressed by the plan:

**El Dorado Lake (KDHE Station LM030001)**
- High Priority Eutrophication TMDL
- High Priority Siltation TMDL

In order to reach the load reduction goals associated with the El Dorado Lake WRAPS Project Area impairments, an implementation schedule for BMP implementation spanning 25 years has been developed.

The selected practices included in the plan will be implemented throughout the targeted areas within the El Dorado Lake watershed.  Water quality milestones have been developed for El Dorado Lake as well as contributing tributaries within the watershed.  The purpose of the milestones and indicators is to measure water quality improvements associated with the implementation schedule contained in this plan.

## Monitoring Sites in the El Dorado Lake WRAPS Project Area

Water quality milestones contained in this section are tied to the KDHE monitoring station on El Dorado Lake as well as stream monitoring sites which Butler Community College has monitored within the watershed.  These milestones were developed as a mechanism to monitor water quality conditions within El Dorado Lake was well as contributing streams which will be positively affected by the BMP implementation schedule included in this plan.  The stations listed below will be utilized to measure water quality improvements throughout the implementation of the plan.

| Station ID | Water Body | Type of Station |
|---|---|---|
| LM030001 | El Dorado Lake | KDHE - Lake |
| | Cole Creek | Butler C.C. |
| | Walnut River | Butler C.C. |
| | Durechen Creek | Butler C.C. |
| | Satchel Creek | Butler C.C. |
| | Bemis/Harrison Creek | Butler C.C. |
| | Shady Creek | Butler C.C. |

# El Dorado Lake WRAPS
# Water Monitoring Network
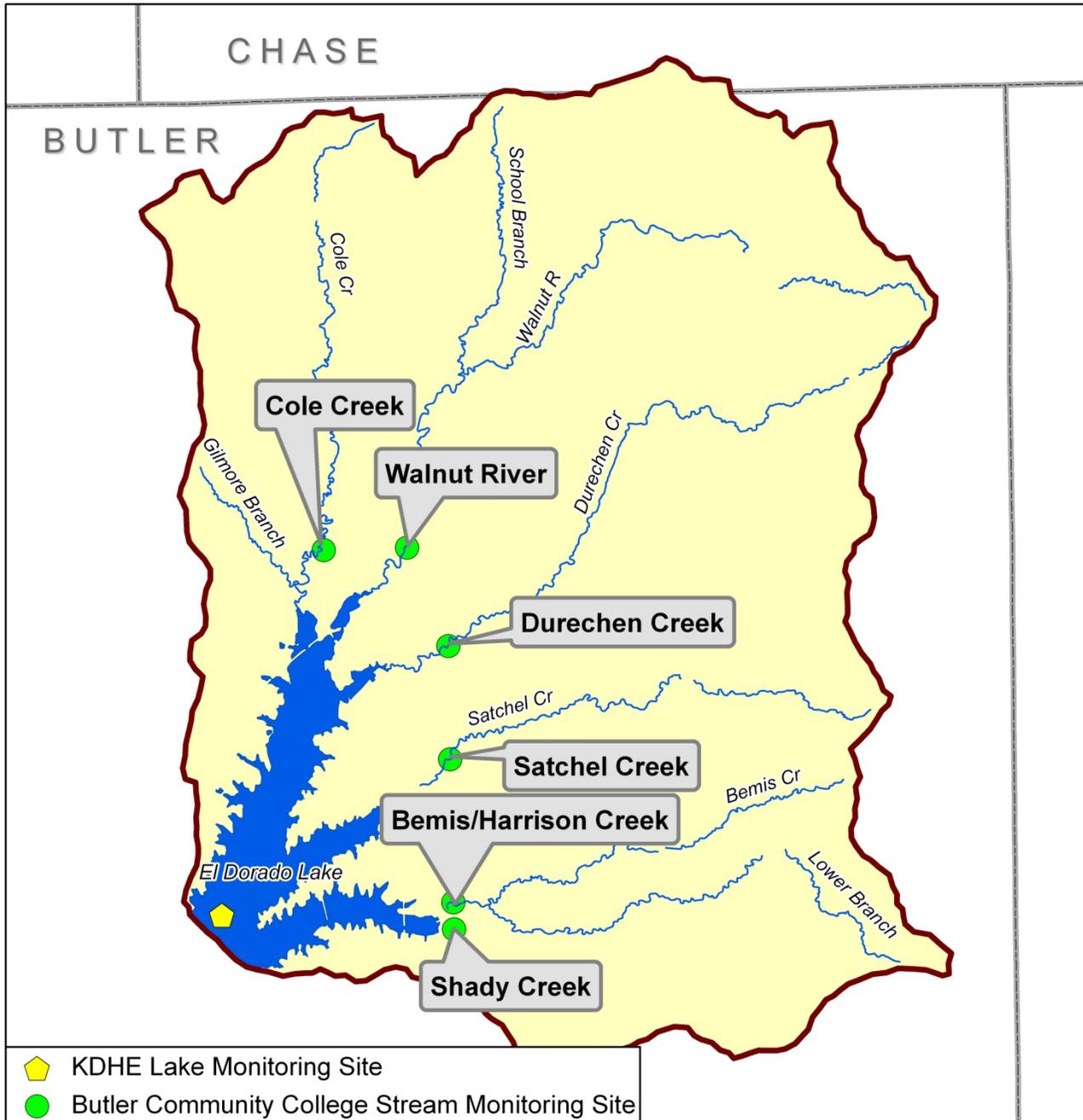


The purpose of this publication is to illustrate general watershed conditions in the state of Kansas. This map product is provided without representation or implied or expressed warranty of accuracy and is intended for watershed planning purposes only. The originating agency is not responsible for publication or use of this product for any other purpose. This product may be corrected or updated as necessary without prior notification.

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Department of Health
and Environment
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The previous map shows both El Dorado Lake as well as the stream monitoring network from which Butler Community College collected water quality monitoring data dating back from 1995 to 2007. The Butler Community College stream monitoring sites were sampled for various water quality parameters including bacteria, total suspended solids, and phosphorus. Sampling took place every two to four weeks during the period of sampling for these sites. With the absence of KDHE stream monitoring data within the El Dorado Lake watershed, the El Dorado Lake WRAPS project hopes to utilize this stream monitoring data to help establish baseline water quality conditions for the tributaries feeding El Dorado Lake. Future stream monitoring efforts within the watershed could be compared to this data set to evaluate progress being made on reduction of nutrient and sediment loads entering El Dorado Lake.

The KDHE lake monitoring sites are typically sampled once every 3 years between April and October. KDHE lake monitoring sites are sampled for chlorophyll a, total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), turbidity, dissolved oxygen, and secchi disk depth. The pollutant indicators tested for at each site may vary depending on the season at collection time and other factors.

In addition to the KDHE water quality monitoring, the U.S. Army Corps of Engineers conducts periodic sampling of El Dorado Lake. This monitoring typically takes place between April and October and includes chlorophyll a, total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), turbidity, dissolved oxygen, and secchi disk depth. This water quality monitoring data can be utilized as another dataset to evaluate improvements in water quality noted for El Dorado Lake over the duration of the watershed plan.

## Water Quality Milestones for El Dorado Lake WRAPS Project Area

As previously stated, this plan estimates that it will take 25 years to implement the planned BMPs necessary to meet the load reduction goals for the impairments being addressed in the El Dorado Lake WRAPS Project Area. Several water quality milestones and indicators have been developed, as included herein. The tables below include water quality goals for various parameters monitored in the watershed. It should be noted that stream monitoring data utilized for development of water quality milestones as included within the plan were not evaluated by the KDHE TMDL Section to make a determination as to whether or not the monitored water bodies are impaired or not. These data are to be utilized as a tool for local stakeholders to evaluate general improvements in water quality conditions for the tributaries feeding El Dorado Lake.

Phosphorus and total suspended solids data were evaluated to develop water quality milestones for El Dorado Lake watershed tributaries. These data indicate that the majority of phosphorus and sediment loading originating from the watershed results from high precipitation/high streamflow events. Minimizing sediment and nutrient runoff originating from grazed land as well as cropland during high precipitation events will help to mitigate silt and phosphorus loading contributing to the eutrophication and siltation TMDLs for El Dorado Lake.

| Water Quality Milestones for El Dorado Lake | | | | |
|---|---|---|---|---|
| | | **10-Year Goal** | | **Long Term Goal** |
| | **Current Condition (1996 - 2010) Chlorophyll a** | **Improved Condition (2011 - 2020) Chlorophyll a** | **Total Reduction Needed** | **Improved Condition Chlorophyll a** |
| **Sampling Site** | **Chlorophyll a (average of data collected during indicated period), ppb** | | | |
| El Dorado Lake LM030001 | 13 | 12 | 7.7% | **Maintain Average Chlorophyll a ≤ 10** |
| | | **10-Year Goal** | | **Long Term Goal** |
| | **Current Condition (1996 - 2010) Secchi (Avg)** | **Improved Condition (2011 - 2020)    Secchi (Avg)** | | **Improved Condition Secchi (Avg)** |
| **Sampling Site** | **Secchi (average of data collected during indicated period), m** | | | |
| El Dorado Lake LM030001 | 0.83 | **Secchi depth > 1.0** | | **Maintain Secchi depth > 1.0** |

| Water Quality Milestones for El Dorado Lake Tributaries | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| | Current Condition (1995-2007 Butler C.C.) | 10-Year Goal | | Long Term Goal | |
| | | Improved Condition (2012 - 2021) Median | Total Reduction Needed | Improved Condition Median | Total Reduction Needed |
| Sampling Site | Phosphorus (median value of dataset), µg/L | | | | |
| Cole Creek | 400 | 360 | 10% | 200 | 50% |
| Walnut River | 260 | 234 | 10% | 182 | 30% |
| Durechen Creek | 300 | 270 | 10% | 200 | 33% |
| Satchel Creek | 400 | 360 | 10% | 200 | 50% |
| Bemis/Harrison Creek | 295 | 266 | 10% | 200 | 32% |
| Shady Creek | 300 | 270 | 10% | 200 | 33% |
| | | | | | |

| Water Quality Milestones for El Dorado Lake Tributaries | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| | Current Condition (1995-2007 Butler C.C.) | 10-Year Goal | | Long Term Goal | |
| | | Improved Condition (2012 - 2021) | Total Reduction Needed | Improved Condition | Total Reduction Needed |
| Sampling Site | Total Suspended Solids (90th percentile value of dataset), mg/L | | | | |
| Cole Creek | 111 | 100 | 10% | 78 | 30% |
| Walnut River | 68 | 61 | 10% | 48 | 30% |
| Durechen Creek | 69 | 62 | 10% | 48 | 30% |
| Satchel Creek | 96 | 86 | 10% | 67 | 30% |
| Bemis/Harrison Creek | 91 | 82 | 10% | 64 | 30% |
| Shady Creek | 75 | 68 | 10% | 53 | 30% |
| | | | | | |

## Additional Water Quality Indicators

In addition to the monitoring data, other water quality indicators can be utilized by KDHE and the SLT. Such indicators may include anecdotal information from the SLT and other citizen groups within the watershed (skin rash outbreaks, fish kills, nuisance odors), which can be used to assess short-term deviations from water quality standards. These additional indicators can act as trigger-points that might initiate further revisions or modifications to the WRAPS plan by KDHE and the SLT.

- Taste and odor issues from public water supplies utilizing water from El Dorado Lake
- Occurrence of algal blooms in El Dorado Lake
- Visitor traffic to El Dorado Lake
- Boating traffic in El Dorado Lake
- Trends of quantity and quality of fishing in El Dorado Lake
- Beach closings

## Evaluation of Monitoring Data

Monitoring data in the El Dorado Lake watershed will be used to determine water quality progress, track water quality milestones, and to determine the effectiveness of the implementation of conservation practices outlined in the plan. The schedule of review for the monitoring data will be tied to the water quality milestones that have been developed, as well as the frequency of the sampling data.

The implementation schedule and water quality milestones for the El Dorado Lake watershed extend through a 25-year period from 2011 to 2037. Throughout that period, KDHE will continue to analyze and evaluate the monitoring data collected. After the first ten years of monitoring and implementation of water quality protection best management practices, KDHE will evaluate the available water quality data to determine whether the water quality milestones have been achieved. If milestones are not achieved, KDHE will assist the El Dorado Lake WRAPS group to analyze and understand the context for non-achievement, as well as the need to review and/or revise the water quality milestones included in the plan. KDHE and the SLT can address any necessary modifications or revisions to the plan based on the data analysis. In 2037, at the end of the plan, a final determination can be made as to whether the water quality standards have been attained for El Dorado Lake.

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

## X. Description of Existing Water Quality Monitoring Network or Other Related Data Gathering that will be used to Evaluate Plan Success.

The existing water quality monitoring network includes KDHE's Lake Monitoring Program which is typically done on a 3 year rotation. Much of the evaluation and review of the sediment and eutrophication TMDL's will be based on water quality data collected by KDHE.

No permanent stream monitoring stations are located in the watershed above El Dorado Lake; therefore, no data except for the Butler County Conservation District / Butler Community College water monitoring program is available from streams. BCCD, in cooperation with BCC continues to take samples in the streams above El Dorado Lake and tests for fecal coliform bacteria using the membrane filtration technique. Test strips are used for nitrate and phosphorus. This monitoring program is more of an educational tool used to familiarize students with water monitoring. For evaluation, it might be beneficial to have a certified lab test samples from streams above El Dorado Lake for accurate reporting and WRAPS accountability.

One cost effective option for water sampling might be to have Conservation District Staff collect the samples and have City of El Dorado Water Department analyze the samples in their lab. There are 5 main tributary arms with specific outlets at El Dorado Lake. Water samples could be collected from these tributaries for testing on a monthly basis. Additional samples (for a total of 10 samples monthly) could be taken in high priority sub-watersheds as the WRAPS program progresses to help evaluate Best Management Practices and their effectiveness in controlling sediment and nutrient runoff from those areas. It would also be beneficial to move current water sampling collection points off bridges as these areas can skew the data collected. This information would be useful in updating or amending the WRAPS plan and further target practices that reduce nutrients and sediment.

As this is a small watershed, visual monitoring of stream and lake water resources by stakeholders, recreational users and agency personnel will be useful to identify and report algal blooms, fish kills, pipeline breaks, etc.

## Y. Supplemental Monitoring if Applicable and Estimate of Costs

1.  KDHE's Lake Monitoring Program will continue to be used for assessment.
2.  Work with the Kansas Biological Survey to complete the 2011 survey with the City of El Dorado.
3.  Explore partnering with the City of El Dorado to analyze samples in their certified lab with Conservation District staff collecting the samples on a regular basis. (BCCD staff time to collect samples = 4 hours per month x $20/hour = $960.00/year; City of El Dorado Staff time to analyze samples = 1 hour/month x $30/hour = $360.00/year; lab supplies for bacteria, total suspended solids, nitrate and phosphorus testing = $5/test x 4 tests/month x 12 months = $240.00/year; Total Cost = $1,560.00.
4.  Rainfall varies widely from the north end of the watershed to the south end, and from the east to the west. Establishing rain gauges in several areas of the watershed will help us determine flooding in specific areas of the watershed, such as where we have surveyed and set stream bank pins, so that we can show what amount of rainfall causes the majority of stream bank erosion as it occurs in the watershed. Rainfall data would also be useful for determining if additional water testing would need to be conducted. The National Weather Service has a voluntary rainfall collection project called CoCoRahs. This project requires volunteers to report precipitation via internet as it occurs.

This would not only give us valuable data, but it would allow stakeholders an opportunity to assist with the project in a non-threatening, helpful way.  The cost of the rain gauges is $26.25 plus shipping and we would need a minimum of 5 with an optimal number of 10.   Five gauges plus shipping and handling is estimated to cost $156.25; ten gauges plus shipping and handling is estimated to cost $312.50.

## Appendix A

http://www.kwo.org/projects_programs/Steambank_Assessments/Rpt_Draft_WAL_ED_SBErosionAssessment_052611_ap.pdf

## Appendix B

http://www.kwo.org/reports_publications/Reports/rpt_final_FS_COE_020808_db.pdf

## Appendix C

http://www.kdheks.gov/tmdl/watmdl.htm

## Appendix D

http://efotg.sc.egov.usda.gov/treemenuFS.aspx

## Appendix E

Additional data compiled by Josh Roe, Watershed Economist, KSU Office of Local Government, Agriculture Economics. This data reflects information for each priority area in the Watershed above El Dorado Lake.

**Livestock BMP Adoption by Priority Area**

| Priority Area | Vegetative Filter Strip | Relocate Feeding Site | Relocate Pasture Feeding Site | Off-Stream Watering System | Rotational Grazing | Fence Out Stream or Pond | Grazing Mgmt Plans |
|---|---|---|---|---|---|---|---|
| 1 | 20 | 2 | 20 | 20 | 10 | 2 | 15 |
| 2 | 20 | 2 | 20 | 20 | 10 | 2 | 15 |
| 3 | 10 | 1 | 10 | 10 | 5 | 1 | 20 |
| **Total** | 50 | 5 | 50 | 50 | 25 | 5 | 50 |

**Livestock BMP Cost Before Cost-Share by Priority Area**

| Priority Area | Vegetative Filter Strip | Relocate Feeding Site | Relocate Pasture Feeding Site | Off-Stream Watering System | Rotational Grazing | Fence Out Stream or Pond | Grazing Mgmt Plans |
|---|---|---|---|---|---|---|---|
| 1 | $14,280 | $13,242 | $44,060 | $75,900 | $70,000 | $12,000 | $24,000 |
| 2 | $14,280 | $13,242 | $44,060 | $75,900 | $70,000 | $12,000 | $24,000 |
| 3 | $7,140 | $6,621 | $22,030 | $37,950 | $35,000 | $6,000 | $32,000 |
| **Total** | $35,700 | $33,105 | $110,150 | $189,750 | $175,000 | $30,000 | $80,000 |

**Livestock BMP Cost After Cost-Share by Priority Area**

| Priority Area | Vegetative Filter Strip | Relocate Feeding Site | Relocate Pasture Feeding Site | Off-Stream Watering System | Rotational Grazing | Fence Out Stream or Pond | Grazing Mgmt Plans |
|---|---|---|---|---|---|---|---|
| 1 | $7,140 | $6,621 | $22,030 | $37,950 | $35,000 | $6,000 | $12,000 |
| 2 | $7,140 | $6,621 | $22,030 | $37,950 | $35,000 | $6,000 | $12,000 |
| 3 | $3,570 | $3,311 | $11,015 | $18,975 | $17,500 | $3,000 | $16,000 |
| **Total** | $17,850 | $16,553 | $55,075 | $94,875 | $87,500 | $15,000 | $40,000 |

**Livestock BMP Phosphorous Load Reduction by Priority Area**

| Priority Area | Vegetative Filter Strip | Relocate Feeding Site | Relocate Pasture Feeding Site | Off-Stream Watering System | Rotational Grazing | Fence Out Stream or Pond | Grazing Mgmt Plans |
|---|---|---|---|---|---|---|---|
| 1 | 12,758 | 2,552 | 1,200 | 1,200 | 1,400 | 160 | 4,215 |
| 2 | 12,758 | 2,552 | 1,200 | 1,200 | 1,400 | 160 | 4,215 |
| 3 | 6,379 | 1,276 | 600 | 600 | 700 | 80 | 5,620 |
| **Total** | 31,894 | 6,380 | 3,000 | 3,000 | 3,500 | 400 | 14,050 |

### Livestock BMP Nitrogen Load Reduction by Priority Area

| Priority Area | Vegetative Filter Strip | Relocate Feeding Site | Relocate Pasture Feeding Site | Off-Stream Watering System | Rotational Grazing | Fence Out Stream or Pond | Grazing Mgmt Plans |
|---|---|---|---|---|---|---|---|
| 1 | 24,029 | 4,807 | 2,260 | 2,260 | 2,637 | 301 | 7,939 |
| 2 | 24,029 | 4,807 | 2,260 | 2,260 | 2,637 | 301 | 7,939 |
| 3 | 12,014 | 2,403 | 1,130 | 1,130 | 1,318 | 151 | 10,585 |
| **Total** | 60,072 | 12,017 | 5,651 | 5,651 | 6,592 | 753 | 26,463 |

### Priority Area #1 Annual Adoption (treated acres), Cropland BMPs

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total Adoption |
|---|---|---|---|---|---|---|---|---|
| 1 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 2 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 3 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 4 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 5 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 6 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 7 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 8 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 9 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 10 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 11 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 12 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 13 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 14 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 15 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 16 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 17 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 18 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 19 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 20 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 21 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 22 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 23 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 24 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| 25 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |

**Priority Area #2 Annual Adoption (treated acres), Cropland BMPs**

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total Adoption |
|---|---|---|---|---|---|---|---|---|
| 1 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 2 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 3 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 4 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 5 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 6 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 7 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 8 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 9 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 10 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 11 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 12 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 13 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 14 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 15 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 16 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 17 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 18 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 19 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 20 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 21 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 22 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 23 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 24 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| 25 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |

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

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total Adoption |
|---|---|---|---|---|---|---|---|---|
| 1 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 2 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 3 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 4 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 5 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 6 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 7 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 8 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 9 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 10 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 11 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 12 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 13 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 14 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 15 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 16 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 17 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 18 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 19 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 20 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 21 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 22 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 23 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 24 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| 25 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |

## Priority Area #1 Annual Adoption (treated acres), Cropland BMPs

| | Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total Adoption |
|---|---|---|---|---|---|---|---|---|---|
| Short Term | 1 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 2 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 3 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 4 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 5 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| *Total* | | *106* | *53* | *211* | *159* | *53* | *106* | *159* | *846* |
| Medium Term | 6 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 7 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 8 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 9 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 10 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| *Total* | | *211* | *106* | *423* | *317* | *106* | *211* | *317* | *1,692* |
| Long Term | 11 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 12 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 13 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 14 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 15 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 16 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 17 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 18 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 19 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 20 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 21 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 22 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 23 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 24 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| | 25 | 21 | 11 | 42 | 32 | 11 | 21 | 32 | 169 |
| *Total* | | *529* | *264* | *1,057* | *793* | *264* | *529* | *793* | *4,229* |

**Priority Area #2 Annual Adoption (treated acres), Cropland BMPs**

| | Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total Adoption |
|---|---|---|---|---|---|---|---|---|---|
| Short Term | 1 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 2 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 3 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 4 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 5 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| *Total* | | *40* | *20* | *79* | *59* | *20* | *40* | *59* | *316* |
| Medium Term | 6 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 7 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 8 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 9 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 10 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| *Total* | | *79* | *40* | *158* | *119* | *40* | *79* | *119* | *632* |
| Long Term | 11 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 12 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 13 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 14 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 15 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 16 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 17 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 18 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 19 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 20 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 21 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 22 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 23 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 24 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| | 25 | 8 | 4 | 16 | 12 | 4 | 8 | 12 | 63 |
| *Total* | | *198* | *99* | *395* | *296* | *99* | *198* | *296* | *1,580* |

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

| | Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total Adoption |
|---|---|---|---|---|---|---|---|---|---|
| **Short Term** | 1 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 2 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 3 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 4 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 5 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| **Total** | | 26 | 13 | 52 | 39 | 13 | 26 | 39 | 206 |
| **Medium Term** | 6 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 7 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 8 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 9 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 10 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| **Total** | | 52 | 26 | 103 | 77 | 26 | 52 | 77 | 413 |
| **Long Term** | 11 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 12 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 13 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 14 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 15 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 16 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 17 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 18 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 19 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 20 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 21 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 22 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 23 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 24 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| | 25 | 5 | 3 | 10 | 8 | 3 | 5 | 8 | 41 |
| **Total** | | 129 | 65 | 258 | 194 | 65 | 129 | 194 | 1,032 |

## Priority Area #1 Annual Soil Erosion Reduction

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | 34 | 7 | 53 | 16 | 4 | 18 | 27 | 159 |
| 2 | 68 | 14 | 107 | 32 | 9 | 36 | 53 | 319 |
| 3 | 101 | 21 | 160 | 48 | 13 | 53 | 80 | 478 |
| 4 | 135 | 28 | 214 | 64 | 18 | 71 | 107 | 637 |
| 5 | 169 | 36 | 267 | 80 | 22 | 89 | 134 | 797 |
| 6 | 203 | 43 | 320 | 96 | 27 | 107 | 160 | 956 |
| 7 | 237 | 50 | 374 | 112 | 31 | 125 | 187 | 1,115 |
| 8 | 271 | 57 | 427 | 128 | 36 | 142 | 214 | 1,275 |
| 9 | 304 | 64 | 481 | 144 | 40 | 160 | 240 | 1,434 |
| 10 | 338 | 71 | 534 | 160 | 45 | 178 | 267 | 1,593 |
| 11 | 372 | 78 | 588 | 176 | 49 | 196 | 294 | 1,753 |
| 12 | 406 | 85 | 641 | 192 | 53 | 214 | 320 | 1,912 |
| 13 | 440 | 93 | 694 | 208 | 58 | 231 | 347 | 2,071 |
| 14 | 474 | 100 | 748 | 224 | 62 | 249 | 374 | 2,231 |
| 15 | 507 | 107 | 801 | 240 | 67 | 267 | 401 | 2,390 |
| 16 | 541 | 114 | 855 | 256 | 71 | 285 | 427 | 2,549 |
| 17 | 575 | 121 | 908 | 272 | 76 | 303 | 454 | 2,709 |
| 18 | 609 | 128 | 961 | 288 | 80 | 320 | 481 | 2,868 |
| 19 | 643 | 135 | 1,015 | 304 | 85 | 338 | 507 | 3,027 |
| 20 | 677 | 142 | 1,068 | 320 | 89 | 356 | 534 | 3,187 |
| 21 | 710 | 150 | 1,122 | 336 | 93 | 374 | 561 | 3,346 |
| 22 | 744 | 157 | 1,175 | 353 | 98 | 392 | 588 | 3,505 |
| 23 | 778 | 164 | 1,228 | 369 | 102 | 409 | 614 | 3,665 |
| 24 | 812 | 171 | 1,282 | 385 | 107 | 427 | 641 | 3,824 |
| 25 | 846 | 178 | 1,335 | 401 | 111 | 445 | 668 | 3,983 |

## Priority Area #2 Annual Soil Erosion Reduction

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | 12 | 3 | 19 | 6 | 2 | 6 | 9 | 56 |
| 2 | 24 | 5 | 38 | 11 | 3 | 13 | 19 | 113 |
| 3 | 36 | 8 | 57 | 17 | 5 | 19 | 28 | 169 |
| 4 | 48 | 10 | 76 | 23 | 6 | 25 | 38 | 226 |
| 5 | 60 | 13 | 95 | 28 | 8 | 32 | 47 | 282 |
| 6 | 72 | 15 | 114 | 34 | 9 | 38 | 57 | 339 |
| 7 | 84 | 18 | 132 | 40 | 11 | 44 | 66 | 395 |
| 8 | 96 | 20 | 151 | 45 | 13 | 50 | 76 | 452 |
| 9 | 108 | 23 | 170 | 51 | 14 | 57 | 85 | 508 |
| 10 | 120 | 25 | 189 | 57 | 16 | 63 | 95 | 564 |
| 11 | 132 | 28 | 208 | 62 | 17 | 69 | 104 | 621 |
| 12 | 144 | 30 | 227 | 68 | 19 | 76 | 114 | 677 |
| 13 | 156 | 33 | 246 | 74 | 20 | 82 | 123 | 734 |
| 14 | 168 | 35 | 265 | 79 | 22 | 88 | 132 | 790 |
| 15 | 180 | 38 | 284 | 85 | 24 | 95 | 142 | 847 |
| 16 | 192 | 40 | 303 | 91 | 25 | 101 | 151 | 903 |
| 17 | 204 | 43 | 322 | 96 | 27 | 107 | 161 | 960 |
| 18 | 216 | 45 | 341 | 102 | 28 | 114 | 170 | 1,016 |
| 19 | 228 | 48 | 359 | 108 | 30 | 120 | 180 | 1,072 |
| 20 | 240 | 50 | 378 | 114 | 32 | 126 | 189 | 1,129 |
| 21 | 252 | 53 | 397 | 119 | 33 | 132 | 199 | 1,185 |
| 22 | 264 | 55 | 416 | 125 | 35 | 139 | 208 | 1,242 |
| 23 | 276 | 58 | 435 | 131 | 36 | 145 | 218 | 1,298 |
| 24 | 288 | 61 | 454 | 136 | 38 | 151 | 227 | 1,355 |
| 25 | 300 | 63 | 473 | 142 | 39 | 158 | 236 | 1,411 |

## Priority Area #3 Annual Soil Erosion Reduction

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | 7 | 1 | 11 | 3 | 1 | 4 | 6 | 33 |
| 2 | 14 | 3 | 22 | 7 | 2 | 7 | 11 | 67 |
| 3 | 21 | 4 | 33 | 10 | 3 | 11 | 17 | 100 |
| 4 | 28 | 6 | 45 | 13 | 4 | 15 | 22 | 133 |
| 5 | 35 | 7 | 56 | 17 | 5 | 19 | 28 | 166 |
| 6 | 42 | 9 | 67 | 20 | 6 | 22 | 33 | 200 |
| 7 | 49 | 10 | 78 | 23 | 7 | 26 | 39 | 233 |
| 8 | 56 | 12 | 89 | 27 | 7 | 30 | 45 | 266 |
| 9 | 64 | 13 | 100 | 30 | 8 | 33 | 50 | 299 |
| 10 | 71 | 15 | 111 | 33 | 9 | 37 | 56 | 333 |
| 11 | 78 | 16 | 123 | 37 | 10 | 41 | 61 | 366 |
| 12 | 85 | 18 | 134 | 40 | 11 | 45 | 67 | 399 |
| 13 | 92 | 19 | 145 | 43 | 12 | 48 | 72 | 432 |
| 14 | 99 | 21 | 156 | 47 | 13 | 52 | 78 | 466 |
| 15 | 106 | 22 | 167 | 50 | 14 | 56 | 84 | 499 |
| 16 | 113 | 24 | 178 | 53 | 15 | 59 | 89 | 532 |
| 17 | 120 | 25 | 189 | 57 | 16 | 63 | 95 | 565 |
| 18 | 127 | 27 | 201 | 60 | 17 | 67 | 100 | 599 |
| 19 | 134 | 28 | 212 | 64 | 18 | 71 | 106 | 632 |
| 20 | 141 | 30 | 223 | 67 | 19 | 74 | 111 | 665 |
| 21 | 148 | 31 | 234 | 70 | 20 | 78 | 117 | 698 |
| 22 | 155 | 33 | 245 | 74 | 20 | 82 | 123 | 732 |
| 23 | 162 | 34 | 256 | 77 | 21 | 85 | 128 | 765 |
| 24 | 169 | 36 | 267 | 80 | 22 | 89 | 134 | 798 |
| 25 | 176 | 37 | 279 | 84 | 23 | 93 | 139 | 831 |

**Priority Area #1 Annual Phosphorous Runoff Reduction**

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|------|------|------|------|------|------|------|------|------|
| 1 | 50 | 11 | 42 | 24 | 7 | 26 | 39 | 199 |
| 2 | 100 | 21 | 84 | 47 | 13 | 53 | 79 | 397 |
| 3 | 150 | 32 | 126 | 71 | 20 | 79 | 118 | 596 |
| 4 | 200 | 42 | 168 | 95 | 26 | 105 | 158 | 795 |
| 5 | 250 | 53 | 211 | 118 | 33 | 132 | 197 | 994 |
| 6 | 300 | 63 | 253 | 142 | 39 | 158 | 237 | 1,192 |
| 7 | 350 | 74 | 295 | 166 | 46 | 184 | 276 | 1,391 |
| 8 | 400 | 84 | 337 | 190 | 53 | 211 | 316 | 1,590 |
| 9 | 450 | 95 | 379 | 213 | 59 | 237 | 355 | 1,789 |
| 10 | 500 | 105 | 421 | 237 | 66 | 263 | 395 | 1,987 |
| 11 | 550 | 116 | 463 | 261 | 72 | 290 | 434 | 2,186 |
| 12 | 600 | 126 | 505 | 284 | 79 | 316 | 474 | 2,385 |
| 13 | 650 | 137 | 548 | 308 | 86 | 342 | 513 | 2,584 |
| 14 | 700 | 147 | 590 | 332 | 92 | 369 | 553 | 2,782 |
| 15 | 750 | 158 | 632 | 355 | 99 | 395 | 592 | 2,981 |
| 16 | 800 | 168 | 674 | 379 | 105 | 421 | 632 | 3,180 |
| 17 | 850 | 179 | 716 | 403 | 112 | 448 | 671 | 3,379 |
| 18 | 900 | 190 | 758 | 426 | 118 | 474 | 711 | 3,577 |
| 19 | 950 | 200 | 800 | 450 | 125 | 500 | 750 | 3,776 |
| 20 | 1,000 | 211 | 842 | 474 | 132 | 526 | 790 | 3,975 |
| 21 | 1,050 | 221 | 884 | 498 | 138 | 553 | 829 | 4,174 |
| 22 | 1,100 | 232 | 927 | 521 | 145 | 579 | 869 | 4,372 |
| 23 | 1,150 | 242 | 969 | 545 | 151 | 605 | 908 | 4,571 |
| 24 | 1,200 | 253 | 1,011 | 569 | 158 | 632 | 948 | 4,770 |
| 25 | 1,250 | 263 | 1,053 | 592 | 165 | 658 | 987 | 4,969 |

**Priority Area #2 Annual Phosphorous Runoff Reduction**

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | 18 | 4 | 15 | 9 | 2 | 9 | 14 | 72 |
| 2 | 36 | 8 | 30 | 17 | 5 | 19 | 28 | 143 |
| 3 | 54 | 11 | 46 | 26 | 7 | 28 | 43 | 215 |
| 4 | 72 | 15 | 61 | 34 | 9 | 38 | 57 | 286 |
| 5 | 90 | 19 | 76 | 43 | 12 | 47 | 71 | 358 |
| 6 | 108 | 23 | 91 | 51 | 14 | 57 | 85 | 429 |
| 7 | 126 | 27 | 106 | 60 | 17 | 66 | 100 | 501 |
| 8 | 144 | 30 | 121 | 68 | 19 | 76 | 114 | 573 |
| 9 | 162 | 34 | 137 | 77 | 21 | 85 | 128 | 644 |
| 10 | 180 | 38 | 152 | 85 | 24 | 95 | 142 | 716 |
| 11 | 198 | 42 | 167 | 94 | 26 | 104 | 156 | 787 |
| 12 | 216 | 46 | 182 | 102 | 28 | 114 | 171 | 859 |
| 13 | 234 | 49 | 197 | 111 | 31 | 123 | 185 | 930 |
| 14 | 252 | 53 | 212 | 119 | 33 | 133 | 199 | 1,002 |
| 15 | 270 | 57 | 228 | 128 | 36 | 142 | 213 | 1,074 |
| 16 | 288 | 61 | 243 | 137 | 38 | 152 | 228 | 1,145 |
| 17 | 306 | 64 | 258 | 145 | 40 | 161 | 242 | 1,217 |
| 18 | 324 | 68 | 273 | 154 | 43 | 171 | 256 | 1,288 |
| 19 | 342 | 72 | 288 | 162 | 45 | 180 | 270 | 1,360 |
| 20 | 360 | 76 | 303 | 171 | 47 | 190 | 284 | 1,431 |
| 21 | 378 | 80 | 319 | 179 | 50 | 199 | 299 | 1,503 |
| 22 | 396 | 83 | 334 | 188 | 52 | 209 | 313 | 1,575 |
| 23 | 414 | 87 | 349 | 196 | 55 | 218 | 327 | 1,646 |
| 24 | 432 | 91 | 364 | 205 | 57 | 228 | 341 | 1,718 |
| 25 | 450 | 95 | 379 | 213 | 59 | 237 | 356 | 1,789 |

**Priority Area #3 Annual Phosphorous Runoff Reduction**

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | 11 | 2 | 9 | 5 | 1 | 6 | 9 | 44 |
| 2 | 22 | 5 | 19 | 10 | 3 | 12 | 17 | 88 |
| 3 | 33 | 7 | 28 | 16 | 4 | 17 | 26 | 131 |
| 4 | 44 | 9 | 37 | 21 | 6 | 23 | 35 | 175 |
| 5 | 55 | 12 | 46 | 26 | 7 | 29 | 44 | 219 |
| 6 | 66 | 14 | 56 | 31 | 9 | 35 | 52 | 263 |
| 7 | 77 | 16 | 65 | 37 | 10 | 41 | 61 | 307 |
| 8 | 88 | 19 | 74 | 42 | 12 | 46 | 70 | 351 |
| 9 | 99 | 21 | 84 | 47 | 13 | 52 | 78 | 394 |
| 10 | 110 | 23 | 93 | 52 | 15 | 58 | 87 | 438 |
| 11 | 121 | 26 | 102 | 57 | 16 | 64 | 96 | 482 |
| 12 | 132 | 28 | 111 | 63 | 17 | 70 | 104 | 526 |
| 13 | 143 | 30 | 121 | 68 | 19 | 75 | 113 | 570 |
| 14 | 154 | 33 | 130 | 73 | 20 | 81 | 122 | 614 |
| 15 | 165 | 35 | 139 | 78 | 22 | 87 | 131 | 657 |
| 16 | 176 | 37 | 149 | 84 | 23 | 93 | 139 | 701 |
| 17 | 188 | 39 | 158 | 89 | 25 | 99 | 148 | 745 |
| 18 | 199 | 42 | 167 | 94 | 26 | 104 | 157 | 789 |
| 19 | 210 | 44 | 176 | 99 | 28 | 110 | 165 | 833 |
| 20 | 221 | 46 | 186 | 104 | 29 | 116 | 174 | 877 |
| 21 | 232 | 49 | 195 | 110 | 30 | 122 | 183 | 920 |
| 22 | 243 | 51 | 204 | 115 | 32 | 128 | 192 | 964 |
| 23 | 254 | 53 | 214 | 120 | 33 | 134 | 200 | 1,008 |
| 24 | 265 | 56 | 223 | 125 | 35 | 139 | 209 | 1,052 |
| 25 | 276 | 58 | 232 | 131 | 36 | 145 | 218 | 1,096 |

## Priority Area #1 Annual Nitrogen Runoff Reduction

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | 237 | 50 | 125 | 112 | 31 | 62 | 187 | 805 |
| 2 | 474 | 100 | 250 | 225 | 62 | 125 | 375 | 1,611 |
| 3 | 712 | 150 | 375 | 337 | 94 | 187 | 562 | 2,416 |
| 4 | 949 | 200 | 499 | 449 | 125 | 250 | 749 | 3,221 |
| 5 | 1,186 | 250 | 624 | 562 | 156 | 312 | 936 | 4,027 |
| 6 | 1,423 | 300 | 749 | 674 | 187 | 375 | 1,124 | 4,832 |
| 7 | 1,661 | 350 | 874 | 787 | 218 | 437 | 1,311 | 5,637 |
| 8 | 1,898 | 400 | 999 | 899 | 250 | 499 | 1,498 | 6,443 |
| 9 | 2,135 | 449 | 1,124 | 1,011 | 281 | 562 | 1,686 | 7,248 |
| 10 | 2,372 | 499 | 1,249 | 1,124 | 312 | 624 | 1,873 | 8,053 |
| 11 | 2,609 | 549 | 1,373 | 1,236 | 343 | 687 | 2,060 | 8,858 |
| 12 | 2,847 | 599 | 1,498 | 1,348 | 375 | 749 | 2,247 | 9,664 |
| 13 | 3,084 | 649 | 1,623 | 1,461 | 406 | 812 | 2,435 | 10,469 |
| 14 | 3,321 | 699 | 1,748 | 1,573 | 437 | 874 | 2,622 | 11,274 |
| 15 | 3,558 | 749 | 1,873 | 1,686 | 468 | 936 | 2,809 | 12,080 |
| 16 | 3,796 | 799 | 1,998 | 1,798 | 499 | 999 | 2,997 | 12,885 |
| 17 | 4,033 | 849 | 2,123 | 1,910 | 531 | 1,061 | 3,184 | 13,690 |
| 18 | 4,270 | 899 | 2,247 | 2,023 | 562 | 1,124 | 3,371 | 14,496 |
| 19 | 4,507 | 949 | 2,372 | 2,135 | 593 | 1,186 | 3,558 | 15,301 |
| 20 | 4,745 | 999 | 2,497 | 2,247 | 624 | 1,249 | 3,746 | 16,106 |
| 21 | 4,982 | 1,049 | 2,622 | 2,360 | 655 | 1,311 | 3,933 | 16,912 |
| 22 | 5,219 | 1,099 | 2,747 | 2,472 | 687 | 1,373 | 4,120 | 17,717 |
| 23 | 5,456 | 1,149 | 2,872 | 2,585 | 718 | 1,436 | 4,308 | 18,522 |
| 24 | 5,693 | 1,199 | 2,997 | 2,697 | 749 | 1,498 | 4,495 | 19,328 |
| 25 | 5,931 | 1,249 | 3,121 | 2,809 | 780 | 1,561 | 4,682 | 20,133 |

## Priority Area #2 Annual Nitrogen Runoff Reduction

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | 84 | 18 | 44 | 40 | 11 | 22 | 67 | 286 |
| 2 | 169 | 36 | 89 | 80 | 22 | 44 | 133 | 573 |
| 3 | 253 | 53 | 133 | 120 | 33 | 67 | 200 | 859 |
| 4 | 337 | 71 | 178 | 160 | 44 | 89 | 266 | 1,145 |
| 5 | 422 | 89 | 222 | 200 | 55 | 111 | 333 | 1,432 |
| 6 | 506 | 107 | 266 | 240 | 67 | 133 | 400 | 1,718 |
| 7 | 590 | 124 | 311 | 280 | 78 | 155 | 466 | 2,005 |
| 8 | 675 | 142 | 355 | 320 | 89 | 178 | 533 | 2,291 |
| 9 | 759 | 160 | 400 | 360 | 100 | 200 | 599 | 2,577 |
| 10 | 844 | 178 | 444 | 400 | 111 | 222 | 666 | 2,864 |
| 11 | 928 | 195 | 488 | 440 | 122 | 244 | 733 | 3,150 |
| 12 | 1,012 | 213 | 533 | 479 | 133 | 266 | 799 | 3,436 |
| 13 | 1,097 | 231 | 577 | 519 | 144 | 289 | 866 | 3,723 |
| 14 | 1,181 | 249 | 622 | 559 | 155 | 311 | 932 | 4,009 |
| 15 | 1,265 | 266 | 666 | 599 | 166 | 333 | 999 | 4,296 |
| 16 | 1,350 | 284 | 710 | 639 | 178 | 355 | 1,066 | 4,582 |
| 17 | 1,434 | 302 | 755 | 679 | 189 | 377 | 1,132 | 4,868 |
| 18 | 1,518 | 320 | 799 | 719 | 200 | 400 | 1,199 | 5,155 |
| 19 | 1,603 | 337 | 844 | 759 | 211 | 422 | 1,265 | 5,441 |
| 20 | 1,687 | 355 | 888 | 799 | 222 | 444 | 1,332 | 5,727 |
| 21 | 1,771 | 373 | 932 | 839 | 233 | 466 | 1,399 | 6,014 |
| 22 | 1,856 | 391 | 977 | 879 | 244 | 488 | 1,465 | 6,300 |
| 23 | 1,940 | 408 | 1,021 | 919 | 255 | 511 | 1,532 | 6,586 |
| 24 | 2,025 | 426 | 1,066 | 959 | 266 | 533 | 1,598 | 6,873 |
| 25 | 2,109 | 444 | 1,110 | 999 | 277 | 555 | 1,665 | 7,159 |

**Priority Area #3 Annual Nitrogen Runoff Reduction**

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | 52 | 11 | 28 | 25 | 7 | 14 | 41 | 178 |
| 2 | 105 | 22 | 55 | 50 | 14 | 28 | 83 | 356 |
| 3 | 157 | 33 | 83 | 74 | 21 | 41 | 124 | 534 |
| 4 | 210 | 44 | 110 | 99 | 28 | 55 | 165 | 712 |
| 5 | 262 | 55 | 138 | 124 | 34 | 69 | 207 | 889 |
| 6 | 314 | 66 | 165 | 149 | 41 | 83 | 248 | 1,067 |
| 7 | 367 | 77 | 193 | 174 | 48 | 97 | 290 | 1,245 |
| 8 | 419 | 88 | 221 | 199 | 55 | 110 | 331 | 1,423 |
| 9 | 472 | 99 | 248 | 223 | 62 | 124 | 372 | 1,601 |
| 10 | 524 | 110 | 276 | 248 | 69 | 138 | 414 | 1,779 |
| 11 | 576 | 121 | 303 | 273 | 76 | 152 | 455 | 1,957 |
| 12 | 629 | 132 | 331 | 298 | 83 | 165 | 496 | 2,135 |
| 13 | 681 | 143 | 359 | 323 | 90 | 179 | 538 | 2,313 |
| 14 | 734 | 154 | 386 | 348 | 97 | 193 | 579 | 2,490 |
| 15 | 786 | 165 | 414 | 372 | 103 | 207 | 621 | 2,668 |
| 16 | 838 | 177 | 441 | 397 | 110 | 221 | 662 | 2,846 |
| 17 | 891 | 188 | 469 | 422 | 117 | 234 | 703 | 3,024 |
| 18 | 943 | 199 | 496 | 447 | 124 | 248 | 745 | 3,202 |
| 19 | 996 | 210 | 524 | 472 | 131 | 262 | 786 | 3,380 |
| 20 | 1,048 | 221 | 552 | 496 | 138 | 276 | 827 | 3,558 |
| 21 | 1,100 | 232 | 579 | 521 | 145 | 290 | 869 | 3,736 |
| 22 | 1,153 | 243 | 607 | 546 | 152 | 303 | 910 | 3,914 |
| 23 | 1,205 | 254 | 634 | 571 | 159 | 317 | 952 | 4,092 |
| 24 | 1,258 | 265 | 662 | 596 | 165 | 331 | 993 | 4,269 |
| 25 | 1,310 | 276 | 690 | 621 | 172 | 345 | 1,034 | 4,447 |

## Priority Area #1 Total Annual Cost Before Cost-Share, Cropland BMPs

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | $3,172 | $1,692 | $3,285 | $3,172 | $600 | $2,114 | $7,929 | $21,963 |
| 2 | $3,267 | $1,742 | $3,384 | $3,267 | $618 | $2,178 | $8,167 | $22,622 |
| 3 | $3,365 | $1,795 | $3,485 | $3,365 | $636 | $2,243 | $8,412 | $23,301 |
| 4 | $3,466 | $1,848 | $3,590 | $3,466 | $655 | $2,310 | $8,664 | $24,000 |
| 5 | $3,570 | $1,904 | $3,698 | $3,570 | $675 | $2,380 | $8,924 | $24,720 |
| 6 | $3,677 | $1,961 | $3,809 | $3,677 | $695 | $2,451 | $9,192 | $25,461 |
| 7 | $3,787 | $2,020 | $3,923 | $3,787 | $716 | $2,525 | $9,468 | $26,225 |
| 8 | $3,901 | $2,080 | $4,041 | $3,901 | $737 | $2,600 | $9,752 | $27,012 |
| 9 | $4,018 | $2,143 | $4,162 | $4,018 | $759 | $2,678 | $10,044 | $27,822 |
| 10 | $4,138 | $2,207 | $4,287 | $4,138 | $782 | $2,759 | $10,346 | $28,657 |
| 11 | $4,262 | $2,273 | $4,415 | $4,262 | $806 | $2,842 | $10,656 | $29,516 |
| 12 | $4,390 | $2,341 | $4,548 | $4,390 | $830 | $2,927 | $10,976 | $30,402 |
| 13 | $4,522 | $2,412 | $4,684 | $4,522 | $855 | $3,015 | $11,305 | $31,314 |
| 14 | $4,658 | $2,484 | $4,825 | $4,658 | $880 | $3,105 | $11,644 | $32,253 |
| 15 | $4,797 | $2,559 | $4,969 | $4,797 | $907 | $3,198 | $11,993 | $33,221 |
| 16 | $4,941 | $2,635 | $5,118 | $4,941 | $934 | $3,294 | $12,353 | $34,218 |
| 17 | $5,089 | $2,714 | $5,272 | $5,089 | $962 | $3,393 | $12,724 | $35,244 |
| 18 | $5,242 | $2,796 | $5,430 | $5,242 | $991 | $3,495 | $13,105 | $36,302 |
| 19 | $5,399 | $2,880 | $5,593 | $5,399 | $1,021 | $3,600 | $13,499 | $37,391 |
| 20 | $5,561 | $2,966 | $5,761 | $5,561 | $1,051 | $3,708 | $13,904 | $38,512 |
| 21 | $5,728 | $3,055 | $5,934 | $5,728 | $1,083 | $3,819 | $14,321 | $39,668 |
| 22 | $5,900 | $3,147 | $6,112 | $5,900 | $1,115 | $3,933 | $14,750 | $40,858 |
| 23 | $6,077 | $3,241 | $6,295 | $6,077 | $1,149 | $4,051 | $15,193 | $42,083 |
| 24 | $6,259 | $3,338 | $6,484 | $6,259 | $1,183 | $4,173 | $15,649 | $43,346 |
| 25 | $6,447 | $3,439 | $6,678 | $6,447 | $1,219 | $4,298 | $16,118 | $44,646 |

## Priority Area #2 Total Annual Cost Before Cost-Share, Cropland BMPs

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | $1,185 | $632 | $1,228 | $1,185 | $224 | $790 | $2,963 | $8,206 |
| 2 | $1,221 | $651 | $1,264 | $1,221 | $231 | $814 | $3,051 | $8,452 |
| 3 | $1,257 | $670 | $1,302 | $1,257 | $238 | $838 | $3,143 | $8,706 |
| 4 | $1,295 | $691 | $1,341 | $1,295 | $245 | $863 | $3,237 | $8,967 |
| 5 | $1,334 | $711 | $1,382 | $1,334 | $252 | $889 | $3,334 | $9,236 |
| 6 | $1,374 | $733 | $1,423 | $1,374 | $260 | $916 | $3,434 | $9,513 |
| 7 | $1,415 | $755 | $1,466 | $1,415 | $267 | $943 | $3,537 | $9,798 |
| 8 | $1,457 | $777 | $1,510 | $1,457 | $275 | $972 | $3,644 | $10,092 |
| 9 | $1,501 | $801 | $1,555 | $1,501 | $284 | $1,001 | $3,753 | $10,395 |
| 10 | $1,546 | $825 | $1,602 | $1,546 | $292 | $1,031 | $3,865 | $10,707 |
| 11 | $1,593 | $849 | $1,650 | $1,593 | $301 | $1,062 | $3,981 | $11,028 |
| 12 | $1,640 | $875 | $1,699 | $1,640 | $310 | $1,094 | $4,101 | $11,359 |
| 13 | $1,690 | $901 | $1,750 | $1,690 | $319 | $1,126 | $4,224 | $11,700 |
| 14 | $1,740 | $928 | $1,803 | $1,740 | $329 | $1,160 | $4,351 | $12,051 |
| 15 | $1,792 | $956 | $1,857 | $1,792 | $339 | $1,195 | $4,481 | $12,412 |
| 16 | $1,846 | $985 | $1,912 | $1,846 | $349 | $1,231 | $4,615 | $12,785 |
| 17 | $1,902 | $1,014 | $1,970 | $1,902 | $359 | $1,268 | $4,754 | $13,168 |
| 18 | $1,959 | $1,045 | $2,029 | $1,959 | $370 | $1,306 | $4,897 | $13,563 |
| 19 | $2,017 | $1,076 | $2,090 | $2,017 | $381 | $1,345 | $5,043 | $13,970 |
| 20 | $2,078 | $1,108 | $2,152 | $2,078 | $393 | $1,385 | $5,195 | $14,389 |
| 21 | $2,140 | $1,141 | $2,217 | $2,140 | $405 | $1,427 | $5,351 | $14,821 |
| 22 | $2,204 | $1,176 | $2,284 | $2,204 | $417 | $1,470 | $5,511 | $15,266 |
| 23 | $2,271 | $1,211 | $2,352 | $2,271 | $429 | $1,514 | $5,676 | $15,724 |
| 24 | $2,339 | $1,247 | $2,423 | $2,339 | $442 | $1,559 | $5,847 | $16,195 |
| 25 | $2,409 | $1,285 | $2,495 | $2,409 | $455 | $1,606 | $6,022 | $16,681 |

**Priority Area #3 Total Annual Cost Before Cost-Share, Cropland BMPs**

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|------|----------|----------|--------|----------|--------|--------|----------|---------|
| 1 | $774 | $413 | $802 | $774 | $146 | $516 | $1,935 | $5,360 |
| 2 | $797 | $425 | $826 | $797 | $151 | $531 | $1,993 | $5,521 |
| 3 | $821 | $438 | $851 | $821 | $155 | $547 | $2,053 | $5,686 |
| 4 | $846 | $451 | $876 | $846 | $160 | $564 | $2,114 | $5,857 |
| 5 | $871 | $465 | $902 | $871 | $165 | $581 | $2,178 | $6,033 |
| 6 | $897 | $479 | $929 | $897 | $170 | $598 | $2,243 | $6,214 |
| 7 | $924 | $493 | $957 | $924 | $175 | $616 | $2,310 | $6,400 |
| 8 | $952 | $508 | $986 | $952 | $180 | $635 | $2,380 | $6,592 |
| 9 | $980 | $523 | $1,016 | $980 | $185 | $654 | $2,451 | $6,790 |
| 10 | $1,010 | $539 | $1,046 | $1,010 | $191 | $673 | $2,525 | $6,993 |
| 11 | $1,040 | $555 | $1,077 | $1,040 | $197 | $693 | $2,600 | $7,203 |
| 12 | $1,071 | $571 | $1,110 | $1,071 | $203 | $714 | $2,678 | $7,419 |
| 13 | $1,104 | $589 | $1,143 | $1,104 | $209 | $736 | $2,759 | $7,642 |
| 14 | $1,137 | $606 | $1,177 | $1,137 | $215 | $758 | $2,842 | $7,871 |
| 15 | $1,171 | $624 | $1,213 | $1,171 | $221 | $780 | $2,927 | $8,107 |
| 16 | $1,206 | $643 | $1,249 | $1,206 | $228 | $804 | $3,015 | $8,351 |
| 17 | $1,242 | $662 | $1,287 | $1,242 | $235 | $828 | $3,105 | $8,601 |
| 18 | $1,279 | $682 | $1,325 | $1,279 | $242 | $853 | $3,198 | $8,859 |
| 19 | $1,318 | $703 | $1,365 | $1,318 | $249 | $878 | $3,294 | $9,125 |
| 20 | $1,357 | $724 | $1,406 | $1,357 | $257 | $905 | $3,393 | $9,399 |
| 21 | $1,398 | $746 | $1,448 | $1,398 | $264 | $932 | $3,495 | $9,681 |
| 22 | $1,440 | $768 | $1,492 | $1,440 | $272 | $960 | $3,600 | $9,971 |
| 23 | $1,483 | $791 | $1,536 | $1,483 | $280 | $989 | $3,708 | $10,270 |
| 24 | $1,528 | $815 | $1,582 | $1,528 | $289 | $1,018 | $3,819 | $10,578 |
| 25 | $1,573 | $839 | $1,630 | $1,573 | $297 | $1,049 | $3,933 | $10,896 |

## Priority Area #1 Total Annual Cost After Cost-Share, Cropland BMPs

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | $1,586 | $846 | $2,004 | $1,586 | $450 | $211 | $3,965 | $10,647 |
| 2 | $1,633 | $871 | $2,064 | $1,633 | $463 | $218 | $4,083 | $10,966 |
| 3 | $1,682 | $897 | $2,126 | $1,682 | $477 | $224 | $4,206 | $11,295 |
| 4 | $1,733 | $924 | $2,190 | $1,733 | $491 | $231 | $4,332 | $11,634 |
| 5 | $1,785 | $952 | $2,256 | $1,785 | $506 | $238 | $4,462 | $11,983 |
| 6 | $1,838 | $980 | $2,323 | $1,838 | $521 | $245 | $4,596 | $12,343 |
| 7 | $1,894 | $1,010 | $2,393 | $1,894 | $537 | $252 | $4,734 | $12,713 |
| 8 | $1,950 | $1,040 | $2,465 | $1,950 | $553 | $260 | $4,876 | $13,094 |
| 9 | $2,009 | $1,071 | $2,539 | $2,009 | $570 | $268 | $5,022 | $13,487 |
| 10 | $2,069 | $1,104 | $2,615 | $2,069 | $587 | $276 | $5,173 | $13,892 |
| 11 | $2,131 | $1,137 | $2,693 | $2,131 | $604 | $284 | $5,328 | $14,309 |
| 12 | $2,195 | $1,171 | $2,774 | $2,195 | $622 | $293 | $5,488 | $14,738 |
| 13 | $2,261 | $1,206 | $2,857 | $2,261 | $641 | $301 | $5,652 | $15,180 |
| 14 | $2,329 | $1,242 | $2,943 | $2,329 | $660 | $311 | $5,822 | $15,636 |
| 15 | $2,399 | $1,279 | $3,031 | $2,399 | $680 | $320 | $5,997 | $16,105 |
| 16 | $2,471 | $1,318 | $3,122 | $2,471 | $701 | $329 | $6,177 | $16,588 |
| 17 | $2,545 | $1,357 | $3,216 | $2,545 | $722 | $339 | $6,362 | $17,085 |
| 18 | $2,621 | $1,398 | $3,312 | $2,621 | $743 | $349 | $6,553 | $17,598 |
| 19 | $2,700 | $1,440 | $3,412 | $2,700 | $766 | $360 | $6,749 | $18,126 |
| 20 | $2,781 | $1,483 | $3,514 | $2,781 | $788 | $371 | $6,952 | $18,670 |
| 21 | $2,864 | $1,528 | $3,620 | $2,864 | $812 | $382 | $7,160 | $19,230 |
| 22 | $2,950 | $1,573 | $3,728 | $2,950 | $836 | $393 | $7,375 | $19,807 |
| 23 | $3,039 | $1,621 | $3,840 | $3,039 | $862 | $405 | $7,596 | $20,401 |
| 24 | $3,130 | $1,669 | $3,955 | $3,130 | $887 | $417 | $7,824 | $21,013 |
| 25 | $3,224 | $1,719 | $4,074 | $3,224 | $914 | $430 | $8,059 | $21,643 |

**Priority Area #2 Total Annual Cost After Cost-Share, Cropland BMPs**

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | $593 | $316 | $749 | $593 | $168 | $79 | $1,481 | $3,978 |
| 2 | $610 | $325 | $771 | $610 | $173 | $81 | $1,526 | $4,097 |
| 3 | $629 | $335 | $794 | $629 | $178 | $84 | $1,571 | $4,220 |
| 4 | $647 | $345 | $818 | $647 | $184 | $86 | $1,619 | $4,347 |
| 5 | $667 | $356 | $843 | $667 | $189 | $89 | $1,667 | $4,477 |
| 6 | $687 | $366 | $868 | $687 | $195 | $92 | $1,717 | $4,612 |
| 7 | $707 | $377 | $894 | $707 | $201 | $94 | $1,769 | $4,750 |
| 8 | $729 | $389 | $921 | $729 | $207 | $97 | $1,822 | $4,892 |
| 9 | $751 | $400 | $949 | $751 | $213 | $100 | $1,876 | $5,039 |
| 10 | $773 | $412 | $977 | $773 | $219 | $103 | $1,933 | $5,190 |
| 11 | $796 | $425 | $1,006 | $796 | $226 | $106 | $1,991 | $5,346 |
| 12 | $820 | $437 | $1,036 | $820 | $233 | $109 | $2,050 | $5,507 |
| 13 | $845 | $451 | $1,068 | $845 | $240 | $113 | $2,112 | $5,672 |
| 14 | $870 | $464 | $1,100 | $870 | $247 | $116 | $2,175 | $5,842 |
| 15 | $896 | $478 | $1,133 | $896 | $254 | $119 | $2,241 | $6,017 |
| 16 | $923 | $492 | $1,167 | $923 | $262 | $123 | $2,308 | $6,198 |
| 17 | $951 | $507 | $1,202 | $951 | $270 | $127 | $2,377 | $6,384 |
| 18 | $979 | $522 | $1,238 | $979 | $278 | $131 | $2,448 | $6,575 |
| 19 | $1,009 | $538 | $1,275 | $1,009 | $286 | $134 | $2,522 | $6,772 |
| 20 | $1,039 | $554 | $1,313 | $1,039 | $295 | $139 | $2,597 | $6,975 |
| 21 | $1,070 | $571 | $1,352 | $1,070 | $303 | $143 | $2,675 | $7,185 |
| 22 | $1,102 | $588 | $1,393 | $1,102 | $313 | $147 | $2,756 | $7,400 |
| 23 | $1,135 | $605 | $1,435 | $1,135 | $322 | $151 | $2,838 | $7,622 |
| 24 | $1,169 | $624 | $1,478 | $1,169 | $332 | $156 | $2,923 | $7,851 |
| 25 | $1,204 | $642 | $1,522 | $1,204 | $342 | $161 | $3,011 | $8,087 |

## Priority Area #3 Total Annual Cost After Cost-Share, Cropland BMPs

| Year | Permanent Vegetation | Grassed Waterways | No-Till | Terraces | Nutrient Mgmt Plan | Buffers & Field Borders | Grade Stabilization Structures | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | $387 | $206 | $489 | $387 | $110 | $52 | $968 | $2,598 |
| 2 | $399 | $213 | $504 | $399 | $113 | $53 | $997 | $2,676 |
| 3 | $411 | $219 | $519 | $411 | $116 | $55 | $1,026 | $2,757 |
| 4 | $423 | $226 | $534 | $423 | $120 | $56 | $1,057 | $2,839 |
| 5 | $436 | $232 | $550 | $436 | $124 | $58 | $1,089 | $2,924 |
| 6 | $449 | $239 | $567 | $449 | $127 | $60 | $1,122 | $3,012 |
| 7 | $462 | $246 | $584 | $462 | $131 | $62 | $1,155 | $3,103 |
| 8 | $476 | $254 | $601 | $476 | $135 | $63 | $1,190 | $3,196 |
| 9 | $490 | $261 | $620 | $490 | $139 | $65 | $1,226 | $3,291 |
| 10 | $505 | $269 | $638 | $505 | $143 | $67 | $1,262 | $3,390 |
| 11 | $520 | $277 | $657 | $520 | $147 | $69 | $1,300 | $3,492 |
| 12 | $536 | $286 | $677 | $536 | $152 | $71 | $1,339 | $3,597 |
| 13 | $552 | $294 | $697 | $552 | $156 | $74 | $1,379 | $3,705 |
| 14 | $568 | $303 | $718 | $568 | $161 | $76 | $1,421 | $3,816 |
| 15 | $585 | $312 | $740 | $585 | $166 | $78 | $1,463 | $3,930 |
| 16 | $603 | $322 | $762 | $603 | $171 | $80 | $1,507 | $4,048 |
| 17 | $621 | $331 | $785 | $621 | $176 | $83 | $1,553 | $4,170 |
| 18 | $640 | $341 | $808 | $640 | $181 | $85 | $1,599 | $4,295 |
| 19 | $659 | $351 | $833 | $659 | $187 | $88 | $1,647 | $4,423 |
| 20 | $679 | $362 | $858 | $679 | $192 | $90 | $1,697 | $4,556 |
| 21 | $699 | $373 | $883 | $699 | $198 | $93 | $1,747 | $4,693 |
| 22 | $720 | $384 | $910 | $720 | $204 | $96 | $1,800 | $4,834 |
| 23 | $742 | $395 | $937 | $742 | $210 | $99 | $1,854 | $4,979 |
| 24 | $764 | $407 | $965 | $764 | $217 | $102 | $1,909 | $5,128 |
| 25 | $787 | $420 | $994 | $787 | $223 | $105 | $1,967 | $5,282 |