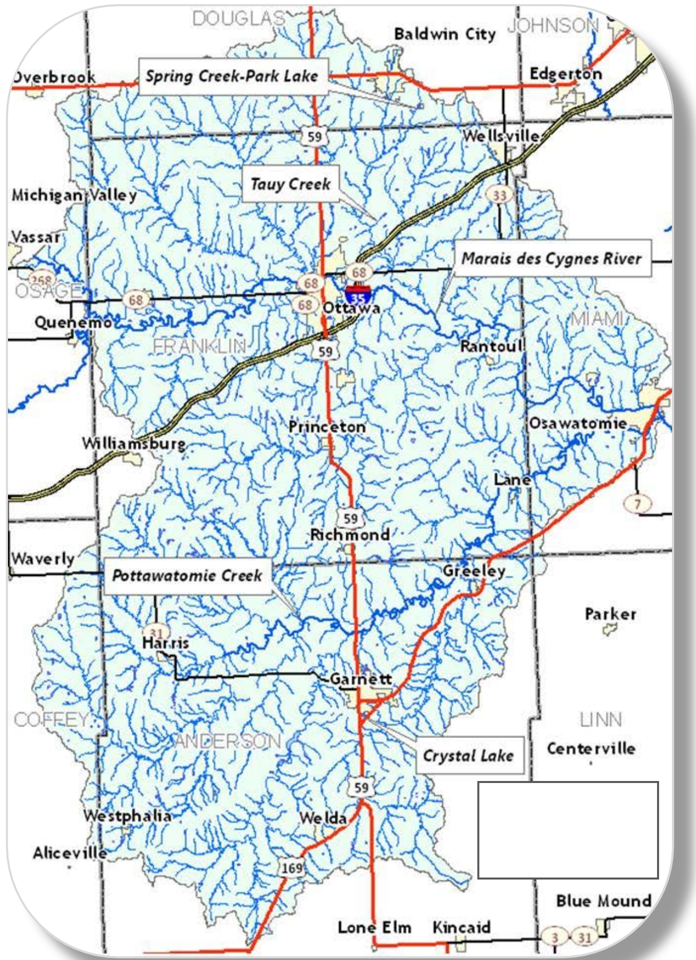
Middle Marais des Cynges Watershed Plan

Watershed Restoration and Protection Strategy



Water Quality Impairments Directly Addressed:

- Pottawatomie Creek near Osawatomie – Dissolved Oxygen (High Priority)
- Marais des Cygnes River near Ottawa – Bacteria (High Priority)

Other Impairments Positively Affected by Watershed Plan Implementation:

TMDLs

- Ottawa (Tauy) Creek Near Ottawa – Dissolved Oxygen (High Priority)
- Crystal Lake In Garnett – Eutrophication (Medium Priority)
- Spring Creek Park Lake Near Baldwin City – Eutrophication/Aquatic Plants (Low Priority)

303(d) List

- MdC River below Ottawa – Biological (Medium Priority) and Acute Copper (Medium Priority)
- MdC River above Ottawa (Richter) – Chronic Copper (Low Priority)
- Ottawa Creek – Acute Copper (Medium Priority)
- Appanoose Creek – Dissolved Oxygen (Low Priority)
- Cedar Creek Lake – Turbidity (Medium Priority) and Eutrophication (Low Priority)
- Richmond City Lake – Dissolved Oxygen (Medium Priority)
- Westphalia Lake – Turbidity (Low Priority)

Determination of Priority Areas

- Two riparian assessments were conducted by the Watershed Forester and Watershed Livestock Specialist to identify high priority sites within the watershed. A scoring system was established with eight different categories, channel conditions, bank stability, livestock access, riparian vegetation, canopy cover, riparian zone width, bank height, and stream habitat, to determine the quality of the site using the Stream Visual Assessment Protocol (NWCC Technical Note 99-1, 1998).
- Interpretation of KDHE monitoring data was completed identify targeted areas.
- Presence of High Priority TMDLs within the HUC 12 boundaries.
- Analysis of data and input from the SLT, the coordinator, and other interested parties identified two priority areas; one in the north and on in the south.

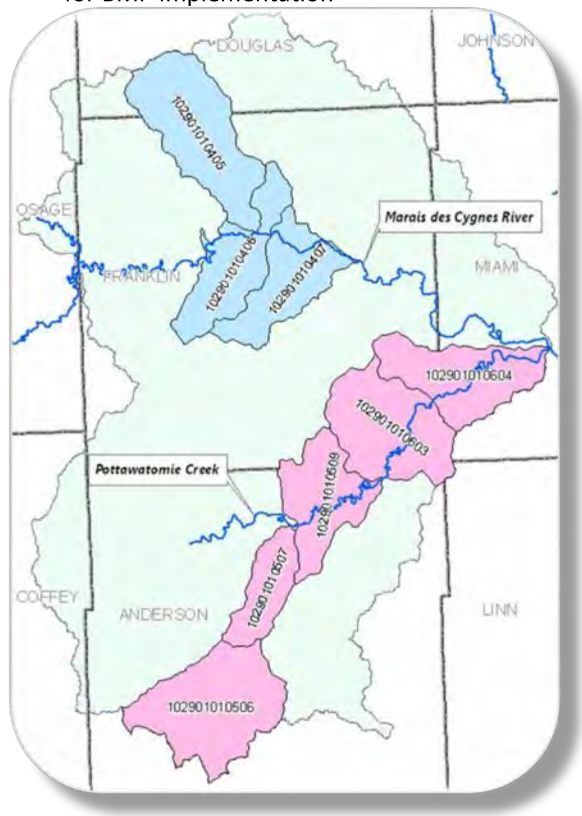
BMPs to be implemented:

- Vegetative Filter Strip
- Relocate Feeding Pens
- Relocate Pasture Feeding Site
- Off Stream Watering System
- Rotational Grazing
- Grazing Mgmt Plans
- Fence off Streams and Ponds
- Terraces and Waterways
- No-Till
- Nutrient Management Plans
- Vegetative and Riparian Buffers
- Grade Stabilization Structures

The load reduction goals for the watershed plan will be met within 12 years if BMPs are implemented as scheduled.

The total BMP implementation schedule to address identified conservation needs within the watershed covers 20 years.

Middle Marais des Cygnes Priority Areas for BMP Implementation



MdC River Load Reduction Goal

70,949 lbs/yr phosphorous load entering the Marais des Cygnes River − **55,070 lbs/yr is desired load for the Marais des Cygnes River** − **1,522 lbs/yr P Ottawa MS4 Waste Load Allocation** = **14,357 lbs/yr phosphorous reduction needed to meet the TMDL**

Pottawatomie Creek Phosphorous Load Reduction Goal

7,980 lbs/yr phosphorous load entering the Pottawatomie − **5,460 lbs/yr is desired load for Pottawatomie Creek** = **2,520 lbs/yr phosphorous reduction needed to meet the TMDL**

Pottawatomie Creek Sediment Load Reduction Goal

1,040 tons/yr sediment load entering the Pottawatomie Creek − **910 tons/yr is desired sediment load for Pottawatomie** = **130 tons/yr sediment reduction needed to meet the TMDL**

Middle Marais des Cygnes

Constructed Wetland near Hillsdale Reservoir

Photo provided by Bi-State Targeted Watershed Grant

Nine Element Watershed Restoration and Protection Strategy

Lake Region Resource Conservation and Development Council

December 31, 2012

The Kansas Department of Health and Environment has provided financial assistance to this project through EPA Section 319 Nonpoint Source Pollution Control Grant No. 2008-0079

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Watershed Restoration and Protection Strategy

The Kansas Department of Health and Environment (KDHE) created the term WRAPS in response to the 1998 Clean Water Action Plan issued by the Clinton Administration. The Clean Water Action Plan directed the state environmental agency and the State Conservationist of each state to complete a “unified watershed assessment”. Once the assessment was completed, states developed “watershed restoration action strategies” (WRAS).

Watershed Restoration and Protection Strategy (WRAPS) is a planning and management framework that engages stakeholders within in a watershed in a process to:

- Identify watershed restoration and protection needs and opportunities
- Establish management goals for the watershed community
- Create a cost effective action plan to achieve goals
- Implement the action plan

The WRAPS initiative is the result of a long history of Kansas’ water resource management, programs and activities. Kansas has long contended that restoration of damages is only part of the need and that action to protect the water is necessary, resulting in the term WRAPS.

Since the 1950’s, watershed districts have been developing and implementing watershed general plans to address flooding and erosion concerns with federal and state assistance. The original general watershed management plans were developed to reduce flooding, protect valuable agricultural and other land, and provide water sources. Watershed districts, with assistance from the Natural Resources Conservation Service (NRCS), began writing general watershed plans in the mid 1960’s. A Kansas Water Quality Management Plan was developed by the Kansas Department of Health and Environment (KDHE) in the late 1970’s, outlining a 20 year strategy for protecting the quality of surface and ground waters in Kansas, including control of nonpoint source (NPS) pollution. Federal Emergency Management (FEMA) funds were provided to the Kansas Department of Agriculture Division of Water Resources (DWR) for flood management planning in the 1990’s. As used by KDHE, WRAPS referred to the development of action plans to address nonpoint pollution sources on a watershed basis. The Watershed Stakeholders initiate the WRAPS projects and receive financial support from KDHE to address the Total Maximum Daily Load(s) (TMDLs) and related water quality concerns. As defined by the U.S. Environmental Protection Agency (EPA), a TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that load among the various sources of that pollutant. There are two categories of pollutant sources:

- point sources that receive a waste load allocation
- non-point sources that receive a load allocation.

The Kansas TMDL Program is on a five-year cycle through the river basins of the state, developing and revising TMDLs for selected impairments identified in the current Section 303(d) or Clean Water Act list. The selection of impairments to be addressed by TMDLs will be made jointly between KDHE and the Kansas Water Plan’s Basin Advisory Committee in each basin. TMDL development means a draft TMDL is complete, there has been public comment, and revisions are complete, and submitted to EPA for approval. The desired outcome of the TMDL process will be indicated, using the current situation as the baseline. All deviations from the water quality standards will be documented. The TMDL will state its objective in meeting the appropriate water quality standard by quantifying the degree of pollution reduction expected over time. Interim objectives are defined for midpoints in the implementation process. In summary, TMDLs provide a tool to target and reduce point and non-point pollution sources. The goal of the WRAPS process is to address high priority TMDLs. KDHE reviews TMDLs assigned in each of the twelve basins of Kansas every five years on a rotational schedule.

The EPA has identified nine minimum elements that need to be included in a watershed plan for impaired waters. The impaired waters are rivers, streams, lakes or wetlands that have a TMDL established by KDHE and water bodies listed on the Kansas 303(d) List of Impaired Waters. Funded by EPA 319 Clean Water Act Program and administered by KDHE, the WRAPS Plan document is a long-term living document. Watershed Restoration and Protection are the goals of the WRAPS. Watershed goals will be characterized as “restoration” or “protection”. Watershed restoration is for surface waters that do not meet Kansas water quality standards, and for areas of the watershed that need improvement in habitat, land management, or other attributes. Watershed protection is needed for surface waters that currently meet water quality standards, but are in need of protection from future degradation. The EPA nine elements must be addressed in watershed plans that utilize EPA Section 319 funds for plan implementation. The nine elements include:

1. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan.
2. An estimate of the load reductions expected from management measures.
3. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions, and a description of the critical areas in which those measures will be needed to implement this plan.
4. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.
5. An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.
6. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.
7. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.
8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.
9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item 8.

The Purpose of the Plan

The Lake Region Resource Conservation and Development Council (RC&D) completed the original WRAPS in 2003 for the entire Marais des Cygnes (MdC) watershed and the original intent of the current WRAPS was to update the existing WRAPS plan. Since the development of the original MdC WRAPS in 2003 several smaller watersheds within the MdC have developed their own WRAPS Plans. The Middle MdC WRAPS watershed defined the project area to comply with EPA regulations and not duplicate existing plans in the MdC watershed. The plan area is based on the high priority TMDLs, input from the Stakeholders Leadership Team, KDHE and EPA. The Middle MdC extends from Southern Douglas County through Franklin County and into Anderson County, and includes sections of eastern Coffey, Osage and western Miami Counties (Figure 1). The goal of the Middle MdC WRAPS is to create a plan that discusses the high priority non-point pollution problems in the Middle MdC Watershed and identifies specific strategies to address the most significant issues in the Middle MdC plan area. This will be a two-section plan, the North Section will address the water quality issues and develop an implementation plan for the MdC River near Ottawa and South Section will address the water quality issues and develop an implementation plan for the Pottawatomie Creek (Figure 1). Developing a watershed plan for a smaller area will lead to more effective targeting of high priority areas for Best Management Practices (BMP) implementation.

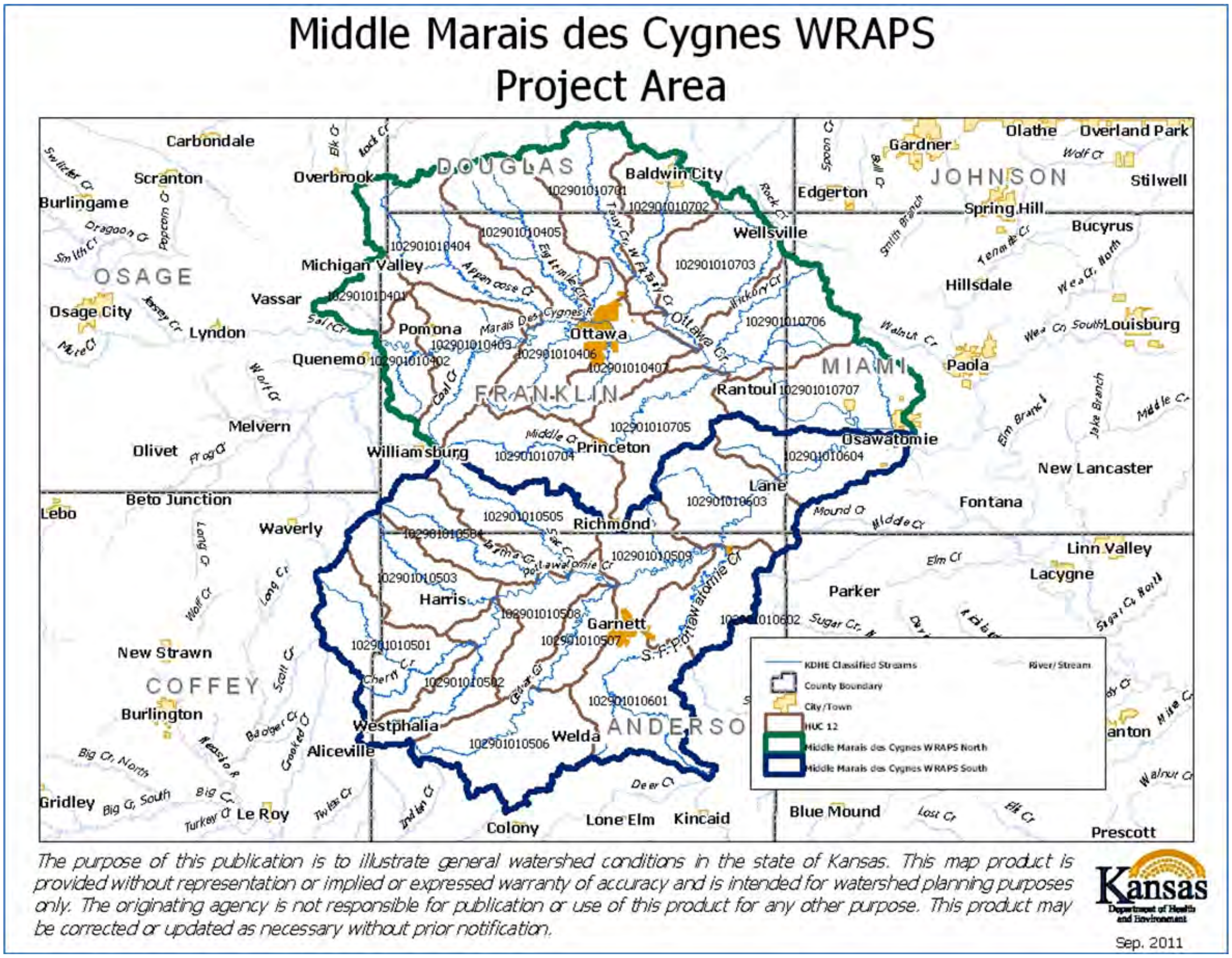


Figure 1. The Middle MdC project area.

Final goals for the watershed at the end of the WRAPS process are to:

- provide a sustainable water source.
- maintain recreational opportunities and biodiversity.
- protect the environment from negative effects of urbanization.
- restore riparian areas.

The ultimate goal will be to eliminate the need for TMDL development of these impairments. This will be achieved by targeting the 303d listed water bodies for priority of implementation resources.

Background of the Middle MdC Watershed

The Middle MdC extends from Southern Douglas County through Franklin County and into Anderson County, and includes sections of eastern Coffey, Osage and western Miami Counties (Figure 1).

The plan contains two Sections the North Section shown in Figure 1(green outline) is located primarily in Franklin County, bordered on the north by Douglas County, on the east by Miami, on the south by Anderson, and on the west by Osage counties. The South Section is located primarily in Anderson County shown in Figure 1 (blue outline) is located primarily in Anderson County, bordered by Franklin, Coffey, Linn and Miami Counties.

North Section

The MdC River is the main stem body of water flowing through the North Section. Originating in east central Kansas, the MdC River flows 184 miles through Kansas and 34 miles in Missouri before joining the Marmaton River. Both rivers feed into the Osage River which eventually drains into the Missouri River after passing through Truman Lake Reservoir and the Lake of the Ozarks. The watershed of the MdC River encompasses 3,230 (mi^2) in Kansas (2,067,200 acres) and 453 mi^2 (289,835 acres) in Missouri and is located in the ecological region known as the Osage Plains, a flat to gently rolling unglaciated prairie plain that extends from eastern Kansas and western Missouri and south into northern Texas.

Franklin County is located in the east-central part of Kansas. It has a total area of 369,280 acres, or 576 square miles. In 2010, Franklin County had a population of 25,992 according to the United States Census Bureau, about 50 percent of which lives in the City of Ottawa, the county seat. Ottawa is near the center of the county, along the MdC River. Farming is the principal economic enterprise. Livestock and cash grain farming are of equal importance to the local economy. Also important are various industries and Ottawa University.

Franklin County was originally a part of the Osage Indian Reservation. In July of 1855, Franklin County was established by the First Territorial Legislature as one of the original 33 counties in the territory and named in honor of Benjamin Franklin. In September of 1864, the City of Ottawa was organized and named in honor of the Ottawa Indians.

PHYSIOGRAPHY, DRAINAGE, AND RELIEF

Franklin County is in the Osage Plains section of the Central Lowland physiographic province. The land resource area is the Cherokee Prairies. The major topographic features are the east trending valley of the MdC River, the northeast trending valley of Pottawatomie Creek, and upland cuestas, which formed through differential erosion of limestone, shale, and sandstone strata. The landscape is nearly level to rolling, in a few areas relief is strong.

The MdC River and its tributaries drain the entire county. The highest elevation, in the northwestern part of the county, is about 1,145 feet above sea level. The lowest, along the MdC River in the eastern part, is about 840 feet. The average gradient of this river is about 2 feet per mile.

WATER SUPPLY

The MdC River and Pottawatomie Creek are the major sources of water in the county. In some areas in the western part of the county, however, ground water is available from wells. These wells generally yield enough water for domestic uses, only a few wells yield dependable water supplies in the eastern part of the county. The main source of water for livestock is surface water impounded by dams and local streams. Rural water districts supply most of the water needed in rural areas.

NATURAL RESOURCES

Soil is the most important natural resource in the county. It provides a growing medium for cash crops and for the grasses grazed by livestock.

Other mineral resources are limestone, shale, oil, gas, and gravel. Limestone is quarried and crushed for various uses, such as road surfacing and agricultural lime. Shale is mined and then expanded to larger particles and used as aggregate material and decorative gravel.

South Section

The uplands, comprising about eighty-four percent of the surface, are generally level or gently undulating prairie. The most uneven portion is in Pottawatomie Township, which occupies the southeastern corner of the county. Here the highest hills rise about two hundred feet above the level of Pottawatomie Creek, and are sometimes precipitous and difficult of ascent. There are some hilly sections about four miles southwest of Ottawa, about the same distance southwest, and also about two miles west of Richmond.

Pottawatomie Creek is the main stem body of water flowing through the Middle MdC South Section. The watershed for Pottawatomie Creek covers 373.8 square miles (mi^2). The creek originates in Anderson County, KS, along the western edge of the south section, and empties into the MdC River along the northeastern border of the south section. Anderson County is in the east-central part of Kansas and covers a total area of 577 square miles, or about 369,024 acres.

The City of Garnett, in the north-central part of the county, is the county seat. In 2010, the population of Anderson County was 8,102. About 60 percent was rural. Farming is an important enterprise in the county. Soy-beans, grain sorghum, corn, wheat, and alfalfa are the main crops. Beef cattle are the main livestock.

PHYSIOGRAPHY, DRAINAGE, AND RELIEF

Anderson County is in the Osage Plains section of the Central Lowlands physiographic province. The landscape is one of gently rolling prairies, low hills, and well-defined drainage patterns. Along the northwest edge of the county are rolling hills of Eram and Summit soils. These hills are capped by limestone bedrock and underlain by interceded sandstone and shale. To the east of these hills, from along the northern border of the county to the southwest corner, is a nearly level and gently sloping old alluvial plain dissected by upland streams. Woodson and Kenoma soils are the main soils. Isolated low hills are common. The south central part of the county is gently undulating uplands of old alluvium overlying limestone and shale. Kenoma soils are the main soils. Gravelly knolls occupied by Olpe soils are common.

The northeastern and eastern parts of the county are gently sloping to rolling uplands. Steep and broken slopes along drainage ways and ridges are common throughout these areas. Catoosa and Clareson soils are in the higher areas underlain by limestone bedrock. Outcrops of limestone are common. Eram and Talihina soils are in the steeper areas and Summit and Dennis soils are on the gentle side slopes. The valleys of the major drainage ways are of Lanton, Verdigris, and Mason soils.

The main streams in the county are Pottawatomie Creek, Deer Creek, Sugar Creek, and Indian Creek. A number of smaller streams empty into Pottawatomie Creek, which flows eastward, turns to the north at Greeley, and intercepts the MdC River near Osawatomie (Miami County). Pottawatomie Creek and its tributaries drain about 65 percent of the county in the north, west-central, and central parts. These tributaries are Crystal, Kenoma, Iantha, Sac, Thomas, Cedar, Fish, and South Fork Pottawatomie Creeks. Deer Creek, which drains the south-central part, and Indian Creek, which drains the southwest corner, flow south into Allen

County to join the Neosho River. Sugar Creek and its tributaries drain the eastern part of the county and flow east into Linn County. The Little Osage River drains the southeastern corner of the county.

The lowest point in the county, about 860 feet above sea level, is where Pottawatomie Creek leaves the county north of Greeley. The highest points, about 1,210 feet, are in the gravelly area north and west of Kincaid and between Garnett and Bush City. Most of the county is at an elevation between 1,000 and 1,100 feet. The greatest difference in local relief, about 200 to 300 feet, is along Cedar Creek and Pottawatomie Creek, near Garnett. Steep bluffs with rock escarpments bound the valley floors in many places.

WATER SUPPLY

Dug or drilled wells supply a limited amount of water for domestic use on farms. Underground sources are limited, except in the stream valleys. The main source of water for livestock is surface water impounded by dams and local streams. There are many spring-fed streams throughout the county. In the northern and western parts of the county, many rural residents are served by rural water districts that pump water from reservoirs and from wells.

INDUSTRY AND NATURAL RESOURCES

Although farming is the major enterprise in Anderson County, there are a number of manufacturing industries in the county. These industries are manufacturing church furniture, clothing, cheese, sheet metal, truss rafters, recreational vehicle equipment, and other products. Most are in Garnett. An industrial welding firm is near Greeley. The buying, selling, and distributing of farm products are important enterprises. Limestone was quarried extensively for railroad ballast north of Garnett in the early 1900's. Crushed limestone is used for road surfacing, in concrete, and for agricultural lime.

Oil and gas were formerly obtained from shallow wells in parts of the county. The largest boom was in the early 1920's when fields near Colony and Welda were brought into production. Natural gas storage, near Welda and Colony, is important in the county. The natural gas is piped in and stored underground, in natural reservoirs, until needed. A number of transporting pipelines cross the county. Additional information pertaining to potential pollution sources relative to oil and gas is located on page 48.

Land Cover and Land Use

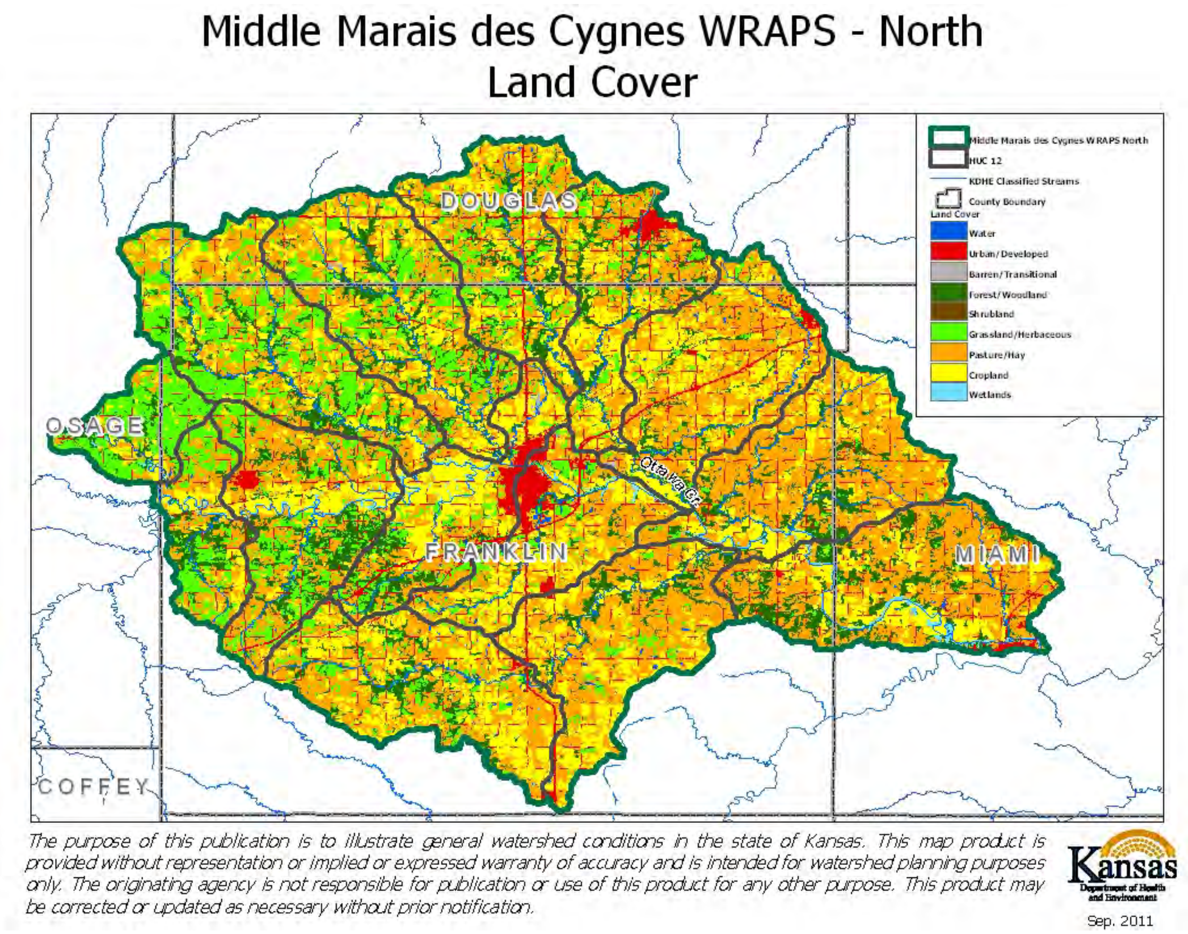


Figure 2. (Above) Map showing land cover in the North Section of the Middle Marais des Cygnes watershed.

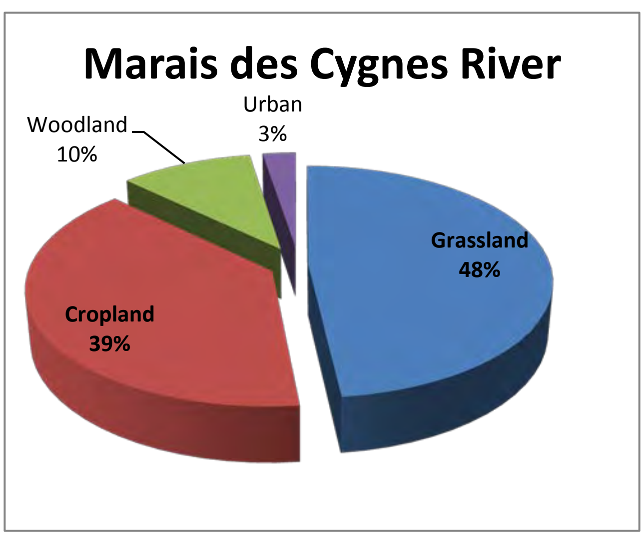


Figure 3. (Left) Graph showing land use within the Northern Section TMDL of the Middle Marais des Cygnes project Area.

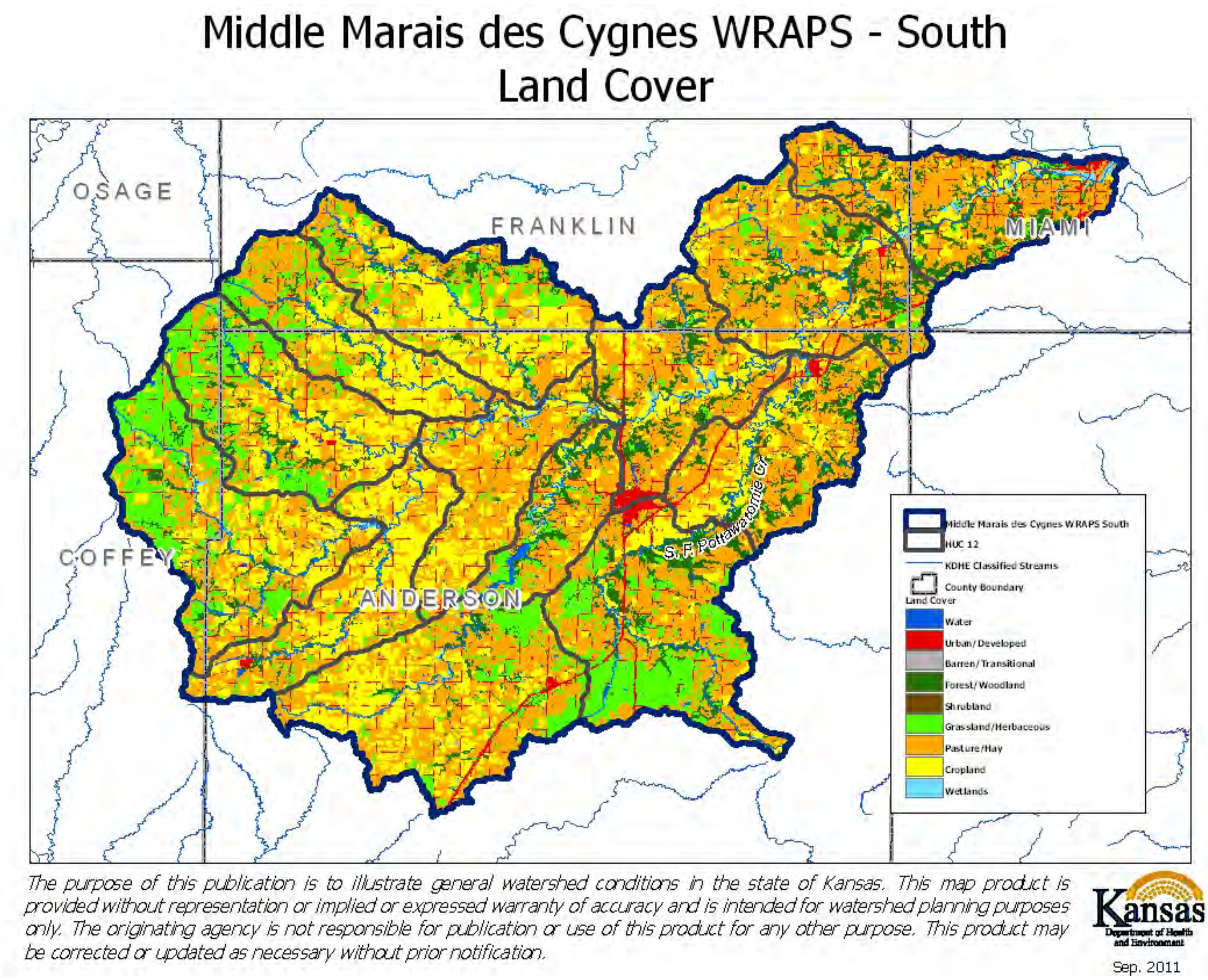
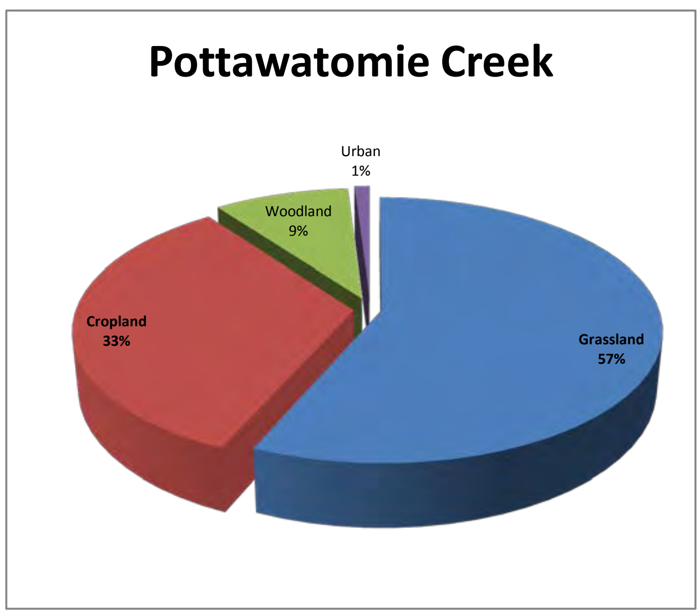


Figure 4. (Above) Map showing land cover in the South Section of the Middle Marais des Cygnes Watershed

Figure 5. (Right) Graph showing land use within the South Section TMDL of the Middle Marais des Cygnes plan area.



Land use activities have a significant impact on the types and quantity of pollutants in the watershed. The major land use in the watershed is Pasture/Hay (43%).

- Pasture/Hay can contribute fecal coliform bacteria from livestock access to streams and ponds. Erosion can occur from pathways made by livestock in creeks or gullies in pastures.
- Cropland is the second most prominent land use at 24 percent. Cropland can contribute nutrients from fertilizer and sediment from bare crop ground that will erode during heavy rainfall events. Improper application of pesticides can also create impacts to water quality.
- Grassland/Herbaceous is third land use at 14 percent that can contribute fecal coliform bacteria from livestock access. Grasslands are typically warm season native grasses compared to cool season grasses often found in pasture/hay. Native grasses have a deeper root system that allows more infiltration and filter of nutrients.
- Forest/Woodland is fourth land use at 12 percent. Typically, these are found adjacent to streams or riparian areas that are critical to stabilize banks and provide canopy cover for aquatic life.
- Urban or developed land use is only 6 percent but is expected to increase and can be made up of impervious surfaces that can contribute to Stormwater issues.
- The remainder of the land uses (1%) in the watershed are wetlands, water and other.

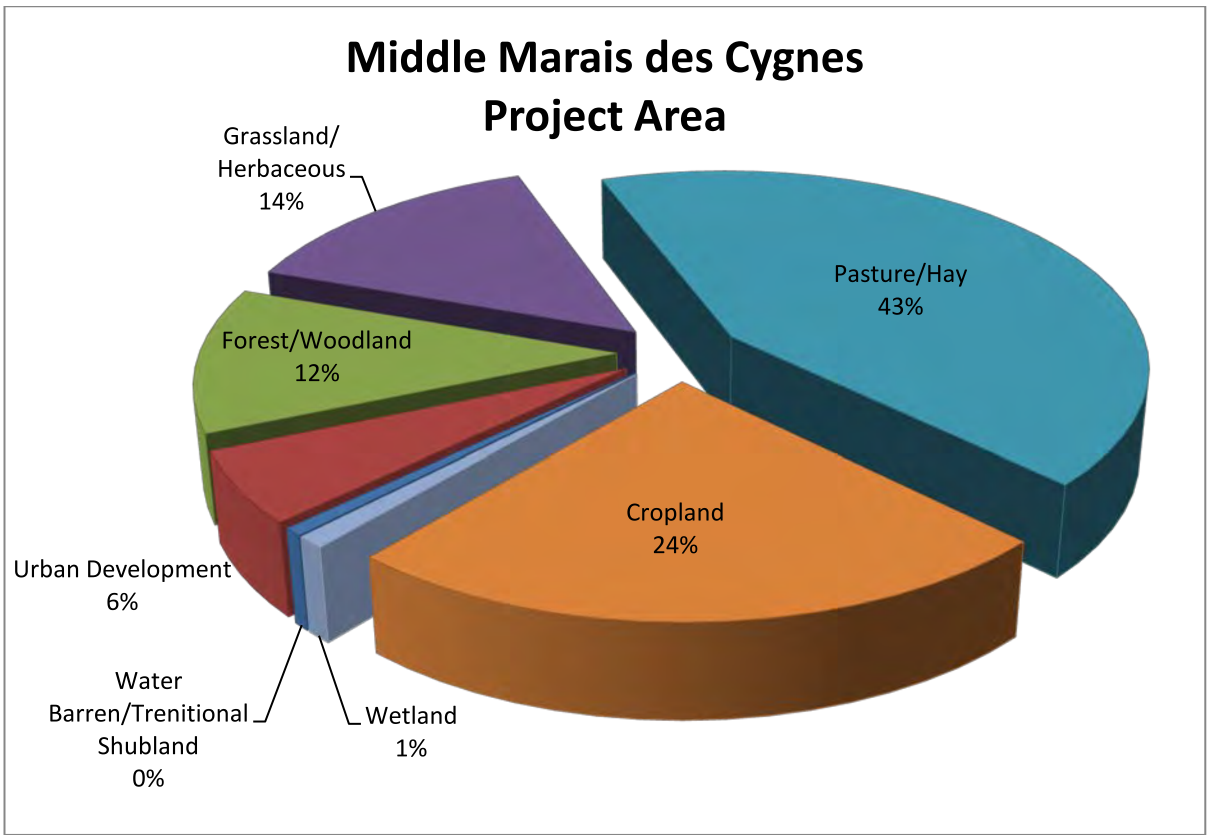


Figure 4. Land Use for Total Middle MdC Project Area

Designated Uses

States adopt water quality standards to protect public health or welfare, enhance the quality of water, and serve the purposes of the Clean Water Act. "Serve the purposes of the Act" (as defined in sections 101(a)(2), and 303(c) of the Act) means that water quality standards should:

- provide, wherever attainable, water quality for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water ("fishable/swimmable"), and
- consider the use and value of State waters for public water supplies, propagation of fish and wildlife, recreation, agriculture and industrial purposes, and navigation.

The classified waters (Figure 6) in the Middle MdC Watershed are generally 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 can be used for as stated in the Kansas Surface Water Register, 2010, issued by KDHE. For 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." (Table 1).

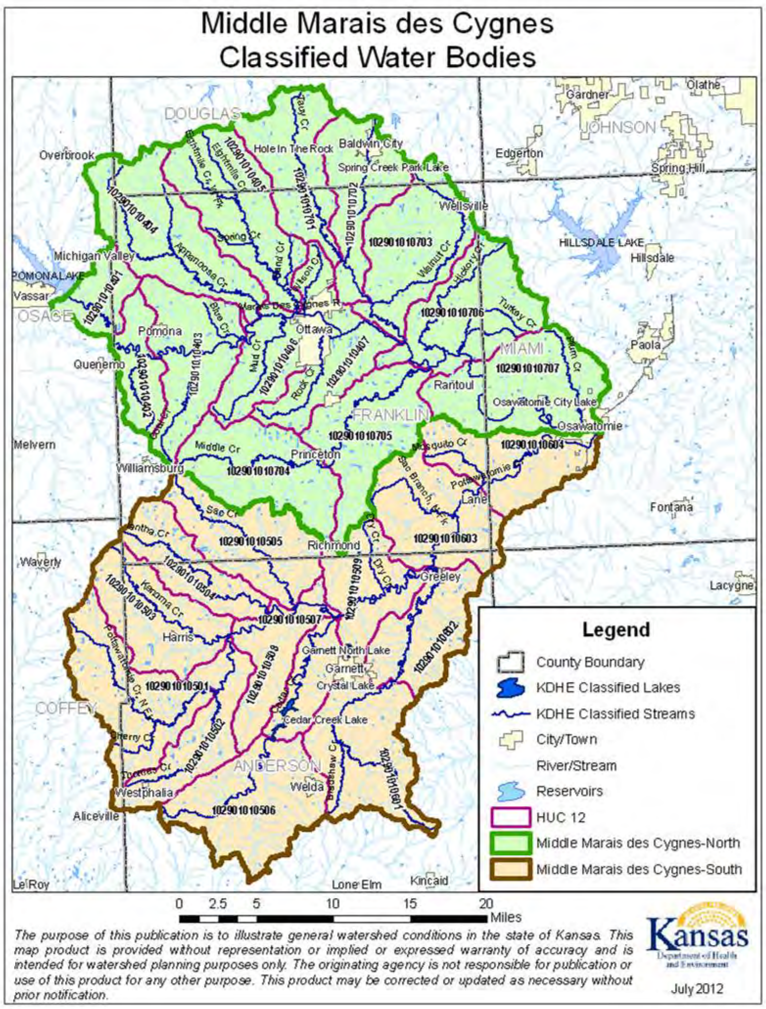


Figure 5. Classified Water Bodies

The information provided in Table 1 includes the information on the designated use of streams and waters in both the North and South section of the plan.

Table 1. Designated use of streams and creeks located within the Middle MdC watershed.

Creek Name	Segment	Acreage	Expected Aquatic life	Contact recreational	Domestic Water Supply	Food Procurement	Ground Water	Industrial Water Use	Irrigation Water Use	Livestock Water Supply
Appanoose Cr	16	38,182	S	b	X	O	X	X	X	X
Appanoose Cr, East	89	38,182	E	b	X	O	X	X	X	X
Blue Cr	81	29,746	E	b	O	O	X	O	X	X
Cedar Cr	66	37,301	E	b	X	X	X	X	X	X
Cherry Cr	74	34,662	E	b	O	O	O	O	X	X
Coal Cr	48	29,746	E	b	X	O	X	X	X	X
Dry Cr	57	23,249	E	C	O	O	X	O	X	X
Eightmile Cr	13	35,057	E	b	X	O	X	X	X	X
Eightmile Cr	88	35,057	E	b	X	X	X	X	X	X
Hard fish Cr	47	13,638	E	b	X	O	X	X	X	X
Hickory Cr	8	33,891	S	C	X	X	X	X	X	X
Iantha Cr	62	20,352	E	b	X	X	X	X	X	X
Kenoma Cr	64	28,526	E	C	O	X	X	O	X	X
MdC	1	37,718	S	C	X	X	X	X	X	X
MdC R	3		S	B	X	X	X	X	X	X
MdC R	7	33,891	S	C	X	X	X	X	X	X
MdC R	9		S	C	X	X	X	X	X	X
MdC R	10		S	C	X	X	X	X	X	X
MdC R	12	22,594	S	B	X	X	X	X	X	X
MdC R	17	23,564	E	C	X	X	X	X	X	X
MdC R	18	29,746	E	C	X	X	X	X	X	X
MdC R	19	13,638	E	C	X	X	X	X	X	X
Middle Cr	50	31,266	E	b	X	X	X	X	X	X
Middle Cr	50	32,782	E	b	X	X	X	X	X	X
Mosquito Cr	52	27,157	E	b	X	O	X	X	X	X
Mud Cr	49	23,564	E	b	O	O	X	O	X	X
Ottawa Cr	9011	33,417	E	C	X	X	X	X	X	X
Plum Cr	2	37,718	E	b	X	X	X	X	X	X
Pottawatomie Cr	51	27,157	S	C	X	X	X	X	X	X
Pottawatomie Cr	53	32,051	S	C	X	X	X	X	X	X
Pottawatomie Cr	55		S	b	X	X	X	X	X	X
Pottawatomie Cr	56	23,249	S	b	X	X	X	X	X	X
Pottawatomie Cr	58		S	C	X	X	X	X	X	X
Pottawatomie Cr	59	20,023	S	C	X	X	X	X	X	X
Pottawatomie Cr	61		S	b	X	X	X	X	X	X
Pottawatomie Cr	63		S	C	X	X	X	X	X	X

Creek Name	Segment	Acreage	Expected Aquatic life	Contact recreational	Domestic Water Supply	Food Procurement	Ground Water	Industrial Water Use	Irrigation Water Use	Livestock Water Supply
Pottawatomie Cr, N Fk	65	34662	E	C	X	X	X	X	X	X
Pottawatomie Cr, S Fk	67	23916	S	C	X	O	X	X	X	X
Rock Cr	97	22,594	E	b	X	O	X	X	X	X
Sac Branch	54	32,051	E	b	O	O	X	O	X	X
Sac Cr	60	29,971	E	C	X	X	X	X	X	X
Sand Cr	82	35,052	E	b	O	O	O	O	X	X
Spring Cr	84	35,052	E	b	X	O	X	X	X	X
Tauy Cr	11	25,293	E	C	X	X	X	X	X	X
Tauy Cr, E Fk	85	25,293	E	b	X	X	X	X	X	X
Tauy Cr, W Fk	9911	27,340	S	b	X	X	X	X	X	X
Thomas Cr	72	22,529	E	b	O	O	O	O	X	X
Turkey Cr	4		E	C	X	X	X	X	X	X
Turkey Cr	6	33,891	E	C	X	X	X	X	X	X
Unnamed Stream	5		E	b	X	X	X	X	X	X
Walnut Cr	90	33,417	E	b	X	O	X	X	X	X
Wilson Cr	83		S	b	X	O	X	X	X	X
Wolf Cr	96	33,417	E	b	X	X	X	X	O	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 case-by-case basis in accordance with K.A.R. 28-16-28d(d).

Abbreviations:
O = referenced stream segment does not support the indicated designated use
X = referenced stream segment is assigned the indicated designated use

<u>Expected Aquatic Life</u>
S = special aquatic life use water
E = expected aquatic life use water
R = restricted aquatic life use water

<u>Contact Recreation</u>
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

Table 2. Designated Lakes located within the Middle MdC watershed.

Lake Name	County	Expected Aquatic life	Contact recreational use	Domestic Water Supply	Food Procurement	Ground Water Recharge	Industrial Water Use	Irrigation Water Use	Livestock Water Supply
Cedar Creek Lake	Anderson	E	A	X	X	O	X	X	X
Crystal Lake	Anderson	E	B	X	X	O	X	X	X
Hole in the Rock	Douglas	E	B	X	X	X	X	X	X
Garnett North Lake	Anderson	E	A	X	X	O	X	X	X
Osawatomie City Lake	Miami	E	B	X	X	X	X	X	X
Richmond City Lake	Franklin	E	B	X	X	O	X	X	X
Spring Creek Park Lake	Douglas	E	B	X	X	O	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 case-by-case basis in accordance with K.A.R. 28-16-28d(d).

Abbreviations:
O = referenced lake does not support the indicated designated use
X = referenced lake is assigned the indicated designated use

Expected Aquatic Life
S = special aquatic life use water
E = expected aquatic life use water
R = restricted aquatic life use water

Contact Recreation
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
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Watershed Threats and Restoration Efforts

Watershed Plans in Place

In Kansas, wide varieties of water quality enhancement projects are underway throughout the MdC watershed. One project, the MdC Watershed Riparian Forestry Initiative stemmed from the original 2003 basin wide WRAPS. Beginning its 8th year of implementation, it provides forestry assistance to watershed landowners to install projects and educational events through the Watershed Forester. A two-year Basin Advisory Committee Information and Education project was completed that covered the entire basin including Middle MdC project area. The Franklin County Conservation District and Kansas State University (KSU) Research & Extension Watershed Specialist completed a two-year Livestock project. The project provided cost-share funds to install practices. The KSU Watershed Specialist has been a service provider in the entire watershed during the completion of the 2003 WRAPS. An EPA Targeted Watershed Grant (TWG) was completed for both Kansas and Missouri portions of the MdC watershed.

Additionally, WRAPS projects are currently covering three sub-watersheds within the MdC: Melvern, Pomona, and Marmaton. Hillsdale watershed has a draft WRAPS plan. Further projects may be underway through local conservation districts, NRCS projects or other agencies that are working to improve water quality through their outside projects and programs. Although multiple plans are in place within the MdC watershed, no plans have been developed or are being implemented within the Middle MdC watershed. With three of the five monitoring stations within this watershed are located on streams that are classified as high priority due to TMDL impairments (Table 3), a watershed restoration plan is critical. The Stakeholder Leadership Team selected the targeted areas (highlighted in green) after review and discussion of TMDL reports from KDHE and review of Needs Inventory by the Division of Conservation-Kansas Department of Agriculture.

Water Quality Impairments

High Priority TMDL watersheds are used to target technical and financial assistance for implementation of non-point source pollution management practices that can address designated pollutants. Identified TMDL impairments in the MdC watershed include aquatic plants (greater than 70% cover of a lake surface), atrazine, biology (impairment in the structure or function of the biological community), dissolved oxygen, eutrophication, fecal coliform bacteria, ammonia, pH, selenium, and siltation. The predominant impairment within the watershed is low dissolved oxygen (DO) (Table 3). Low DO levels typically coincide with an abundance of algae, which may be caused by excess nutrients. Suspected sources of water quality impairments for this watershed include livestock and cropland practices, municipal waste treatment systems, residential waste treatment systems, stormwater, and naturally occurring sources.

Table 3. TMDL impairments and priority rankings for 3 creeks and 2 lakes located within the Middle MdC Watershed. Highlighted impairments will be directly addressed by this plan.

Watershed	Sampling Location	Impairment	Priority
Ottawa (Tauy) Creek Near Ottawa	SC 616	Dissolved Oxygen	High
Pottawatomie Creek near Osawatomie	SC 556	Dissolved Oxygen	High
MdC River near Ottawa	SC 270	Bacteria	High
Crystal Lake	Crystal Lake	Eutrophication	Medium
Spring Creek	Park Lake	Eutrophication / Aquatic Plants	Low

The following map illustrates the Middle MdC directly Addressed TMDLs for each section of the plan. The high priority streams for both sections of the plan are shown. The streams for Section 1 shown in green on the map, are the Marais des Cygnes River FCB high priority streams. For Section 2 the streams shown in red on the map are the Pottawatomie Creek DO high priority streams. The plans will focus on the projects closest to the high priority areas shown on the map.

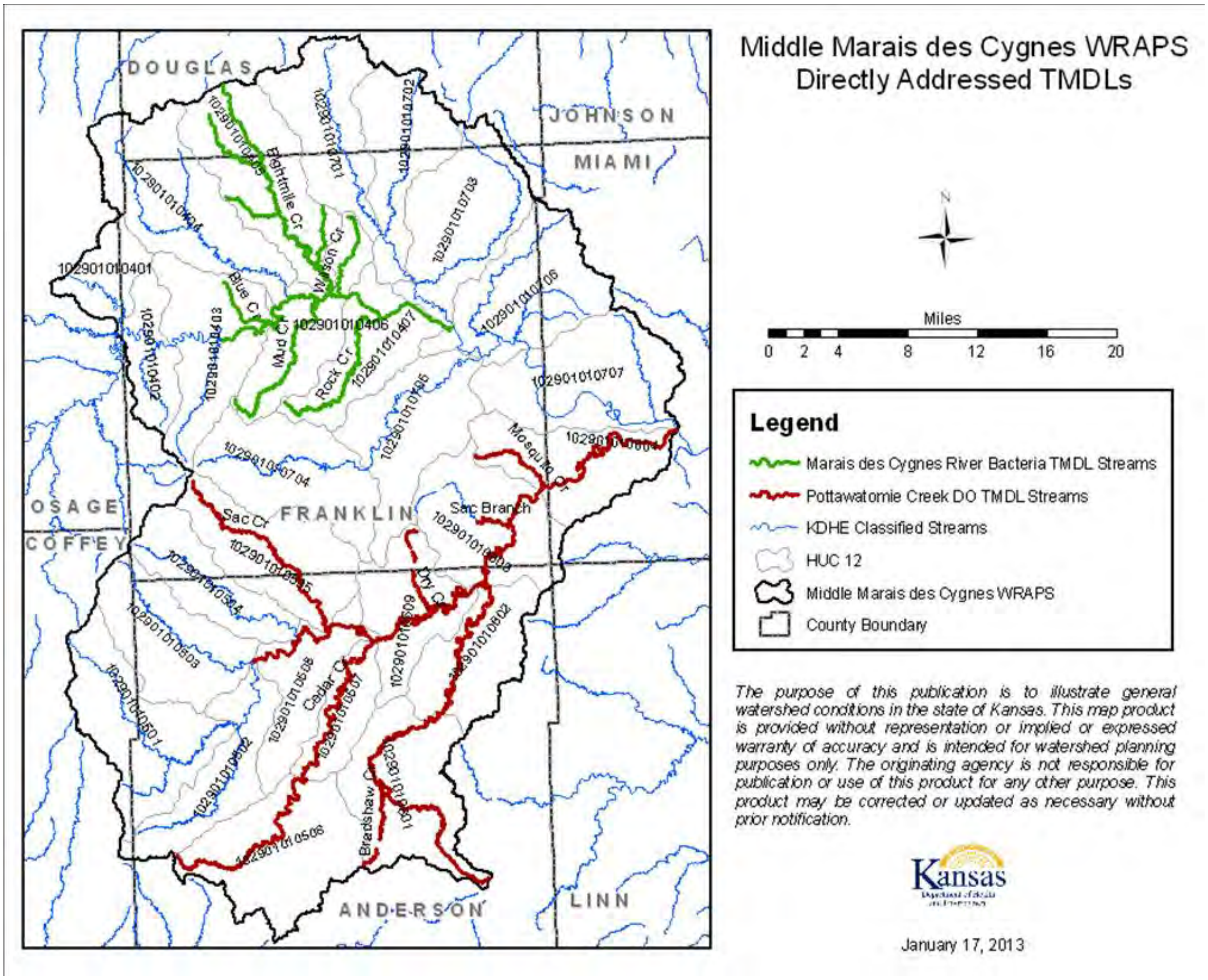

Figure 6. Middle MdC WRAPS Directly Addressed TMDLs

As stated by the EPA the term "303(d) list" is short for the list of impaired and threatened waters (stream/river segments, lakes) that the Clean Water Act requires all states to submit for EPA approval every two years on even-numbered years. The states identify all waters where required pollution controls are not sufficient to attain or maintain applicable water quality standards, and establish priorities for development of TMDLs based on the severity of the pollution and the sensitivity of the uses to be made of the waters, among other factors (40C.F.R. §130.7(b)(4)). States then provide a long-term plan for completing TMDLs within 8 to 13 years from first listing.

EPA policy allows states to remove waterbodies from the list after they have developed a TMDL or after other changes to correct water quality problems have been made. Occasionally, a waterbody can be taken off the list as a result of a change in water quality standards or removal of designated uses; however, designated uses cannot be deemed unattainable and removed until a thorough analysis clearly shows that they cannot be attained.

KDHE completed the first round of TMDLs within the MdC basin based on the 1998 and 2004 303(d) list. There are nine approved TMDLs within the Middle MdC basin that describe the strategies and goals to reduce pollution and achieve water quality standards. The 2008 303(d) list submitted to EPA identifies watersheds associated with 12 stream chemistry sampling stations as water quality impaired.

Table 4. 303(d) listed waters in the Middle MdC Watershed

Impaired Watershed/Lake	Pollutant	2006 - 2008 Priority for Development	Waterbody Type	Monitoring Station	HUC 8	Counties
MdC River below Ottawa	Biological	Medium	Stream	270	10290101	FR
MdC River below Ottawa	Acute Copper	Medium	Stream	270	10290101	FR
Ottawa Creek	Acute Copper	Medium	Stream	616	10290101	FR
MdC River above Ottawa (Richter)	Chronic Copper	Low	Stream	555	10290101	FR
Appanoose Creek	Dissolved Oxygen	Low	Stream	692	10290101	FR
Cedar Creek Lake	Turbidity	Medium	Lake	40701	10290101	AN
Cedar Creek Lake	Eutrophication	Low	Lake	40701	10290101	AN
Richmond City Lake	Dissolved Oxygen	Medium	Lake	46801	10290101	FR
Westphalia Lake	Turbidity	Low	Lake	66901	10290101	AN

Riparian Assessment

Riparian/wetland zones provide some of the most productive natural resources found on public and private lands. Sustainability and function of riparian areas is fundamental to channel stability and ecologic integrity in most cases.

Evaluating the existing riparian areas will help characterize the physical and ecological attributes that represent thresholds for sustainability. Subsequent ratings over a period of time on the same stream reach can be used to evaluate trend. The ratings are only comparable to streams of the same type in the same local area (i.e. same hydrologic unit and having the same potential). The highest ecological status a riparian-wetland area can attain given no constraints is potential and referred to as the potential natural community. The evaluation identifies recovery strategies and management needs to reverse the downward trend.

The Watershed Forester and Watershed Livestock Specialist conducted a Riparian Assessment of the watershed to identify high priority sites within the watershed. Two riparian assessments were conducted to address the Total Maximum Daily Loads (TMDLs). The two assessments were the MdC River Assessment illustrated on the map in figure 6 (Franklin, eastern Osage, southern Douglas, and western Miami counties) and the Pottawatomie Creek Assessment in figure 7 (Anderson, eastern Coffey, and southwest corner of Miami counties) and focused on dissolved oxygen and fecal coliform bacteria. A scoring system was established with eight different categories to determine the quality of the site using the Stream Visual Assessment Protocol (NWCC Technical Note 99-1, 1998). The categories were channel conditions, bank stability, livestock access, riparian vegetation, canopy cover, riparian zone width, bank height, and stream habitat (Table 1). They had to make some modifications to reach their goals due to limited access to these sites. The site's quality was ranked using a numbering system with low scores indicating high priority sites (poor riparian conditions) and high scores indicating low priority sites (good riparian conditions).

To locate sites for the assessment areas, the observers used a grid system to cover the entire riparian assessment area. The grid system was set up along local roads due to no accessablitiy of specific sites. The observers used the National Hydrography Dataset (NHD) flow lines layer to identify all streams that crossed the transect road. At each location evaluations were made for the stream (upstream and downstream) and if feasible the cropland adjacent to each side of the stream. Within the areas, the observers classified the sites in one of three categories: poor, medium, or high. The sites classified as poor required immediate attention to improve the area. Sites classified as medium needed some work to improve the area. Sites classified as high were good quality and needed little to no work. Within the MdC River Riparian Assessment area, observers located 386 sites. Of these 386 sites, 65 sites were classified in the poor category, 191 in the medium category, and 130 in the high category. In the Pottawatomie Creek Riparian Assessment area, a total of 426 sites were observed. Of these sites, 95 were classified as poor, 193 sites were classified as medium, and 138 sites were classified as high.

The cropland assessments were made of the cropland areas adjacent to the NHD flow line streams. The cropland fields that were assessed are shown in figure 8 later in this report. Cropland was evaluated for cropland cover, tillage types, gully conditions, and terrace height. Figure 8 shows the cropland fields that are adjacent to riparian sites that had evaluation completed. Not all stream evaluation sites had a cropland assessment only those adjacent and eligible as cropland. The cropland assessments were recorded on a layer connected to the common land unit (CLU) layer so entire fields that received evaluation are highlighted. Fields that were evaluated received a value of 1 all other fields in the layer were set to default of 0. Some related fields to the CLU are also highlighted.

Additional notes were made of livestock feeding sites observed.

Table 5. The qualitative and quantitative scoring system used to rank each category for site quality using the "Stream Visual Assessment Protocol".

Channel Conditions			
Stable	Stabilizing	Widening	Incision
10	7	3	1

Bank Stability			
Stable	Moderately stable	Moderately unstable	Unstable
10	7	3	1

Livestock Access				
No access	Limited access	Evidence of access	Unlimited access-Seasonal	Unlimited access - Year round
10	7	5	3	1

Riparian Vegetation						
Quality woodland	Native grass	Poor woodland	Shrubs	Mixed tree/pasture	Cool season grasses	No vegetation
10	8	7	6	5	3	1

Canopy Cover (%)				
50-74	75-100	25—50	10-24	0-9%
10	7	5	3	1

Riparian Zone Width (ft)			
>100	36-100	11-25	0-10
10	7	3	1

Bank Height (ft)		
<5	5-10	>10
10	5	1

Stream Habitat					
Vegetation present in the stream	Riffles in the stream	Deep pools in the stream	Woody Debris in the stream	Sediment present in the stream	Undercut banks
10	8	7	5	3	1

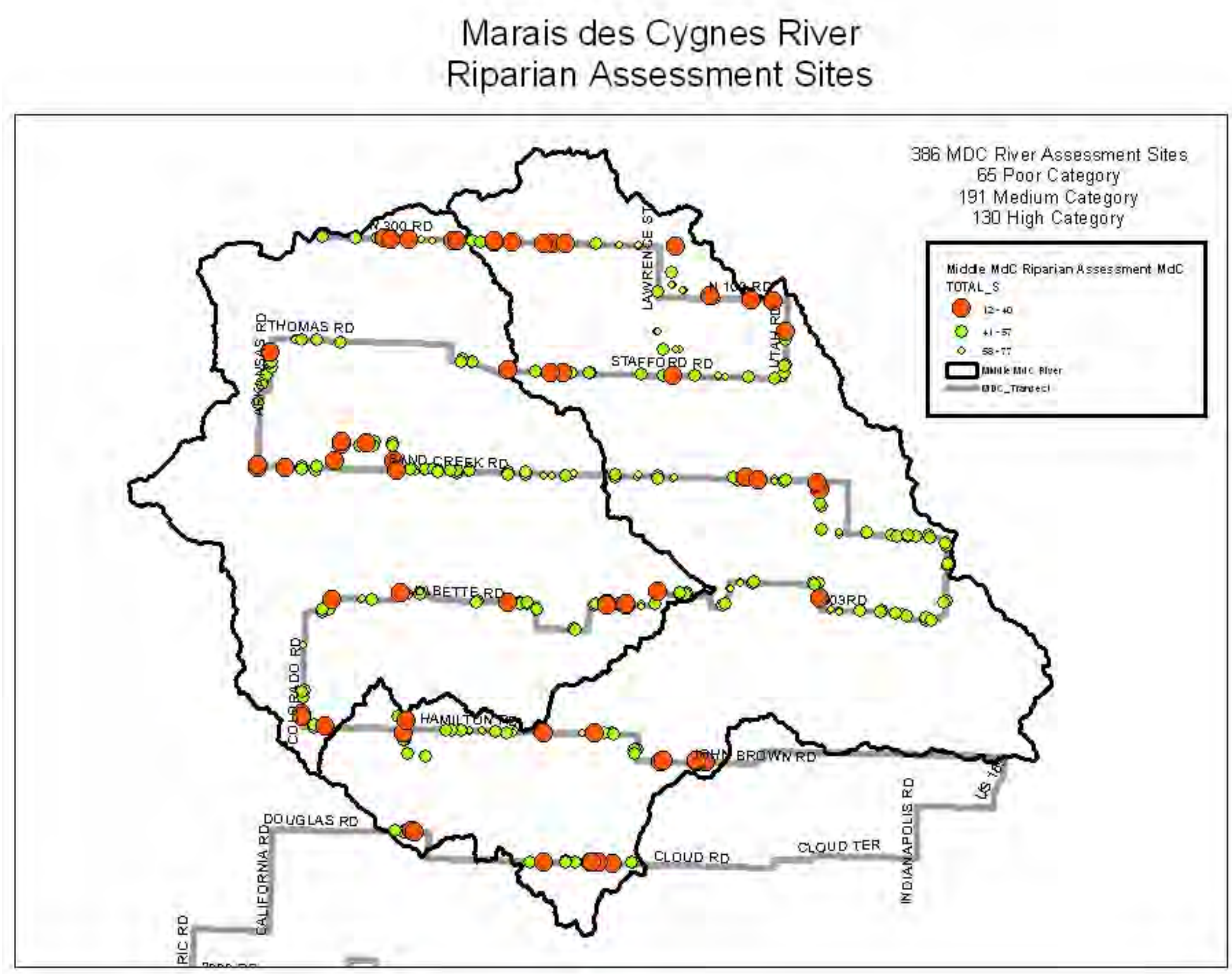

Figure 7. MdC River Riparian Assessment Sites

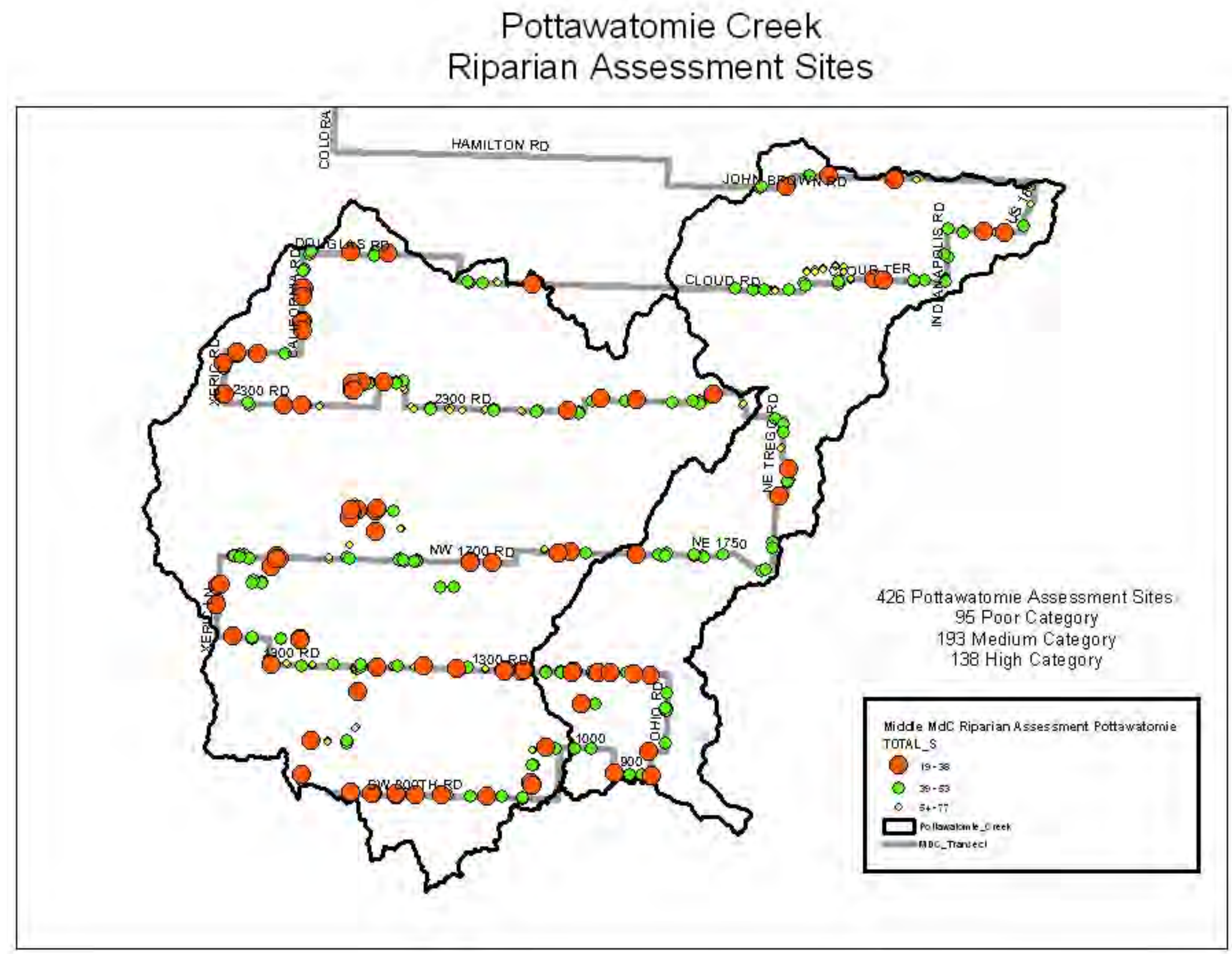

Figure 8. Pottawatomie Creek Riparian Assessment Sites

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Middle Marais des Cygnes Cropland Assessment

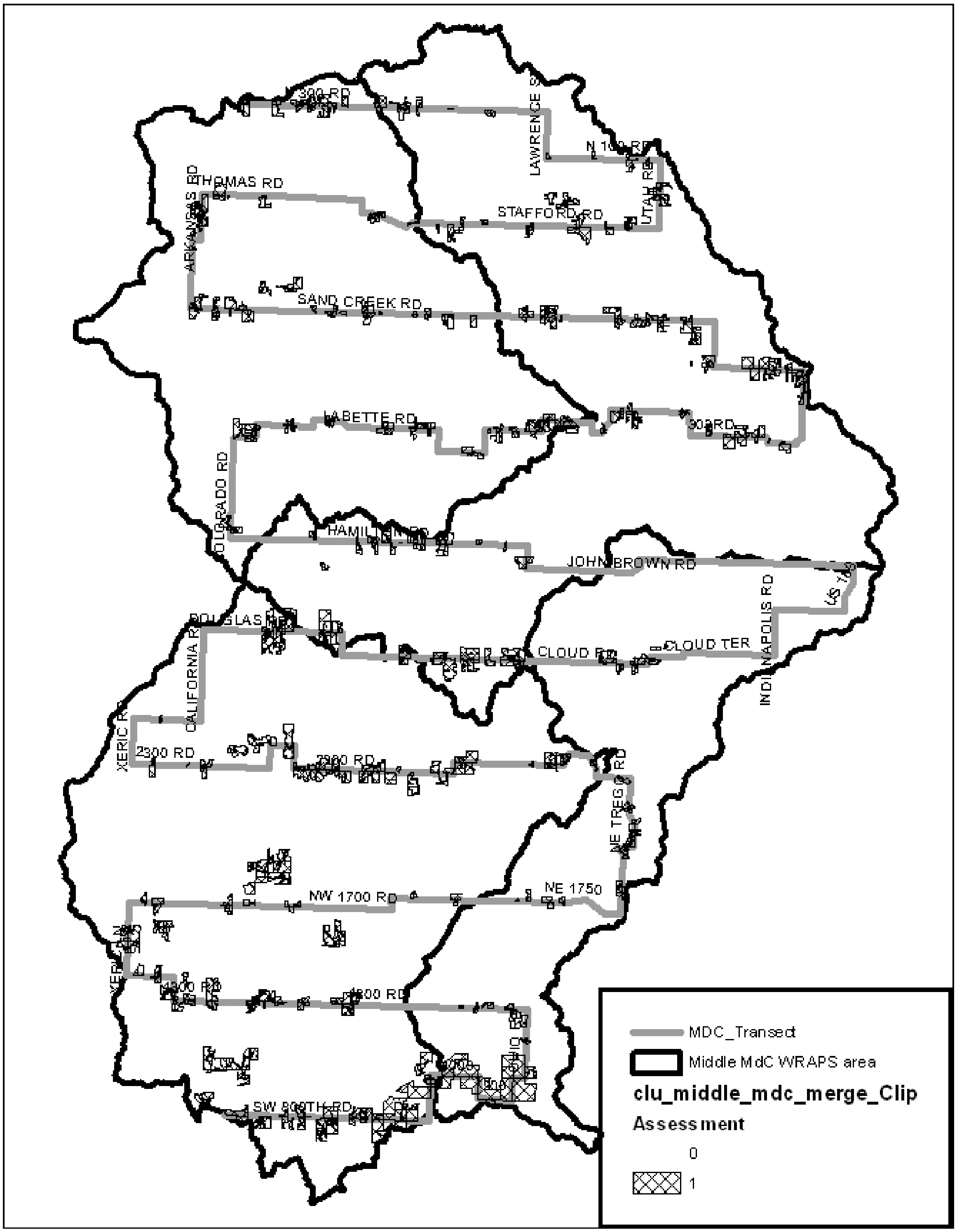


Figure 9. Middle MdC Cropland Assessment

Monitoring

Water quality monitoring and assessment operations in Kansas are administered primarily by KDHE. The Kansas Water Quality Monitoring and Assessment Strategy, 2011–2015 provides information on the types of monitoring used. One type of monitoring is stream chemistry monitoring, which generates physical, chemical, radiological, and microbiological data useful in the characterization of pollutant loadings from the contributing drainage area. The results from stream chemistry measurements provide a snap shot of chemical conditions the moment they are collected.

Stream biological monitoring is another type of monitoring, collecting water samples from a designated location and evaluating the pollution-tolerance of macroinvertebrates. In the article *Biomonitoring Our Streams- What's it All About*, by Thomas D. Byl and George F. Smith, three components of an aquatic ecosystem influence the biological community, water chemistry, geomorphology and hydrology. As shown in figure 9 below. Each component influences the health of the biological community individually and together.

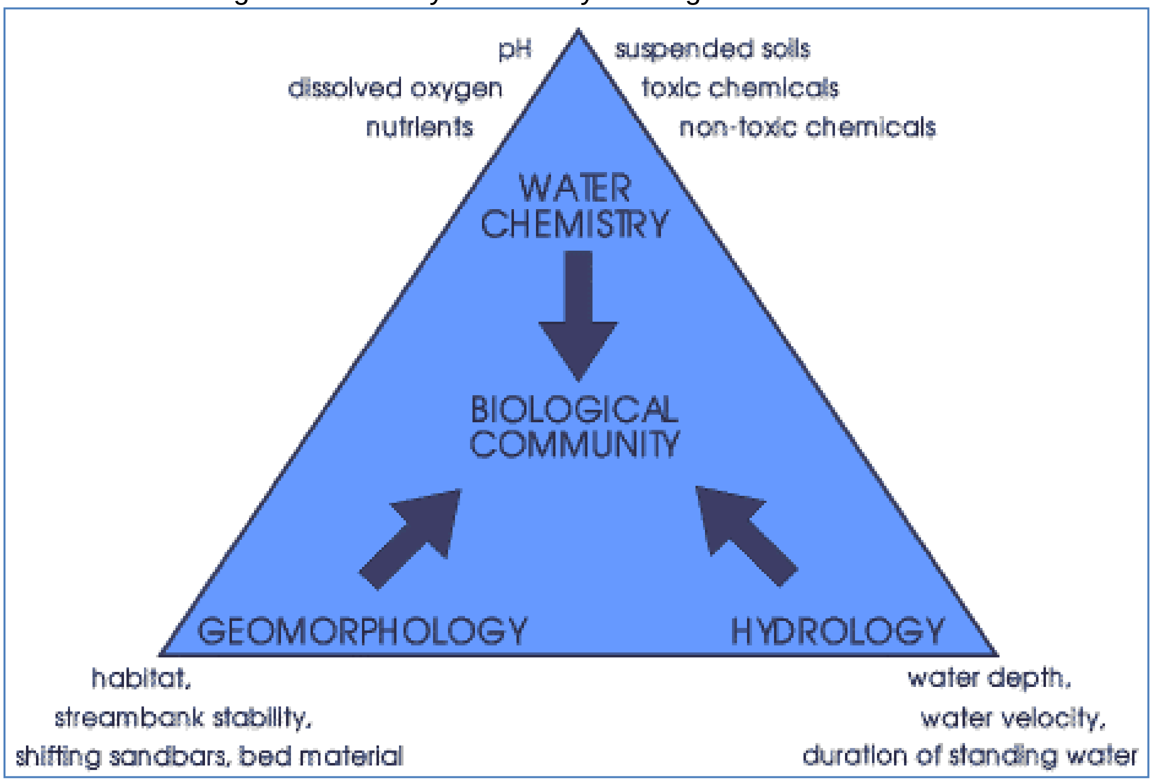


Figure 10. Three general components that influence the biological community composition.

KDHE has several ongoing monitoring sites in the watershed as listed in Table 5 below. There are two types of monitoring sites utilized by KDHE: permanent and rotational as shown in Table 5 below. Permanent sites are continuously sampled, whereas rotational sites are only sampled every fourth year. Each site is tested for nutrients, metals, ammonia, solid fractions, turbidity, alkalinity, pH, dissolved oxygen, e. coli bacteria and chemicals. Not all sites are tested for these parameters at each collection time. This is dependent upon the anticipated pollutant concern as well as other factors. For example, herbicide analysis would not be necessary in the winter as there are no applications at that time.

Table 6. KDHE permanent and rotational water monitoring sites within the watershed.

Station #	Stream Name	Station Type	Sampling Frequency	Period of Record	Date of Last Sampling
SC270	MdC River Near Ottawa	Permanent	Once a year	1974-2010	10/19/2010
SC556	Pottawatomie Creek Near Osawatomie	Permanent	Once a year	1990-2010	10/19/2010
SC555	MdC River Near Richter	Rotational	Once every 4 years	1990-2007	10/31/2007
SC616	Ottawa Creek Near Ottawa	Rotational	Once every 4 years	1993-2007	10/31/2007
SC692	Appanoose Creek Near Richter	Rotational	Once every 4 years	1994-2007	10/31/2007

NORTH SECTION 1. MDC RIVER

The North Section of the Middle MdC plan focuses on the MdC River near Ottawa. Bacteria is the primary TMDL for the North Section of the plan as highlighted in table 3. A map of the North Section project area in Figure 11 highlights the high priority areas that will be the focus of the plan. The SLT selected targeted areas from review of TMDL reports from KDHE, Needs Inventory by KDA-DOC and discussion with the TMDL Section of KDHE. The Targeted area coincides with the bacteria TMDL area. Targeted high priority areas for the Middle MdC North section of the plan have been identified as the following HUC 12's 10290101-0405, 10290101-0406 and 10290101-0407. Currently these areas have impaired waters that need BMPs to reduce pollutant loads. Additional areas within the Northern portion have lower priority TMDL or naturally causing pollutants. The targeted areas will be reviewed if the TMDL's change after further monitoring.

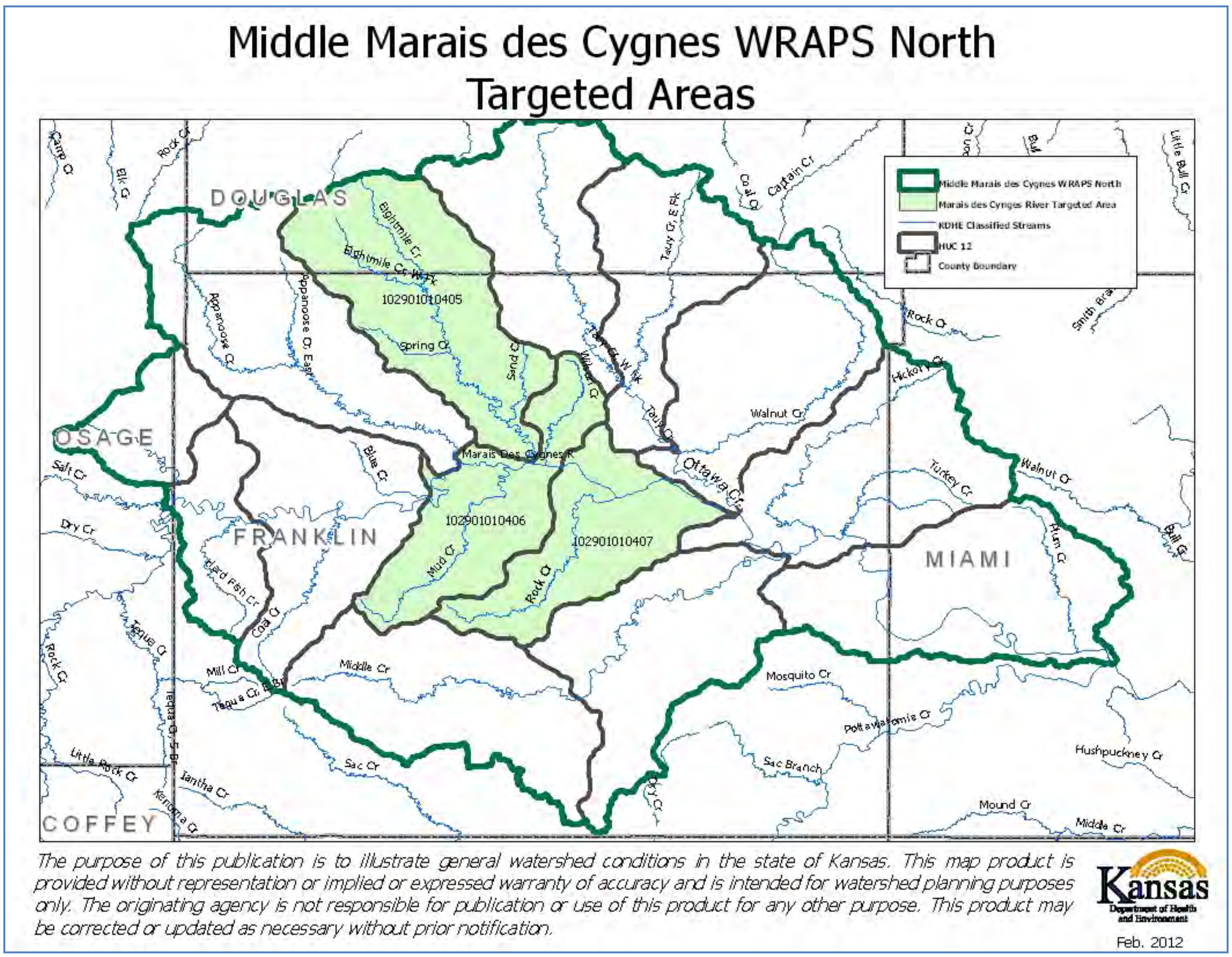


Figure 12. North section with high priority areas highlighted.

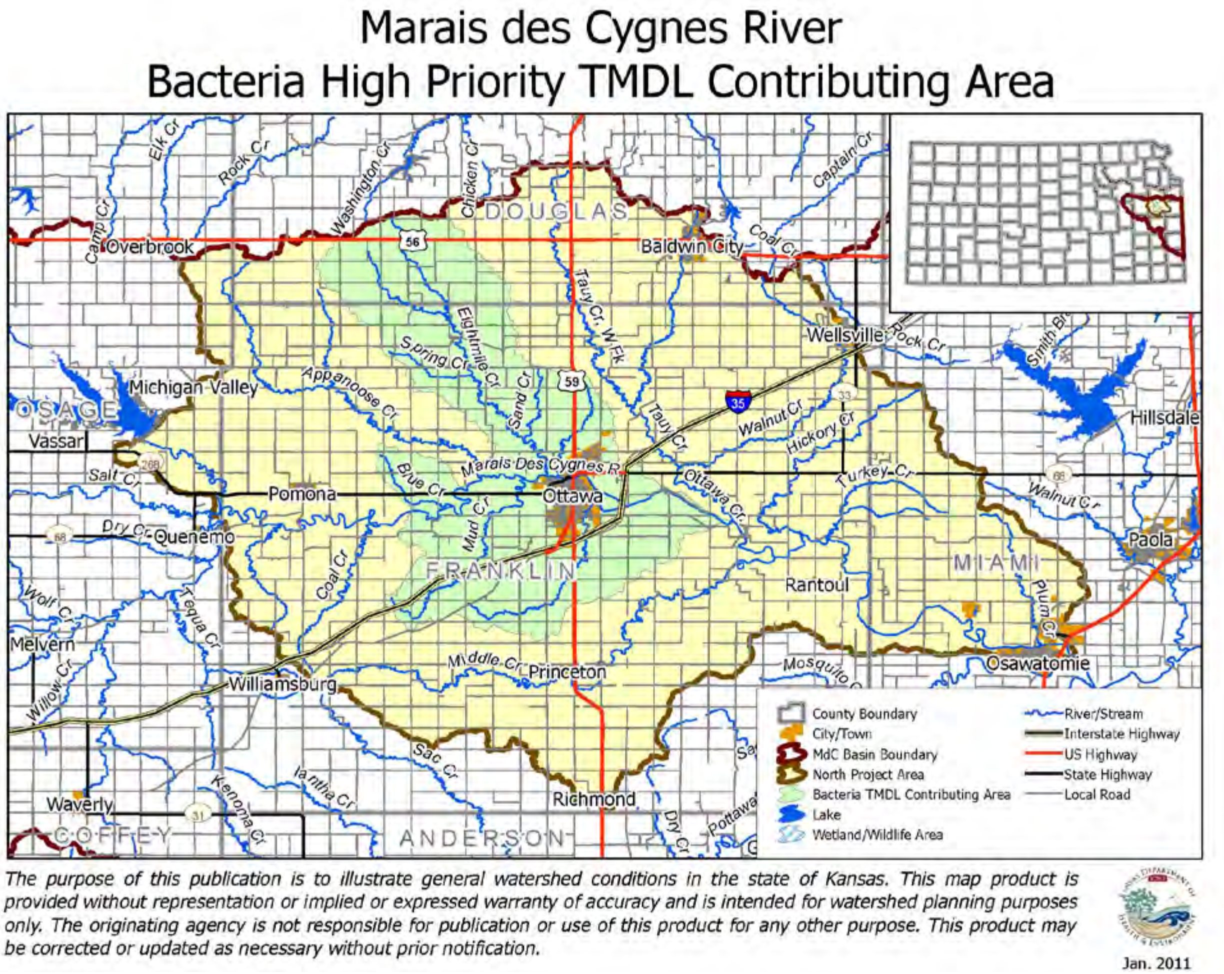


Figure 13. Map Showing MdC River Bacteria High Priority TMDL Contributing Area

The ultimate endpoint for this TMDL will be to achieve Kansas Water Quality Standards fully supporting Primary Contact Recreation and Secondary Contact Recreation. This TMDL will, however, be phased. Kansas adopted a Primary Contact Recreation standard of 900 colonies per 100 ml but EPA subsequently disapproved that standard. This standard was used to establish a load duration curve shown in the TMDL figure (Figure 8). It is recognized, however, that this Primary Contact Recreation standard will be revised in the future in accordance with national guidance. A revised Primary Contact Recreation TMDL curve will be established in Phase Two of this TMDL to reflect changes in this standard. For Phase One the endpoint will be to achieve the Secondary Contact Recreation value of 2,000 colonies per 100 ml and this Phase One load curve is also shown in the TMDL Figure 12. The Kansas Standards allow for excursions above these criteria when the stream flow exceeds flow that is surpassed 10% of the time, for this instance, 2,800 cfs. Monitoring data plotting below the TMDL curve will indicate attainment of the water quality standards.

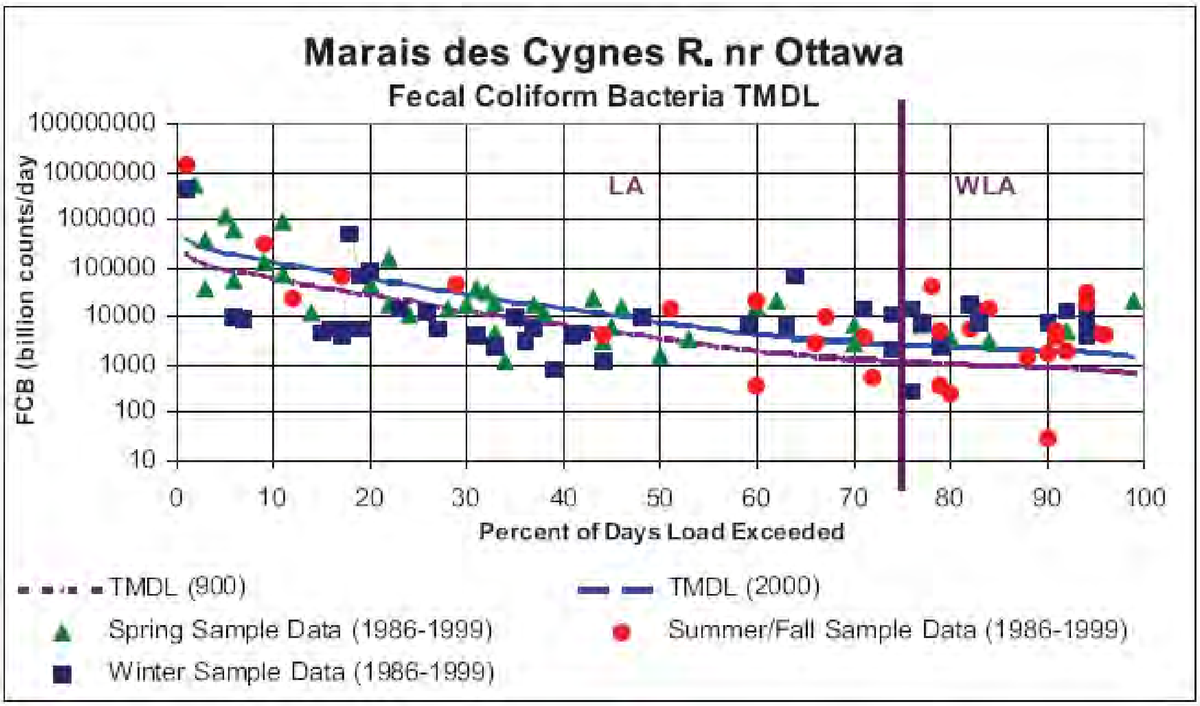


Figure 14. Chart showing the (FCB) Fecal Coliform Bacteria

Potential sources of Fecal Coliform Bacteria (FCB) and the nutrients causing DO include feedlots, wastewater treatment facilities, septic systems, pesticides, fertilizers, and wildlife. Potential sources of ammonia include livestock, septic systems, wildlife, and wastewater treatment facilities. Activities to reduce FCB should be directed towards smaller unpermitted livestock operations, rural homesteads and farmsteads along the river and urban runoff from the City of Ottawa.

In the State of Kansas, confined animal feeding operations (CAFOs) with greater than 300 animal units must register with KDHE. There are approximately 267 registered CAFOs located within HUC8 10290101 shown in Figure 13 below (this number, which is based on best available information, may be dated and subject to change). Waste disposal practices and wastewater effluent quality are monitored by KDHE for these registered CAFOs. Because of this tracking, registered CAFOs are not considered a significant threat to water resources within the watershed. A portion of the State's livestock population exists on small unregistered farms. These small unregistered livestock operations may contribute a significant source of fecal coliform bacteria and nutrients, depending on the presence and condition of waste management systems and proximity to water resources.

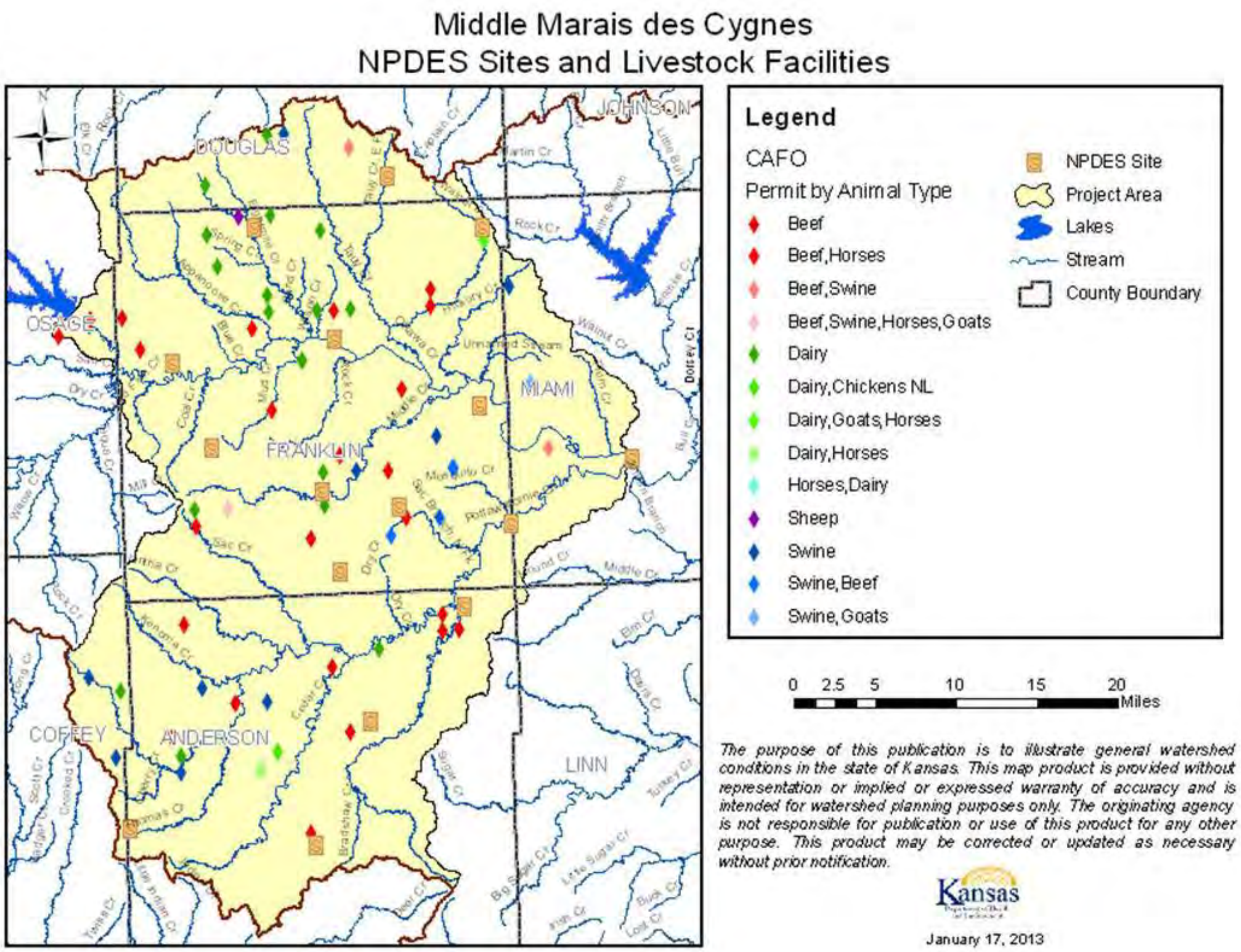


Figure 15. Map showing NPDES Sites and Livestock Waste Facilities

There are 16 NPDES permitted wastewater dischargers within the watershed (Figure 13). These systems are outlined in Table 8. The city of Rantoul, although located within the watershed, discharges a substantial distance downstream of water quality monitoring site 270 and therefore, cannot contribute to the impairment listed at the monitoring site.

Table 7. NPDES permitted wastewater dischargers within the watershed

DISCHARGING FACILITY	CITY	COUNTY	RECEIVING STREAM
OTTAWA MWTP	OTTAWA	FRANKLIN	MARAIS DES CYGNES RIVER
RANTOUL MWTF	MDC R	FRANKLIN	MARAIS DES CYGNES RIVER
CITY OF BALDWIN CITY	BALDWIN	DOUGLAS	EAST FORK TAUY CREEK TO TUAY CREEK
CITY OF GARNETT	GARNETT	ANDERSON	SOUTH FORK POTTAWATOMIE CREEK
CITY OF GREELEY	GREELEY	ANDERSON	SOUTH FORK POTTAWATOMIE CREEK
CITY OF LANE	LANE	FRANKLIN	POTTAWATOMIE CREEK

DISCHARGING FACILITY	CITY	COUNTY	RECEIVING STREAM
CITY OF OSAWATOMIE	OSAWATOMIE	MIAMI	MARAIS DES CYGNES RIVER
KDOT - FRANKLIN CO. REST AREA	INDEPENDENCE	FRANKLIN	MIDDLE CREEK VIA PAYNE CREEK
CITY OF OTTAWA	OTTAWA	FRANKLIN	MARAIS DES CYGNES RIVER
POMONA WASTEWATER PLANT	POMONA	FRANKLIN	MARAIS DES CYGNES RIVER
PRINCETON WASTEWATER PLANT	PRINCETON	FRANKLIN	MARAIS DES CYGNES RIVER VIA MIDDLE CREK
CITY OF RANTOUL	RANTOUL	FRANKLIN	MARAIS DES CYGNES R VIA TRIBUTARY
CITY OF RICHMOND	RICHMOND	FRANKLIN	MIDDLE CREEK VIA UNNAMED TRIB
USD #288 CENTRAL HEIGHTS SCHOOL	RICHMOND	FRANKLIN	POTTAWATOMIE CREEK VIA SAC BRANCH CRK
WELLSVILLE, CITY OF	WELLSVILLE	FRANKLIN	WALNUT CREEK
WESTPHALIA, CITY OF	WESTPHALIA	ANDERSON	POTTAWATOMIE CEERK VIA CHERRY CREEK

Population projections for Ottawa to the year 2020 indicate substantial growth. Communities experiencing growth and expansion will have increased impervious areas. The amount of impervious area in a watershed (i.e rooftops, roads, parking lots, etc.) increases, water resources can be adversely impacted from increases in runoff volume and additional pollutants associated with urban environments, unless efforts are made by local governments and urban residents to minimize these adverse impacts through sound land use planning and stormwater management. City of Ottawa Public Works projections of future water use and resulting wastewater appear to be within the design flow for the current system's treatment capacity. The excursions from the water quality standards appear to occur under a variety of flow conditions but particularly under the flow extremes, both high and low flow conditions. Of significance to point sources are the excursions under low flow in all seasons, especially during winter, indicating that point sources may have an impact under lower flows in the watershed.

Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. Flow duration data were determined from the MdC near Ottawa Gage Station for each of the three defined seasons: Spring (April-July), Summer-Fall (August-October) and Winter (November-March). High flows and runoff equate to lower flow durations; baseflow and point source influences generally occur in the 75-99% range. Load curves were established for Primary and Secondary Contact Recreation criterion by multiplying the flow values along the curve by the applicable water quality criterion and converting the units to derive a load duration curve of colonies of bacteria per day. These load curves represent the TMDL since any point along the curve represents water quality for the standard at that flow.

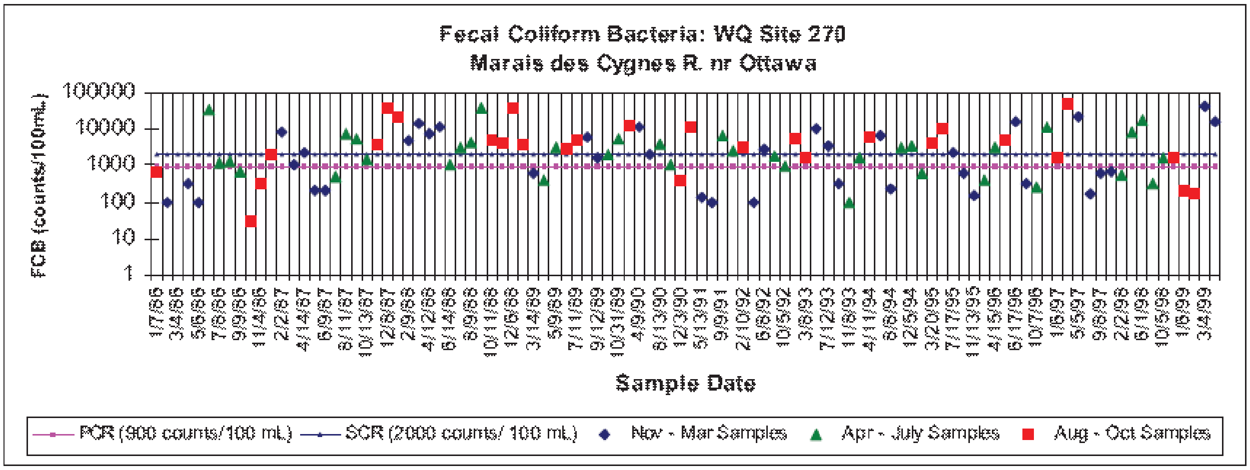


Figure 16. Fecal Coliform Bacteria load curves.

Historic excursions from the water quality standard are seen as plotted points above the load curves. Water quality standards are met for those points plotting below the applicable load duration curves (Figure 14). Excursions were seen in each of the three defined seasons and are outlined in Table 9 below. Forty seven percent of Spring samples and 63% of Summer-Fall samples were over the secondary contact criterion. Forty five percent of Winter samples were over the secondary criterion. Overall, 51% of the samples were over the criteria. This would represent a baseline condition of non-support of the impaired designated use.

Table 8. Bacteria standard of 2000 by flow and season.

NUMBER OF SAMPLES OVER BACTERIA STANDARD OF 2000 BY FLOW AND SEASON

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Marais des Cygnes River near Ottawa (270)	Spring	4	2	4	3	3	2	18/38 = 47%
	Summer	2	0	1	4	5	7	19/30 = 63%
	Winter	1	3	1	5	4	4	18/40 = 45%

Phosphorus load reduction goal to correlate with the Fecal coliform bacteria TMDL

The load reduction goal for the North Section is a 23% reduction in Phosphorus which equals 14,357 lbs/yr. The following table represents the correlation between the Phosphorus entering the stream and the bacteria concentration found in the stream. We can assume that this reduction in Phosphorus will get us to the bacterial index level that we need, and therefore meet the FCB TMDL.

The phosphorus load reduction is shown in the illustration below.

MdC River Load Reduction Goal

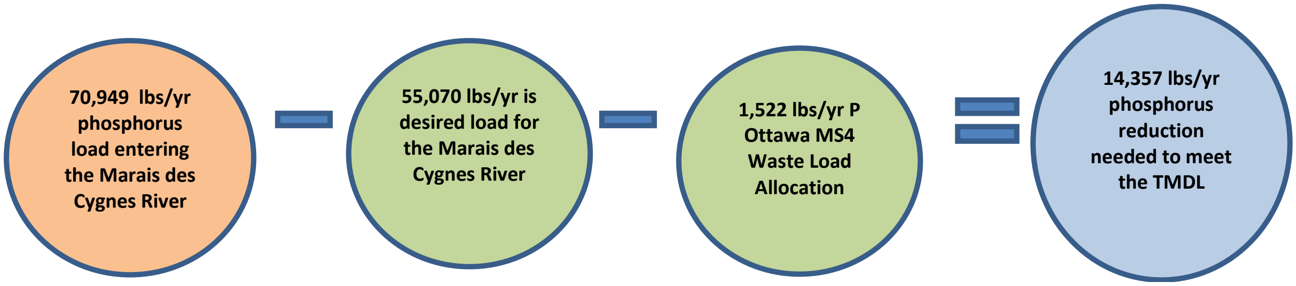


Figure 17. Illustration of Load Reduction Goal for the North Portion of the Plan.

Table 9 illustrates the phosphorus reduction for each BMP type by year.

Table 9. Annual Phosphorus Load Reductions (lbs) North Portion

Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Grazing Mgmt Plans	Fence off Streams and Ponds	Annual Load Reduction
1	638	0	63	63	140	0	146	**1,050**
2	638	797	126	126	140	281	292	**2,400**
3	1,276	797	189	189	280	281	438	**3,450**
4	1,276	1,595	252	252	280	562	584	**4,801**
5	1,914	1,595	315	315	420	562	730	**5,851**
6	1,914	2,392	378	378	420	843	876	**7,201**
7	2,552	2,392	441	441	560	843	1,022	**8,251**
8	2,552	3,189	504	504	560	1,124	1,168	**9,602**
9	3,189	3,189	568	568	700	1,124	1,314	**10,652**
10	3,189	3,987	631	631	700	1,405	1,460	**12,002**
11	3,827	3,987	694	694	840	1,405	1,606	**13,052**
12	3,827	4,784	757	757	840	1,686	1,752	**14,403**
13	4,465	4,784	820	820	980	1,686	1,898	**15,453**
14	4,465	5,581	883	883	980	1,967	2,044	**16,803**
15	5,103	5,581	946	946	1,120	1,967	2,190	**17,853**
16	5,103	6,379	1,009	1,009	1,120	2,248	2,336	**19,204**
17	5,741	6,379	1,072	1,072	1,260	2,248	2,482	**20,254**
18	5,741	7,176	1,135	1,135	1,260	2,529	2,628	**21,604**
19	6,379	7,176	1,198	1,198	1,400	2,529	2,774	**22,654**
20	6,379	7,973	1,261	1,261	1,400	2,810	2,920	**24,005**

Additional sources of fecal coliform bacteria

Septic Systems: There are currently thousands of septic systems within the watershed and this number is increasing. In Franklin County alone permits were issued for twenty-nine on-site septic system upgrades and eighteen new on-site septic systems for 2011 and the first six months of 2012.

When properly designed, installed, and maintained, septic systems can act as an effective means of wastewater treatment. However, poorly maintained or "failing" septic systems can leach pollutants into nearby surface waters and groundwater. Table 11 was developed using data research from USEPA Onsite Wastewater Treatment Systems Manual (Figures from EPA Tables 3-7, 3-8) and assistance from Kansas State University, Extension Engineer, Water Quality.

Table 10. Organic waste generated by a 3 person household with a septic system.

BOD-5 (5-day Biological oxygen demand)	63.2 grams per capita per day (gpcd)	X 3 people/home	.42 lbs
TSS (Total suspended solids)	70.7 grams per capita per day	X 3 people/home	.47lbs
Total N (Nitrogen)	11.2 grams per capita per day	X 3 people/home	.07 lbs
Total P (Phosphorus)	2.7 grams per capita per day	X 3 people/home	.02 lbs

Based on the figures provided above each septic system generates a total of .98 lbs organic waste per day.

From the EPA data on concentrations and the SWKLEPG (Southwest Kansas Local Environmental Planning Group) database, a figure showing the potential threat to ground water and public health that can be reduced when a failing system is replaced and brought to current standards. Shown in the figure below, using the figure of .98 pounds of organic waste for one household, the potential reduction of bacterial pollution would be 358 pounds of organic waste per household per year for every failing septic system that was replaced and brought to the minimum state standards. The estimated reduction is carried forward for the life of the properly maintained septic system. A properly maintained system can be expected to have a service life of up to thirty years

Table 11. Calculation of the organic waste generated by a 3 person hosehold over the estimated life of a septic system (30 Years)

.98 lbs organic waste per 3 person household per day x 365 =
358 lbs organic waste per household per year
358 lbs x 30 years = 10,740 lbs over the life of the system

The exact number of failing septic systems within the watershed is unknown; however the number may be increasing due to the current trends in suburban development.

Local Environmental Protection Programs and County Health Departments may provide excellent sources of information regarding the proper design, installation, and maintenance for septic systems.

Wildlife located throughout the watershed is not usually considered a significant source of nonpoint source pollutants. However, during seasonal migrations, concentrations of waterfowl can add significant amounts of fecal coliform bacteria and nutrients into surface water resources.

Additional nonpoint source pollution

As shown in Figure 2, approximately 27% of the watershed's land is used for row crop agriculture. Row crop agriculture can be a significant source of nonpoint source pollution. Common pollutants from row crop agriculture include sediment, nutrients, pesticides, and fecal coliform bacteria (from manure applications). Many producers within the watershed regularly implement and maintain BMPs to limit the amount of nonpoint source pollutants leaving their farm. Some common BMPs include: the use of contour plowing; use of cover crops; maintaining buffer strips along field edges; and proper timing of fertilizer application.

BEST MANAGEMENT PRACTICES NORTH SECTION

Bacteria survival is dependent on soil moisture, temperature, pH, and the availability of nutrients. In ideal conditions the bacteria is retained near the soil surface long enough for infiltration into unsaturated soil to occur resulting in bacteria die off within the first two feet. When conditions are not ideal BMPs are implemented to prevent or reduce the amount of bacteria that enters the surface waters.

Non-Structural BMPs control bacteria at the source. Examples of non-structural BMPs are septic inspections and pumping the septic tank, managing pet waste, proper manure management and livestock grazing management plans. Properly maintained septic systems are less likely to fail and contaminate surface or ground water.

Structural BMPs require construction and there is usually significant cost associated with them. Some examples are constructed wetlands, sand filters, infiltration trenches, livestock waste management systems, low impact development and fences. Dense vegetative buffers are used to facilitate conventional removal of bacteria through detention, filtration by vegetation and infiltration into the soil.

Failing onsite wastewater systems are direct contributors of FCB. Upgrading these systems will return them to proper functioning conditions. Other methods include the use of chemicals and nutrients such as chlorine or even ultraviolet lights, which can be costly and require considerable oversight.

The Watershed Assessment focused on the riparian area due to the direct correlation of the FCB TMDL and riparian area condition. Livestock access and type of vegetation were two variables recorded. A total of 386 assessment sites were completed in the entire northern section with 65 sites in the poor condition category, 191 medium condition category, and 130 in high condition category. Livestock feeding sites were a portion of the 56 points of interest also recorded. Livestock BMPs will be one of the focal points for restoration practices to achieve the FCB TMDL. Removal of livestock from the riparian area along with relocating feeding and watering sites are examples of the BMPs to be utilized.

The type of riparian vegetation and its condition to function as a proper buffer for pollutants will be another focal point for restoration practices. Livestock access to the riparian area degraded the vegetation reducing its function as a buffer. Vegetative and riparian forest buffers provide a high filter and retention of nutrients and sediment. Trees provide streambank stability reducing sediment with attached phosphorus from entering streams. Agroforestry practices will be utilized to integrate the benefits of vegetative and riparian forest buffers with livestock protection and production. Agroforestry is the integration of agriculture and forestry.

Detailed definitions of the BMPs that have been selected begin on page 65.

BMP Adoption Rates

Implementation of adopted BMPs are based on the Kansas Department of Agriculture - Division of Conservation (KDA-DOC), formerly known as the State Conservation Commission (SCC), needs inventory and previous WRAPS service provider implementations. The needs inventory was reviewed and analyzed for areas needing treatment related to cropland and livestock. The Watershed Specialist and Watershed Forester have been working in the watershed since the original 2003 WRAPS was completed and have years of on-the-ground experience of the needs and adoption of BMPs.

The KDA-DOC Needs Inventory was utilized to estimate the number of BMP needs based on the inventory results. The needs inventory and estimated adoption rates per practice per year was used to determine the BMP needs and achievable goals for load reductions per year. The table of needs is provided in the appendix.

ESTIMATED LOAD REDUCTIONS AND COSTS

MdC River BMPs, Costs and Estimated Phosphorus Reduction

Based on the TMDL, livestock is one of the primary contributors to the FCB. Livestock BMPs were used to calculate the needed reduction to meet the TMDL. The load reduction goal for the MdC River is 23% reduction in phosphorus which equals 14,357 lbs/yr. The table in Appendix B illustrates the current phosphorus reduction goal will be met within 12 years. Also found in the appendix are tables showing the calculations used to determine the load reduction, estimated adoption rates and cost estimates for the implementation of BMPs selected to address the FCB TMDL.

Livestock BMP Adoption Rates and Annual Costs

Implementation of adopted BMPs is based on the KDA-DOC needs inventory and previous WRAPS service provider implementations. The KDA-DOC needs inventory was reviewed and analyzed for areas needing treatment related to livestock needs. A table of needs is provided in Appendix B.

Table 12. Table calculating the Load reduction for MdC River

Avg Flow (cfs)	Current Avg TP Conc	Current Load Based on current TP	% of 270 Load	TMDL 1	Reduction Needed (lbs/day)	Reduction Needed (lbs/year)		
726	0.191	749	74.6%	592	157	57265		flow decreased to allow for d/s flows & loads
52.0	0.168	47	4.7%	37	9.9	3608		flow decreased slightly to account for d/s flows & loads
2.06	1.190	13.24	1.3%	13.24	0.0	0.0		Current effluent volume from Ottawa
885.00	0.210	1004	100.0%	793	210	76751		total current load & 21% reduction
882.94		990.35	98.68%	780.07	210	76752		load & reduction outside of Ottawa wastewater
104.94		194.38	19.37%	150.88	44	15879	22.38% Reduction	
A	B	C	D	E	F	G	H	
Flow at 555 & 692 was reduced to allow for enough flows along d/s main stem, including Ottawa MS4, Ottawa ww flow discounted from total								
Concentrations taken from KDHE samplings or Ottawa DMR								
Current load = avg flow X avg [TP] X 5.4, Incremental load = 270 load - Ottawa load - 555 load - 692 load								
Proportions based on load @ 270								
TMDL set @ estimated [TP] of 0.166 mg/l which by regression is linked to a ECB count of ~ 300, Ottawa allocation fixed @ current, 555 & 692 allocations based on % of 270 load, Incremental load taken as difference between total and Ottawa + 555 + 692 loads								
Reduction = Present - Desired								
Annualized by multiplying by 365 days								
Actual necessary reduction when discounting any reduction by Ottawa wastewater								

Table 13. Estimated flow contribution from Ottawa MS4.

	Avg Flow (cfs)	% Flow	Current Load Based on % Flow	TMDL Based on % Flow	Reduction Needed (lbs/day)	Reduction Needed lbs/year	
Rock Cr	18.1	17.25%	33.5	26.0	7.50	2738.8	
Wilson Cr	6.36	6.06%	11.8	9.1	2.64	962.4	
Eight Mile Cr	46.9	44.69%	86.9	67.4	19.44	7096.6	
Mud Cr	15.9	15.15%	29.5	22.9	6.59	2405.9	
Blue Cr	7.62	7.26%	14.1	11.0	3.16	1153.0	
sum nps tribs	94.88	90.41%	175.7	136.4	39.33	14356.6	
Ottawa MS4 WLA	10.06	**9.59%**	18.6	14.5	4.17	1522.2	Not eligible for 319
Comments	AA	**BB**	**CC**	**DD**	**F**	**G**	
AA	Flows fixed by Perry, MS4 flow estimated @ 10% of incremental flow						
BB	Percentage of incremental flow below 555 and 692 and Ottawa ww						
CC	Proportion of incremental load based on % of incremental flow						
DD	Proportion of incremental desired load (TMDL) based on % of incremental flow						
F	See Above						
G	See Above						

MdC River Subwatershed Livestock and Cropland Breakdown

COUNTY	HUC 8	Subwatershed	Percentage
DOUGLAS	10290101	MdC River Bacteria TMDL	**26.3**
FRANKLIN	10290101	MdC River Bacteria TMDL	**19.4**
OSAGE	10290101	MdC River Bacteria TMDL	**0**

26.3% of 10290101 in Douglas County is within the MdC River Bacteria TMDL Contributing Area
19.4% of 10290101 in Franklin County is within the MdC River Bacteria TMDL Contributing Area

COUNTY	# Permitted CAFOs	Percent in Subwatershed	# Other Confined Livestock Facilities	Percent in Subwatershed	# Concentrated Non-Confined Livestock Operations	Percent in Subwatershed
DOUGLAS	3.00	0.79	35.00	9.21	70.00	18.41
FRANKLIN	15.00	2.91	25.00	4.85	100.00	19.40
OSAGE	9.00	0.00	27.00	0.00	280.00	0.00
Total	27.00	3.70	87.00	14.06	450.00	37.81

COUNTY	Total Acres of Pasture	Percent in Subwatershed	Acres of Pasture Needing Treatment	Percent in Subwatershed	Total Acres of Range Land	Percent in Subwatershed	Acres of Range Land Needing Treatment (2005)	Percent in Subwatershed
DOUGLAS	14,268.00	3,752.48	7,134.00	1,876.24	15,560.00	4,092.28	7,780.00	2,046.14
FRANKLIN	86,500.00	16,781.00	52,000.00	10,088.00	75,000.00	14,550.00	37,500.00	7,275.00
OSAGE	13,404.00	0.00	8,981.00	0.00	126,580.00	0.00	84,809.00	0.00
Total	114,172.00	20,533.48	68,115.00	11,964.24	217,140.00	18,642.28	130,089.00	9,321.14

SOUTH SECTION 2. POTTAWATOMIE CREEK

The Pottawatomie or South Section of the Middle MdC subwatershed is located primarily in Anderson County, Kansas. The Pottawatomie Creek drainage area includes 373.8 square miles (dissolved Oxygen) and the two TMDLs' drainage areas of 230.5 square miles (Fecal Coliform Bacteria TMDL) and 329 square miles (Selenium TMDL) The areas contributing to the dissolved oxygen TMDL in Pottawatomie Creek are 19.3% Franklin County, 100% Anderson County, 28.5% Coffey County and 31.8% Miami County are within the TMDL contributing area. The following HUCs have been identified as high priority areas for the southern portion of the plan 102901010604, 102901010603, 102901010509, 102901010507 and 102901010506 and are highlighted in green on the map in figure 15.

Highlighted in the map below are the high priority areas that have been identified. The SLT selected targeted areas from review of TMDL reports from KDHE, Needs Inventory by KDA-DOC and discussion with the TMDL Section of KDHE. Currently these areas have impaired waters that need BMPs to reduce pollutant loads. Additional high priority areas are along main portions of Pottawatomie Creek and larger tributaries that lack shade producing vegetation. Additional areas within the Southern portion have lower priority TMDL or naturally causing pollutants. The targeted areas will be reviewed if the TMDL's change after further monitoring.

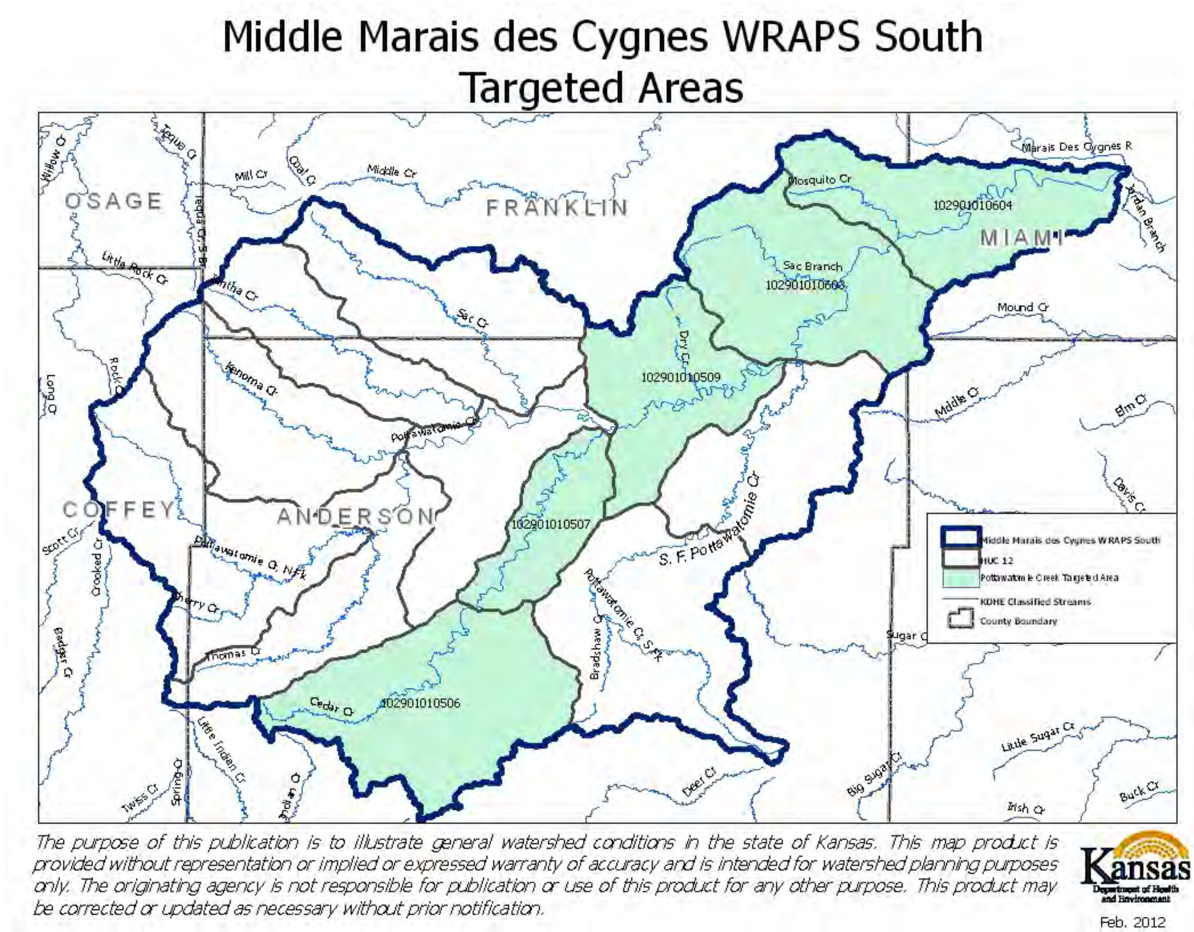


Figure 18. Pottawatomie Creek Targeted Areas

Dissolved Oxygen violations are observed when flows are less than 22 cfs in Pottawatomie Creek. The DO violations vary by season and are typically associated with the drier months during the summer and also during the fall months. The critical period associated with the lowest average DO concentrations in Pottawatomie Creek include the months of July through November, Biological Oxygen Demand (BOD) is allocated in the TMDL and it is suggested that sediment control practices such as buffer strips and grassed waterways should help reduce the nonpoint source BOD load under higher flows as well as reduce oxygen demand exerted by the sediment transported to the stream that may occur during the critical flow period.

There are 5 NPDES permitted wastewater dischargers within the watershed

There are 29 Livestock Waste Management System operations that are registered, certified or permitted within the watershed. The facility type is beef, dairy or swine. Most of these facilities are located along the main stem reach or listed tributaries. Potential animal units for all facilities in the watershed total 9,245. The actual number of animal units on site is variable, but typically less than potential numbers.

Most of the watershed's population density is low (5-19 persons/mi) when compared to densities across the MdC Watershed except for areas associated with the City of Garnett (32-41 persons/mi) which is average for the MdC Watershed.

BEST MANAGEMENT PRACTICES SOUTH SECTION:

Riparian vegetation restoration should occur adjacent to the main stem of Pottawatomie Creek to help reduce the violations that may occur during periods of low flow and higher temperatures. In addition the TMDL suggests that proper manure and livestock waste storage should be installed and that on-site waste systems should be in proper working condition. Further assessment work may be needed to determine sources of organic loading during the October and November months, though it is likely that leaf litter and low flow conditions may be a contributing factor to the DO violations during these months.

Sediment control practices such as buffer strips and grassed waterways should help reduce the non-point source BOD load under higher flows as well as reduce oxygen demand exerted by the sediment transported to the stream that may occur during the critical flow period.

To address DO violations that occurred due to low flows and high seasonal temperatures riparian vegetation restoration should occur adjacent to the main stem of Pottawatomie Creek to provide shade for the stream and generally reduce surface water temperatures during the seasons of concern. Riparian vegetation will increase infiltration allowing more rainfall to be retained locally and help maintain water tables.

The Watershed Assessment focused on the riparian area due to the direct correlation of the DO TMDL and riparian area condition. Livestock access and type of vegetation were two variables recorded. Livestock feeding sites were points of interest also recorded. Livestock BMPs will be one of the focal points for restoration practices to achieve the DO TMDL. Removals of livestock from the riparian area along with relocating feeding and watering sites are examples of the BMPs to be utilized.

The type of riparian vegetation and its condition to function as a proper buffer for pollutants will be another focal point for restoration practices. Livestock access to the riparian area degraded the vegetation reducing its function as a buffer. Vegetative and riparian forest buffers provide a high filter and retention of nutrients and sediment. Agroforestry practices will be utilized to integrate the benefits of vegetative and riparian forest buffers with livestock protection and production. Agroforestry is the integration of agriculture and forestry.

Failing onsite wastewater systems are direct contributors of BOD that effects DO. Upgrading these systems will return them to proper functioning conditions.

Detailed definitions of available BMPs are located on page 65.

BMP Adoption Rates

Implementation of adopted BMPs is based on the KDA-DOC needs inventory and previous WRAPS service provider implementations. The KDA-DOC needs inventory was reviewed and analyzed for areas needing treatment related to cropland and livestock needs. The Watershed Specialist and Watershed Forester have been working in the watershed since the original 2003 WRAPS was completed and have years of on-the-ground experience of the needs and adoption of BMPs. They also completed a Watershed Assessment of the entire watershed focusing on the riparian area condition. A total of 426 assessment sites were completed in the southern section with 95 sites in the poor condition category, 193 medium condition category, and 138 in high condition category. A total of 65 points of interest were recorded including livestock feeding sites, bank stabilization, potential buffer sites and any potential issue in the riparian area.

The KDA-DOC Needs Inventory was utilized to estimate the number of BMP needs based on the inventory results. The needs inventory and estimated adoption rates per practice per year was used to determine the BMP needs and achievable goals for load reductions per year. Table of needs is provided in appendix.

The linear feet of the streams within the Pottawatomie Creek were also used to determine the estimated need of vegetative or riparian forest buffers. The table below shows estimated linear feet of stream. The total was doubled due to two sides of riparian areas with potential vegetation need. Previous adoption rates were then used to determine estimated linear feet of practices per year.

Table 14. Pottawatomie Creek Dissolved Oxygen TMDL

Pottawatomie Creek Dissolved Oxygen TMDL	
Creek Name	**Linear Feet**
North Fork Pottawatomie Creek	3,970
South Fork Pottawatomie Creek	48,086
Pottawatomie Creek	82,678
Sac Creek	68,023
Cedar Creek	40,071
Dry Branch	17,094
Mosquito Creek	16,534
Sac Branch	5,242
Total	**281,698**

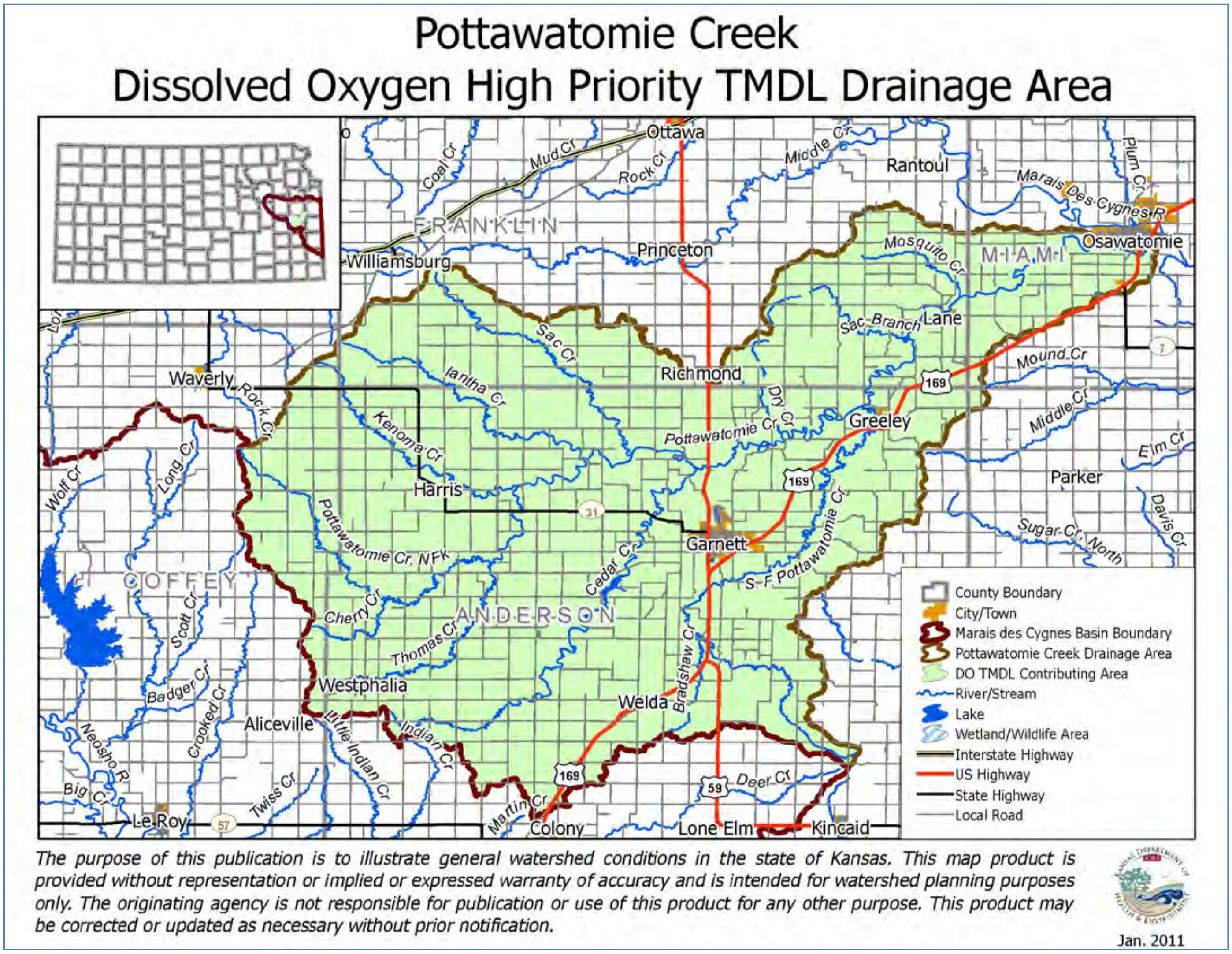
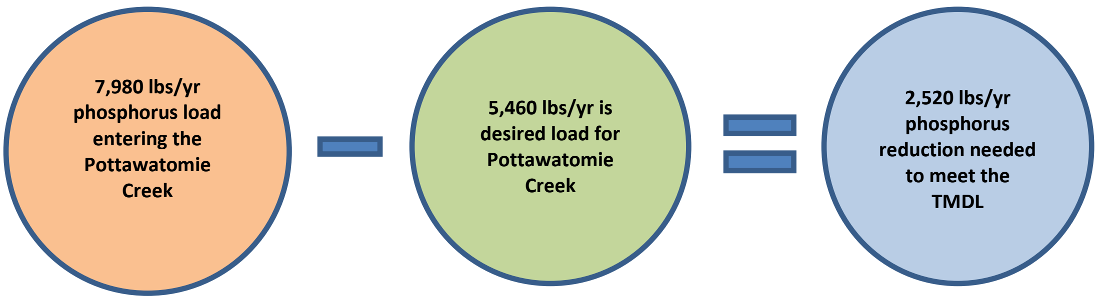


Figure 18. Map showing the Pottawatomie Creek Dissolved Oxygen TMDL Drainage Area

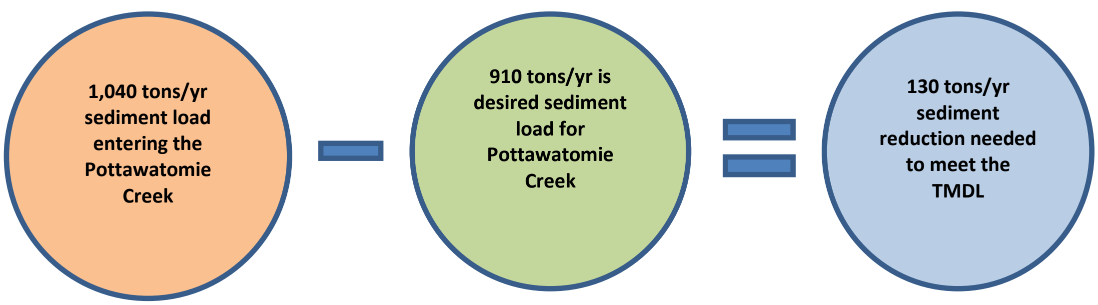
ESTIMATED LOAD REDUCTIONS AND COSTS

The load reduction goal for Section 2 Pottawatomie Creek targeted area is 32% of the current total phosphorus load of 7,980 lbs/yr which equals a reduction of 2520 lbs /yr of phosphorus. The current sediment load is 1,040 tons/yr which equals a reduction of 130 tons/yr of sediment is the goal. The load reduction goal is shown in the illustration below.

Pottawatomie Creek Phosphorus Load Reduction Goal



Pottawatomie Creek Sediment Load Reduction Goal



The load reductions in the following table have been calculated using the BMPs selected to reduce the DO TMDL in the Pottawatomie Creek. It is estimated that within two years 97% of the phosphorus load reduction goal will have been met and sediment load reduction will be met in year one. Table 14 illustrates the soil erosion reduction for each BMP type by year and Table 15 displays the phosphorus runoff reduction for each BMP type by year.

Table 15. Pottawatomie Creek Annual Soil Erosion Reduction

Year	Terraces and Waterways	No-Till	Nutrient Management Plan	Vegetative and Riparian Buffers	Grade Stabilization Structures	Total
1	15	113	19	101	8	255
2	29	225	38	203	15	509
3	44	338	56	304	23	764
4	59	450	75	405	30	1,019
5	74	563	94	506	38	1,274
6	88	675	113	608	45	1,528
7	103	788	131	709	53	1,783
8	118	900	150	810	60	2,038
9	132	1,013	169	911	68	2,292
10	147	1,125	188	1,013	75	2,547
11	162	1,238	206	1,114	83	2,802
12	176	1,350	225	1,215	90	3,056
13	191	1,463	244	1,316	98	3,311
14	206	1,575	263	1,418	105	3,566
15	221	1,688	281	1,519	113	3,821
16	235	1,800	300	1,620	120	4,075
17	250	1,913	319	1,721	128	4,330
18	265	2,025	338	1,823	135	4,585
19	279	2,138	356	1,924	143	4,839
20	294	2,250	375	2,025	150	5,094

Table 16. Pottawatomie Creek Annual Phosphorus Runoff Reduction

Year	Terraces and Waterways	No-Till	Nutrient Management Plan	Vegetative and Riparian Buffers	Grade Stabilization Structures	Total
1	20	80	25	135	10	270
2	39	160	50	270	20	539
3	59	240	75	405	30	809
4	78	320	100	540	40	1,078
5	98	400	125	675	50	1,348
6	118	480	150	810	60	1,618
7	137	560	175	945	70	1,887
8	157	640	200	1,080	80	2,157
9	176	720	225	1,215	90	2,426
10	196	800	250	1,350	100	2,696
11	216	880	275	1,485	110	2,966
12	235	960	300	1,620	120	3,235
13	255	1,040	325	1,755	130	3,505
14	274	1,120	350	1,890	140	3,774
15	294	1,200	375	2,025	150	4,044
16	314	1,280	400	2,160	160	4,314
17	333	1,360	425	2,295	170	4,583
18	353	1,440	450	2,430	180	4,853
19	372	1,520	475	2,565	190	5,122
20	392	1,600	500	2,700	200	5,392

Table 17. Annual Phosphorus Load Reductions (lbs) South Portion

Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Grazing Mgmt Plans	Fence off Streams and Ponds	Annual Load Reduction
1	0	797	63	63	0	0	73	**996**
2	638	797	126	63	140	0	146	**1,910**
3	638	1,595	189	126	140	1	219	**2,908**
4	1,276	1,595	252	126	280	2	292	**3,823**
5	1,276	2,392	315	189	280	3	365	**4,820**
6	1,914	2,392	378	189	420	4	438	**5,735**
7	1,914	3,189	441	252	420	5	511	**6,733**
8	2,552	3,189	504	252	560	6	584	**7,648**
9	2,552	3,987	568	315	560	7	657	**8,645**
10	3,189	3,987	631	315	700	8	730	**9,560**
11	3,189	4,784	694	378	700	9	803	**10,557**
12	3,827	4,784	757	378	840	10	876	**11,472**
13	3,827	5,581	820	441	840	11	949	**12,470**
14	4,465	5,581	883	441	980	12	1,022	**13,385**
15	4,465	6,379	946	504	980	13	1,095	**14,382**
16	5,103	6,379	1,009	504	1,120	14	1,168	**15,297**
17	5,103	7,176	1,072	568	1,120	15	1,241	**16,295**
18	5,741	7,176	1,135	568	1,260	16	1,314	**17,210**
19	5,741	7,973	1,198	631	1,260	17	1,387	**18,207**
20	6,379	7,973	1,261	631	1,400	18	1,460	**19,122**

Needs Inventory

The KDA-DOC Needs Inventory was utilized to estimate the number of BMP needs based on the inventory results. The needs inventory and estimated adoption rates per practice per year was used to determine the BMP needs and achievable goals for load reductions per year. Table 15 shown below indicates there are 15,898 acres of cropland in Anderson County needing treatment. Cropland needing treatment falls into two categories, management practices and structural. Management practices include enhanced nutrient management, enhanced pesticide management, nutrient management plans, annual soil sampling, no-till and ridge-till. Structural practices include terrace restoration, new waterways, waterway restoration, diversions, grade stabilization and water/sediment control basins.

Table 18. Pottawatomie Creek KDA-DOC Needs Inventory

COUNTY	HUC 8	Subwatershed	Percentage	Total Acres of Cropland	Percent in Subwatershed	Acres Cropland Needing Treatment (2005)	Acres Needing Enhanced Nutrient Management
ANDERSON	10290101	Pottawatomie Creek DO TMDL	**100**	90,618.00	100	15,898.00	0.00
COFFEY	10290101	Pottawatomie Creek DO TMDL	**28.5**	23,640.00	28.5	11,112.00	15,366.00
FRANKLIN	10290101	Pottawatomie Creek DO TMDL	**19.3**	173,556.00	19.3	104,133.00	86,000.00
MIAMI	10290101	Pottawatomie Creek DO TMDL	**31.8**	15,984.00	31.8	15,184.00	15,184.00
Total				303,798.00	44.7	146,327.00	116,550.00
COUNTY	**HUC 8**	**Subwatershed**	**Percentage**	**Acres in No-Till**	**Percent in Subwatershed**	**Acres in Ridge Till**	**Acres in Conservation Tillage**
ANDERSON	10290101	Pottawatomie Creek DO TMDL	**100**	9,062.00	100	0.00	18,124.00
COFFEY	10290101	Pottawatomie Creek DO TMDL	**28.5**	3,000.00	28.5	0.00	4,500.00
FRANKLIN	10290101	Pottawatomie Creek DO TMDL	**19.3**	12,000.00	19.3	1,700.00	104,700.00
MIAMI	10290101	Pottawatomie Creek DO TMDL	**31.8**	3,996.00	31.8	0.00	9,590.00
Total				28,058.00	48.1	1,700.00	136,914.00

COUNTY	HUC 8	Subwatershed	Percentage	Acres Needing Grade Stabilization	Acres Needing Water/Sediment Control Watersheds	Acres Need Structural Treatment
ANDERSON	10290101	Pottawatomie Creek DO TMDL	**100**	0.00	0.00	17,487.00
COFFEY	10290101	Pottawatomie Creek DO TMDL	**28.5**	10.00	0.00	2,360.00
FRANKLIN	10290101	Pottawatomie Creek DO TMDL	**19.3**			52,066.00
MIAMI	10290101	Pottawatomie Creek DO TMDL	**31.8**	35.00	35.00	5,163.00
Total				45.00	35.00	77,076.00
COUNTY	**HUC 8**	**Subwatershed**	**Percentage**	**Acres Needing Conversion to Permanent Vegetation (Steep Slope)**	**Acres Needing Conversion to Wetland (swampy areas)**	
ANDERSON	10290101	Pottawatomie Creek DO TMDL	**100**	0.00	115.00	100% of 10290101 in Anderson County is within the Pottawatomie Creek DO TMDL Contributing Area
COFFEY	10290101	Pottawatomie Creek DO TMDL	**28.5**	3,546.00	0.00	28.5% of 10290101 in Coffey County is within the Pottawatomie Creek DO TMDL Contributing Area
FRANKLIN	10290101	Pottawatomie Creek DO TMDL	**19.3**	3,000.00	5,000.00	19.3% of 10290101 in Franklin County is within the Pottawatomie Creek DO TMDL Contributing Area
MIAMI	10290101	Pottawatomie Creek DO TMDL	**31.8**	270.00	40.00	31.8% of 10290101 in Miami County is within the Pottawatomie Creek DO TMDL Contributing Area
Total				6,816.00	5,155.00	

COUNTY	HUC 8	Subwatershed	Percentage	Acres Needing Grade Stabilization	Acres Needing Water/Sediment Control Watersheds	Acres Need Structural Treatment
ANDERSON	10290101	Pottawatomie Creek DO TMDL	**100**	0.00	0.00	17,487.00
COFFEY	10290101	Pottawatomie Creek DO TMDL	**28.5**	10.00	0.00	2,360.00
FRANKLIN	10290101	Pottawatomie Creek DO TMDL	**19.3**			52,066.00
MIAMI	10290101	Pottawatomie Creek DO TMDL	**31.8**	35.00	35.00	5,163.00
Total				45.00	35.00	77,076.00
COUNTY	**HUC 8**	**Subwatershed**	**Percentage**	**Acres Needing Conversion to Permanent Vegetation (Steep Slope)**	**Acres Needing Conversion to Wetland (swampy areas)**	
ANDERSON	10290101	Pottawatomie Creek DO TMDL	**100**	0.00	115.00	100% of 10290101 in Anderson County is within the Pottawatomie Creek DO TMDL Contributing Area
COFFEY	10290101	Pottawatomie Creek DO TMDL	**28.5**	3,546.00	0.00	28.5% of 10290101 in Coffey County is within the Pottawatomie Creek DO TMDL Contributing Area
FRANKLIN	10290101	Pottawatomie Creek DO TMDL	**19.3**	3,000.00	5,000.00	19.3% of 10290101 in Franklin County is within the Pottawatomie Creek DO TMDL Contributing Area
MIAMI	10290101	Pottawatomie Creek DO TMDL	**31.8**	270.00	40.00	31.8% of 10290101 in Miami County is within the Pottawatomie Creek DO TMDL Contributing Area
Total				6,816.00	5,155.00	

Tables developed by KDA-DOC (formerly known as SCC)

FUTURE ISSUES AND PROTECTION

Oil Drilling in Anderson County

As stated in the Anderson County Review, Oil production in Anderson County jumped 8% between 2009 and 2011 as oil wells grew to 1,634. New oil wells and expanded production in old units have increased overall since per barrel prices of crude oil increased over the last few years. The map below shows the gas and oil fields in Anderson County, most of the wells are located within the MMdC watershed.

Some of the new production is a result of fracking, as defined on the website fracfocus.org as a technique that uses a specially blended liquid which is pumped into a well under extreme pressure causing cracks in rock formations underground. These cracks in the rock then allow oil and natural gas to flow, increasing resource production. Vertical fracking has been used since the 1940s when it was pioneered in Kansas and uses much less water than the horizontal method that is popular today.

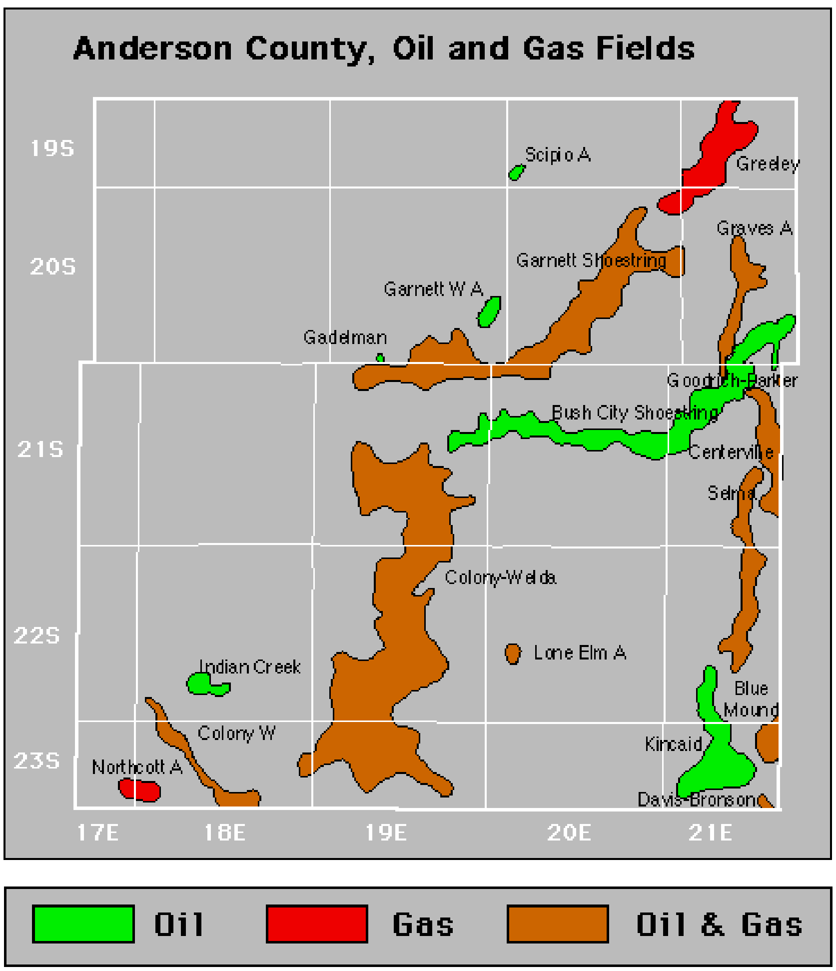


Figure 19. Map of Oil and Gas Fields in Anderson County

A well that is vertically fracked would use about 10,000 to 50,000 gallons of water, said Dave Newell, a research geologist with KGS.

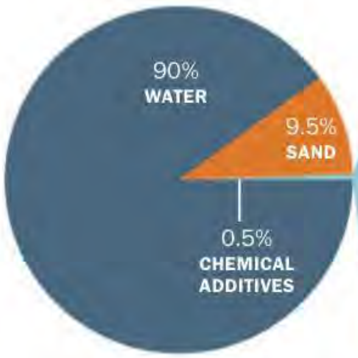
A horizontal well requires about 2.7 million gallons of water in Kansas, SandRidge spokesman Kevin White said. Some of the water used in the wells would likely come from area waterways, many of which have been affected by the drought.

The combination of chemicals used depends on factors such as:

- fracturing for oil or gas
- the particular formation
- the company conducting the fracturing.

For example, differences could exist between the types of chemicals used in hydraulic fracturing for oil and gas in sandstones and carbonate rocks versus gas in shale.

The web site www.energyfromshale.org has a fracking fluids page with a summary of some of the different types of fluids used.



Compound	Purpose	Common application
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Sodium Chloride	Allows a delayed breakdown of the gel polymer chains	Table salt
Polyacrylamide	Minimizes the friction between fluid and pipe	Water treatment, soil conditioner
Ethylene Glycol	Prevents scale deposits in the pipe	Automotive anti-freeze, deicing agent, household cleaners
Borate Salts	Maintains fluid viscosity as temperature increases	Laundry detergent, hand soap, cosmetics
Sodium/Potassium Carbonate	Maintains effectiveness of other components, such as crosslinkers	Washing soda, detergent, soap, water softener, glass, ceramics
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant, sterilization of medical and dental equipment
Guar Gum	Thickens the water to suspend the sand	Thickener in cosmetics, baked goods, ice cream, toothpaste, sauces
Citric Acid	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, hair coloring

Source: DOE, GWPC: Modern Gas Shale Development in the United States: A Primer (2009).

Figure 20. Summary diagram showing some of the fluids used for fracking.

Some serious environmental and human health issues believed to be caused by fracking are:

- groundwater contaminated by fracking fluid leaking from wells
- the lack of transparency of disclosure from the gas industry on actual chemicals utilized in the entire process of fracking
- forest fragmentation caused by well pad, road and pipeline construction that will hurt wildlife
- waste brine used on roads for de-icing; when ice melts or rain falls, the waste can run off roads and end up in the drinking supply
- disposal of drill cuttings and radioactive flowback waste in wastewater treatment plants and/or landfills
- the fact that millions of gallons of fresh water is being used to frack wells, and each time fresh water is used it is completely removed from the water cycle.

MIDDLE MDC WRAPS EDUCATION

Targeted Participants for the North Section – MdC River

Primary participants for implementation will be the city of Ottawa, riparian landowners, small livestock producers lacking BMPs within the priority watershed, urban areas within the priority subwatersheds and owners of failing on-site wastewater systems.

Targeted Participants for the South Section – Pottawatomie Creek

Primary participants for implementation will be the City of Garnett, riparian land owners, small livestock producers lacking BMPs within the priority watershed, urban areas within the priority subwatersheds and owners of failing on-site waste systems.

Selected Activities

Potential sites within one mile of the stream will be identified as high priority since they have the greatest potential to impact water quality of the stream. The following conditions have been identified as contributing to water quality impairments:

1. Facilities without water quality controls.
2. Unregistered permanent feeding/holding areas.
3. Sites where drainage runs through or adjacent to livestock areas.
4. Sites where livestock have full access to contributing tributaries and stream is primary water supply.
5. Grazed acreage, overstocked acreage and acreage with poor range condition.
6. Poor riparian sites.
7. Near stream feeding sites.
8. Failing on-site wastewater systems.
9. Areas with urban runoff.

Table 19. Middle MdC Education

Program	Target Audience	Activity/Event Technical Assistance	Time Frame	Estimated Costs	Sponsor/ Responsible Agency
Residential & Urban BMP Implementation					
On-site wastewater system	Rural Citizens	Workshop/Demonstration One-on-one technical assistance	Annual-Summer	$20,000 funded by DoC	Lake Region RC&D County Health Departments County Government Conservation Districts LEPP
Water Quality Information and Education	General Public	Workshops/public meetings Fair Booth Ag Land Display WET/WILD/Water celebrations Volunteer Water Quality Monitoring	Annual, On-going	$5,000	Lake Region RC&D Conservation districts K-State Research and Extension
Urban Stormwater Education	Urban Citizens Local Business	Tour/Field Day Demonstration Project	Annual-Summer	$10,000	Lake Region RC&D City of Ottawa City of Baldwin City of Osawatomie City of Garnett
Rain Garden Demonstration	Urban Citizens Local Business	Workshop Demonstration Project	Annual-Spring	$3,000	Lake Region RC&D City of Ottawa City of Baldwin City of Osawatomie City of Garnett
Rain Barrel Workshop	Urban Citizens Local Business	Workshop Demonstration Project	Annual-Summer	$3,000	Lake Region RC&D City of Ottawa City of Baldwin City of Osawatomie City of Garnett

Livestock BMP Implementation					
Relocate Pasture Feeding Sites/Pens	Small Livestock Producers	Tour/Field Day	Annual-Fall	$5,000	Kansas Rural Center K-State Research and Extension Conservation Districts Lake Region RC&D
	Small Livestock Producers	Demonstration Project	Annual-Summer	$5,000	Kansas Rural Center K-State Research and Extension Conservation Districts Lake Region RC&D
	Small Livestock Producers	Scholarships to Grazing Schools and Workshops	Annual-Ongoing	5 per year, $100 per scholarship: $500 total	Lake Region RC&D Kansas Rural Center K-State Research and Extension Kansas Grazer's Association
Off-stream/ Alternative Watering Systems	Small Livestock Producers	Tour/Field Day	Annual-Summer	Included above	Kansas Rural Center K-State Research and Extension Conservation Districts NRCS Lake Region RC&D
	Small Livestock Producers	Demonstration Project	Annual-Summer	$5,000	Kansas Rural Center K-State Research and Extension Conservation Districts Lake Region RC&D
	Small Livestock Producers	Scholarships to Grazing Schools and Workshops	Annual-Ongoing	Included above	Kansas Rural Center K-State Research and Extension Kansas Grazer's Association Lake Region RC&D

Rotational Grazing	Small Livestock Producers	Tour/Field Day/Workshop	Annual-Summer	$5,000	Kansas Rural Center K-State Research and Extension Lake Region RC&D
	Small Livestock Producers	Demonstration Project	Annual-Summer	$5,000	Kansas Rural Center K-State Research and Extension Conservation Districts Lake Region RC&D
Grazing Management Plans	Small Livestock Producers	Tour/Field Day/Workshop	Annual-Summer	Included above	Kansas Rural Center K-State Research and Extension Conservation Districts NRCS Lake Region RC&D
Vegetative Filter Strip	Small Livestock Producers	Demonstration Project	Annual-Spring	$5,000	Kansas Rural Center K-State Research and Extension Conservation Districts Lake Region RC&D
Fencing of Streams and Ponds	Small Livestock Producers	Demonstration Project	Annual-Summer	$5,000	Kansas Rural Center K-State Research and Extension Conservation Districts Lake Region RC&D

Cropland BMP Implementation					
Vegetative and Riparian Buffers	Farmers/Landowners	Workshop/Field Day/Tour	Annual, Spring or Fall	$5,000	NRCS Conservation districts Kansas Forest Service Lake Region RC&D Farm Service Agency
Grade Stabilization Structures	Farmers/Landowners	Workshop/Field Day/Tour	Annual, Spring	$5,000	K-State Research and Extension Conservation districts NRCS
Nutrient Management Plans	Farmers/Landowners	Workshop/Field Day	Annual, Spring	$3,000	Conservation Districts K-State Research and Extension NRCS
No-Till	Farmers/Landowners	Scholarships for farmers/ landowners to attend No-Till on the Plains Annual Conference	Annual, Winter	5 per year, $150 per scholarship: $750	No-Till on the Plains Conservation Districts
		Workshop/Field Day/Tour	Annual, Spring	$5,000	No-Till on the Plains Conservation Districts K-State Research and Extension

Technical Assistance for BMP Implementation					
All BMPs	Farmers/Landowners Urban Citizens Local Business	Technical Assistance to conduct BMP Cost-Share Funds WRAPS Coordinator	Annual, Ongoing	$30,000	Lake Region RC&D
Livestock BMP Implementation	Small Livestock Producers	One-on-one technical assistance for producers to implement livestock BMPs in targeted areas	Annual – Ongoing	K-State Watershed Specialist: $30,000/year	Lake Region RC&D K-State Research and Extension
	Small Livestock Producers	One-on-one technical assistance to remove livestock from riparian areas	Annual – Ongoing	Watershed Forester: $15,000/year	Kansas Forest Service Lake Region RC&D
	Small Livestock Producers	One-on-one technical assistance for producers to implement livestock BMPs in targeted areas	Annual – Ongoing	No cost	NRCS Conservation Districts K-State R&E Ag. Agents
Cropland BMP Implementation	Farmers/Landowners	One-on-one technical assistance for producers to implement cropland BMPs in targeted areas	Annual – Ongoing	Watershed Forester: $15,000/year	Kansas Forest Service Lake Region RC&D
	Farmers/Landowners	One-on-one technical assistance for farmers/landowners in targeted areas	Annual	No Cost	Conservation Districts NRCS
	Farmers/Landowners	One-on-one technical assistance for farmers/ landowners to implement no-till in targeted areas	Annual-Ongoing	$5,000	No-Till on the Plains K-State Research and Extension
Vegetated Swales Bioretention Swales Stormwater Wetland	Landowners Local Business	Technical Assistance/ Engineering & Site Design	Ongoing	Varies by project	Consulting firm TBD
Project Management					
Grant Sponsor		Grant Administration	Annual	10% of total grant	Lake Region RC&D

Grant Advisor		Grant Administration	Annual	No cost	KDHE
SLT		Grant Administration	Quarterly	No cost	Volunteers
Total Costs					
Livestock BMP Implementation				$35,500	
Cropland BMP Implementation				$18,750	
Residential & Urban BMP Implementation				$21,000	
Technical Assistance for BMP Implementation				$95,000	
Project Management				$17,025	

WATER QUALITY MILESTONES TO DETERMINE IMPROVEMENTS

For the purposes of this plan, the Middle MdC Basin has been divided into two main sections, the North Section, which focuses on the MdC River near the City of Ottawa, and the South Section, which focuses on Pottawatomie Creek near the City of Osawatomie. The goal of the Middle MdC WRAPS plan is to restore water quality for uses supportive of aquatic life, domestic water supply, irrigation, livestock watering, and recreation for the MdC River near Ottawa and Pottawatomie Creek near Osawatomie.

In the North Section, targeted areas for BMP implementation have been identified in three HUC 12s along the MdC River near the City of Ottawa, and upstream along Rock Creek, Mud Creek, Eightmile Creek, Wilson Creek, and other smaller tributaries, as indicated on the map included in this section. The plan specifically addresses the high priority fecal coliform bacteria (FCB) TMDL for the MdC River near Ottawa. In order to reach the load reduction goals associated with this TMDL, a BMP implementation schedule spanning 20 years has been developed.

In the South Section, targeted areas for BMP implementation have been identified in five HUC 12s along Pottawatomie Creek near the Osawatomie, and upstream along Cedar Creek, as indicated on the map included in this section. The plan specifically addresses the high priority dissolved oxygen (DO) TMDL for Pottawatomie Creek near Osawatomie. In order to reach the load reduction goals associated with this TMDL, a BMP implementation schedule spanning 20 years has been developed.

Separate water quality milestones have been developed for both the MdC River near Ottawa (sampling site SC270) and Pottawatomie Creek near Osawatomie (sampling site SC556), along with additional indicators of water quality. The purpose of the milestones and indicators is to measure water quality improvements associated with the BMP implementation schedules contained in this plan.

Water Quality Milestones for Bacteria – MdC River near Ottawa

As noted previously, this plan is addressing the high priority bacteria TMDL for the MdC River near Ottawa. The original TMDL was developed in 2001, and in 2003, the standard for bacteria changed to *E. coli* and the use of a geometric mean to assess impairments was developed.

Bacteria load reductions resulting from the implementation of targeted BMPs should result in less frequent exceedance of the nominal *E. Coli* Bacteria (ECB) criterion (262 Colony Forming Units (CFUs)/100ml) for the sampling station SC270 on the MdC River near Ottawa, and in lowered magnitude of those exceedances.

In order to assess the impact of BMPs addressing bacteria impairments, the relative frequency and magnitude of bacteria concentrations seen in the receiving streams, monitored by KDHE on a routine or rotational basis, must be measured to determine if water quality improvements are being achieved. The bacteria index is utilized by KDHE to assess the relative frequency and magnitude of the bacteria concentrations at KDHE monitoring sites.

The calculated bacteria index for the MdC River near Ottawa sampling station SC270 is the natural logarithm of each sample value taken during the April-October Primary Recreation season, divided by the natural logarithm of the bacteria criteria for Primary Recreation Class B [ln(262)].

Index = ln(ECB Count) / ln(262)

The indicator will be the Upper Decile of those index values, with the target being that the index is below 1.0 at the upper decile (90th percentile). Ultimately, compliance with water quality standards will require sampling 5 times within 30 days during several periods during the primary recreation season, and calculating the geometric mean of those samplings. Meeting that test will be justification for delisting the stream impairment.

KDHE sampling station SC270 on the MdC River near Ottawa was sampled in accordance with the water quality standard for four different intensive sampling events in 2010. Each intensive sampling event consisted of five ECB samples collected in a 30-day period. The calculated geometric mean of the five samples for each event was over the criterion for the MdC River (262 CFUs/100ml) for two of these intensive sampling events. The following figures show the bacteria index for the MdC River, as well as the results of the intensive sampling events that took place at SC270.

Figure 21. MdC River near Ottawa bacteria index

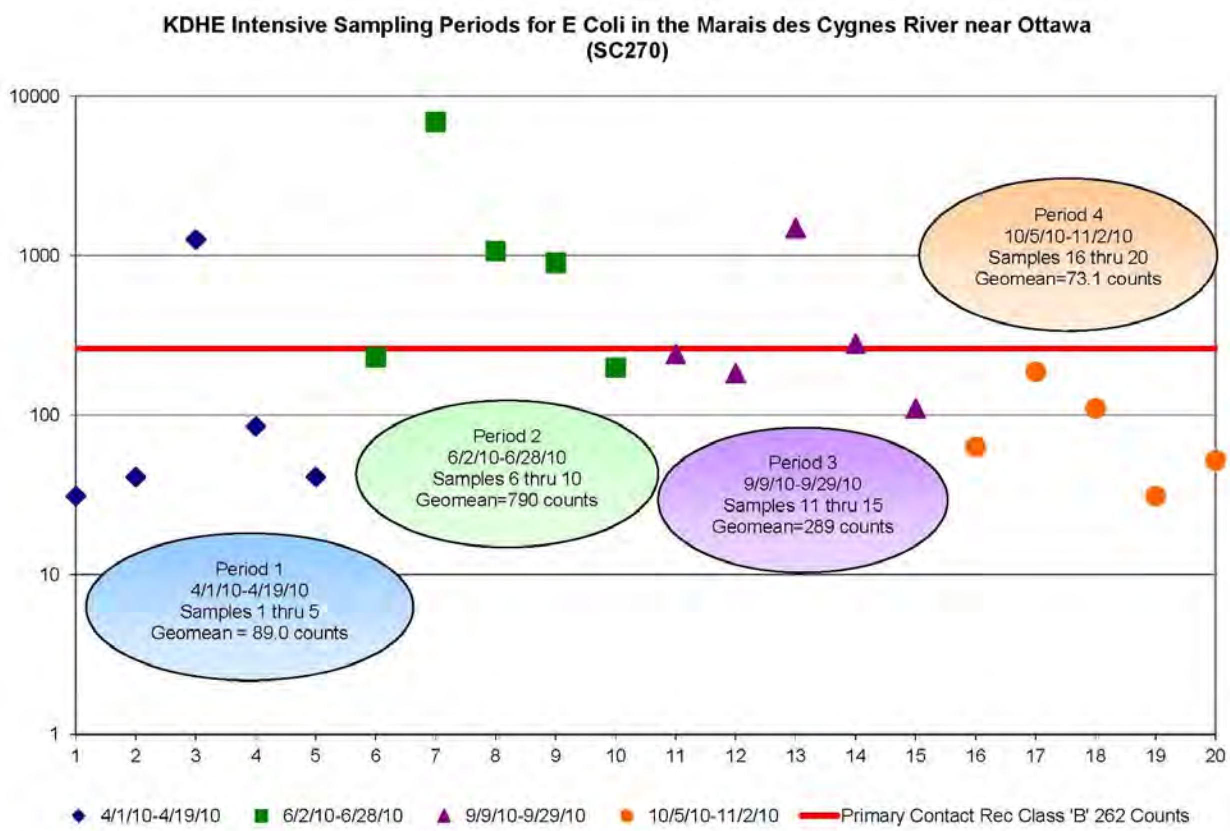


Figure 22. KDHE Sampling periods for E Coli in the MdC River near Ottawa

The water quality goal for the bacteria impairment in the MdC River near Ottawa is for at least 90% of the samples taken during April through October to be below the water quality criterion of 262 cfus/100 ml.

Water Quality Milestones for MdC River near Ottawa

As previously stated, this plan estimates that it will take 20 years to implement the planned BMPs necessary to meet the load reduction goals for the impairments being addressed in the Middle MdC River watershed. The table below includes 10-year and long term water quality goals for total phosphorus (TP) for the MdC River near Ottawa.

Table 20. Water quality milestones for MdC River near Ottawa

Water Quality Milestones for MdC River near Ottawa					
		10-Year Goal		**Long Term Goal**	
	Current Condition* Median TP	**Improved Condition Median TP**	**Total Reduction Needed**	**Improved Condition Median TP**	**Total Reduction Needed**
Sampling Sites	**Median TP All Flows (median of data collected during indicated period), ppb**				
MDC River near Ottawa SC270	180	144	**20%**	108	**40%**

*The current conditions for SC270 was determined utilizing sampling data from the KDHE stream monitoring stations from 1990 to 2010.

Water Quality Milestones for Pottawatomie Creek near Osawatomie

The table below includes the 10-year and long term water quality goals for dissolved oxygen (DO) for Pottawatomie Creek near Osawatomie.

Table 21. Water quality milestones for Pottawatomie Creek near Osawatomie

Water Quality Milestones for Pottawatomie Creek near Osawatomie			
	Current Condition* % Samples DO > 5 ppm	**10-Year Goal**	**Long Term Goal**
		Improved Condition	**Improved Condition**
Sampling Sites	**% Samples with DO > 5 ppm (data collected during indicated period)**		
Pottawatomie Creek near Osawatomie SC556	73	85	DO > 5 ppm for all samples with flows above critical low flow condition (1 cfs)

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.

- Occurrence of algal blooms in watershed lakes and reservoirs
- Visitor traffic to watershed lakes and reservoirs
- Boating traffic in watershed lakes and reservoirs
- Trends of quantity and quality of fishing in watershed lakes and reservoirs

Monitoring Water Quality Progress

KDHE continues to monitor water quality in the Middle MdC River Watershed by maintaining the monitoring stations located within the watershed. The map included in this section shows the monitoring stations located within the Middle MdC River Watershed. The map has been color-coded to indicate the subwatersheds that have been targeted for BMP implementation and water quality monitoring by this plan.

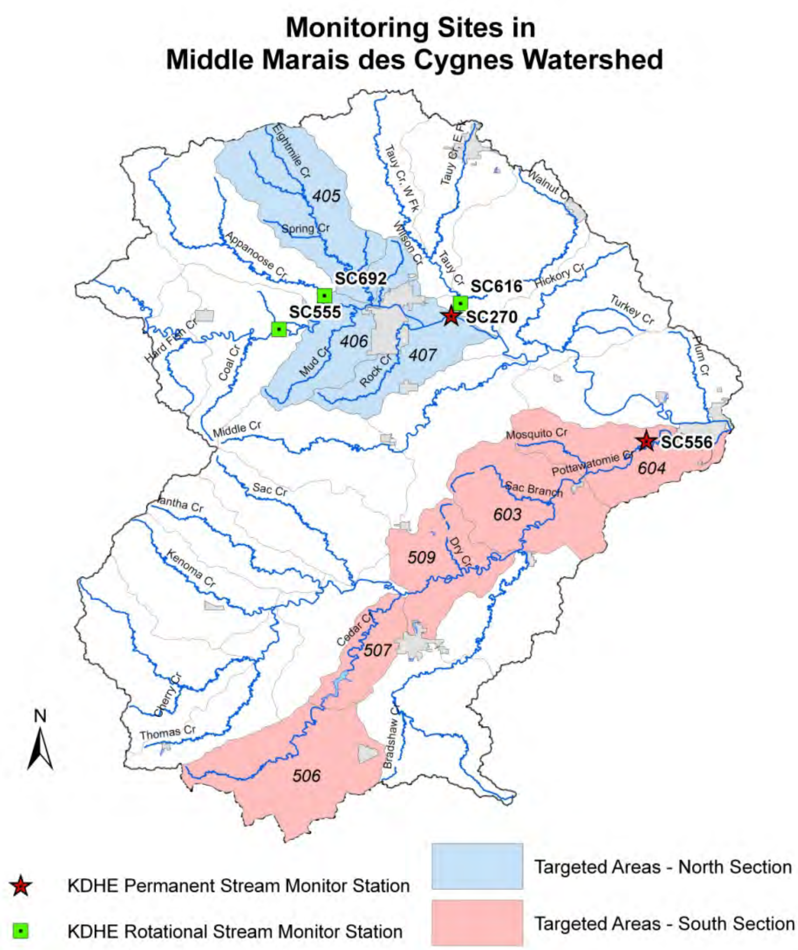


Figure 23. Monitoring sites in the Middle MdC Watershed

The map on previous page shows the KDHE monitoring stations located in streams and lakes. The permanent stream monitoring sites are continuously sampled, the rotational sites are typically sampled every four years, and the KDHE lake monitoring sites are typically sampled every 3 years.

The sites are sampled for nutrients, *E. Coli* bacteria, chemicals, turbidity, alkalinity, dissolved oxygen, pH, ammonia and metals. The pollutant indicators tested for each site may vary depending on the season at collection time and other factors.

Evaluation of Monitoring Data

Monitoring data in the Middle MdC River watershed will be used to determine water quality progress, track water quality milestones, and to determine the effectiveness of the BMP implementation outlined in the plan. The schedule of review for the monitoring data will be tied to the water quality milestones that have been developed for each watershed, as well as the frequency of the sampling data.

The BMP implementation schedules and water quality milestones for the Middle MdC River watershed extend through a twenty-year period. Throughout the plan period, KDHE will continue to analyze and evaluate the monitoring data collected. After the first ten years of monitoring and BMP implementation, KDHE will evaluate the available water quality data to determine whether the water quality milestones have been achieved. KDHE and the SLT can address any necessary modifications or revisions to the plan based on the data analysis. At the end of the plan, a determination can be made as to whether the water quality standards have been attained.

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

Additional Monitoring Sites

Currently Pottawatomie Creek only has one monitoring site near the City of Osawatomie at the lower end of the watershed, as shown in Figure 8 below. Additional monitoring in the Pottawatomie Creek watershed would assist in determining if tributaries have higher priority concerns. Eight Mile Creek identified by the blue oval on the map in Figure 8, would benefit from an additional monitoring site to determine if it has higher or lower priority than remaining sub-watershed of MdC River. Additional monitoring sites would help determine the volume of non-point pollutants from the City of Ottawa.

Year 1 Monitoring Draft Plan:

At the time in which this WRAPS plan was written, a sample plan for monitoring and analyses for the first year of the plan was formulated using the estimated cost of $2,500.

The monitoring draft plan below and $2,500 expense is ONLY for Year 1 monitoring activities. Changes in budget and/or monitoring needs will require additional evaluation and may result in monitoring strategy and plan changes.

The Middle MdC SLT would like to install additional monitoring sites. To ensure that the proper protocol is followed they request KDHE assistance with the first samples.

Samples collected for sediment, nutrients and bacteria would be taken from April through June. Judgment will be made considering fertilizer application periods and rainfall events (to include storm intensity and runoff). In the event there an unusual runoff event occurs during the winter months water samples will be collected.

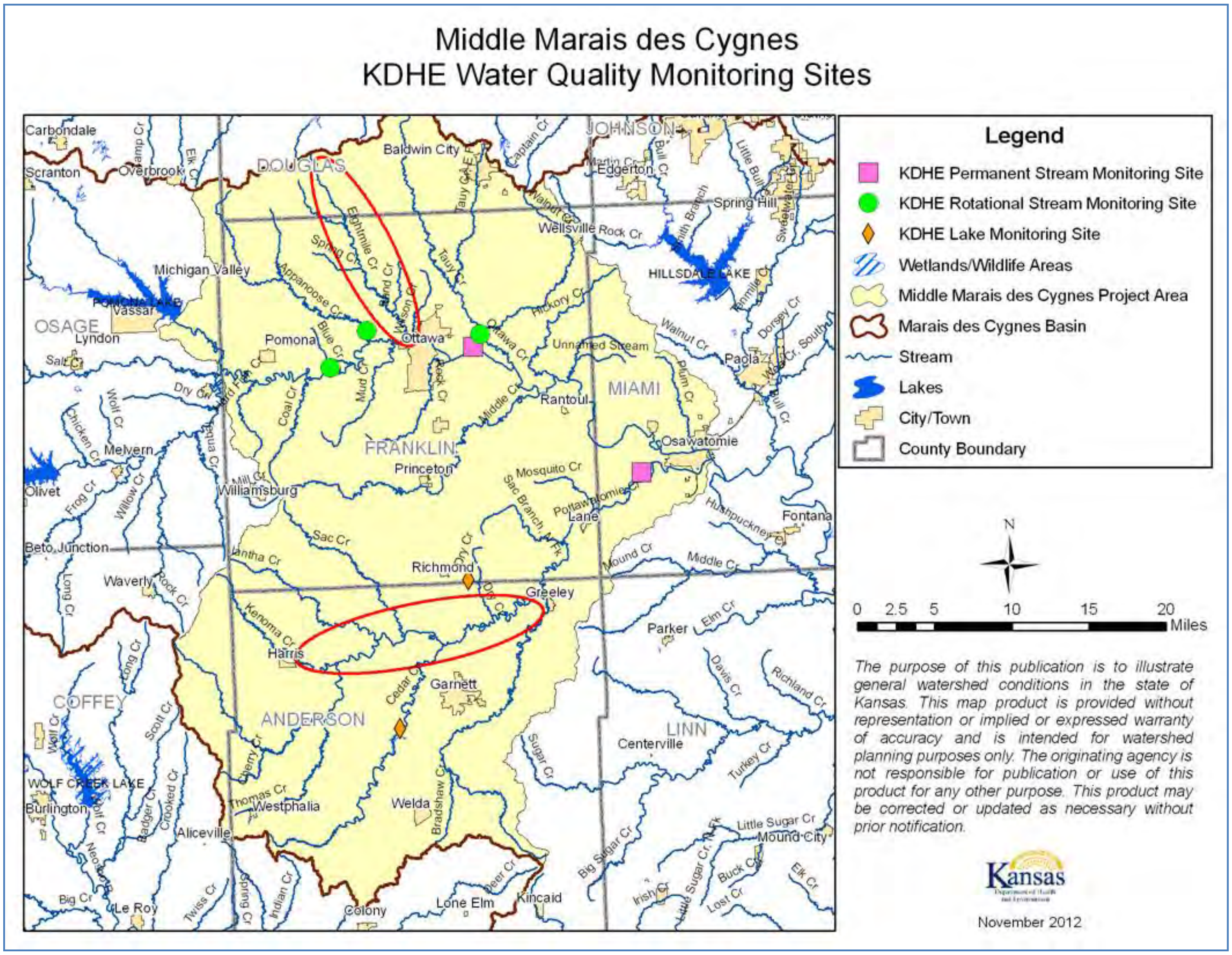


Figure 24. KDHE water monitoring sites in the Middle MdC watershed.

BEST MANAGEMENT PRACTICES DEFINITIONS

Livestock Best Management Practices

Vegetative buffer strip – An area of dense perennial grass vegetation that receives runoff from an animal feeding operation. A buffer often requires an area of land equal to or greater than feeding site or drainage area. Vegetative buffers may or may not require a settling watershed installed upslope, depending on size of operation, slope soil, etc. Management requires harvest of vegetative growth to remove accumulated nutrients. Lifespan estimate 10 years, approximate phosphorus reduction efficiency of 50%

Manure management - When managed properly, manure can be a valuable resource on a farm. Manure can be a source of nutrients for crop production and improve soil quality. The organic matter present in manure can improve both tilth and water holding capacity of the soil. Livestock and poultry manure is a valuable fertilizer for crop and pasture production. Most farm owners do not realize the value of the manure that is produced on their farms.

Install proper manure storage facility - Where manure is generated by livestock, production or processing and a conveyance system is necessary to transfer manure from the source to a storage/treatment facility and/or a loading area, and/or from storage/treatment to an area for utilization.

Develop nutrient management plans - Nutrient management plan (NMP) implementation is a comprehensive plan that describes the optimum use of nutrients to minimize nutrient loss while maintaining yield. A NMP details the type, rate, timing, and placement of nutrients for each crop. Soil, plant tissue, manure and/or sludge tests are used to assure optimal application rates. Plans should be revised every 2 to 3 years.

Relocate Feedlot or Feeding Pens (confinement feeding) – Move a feedlot or pens farther from a stream, waterway, or body of water to increase filtration, infiltration and waste removal.

Relocate feeding site and/or change feeding method within pasture (non-confined feeding) Move feeding site that is in a pasture farther from a stream, waterway, or a body of water to increase filtration, infiltration and waste removal (eg. Move large round bale feeders further from stream). Adopt methods if unrolling or distributing hay throughout pasture to reduce accumulation of waste.

Settling Basin –A designed depression or low area that slows the return flows, allowing sediments to settle out of the water before the water returns to the irrigation delivery system or other water body. The solid material such as manure, feed or debris settle out before entering into a vegetative buffer. Settling watersheds are most often used in conjunction with a vegetative buffer strip. Management requires annual clean out. Life Span estimate 10 years; approximate phosphorus reduction of 50%

Lagoons – a pond like earthen watershed sized to provide biological treatment and long term storage of animal waste. Requires detailed maintenance plan. Lifespan estimate 15 years; approximate phosphorus reduction of 60-95%

Off stream watering – Install an alternative watering system so livestock do not enter stream or body of water to drink. Lifespan estimate 10-20 years; approximate phosphorus reduction 40-98% (greatest phosphorus reduction is by restricting access to water bodies)

Rotational grazing – A grass management program that uses several pastures providing for one paddock or pasture to be grazed while others are rested. Rotation grazing improves grass health and management, Improves grazing distribution which widely distributes waste, increasing filtration and waste removal. Lifespan estimate: 5 years; approximate phosphorus reduction of 20-40%

Fence off stream – Riparian fences are constructed along streams to limit or restrict access of cattle or other livestock to waterways. Lifespan estimate: 20 years; Phosphorus reduction of 40-98%

Stream Crossing- A stream crossing provides a hard, stable area where livestock or equipment can cross a stream without damaging the streambed or banks. Permit maybe required. Lifespan and phosphorus reduction varies.

On-Site Waste Water Systems

Repair or replace failing on-site wastewater treatment systems in proximity to streams - Failing systems contribute to nonpoint source pollution by releasing bacteria, nitrates, viruses, detergents, household chemicals, and trace amounts of metals to surface and groundwater. When runoff carries these pollutants into nearby streams and other bodies of water, they can cause extreme plant and/or algae growth, contributing to low levels of dissolved oxygen needed by fish and other aquatic species.

Urban Best Management Practices

Bioretention cell - Bioretention is a upland water quality and water quantity control practice the uses the chemical, biological and physical properties of plants, microbes and soils for removal of pollutants from storm water runoff. Some of the processes that may take place in a bioretention facility include: sedimentation, adsorption, filtration, volatilization, ion exchange, decomposition, phytoremediation, bioremediation, and storage capacity. This same principle of utilizing biological systems has been widely used in the retention and the transformation of pollutants and nutrients found in agricultural and wastewater treatment practices.

Cropland Best Management Practices

Riparian Forest Buffers - Riparian forest buffers of sufficient width intercept sediment, nutrients, pesticides, and other materials in surface runoff and reduce nutrients and other pollutants in shallow subsurface water flow. Woody vegetation in buffers provides food and cover for wildlife, helps lower water temperatures by shading the stream or waterbody, and slows out-of-bank flood flows. In addition, the vegetation closest to the stream or waterbody provides litter fall and large wood important to fish and other aquatic organisms as a nutrient source and structural components to increase channel roughness and habitat complexity. Also, the woody roots increase the resistance of streambanks and shorelines to erosion caused by high water flows or waves. Some tree and shrub species in a riparian forest buffer can be managed for timber, wood fiber, and horticultural products.

Forest Stand Improvement - Forest Stand Improvement (FSI) is a forest management technique used to remove unwanted trees from an area in order to improve forest stand composition. Young trees readily re-establish themselves following cutting or fire. But tree quality, species composition and individual tree form are often undesirable. Further reduction in quality comes when the better trees are harvested, leaving the lower quality ones. The average unmanaged woodland produces at less than one-third its potential. The FSI practice can be used to increase the woodland's value for timber products, water quality and quantity, recreation, wildlife, natural beauty, or special products.

Minimum till and No-till Farming - No-till farming is a form of conservation tillage in which the crop is seeded directly into vegetative cover or crop residue with little disturbance of the surface soil. Minimum tillage farming involves some disturbance of the soil, but uses tillage equipment that leaves much of the vegetation cover or crop residue on the surface.

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

Grassed waterways in crop fields - Grassed waterway and vegetated filter consist of a natural or constructed vegetated channel that is shaped or graded and vegetated to carry surface water at a non-erosive velocity to a stable outlet that, in turn, spreads the flow of water before the water enters the vegetated filter.

Develop nutrient management plans - Nutrient management plan (NMP) implementation is a comprehensive plan that describes the optimum use of nutrients to minimize nutrient loss while maintaining yield. A NMP details the type, rate, timing, and placement of nutrients for each crop. Soil, plant tissue, manure and/or sludge tests are used to assure optimal application rates. Plans should be revised every 2 to 3 years.

Grade Stabilization Structure - A structure used to control the grade and head cutting in natural or artificial channels.

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APPENDIX A

Endangered species

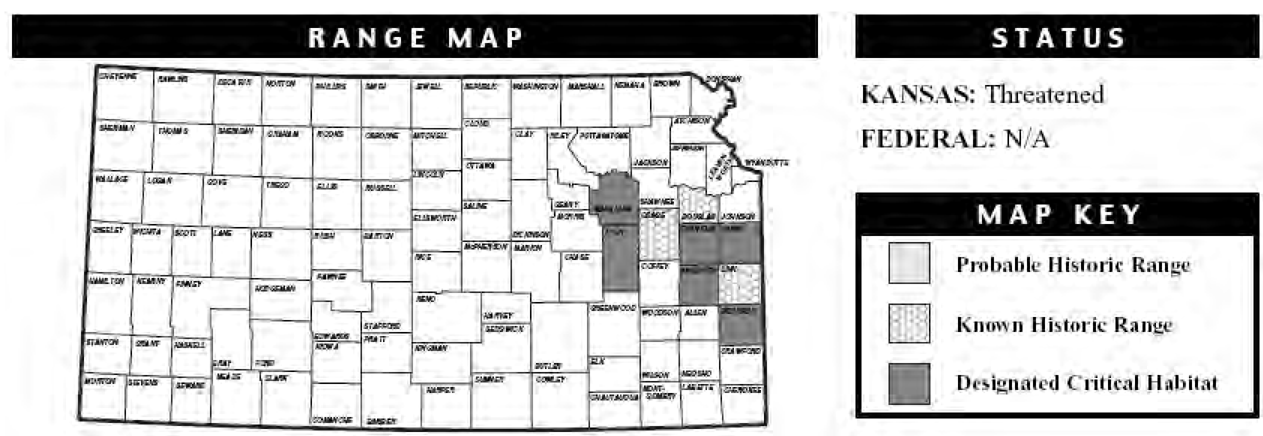
Agricultural practices and urban and suburban construction increase the amount of silt in streams, suffocating the eggs of bottom nesting fish and reducing populations of food organisms which would normally live in between rocks and gravel on the bottom.

Protection efforts should be utilized to maintain the hornyhead chub population as well as the endangered and SINC mussel species present. The hornyhead chub is found near riffles in clear streams with permanent flows. Its range was reduced due to intensive cultivation, siltation and intermittent flows. It can be found in a few tributaries of the MdC River in Kansas.

Much of the historic change to the aquatic environment and the majority of future threats are related to water management and flow modifications. Diversion of water has resulted in changes to flow regimes in mainstem rivers and tributary streams. Dams and reservoirs have degraded habitats and caused habitat fragmentation. Other threats to hornyhead chub include the modification of stream channels through channelization, landscape scale changes resulting from land use, and local destruction of riparian zones that reduce the natural function of the stream ecosystem. Also, introduced non-native species have become both predators and competitors with hornyhead chub.

The Hornyhead Chub is one of Kansas' largest native minnows, attaining a length of 6-8 inches. This fish is quite similar to the more common creek chub. In color, it is dusky to black above and silvery below. It has a large mouth. Adult males have a red spot behind the eye. There is a round blackish spot at the base of the tail fin. The Hornyhead Chub formerly occurred in small to medium sized, moderate to low gradient, clear gravelly streams throughout most of the Kansas River and MdC River basins. It prefers pools and slow to moderate runs and is often associated with aquatic plants. Requires gravel areas free of silt for spawning. Spawns from late April through early July.

SPECIES PROTECTION AND CRITICAL HABITATS



Hornyhead Chubs are protected by the Kansas Nongame and Endangered Species Conservation Act and administrative regulations applicable thereto. Any time an eligible project is proposed that will impact the species' preferred habitats within its probable range, the project sponsor must contact the Ecological Services Section, Kansas Department of Wildlife, Parks and Tourism, 512 SE 25th Ave., Pratt, Kansas 67124-8174. Department personnel can then advise the project sponsor on permit requirements.

DESIGNATED CRITICAL HABITATS

As defined by Kansas Administrative Regulations, critical habitats include those areas documented as currently supporting self-sustaining population(s) of any threatened or endangered species of wildlife as well as those areas determined by the Kansas Department of Wildlife, Parks and Tourism to be essential for the conservation of any threatened or endangered species of wildlife.

Currently, the following areas are designated critical for Hornyhead Chubs:

(1) The main stem Pottawatomie Creek from its confluence with Cherry Creek in Sec. 7, T21S, R18E, Anderson County to its confluence with the MdC River in Sec. 12, T18S, R22E, Miami County.
(2) The main stem Cedar Creek from its point of entry into the Sec. 1, T22S, R18E, to its confluence with Pottawatomie Creek at Sec. 1, T20S, R19E, Anderson County.
(3) The main stem South Fork Pottawatomie Creek from its point of entry into Sec. 27, T21S, R20E, to its confluence with Pottawatomie Creek at SW Corner Sec. 19, T19S, R21E, Anderson County.
(4) The main stem Elm Creek from its point of entry into the NW/4 Sec. 31, T14S, R12E, Wabaunsee County, into Lyon County through Sec. 3, T16S, R12E.
(5) Locust Creek from its point of entry into NW/4 Sec. 2, T15S, R11E to the confluence of Elm Creek (NE/4, Sec. 7, T15S, R12E) Wabaunsee County.
(6) Hickory Creek from Highway 68 crossing (Sec. 36, T16S, R20E), Franklin County to the confluence of MdC River (Sec. 8, T17S, R21E).
(7) The main stem of Marmaton River in Bourbon County from Highway 3 crossing (Sec. 27, T25S, R22E), into the City of Fort Scott (Sec. 30, T25S, R25E).
(8) Mill Creek from Highway 54 crossing (Sec. 23, T25S, R25E) into the City of Fort Scott, at the confluence of the Marmaton River (Sec. 30, T25S, R25E), Bourbon County.
(9) Pawnee Creek from the south point of entry into Sec. 18, T26S, R24E, to the confluence of the Marmaton River in Bourbon County (Sec. 7, T26S, R24E).
(10) North Wea Creek and tributaries in Miami County from where it crosses the Johnson/Miami county line (Sec. 19, T15S, R25E) to State Highway 68 (Sec. 29, T16S, R24E).

APPENDIX B

Table 22. Achieving the TMDL for the MdC River

Achieving the TMDL for the MdC River based on the Implementation of Livestock BMPs		
Year	**Phosphorus Reduction**	**% of TMDL**
1	1,050	7%
2	2,400	17%
3	3,450	24%
4	4,801	33%
5	5,851	41%
6	7,201	50%
7	8,251	57%
8	9,602	67%
9	10,652	74%
10	12,002	84%
11	13,052	91%
12	14,403	100%
13	15,453	108%
14	16,803	117%
15	17,853	124%
16	19,204	134%
17	20,254	141%
18	21,604	150%
19	22,654	158%
20	24,005	167%
Required P Reduction:		14,357 pounds

Goal Met

Table 23. Livestock BMPs Implementation by Practice for the MdC River

Livestock BMPs Implementation by Practice for the MdC River									
Year	Vegetative Filter Strips	Relocate feeding pens	Relocate Pasture Feeding Site	Off-Stream Watering	Rotational grazing	Fence Out streams and Ponds	Grazing Management Plans	Annual Load Reduction	% of TMDL
1	638	0	63	63	140	146	0	1,050	7%
2	638	797	126	126	140	292	281	2,400	17%
3	1,276	797	189	189	280	438	281	3,450	24%
4	1,276	1,595	252	252	280	584	562	4,801	33%
5	1,914	1,595	315	315	420	730	562	5,851	41%
6	1,914	2,392	378	378	420	876	843	7,201	50%
7	2,552	2,392	441	441	560	1,022	843	8,251	57%
8	2,552	3,189	504	504	560	1,168	1,124	9,602	67%
9	3,189	3,189	568	568	700	1,314	1,124	10,652	74%
10	3,189	3,987	631	631	700	1,460	1,405	12,002	84%
11	3,827	3,987	694	694	840	1,606	1,405	13,052	91%
12	3,827	4,784	757	757	840	1,752	1,686	14,403	100%
13	4,465	4,784	820	820	980	1,898	1,686	15,453	108%
14	4,465	5,581	883	883	980	2,044	1,967	16,803	117%
15	5,103	5,581	946	946	1,120	2,190	1,967	17,853	124%
16	5,103	6,379	1,009	1,009	1,120	2,336	2,248	19,204	134%
17	5,741	6,379	1,072	1,072	1,260	2,482	2,248	20,254	141%
18	5,741	7,176	1,135	1,135	1,260	2,628	2,529	21,604	150%
19	6,379	7,176	1,198	1,198	1,400	2,774	2,529	22,654	158%
20	6,379	7,973	1,261	1,261	1,400	2,920	2,810	24,005	167%
							Required P Reduction:		14,357 pounds

Goal Met

Table 24. BMP Implementation cost and efficiency.

BMPs	Approximate P Reduction Efficiency	Animal Units	Unit Cost	After cost Share*	Estimated P Reduction in Pounds	Additional Installations	Total Estimated P Reduction	Total Estimated N Reduction
Vegetative Buffer Strips	50%	100	$714	$357	638	10	6,379	12,014
Relocate feeding pens	95%	100	$6,621	$3,311	797	10	7,973	15,018
Relocate Pasture Feeding Site	50-90%	33	$2,203	$1,102	63	20	1,261	2,375
Off-Stream Watering	85%	33	$3,795	$1,898	63	20	1,261	2,375
Rotational grazing	25%	33	$7,000	$3,500	140	10	1,400	2,637
Fence Out streams and Ponds	85%	33	$4,106	$2,053	73	40	2,920	5,500
Grazing Management Plans	25%	33	$1,600	$800	281	10	2,810	5,293
Failing On-site Wastewater systems			$5,000	$4,000	.02	100	22	16
Stream bank stabilization			$6,621	$3,311	797	2		
Bioretention cells			$6,621	$3,311	797	2		
Agroforestry			$2,000	$500		40		
Total Reduction							**24,026**	**45,228**

Table 25. North Portion Livestock BMP Adoption Milestones

Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Grazing Mgmt Plans	Fence off Streams and Ponds
1	1	0	1	1	1	0	2
2	0	1	1	1	0	1	2
3	1	0	1	1	1	0	2
4	0	1	1	1	0	1	2
5	1	0	1	1	1	0	2
Total	3	2	5	5	3	2	10
6	0	1	1	1	0	1	2
7	1	0	1	1	1	0	2
8	0	1	1	1	0	1	2
9	1	0	1	1	1	0	2
10	0	1	1	1	0	1	2
Total	5	5	10	10	5	5	20
11	1	0	1	1	1	0	2
12	0	1	1	1	0	1	2
13	1	0	1	1	1	0	2
14	0	1	1	1	0	1	2
15	1	0	1	1	1	0	2
16	0	1	1	1	0	1	2
17	1	0	1	1	1	0	2
18	0	1	1	1	0	1	2
19	1	0	1	1	1	0	2
20	0	1	1	1	0	1	2
Total	10	10	20	20	10	10	40

Table 26 BMP Adoption Milestones and Annual Costs

Year	Vegetative Filter Strips	Relocate feeding pens	Relocate Pasture Feeding Site	Off-Stream Watering	Rotational grazing	Fence Out streams and Ponds	Grazing Management Plans	Repair or Replace Septic Systems	Annual Cost*
1	1	0	1	1	1	2	0	5	$21,924
2	0	1	1	1	0	2	1	5	$23,104
3	1	0	1	1	1	2	0	5	$23,259
4	0	1	1	1	0	2	1	5	$24,511
5	1	0	1	1	1	2	0	5	$24,676
6	0	1	1	1	0	2	1	5	$26,004
7	1	0	1	1	1	2	0	5	$26,178
8	0	1	1	1	0	2	1	5	$27,587
9	1	0	1	1	1	2	0	5	$27,773
10	0	1	1	1	0	2	1	5	$29,267
11	1	0	1	1	1	2	0	5	$29,464
12	0	1	1	1	0	2	1	5	$31,050
13	1	0	1	1	1	2	0	5	$31,258
14	0	1	1	1	0	2	1	5	$32,941
15	1	0	1	1	1	2	0	5	$33,162
16	0	1	1	1	0	2	1	5	$34,947
17	1	0	1	1	1	2	0	5	$35,182
18	0	1	1	1	0	2	1	5	$37,075
19	1	0	1	1	1	2	0	5	$37,324
20	0	1	1	1	0	2	1	5	$39,333
Total	**10**	**10**	**20**	**20**	**10**	**40**	**10**	**100**	

*3% Annual Cost Inflation

Table 27. BMP Adoption Milestones and Annual Cost

The table below provides a summary of BMP implementations and estimated costs.

Year	Vegetative Filter Strips	Relocate feeding pens	Relocate Pasture Feeding Site	Off-Stream Watering	Rotational grazing	Fence Out streams and Ponds	Grazing Management Plans	Annual Cost* Before Cost-share	Annual Cost* After Cost-share
5	3	2	5	5	3	10	2	$117,472	$58,738
10	5	5	10	10	5	20	10	$254,281	$127,142
15	8	7	15	15	8	30	7	$412,154	$206,081
20	**10**	**10**	**20**	**20**	**10**	**40**	**10**	$596,013	$298,011

*3% Annual Cost Inflation

Table 28. Annual Cost*Before Cost-Share of Implementing Livestock BMPs, North Portion

Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Fence off Streams and Ponds	Grazing Mgmt Plans	Annual Cost	Total Cost milestones
1	$714	$0	$2,203	$3,795	$7,000	$8,212	$0	**$21,924**	
2	$0	$6,820	$2,269	$3,909	$0	$8,458	$1,648	**$23,104**	
3	$757	$0	$2,337	$4,026	$7,426	$8,712	$0	**$23,258**	
4	$0	$7,235	$2,407	$4,147	$0	$8,973	$1,748	**$24,510**	
5	$804	$0	$2,479	$4,271	$7,879	$9,243	$0	**$24,676**	$117,472
6	$0	$7,676	$2,554	$4,399	$0	$9,520	$1,855	**$26,004**	
7	$853	$0	$2,630	$4,531	$8,358	$9,806	$0	**$26,178**	
8	$0	$8,143	$2,709	$4,667	$0	$10,100	$1,968	**$27,587**	
9	$904	$0	$2,791	$4,807	$8,867	$10,403	$0	**$27,772**	
10	$0	$8,639	$2,874	$4,952	$0	$10,715	$2,088	**$29,268**	$254,281
11	$960	$0	$2,961	$5,100	$9,407	$11,036	$0	**$29,464**	
12	$0	$9,165	$3,049	$5,253	$0	$11,367	$2,215	**$31,049**	
13	$1,018	$0	$3,141	$5,411	$9,980	$11,708	$0	**$31,258**	
14	$0	$9,723	$3,235	$5,573	$0	$12,060	$2,350	**$32,941**	
15	$1,080	$0	$3,332	$5,740	$10,588	$12,421	$0	**$33,161**	$412,154
16	$0	$10,315	$3,432	$5,912	$0	$12,794	$2,493	**$34,946**	
17	$1,146	$0	$3,535	$6,090	$11,233	$13,178	$0	**$35,182**	
18	$0	$10,944	$3,641	$6,273	$0	$13,573	$2,645	**$37,076**	
19	$1,216	$0	$3,750	$6,461	$11,917	$13,980	$0	**$37,324**	
20	$0	$11,610	$3,863	$6,655	$0	$14,400	$2,806	**$39,334**	$596,016
Totals	$9,452	$90,270	$59,192	$101,972	$92,655	$220,659	$21,816	**$596,016**	

3% Annual Cost Inflation

Table 29. Annual Cost* After Cost-Share of Implementing Livestock BMPs, North Portion

Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Grazing Mgmt Plans	Fence off Streams and Ponds	Annual Cost	Total cost at Milestones
1	$357	$0	$1,102	$1,898	$3,500	$0	$4,106	**$10,963**	
2	$0	$3,410	$1,135	$1,954	$0	$824	$4,229	**$11,552**	
3	$379	$0	$1,169	$2,013	$3,713	$0	$4,356	**$11,630**	
4	$0	$3,617	$1,204	$2,073	$0	$874	$4,487	**$12,255**	
5	$402	$0	$1,240	$2,136	$3,939	$0	$4,621	**$12,338**	$58,738
6	$0	$3,838	$1,277	$2,200	$0	$927	$4,760	**$13,002**	
7	$426	$0	$1,315	$2,266	$4,179	$0	$4,903	**$13,089**	
8	$0	$4,071	$1,355	$2,334	$0	$984	$5,050	**$13,794**	
9	$452	$0	$1,395	$2,404	$4,434	$0	$5,201	**$13,886**	
10	$0	$4,319	$1,437	$2,476	$0	$1,044	$5,357	$14,633	$127,142
11	$480	$0	$1,480	$2,550	$4,704	$0	$5,518	**$14,732**	
12	$0	$4,583	$1,525	$2,627	$0	$1,107	$5,684	**$15,526**	
13	$509	$0	$1,570	$2,705	$4,990	$0	$5,854	**$15,628**	
14	$0	$4,862	$1,618	$2,787	$0	$1,175	$6,030	**$16,472**	
15	$540	$0	$1,666	$2,870	$5,294	$0	$6,211	**$16,581**	$206,081
16	$0	$5,158	$1,716	$2,956	$0	$1,246	$6,397	**$17,473**	
17	$573	$0	$1,768	$3,045	$5,616	$0	$6,589	**$17,591**	
18	$0	$5,472	$1,821	$3,136	$0	$1,322	$6,787	**$18,538**	
19	$608	$0	$1,875	$3,230	$5,959	$0	$6,990	**$18,662**	
20	$0	$5,805	$1,931	$3,327	$0	$1,403	$7,200	**$19,666**	$298,011
Totals	$4,726	$45,135	$29,599	$50,987	$46,328	$10,906	$110,330	**$298,011**	

3% Annual Cost Inflation

Table 30. Annual Nitrogen Load Reductions (lbs)

Year	Vegetative Filter Strips	Relocate feeding pens	Relocate Pasture Feeding Site	Off-Stream Watering	Rotational grazing	Fence Out streams and Ponds	Grazing Management Plans	Annual Load Reduction
1	1,201	0	119	119	264	275	0	1,978
2	1,201	1,502	238	238	264	550	529	4,522
3	2,403	1,502	356	356	527	825	529	6,498
4	2,403	3,004	475	475	527	1,100	1,059	9,043
5	3,604	3,004	594	594	794	1,059	1,375	11,024
6	3,604	4,505	713	713	791	1,650	1,588	13,564
7	4,806	4,505	831	831	1,055	1,925	1,588	15,541
8	4,806	6,007	950	950	1,055	2,200	2,117	18,085
9	6,007	6,007	1,069	1,069	1,318	2,475	2,117	20,062
10	6,007	7,509	1,188	1,188	1,318	2,750	2,646	22,606
11	7,209	7,509	1,307	1,307	1,582	3,025	2,646	24,585
12	7,209	9,011	1,425	1,425	1,582	3,300	3,176	27,128
13	8,410	9,011	1,544	1,544	1,846	3,575	3,176	29,106
14	8,410	10,513	1,663	1,663	1,846	3,850	3,705	31,650
15	9,612	10,513	1,785	1,782	2,110	4,125	3,705	33,632
16	9,612	12,014	1,900	1,900	2,110	4,400	4,234	36,170
17	10,813	12,014	2,019	2,019	2,373	4,675	4,234	38,147
18	10,813	13,516	2,138	2,138	2,373	4,950	4,763	40,691
19	12,014	13,516	2,257	2,257	2,637	5,225	4,763	42,669
20	12,014	15,018	2,375	2,375	2,637	5,500	5,293	45,212

APPENDIX C

Table 31. Cropland Scenario

Middle MdC WRAPS, Targeted Area BMP Scenario	South Priority Area	
	Annual	Total
Treated Acres of Cropland	315	**6,300**
BMP Implementation (treated acres)		
Terraces and Waterways	20	**400**
No-Till	100	**2,000**
Nutrient Mgmt Plan	50	**1,000**
Vegetative and Riparian Buffers	135	**2,700**
Grade Stabilization Structures	10	**200**
Total	315	**6,300**
Estimated Cost		
Total Investment Cost	$31,805	**$636,090**
Available Cost-Share	$19,739	**$394,776**
Net Cost	$12,066	**$241,314**
Estimated Annual Runoff Reduction		
Soil Erosion (tons)	254.7	**5,094**
Phosphorus (pounds)	269.6	**5,392**
Nitrogen (pounds)	688.4	**13,768**
Estimated Average Annual Runoff		
Soil Erosion (tons/acre)	1.50	**1.50**
Phosphorus (pounds/acre)	2.00	**2.00**
Nitrogen (pounds/acre)	8.00	**8.00**
Percent Reduction		
Soil Erosion	54%	**54%**
Phosphorus	43%	**43%**
Nitrogen	27%	**27%**

Table 32. Achieving the DO TMDL for Pottawatomie Creek

Sediment				Phosphorus				
Year	Cropland Reduction	% of TMDL		Year	Cropland Reduction	Livestock Reduction	Total Reduction (lbs)	% of TMDL
1	255	196%		1	270	996	1,266	50%
2	509	392%		2	539	1,910	2,450	97%
3	764	588%		3	809	2,908	3,717	147%
4	1,019	784%		4	1,078	3,823	4,901	194%
5	1,274	980%		5	1,348	4,820	6,168	245%
6	1,528	1176%		6	1,618	5,735	7,353	292%
7	1,783	1371%		7	1,887	6,733	8,620	342%
8	2,038	1567%		8	2,157	7,648	9,804	389%
9	2,292	1763%		9	2,426	8,645	11,071	439%
10	2,547	1959%		10	2,696	9,560	12,256	486%
11	2,802	2155%		11	2,966	10,557	13,523	537%
12	3,056	2351%		12	3,235	11,472	14,708	584%
13	3,311	2547%		13	3,505	12,470	15,975	634%
14	3,566	2743%		14	3,774	13,385	17,159	681%
15	3,821	2939%		15	4,044	14,382	18,426	731%
16	4,075	3135%		16	4,314	15,297	19,611	778%
17	4,330	3331%		17	4,583	16,295	20,878	828%
18	4,585	3527%		18	4,853	17,210	22,062	875%
19	4,839	3723%		19	5,122	18,207	23,329	926%
20	5,094	3918%		20	5,392	19,122	24,514	973%
Sediment Portion of DO TMDL: 130 Tons				**Phosphorus Portion of DO TMDL: 2,520 lbs**				

Goal Met

Table 33. Pottawatomie Creek Total Annual Cost Before Cost-Share, Cropland BMPs

Year	Terraces and Waterways	No-Till	Nutrient Management Plan	Vegetative and Riparian Buffers	Grade Stabilization Structures	Total
1	$5,200	$7,769	$2,836	$13,500	$2,500	$31,805
2	$5,356	$8,002	$2,921	$13,905	$2,575	$32,759
3	$5,517	$8,242	$3,008	$14,322	$2,652	$33,741
4	$5,682	$8,489	$3,098	$14,752	$2,732	$34,754
5	$5,853	$8,744	$3,191	$15,194	$2,814	$35,796
6	$6,028	$9,006	$3,287	$15,650	$2,898	$36,870
7	$6,209	$9,277	$3,386	$16,120	$2,985	$37,976
8	$6,395	$9,555	$3,487	$16,603	$3,075	$39,116
9	$6,587	$9,842	$3,592	$17,101	$3,167	$40,289
10	$6,785	$10,137	$3,700	$17,614	$3,262	$41,498
11	$6,988	$10,441	$3,811	$18,143	$3,360	$42,743
12	$7,198	$10,754	$3,925	$18,687	$3,461	$44,025
13	$7,414	$11,077	$4,043	$19,248	$3,564	$45,346
14	$7,636	$11,409	$4,164	$19,825	$3,671	$46,706
15	$7,865	$11,751	$4,289	$20,420	$3,781	$48,107
16	$8,101	$12,104	$4,418	$21,033	$3,895	$49,550
17	$8,344	$12,467	$4,550	$21,664	$4,012	$51,037
18	$8,595	$12,841	$4,687	$22,313	$4,132	$52,568
19	$8,853	$13,226	$4,827	$22,983	$4,256	$54,145
20	$9,118	$13,623	$4,972	$23,672	$4,384	$55,769

Table 34. Pottawatomie Creek Total Annual Cost After Cost-Share. Cropland BMPs

Year	Terraces and Waterways	No-Till	Nutrient Management Plan	Vegetative and Riparian Buffers	Grade Stabilization Structures	Total
1	$2,600	$4,739	$2,127	$1,350	$1,250	$12,066
2	$2,678	$4,881	$2,190	$1,391	$1,288	$12,428
3	$2,758	$5,028	$2,256	$1,432	$1,326	$12,801
4	$2,841	$5,179	$2,324	$1,475	$1,366	$13,185
5	$2,926	$5,334	$2,394	$1,519	$1,407	$13,580
6	$3,014	$5,494	$2,465	$1,565	$1,449	$13,987
7	$3,105	$5,659	$2,539	$1,612	$1,493	$14,407
8	$3,198	$5,828	$2,615	$1,660	$1,537	$14,839
9	$3,294	$6,003	$2,694	$1,710	$1,583	$15,284
10	$3,392	$6,183	$2,775	$1,761	$1,631	$15,743
11	$3,494	$6,369	$2,858	$1,814	$1,680	$16,215
12	$3,599	$6,560	$2,944	$1,869	$1,730	$16,702
13	$3,707	$6,757	$3,032	$1,925	$1,782	$17,203
14	$3,818	$6,960	$3,123	$1,983	$1,836	$17,719
15	$3,933	$7,168	$3,217	$2,042	$1,891	$18,250
16	$4,051	$7,383	$3,313	$2,103	$1,947	$18,798
17	$4,172	$7,605	$3,413	$2,166	$2,006	$19,362
18	$4,297	$7,833	$3,515	$2,231	$2,066	$19,943
19	$4,426	$8,068	$3,620	$2,298	$2,128	$20,541
20	$4,559	$8,310	$3,729	$2,367	$2,192	$21,157

Table 35. Pottawatomie Creek Annual Adoption (treated acres), and costs for Cropland BMPs

	Year	Terraces and Waterways	No-Till	Nutrient Management Plan	Vegetative and Riparian Buffers	Grade Stabilization Structures	Total Adoption	Total Cost before Cost Share	Total Cost After Cost Share
Short Term	1	20	100	50	135	10	315	$31,805	$12,066
	2	20	100	50	135	10	315	$32,759	$12,428
	3	20	100	50	135	10	315	$33,741	$12,801
	4	20	100	50	135	10	315	$34,754	$13,185
	5	20	100	50	135	10	315	$35,796	$13,580
Total		***100***	***500***	***250***	***675***	***50***	***1,575***	**$168,855**	**$64,060**
Medium Term	6	20	100	50	135	10	315	$36,870	$13,987
	7	20	100	50	135	10	315	$37,976	$14,407
	8	20	100	50	135	10	315	$39,116	$14,839
	9	20	100	50	135	10	315	$40,289	$15,284
	10	20	100	50	135	10	315	$41,498	$15,743
Total		***200***	***1,000***	***500***	***1,350***	***100***	***3,150***	**$364,604**	**$138,320**
Long Term	11	20	100	50	135	10	315	$42,743	$16,215
	12	20	100	50	135	10	315	$44,025	$16,702
	13	20	100	50	135	10	315	$45,346	$17,203
	14	20	100	50	135	10	315	$46,706	$17,719
	15	20	100	50	135	10	315	$48,107	$18,250
	16	20	100	50	135	10	315	$49,550	$18,798
	17	20	100	50	135	10	315	$51,037	$19,362
	18	20	100	50	135	10	315	$52,568	$19,943
	19	20	100	50	135	10	315	$54,145	$20,541
	20	20	100	50	135	10	315	$55,769	$21,157
Total		***400***	***2,000***	***1,000***	***2,700***	***200***	***6,300***	***$854,600***	***$324,210***

Table 36. Middle MdC WRAPS Cropland BMPs, Costs, and Reduction Efficiencies

Best Management Practice	Cost per Acre	Available Cost-Share	Erosion Reduction Efficiency	Phosphorus Reduction Efficiency	Nitrogen Reduction Efficiency
Terraces and Waterways	$260	50%	49%	49%	49%
No-Till	$78	39%	75%	40%	25%
Nutrient Mgmt Plan	$57	25%	25%	25%	25%
Vegetative and Riparian Buffers	$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					

Cropland BMP Adoption Milestones

Table 37. Pottawatomie Creek Cropland BMP Adoption Milestones (acres treated)

	Year	Terraces and Waterways	No-Till	Nutrient Management Plan	Vegetative and Riparian Buffers	Grade Stabilization Structures	Total Adoption
Short Term	1	20	100	50	135	10	315
	2	20	100	50	135	10	315
	3	20	100	50	135	10	315
	4	20	100	50	135	10	315
	5	20	100	50	135	10	315
Total		*100*	*500*	*250*	*675*	*50*	*1,575*
Medium Term	6	20	100	50	135	10	315
	7	20	100	50	135	10	315
	8	20	100	50	135	10	315
	9	20	100	50	135	10	315
	10	20	100	50	135	10	315
Total		*200*	*1,000*	*500*	*1,350*	*100*	*3,150*
Long Term	11	20	100	50	135	10	315
	12	20	100	50	135	10	315
	13	20	100	50	135	10	315
	14	20	100	50	135	10	315
	15	20	100	50	135	10	315
	16	20	100	50	135	10	315
	17	20	100	50	135	10	315
	18	20	100	50	135	10	315
	19	20	100	50	135	10	315
	20	20	100	50	135	10	315
Total		*400*	*2,000*	*1,000*	*2,700*	*200*	*6,300*

Livestock BMP Adoption Milestones

Table 38. Pottawatomie Creek Livestock BMP Adoption Milestones (acres treated)

	Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Fence off Streams and Ponds
Short-Term	1	0	1	1	1	0	1
	2	1	0	1	0	1	1
	3	0	1	1	1	0	1
	4	1	0	1	0	1	1
	5	0	1	1	1	0	1
	Total	**2**	**3**	**5**	**3**	**2**	**5**
Medium-Term	6	1	0	1	0	1	1
	7	0	1	1	1	0	1
	8	1	0	1	0	1	1
	9	0	1	1	1	0	1
	10	1	0	1	0	1	1
	Total	***5***	***5***	***10***	***5***	***5***	***10***
Long-Term	11	0	1	1	1	0	1
	12	1	0	1	0	1	1
	13	0	1	1	1	0	1
	14	1	0	1	0	1	1
	15	0	1	1	1	0	1
	16	1	0	1	0	1	1
	17	0	1	1	1	0	1
	18	1	0	1	0	1	1
	19	0	1	1	1	0	1
	20	1	0	1	0	1	1
	Total	10	10	20	10	10	20

Table 39. South Portion Annual Livestock BMP Adoption

Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Fence off Streams and Ponds
1	0	1	1	1	0	1
2	1	0	1	0	1	1
3	0	1	1	1	0	1
4	1	0	1	0	1	1
5	0	1	1	1	0	1
6	1	0	1	0	1	1
7	0	1	1	1	0	1
8	1	0	1	0	1	1
9	0	1	1	1	0	1
10	1	0	1	0	1	1
11	0	1	1	1	0	1
12	1	0	1	0	1	1
13	0	1	1	1	0	1
14	1	0	1	0	1	1
15	0	1	1	1	0	1
16	1	0	1	0	1	1
17	0	1	1	1	0	1
18	1	0	1	0	1	1
19	0	1	1	1	0	1
20	1	0	1	0	1	1
Total	*10*	*10*	*20*	*10*	*10*	*20*

Table 40. Annual Cost*Before Cost-Share of Implementing Livestock BMPs, South Portion

Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Grazing Mgmt Plans	Fence off Streams and Ponds	Annual Cost
1	$0	$6,621	$2,203	$3,795	$0	$0	$4,106	**$16,725**
2	$0	$6,820	$2,269	$3,909	$0	$0	$4,229	**$17,227**
3	$757	$0	$2,337	$0	$7,426	$0	$4,356	**$14,877**
4	$0	$7,235	$2,407	$4,147	$0	$0	$4,487	**$18,276**
5	$804	$0	$2,479	$0	$7,879	$0	$4,621	**$15,783**
6	$0	$7,676	$2,554	$4,399	$0	$0	$4,760	**$19,389**
7	$853	$0	$2,630	$0	$8,358	$0	$4,903	**$16,744**
8	$0	$8,143	$2,709	$4,667	$0	$0	$5,050	**$20,570**
9	$904	$0	$2,791	$0	$8,867	$0	$5,201	**$17,764**
10	$0	$8,639	$2,874	$4,952	$0	$0	$5,357	**$21,822**
11	$960	$0	$2,961	$0	$9,407	$0	$5,518	**$18,846**
12	$0	$9,165	$3,049	$5,253	$0	$0	$5,684	**$23,151**
13	$1,018	$0	$3,141	$0	$9,980	$0	$5,854	**$19,993**
14	$0	$9,723	$3,235	$5,573	$0	$0	$6,030	**$24,561**
15	$1,080	$0	$3,332	$0	$10,588	$0	$6,211	**$21,211**
16	$0	$10,315	$3,432	$5,912	$0	$0	$6,397	**$26,057**
17	$1,146	$0	$3,535	$0	$11,233	$0	$6,589	**$22,503**
18	$0	$10,944	$3,641	$6,273	$0	$0	$6,787	**$27,644**
19	$1,216	$0	$3,750	$0	$11,917	$0	$6,990	**$23,873**
20	$0	$11,610	$3,863	$6,655	$0	$0	$7,200	**$29,327**

3% Annual Cost Inflation

Table 41.Annual Cost* After Cost-Share of Implementing Livestock BMPs, South Portion

Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Grazing Mgmt Plans	Fence off Streams and Ponds	Annual Cost
1	$0	$3,311	$1,102	$1,898	$0	$0	$2,053	**$8,363**
2	$0	$3,410	$1,135	$1,954	$0	$0	$2,115	**$8,613**
3	$379	$0	$1,169	$0	$3,713	$0	$2,178	**$7,439**
4	$0	$3,617	$1,204	$2,073	$0	$0	$2,243	**$9,138**
5	$402	$0	$1,240	$0	$3,939	$0	$2,311	**$7,892**
6	$0	$3,838	$1,277	$2,200	$0	$0	$2,380	**$9,694**
7	$426	$0	$1,315	$0	$4,179	$0	$2,451	**$8,372**
8	$0	$4,071	$1,355	$2,334	$0	$0	$2,525	**$10,285**
9	$452	$0	$1,395	$0	$4,434	$0	$2,601	**$8,882**
10	$0	$4,319	$1,437	$2,476	$0	$0	$2,679	**$10,911**
11	$480	$0	$1,480	$0	$4,704	$0	$2,759	**$9,423**
12	$0	$4,583	$1,525	$2,627	$0	$0	$2,842	**$11,576**
13	$509	$0	$1,570	$0	$4,990	$0	$2,927	**$9,997**
14	$0	$4,862	$1,618	$2,787	$0	$0	$3,015	**$12,281**
15	$540	$0	$1,666	$0	$5,294	$0	$3,105	**$10,606**
16	$0	$5,158	$1,716	$2,956	$0	$0	$3,199	**$13,029**
17	$573	$0	$1,768	$0	$5,616	$0	$3,294	**$11,251**
18	$0	$5,472	$1,821	$3,136	$0	$0	$3,393	**$13,822**
19	$608	$0	$1,875	$0	$5,959	$0	$3,495	**$11,937**
20	$0	$5,805	$1,931	$3,327	$0	$0	$3,600	**$14,664**

3% Annual Cost Inflation

Table 42. Pottawatomie Creek Annual Nitrogen Runoff Reduction

Year	Terraces and Waterways	No-Till	Nutrient Management Plan	Vegetative and Riparian Buffers	Grade Stabilization Structures	Total
1	78	200	100	270	40	688
2	157	400	200	540	80	1,377
3	235	600	300	810	120	2,065
4	314	800	400	1,080	160	2,754
5	392	1,000	500	1,350	200	3,442
6	470	1,200	600	1,620	240	4,130
7	549	1,400	700	1,890	280	4,819
8	627	1,600	800	2,160	320	5,507
9	706	1,800	900	2,430	360	6,196
10	784	2,000	1,000	2,700	400	6,884
11	862	2,200	1,100	2,970	440	7,572
12	941	2,400	1,200	3,240	480	8,261
13	1,019	2,600	1,300	3,510	520	8,949
14	1,098	2,800	1,400	3,780	560	9,638
15	1,176	3,000	1,500	4,050	600	10,326
16	1,254	3,200	1,600	4,320	640	11,014
17	1,333	3,400	1,700	4,590	680	11,703
18	1,411	3,600	1,800	4,860	720	12,391
19	1,490	3,800	1,900	5,130	760	13,080
20	1,568	4,000	2,000	5,400	800	13,768

Table 43. Annual Nitrogen Load Reductions (lbs) South Portion

Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Grazing Mgmt Plans	Fence off Streams and Ponds	Annual Load Reduction
1	0	1,502	119	119	0	0	137	**1,877**
2	1,201	1,502	238	119	264	0	275	**3,598**
3	1,201	3,004	356	238	264	2	412	**5,477**
4	2,403	3,004	475	238	527	4	550	**7,200**
5	2,403	4,505	594	356	527	6	687	**9,079**
6	3,604	4,505	713	356	791	8	825	**10,802**
7	3,604	6,007	831	475	791	9	962	**12,681**
8	4,806	6,007	950	475	1,055	11	1,100	**14,404**
9	4,806	7,509	1,069	594	1,055	13	1,237	**16,283**
10	6,007	7,509	1,188	594	1,318	15	1,375	**18,006**
11	6,007	9,011	1,307	713	1,318	17	1,512	**19,885**
12	7,209	9,011	1,425	713	1,582	19	1,650	**21,608**
13	7,209	10,513	1,544	831	1,582	21	1,787	**23,487**
14	8,410	10,513	1,663	831	1,846	23	1,925	**25,210**
15	8,410	12,014	1,782	950	1,846	24	2,062	**27,089**
16	9,612	12,014	1,900	950	2,110	26	2,200	**28,812**
17	9,612	13,516	2,019	1,069	2,110	28	2,337	**30,691**
18	10,813	13,516	2,138	1,069	2,373	30	2,475	**32,414**
19	10,813	15,018	2,257	1,188	2,373	32	2,612	**34,293**
20	12,014	15,018	2,375	1,188	2,637	34	2,750	**36,016**

Table 44. Pottawatomie Creek Annual Livestock BMP Adoption and Costs

Year	Vegetative Filter Strip	Relocate Feeding Pens	Relocate Pasture Feeding Site	Off Stream Watering System	Rotational Grazing	Fence off Streams and Ponds	Annual cost before Cost Share	Annual Cost after Cost-share	Total Cost at milestones before cost share	Total Cost at milestones after cost share
1	0	1	1	1	0	1	$31,805	$12,066		
2	1	0	1	0	1	1	$32,759	$12,428		
3	0	1	1	1	0	1	$33,741	$12,801		
4	1	0	1	0	1	1	$34,754	$13,185		
5	***0***	***1***	***1***	***1***	***0***	***1***	***$35,796***	***$13,580***	***$168,855***	***$64,060***
6	1	0	1	0	1	1	$36,870	$13,987		
7	0	1	1	1	0	1	$37,976	$14,407		
8	1	0	1	0	1	1	$39,116	$14,839		
9	0	1	1	1	0	1	$40,289	$15,284		
10	***1***	***0***	***1***	***0***	***1***	***1***	***$41,498***	***$15,743***	***$364,604***	***$138,320***
11	0	1	1	1	0	1	$42,743	$16,215		
12	1	0	1	0	1	1	$44,025	$16,702		
13	0	1	1	1	0	1	$45,346	$17,203		
14	1	0	1	0	1	1	$46,706	$17,719		
15	0	1	1	1	0	1	$48,107	$18,250		
16	1	0	1	0	1	1	$49,550	$18,798		
17	0	1	1	1	0	1	$51,037	$19,362		
18	1	0	1	0	1	1	$52,568	$19,943		
19	0	1	1	1	0	1	$54,145	$20,541		
20	***1***	***0***	***1***	***0***	***1***	***1***	***$55,769***	***$21,157***	***$854,600***	***$324,210***
Total	***10***	***10***	***20***	***10***	***10***	***20***	**$854,600**	***$324,210***		

Table 45. South Portion Livestock BMP Adoption by Sub Watershed

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Fence off Streams and Ponds	Total Adoption
506	2	2	4	2	2	4	16
507	2	2	4	2	2	4	16
509	2	2	4	2	2	4	16
603	2	2	4	2	2	4	16
604	2	2	4	2	2	4	16
Total	10	10	20	10	10	20	80

Table 46. South Portion Livestock BMP Cost* Before Cost-Share by Sub Watershed

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Fence off Streams and Ponds	Total Cost
506	$1,428	$13,242	$8,812	$7,590	$14,000	$16,424	$61,496
507	$1,428	$13,242	$8,812	$7,590	$14,000	$16,424	$61,496
509	$1,428	$13,242	$8,812	$7,590	$14,000	$16,424	$61,496
603	$1,428	$13,242	$8,812	$7,590	$14,000	$16,424	$61,496
604	$1,428	$13,242	$8,812	$7,590	$14,000	$16,424	$61,496
Total	$7,140	$66,210	$44,060	$37,950	$70,000	$82,120	$307,480

**2011 Dollars*

Table 47. South Portion Livestock BMP Cost After Cost-Share by Sub Watershed

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Fence off Streams and Ponds	Total Cost
506	$714	$6,621	$4,406	$3,795	$7,000	$8,212	$30,748
507	$714	$6,621	$4,406	$3,795	$7,000	$8,212	$30,748
509	$714	$6,621	$4,406	$3,795	$7,000	$8,212	$30,748
603	$714	$6,621	$4,406	$3,795	$7,000	$8,212	$30,748
604	$714	$6,621	$4,406	$3,795	$7,000	$8,212	$30,748
Total	$3,570	$33,105	$22,030	$18,975	$35,000	$41,060	$153,740

**2011 Dollars*

Table 48. South Portion Livestock BMP Phosphorus Load Reduction by Sub Watershed (pounds)

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Fence off Streams and Ponds	Total Load Reduction
506	1,276	1,595	252	126	280	292	3,821
507	1,276	1,595	252	126	280	292	3,821
509	1,276	1,595	252	126	280	292	3,821
603	1,276	1,595	252	126	280	292	3,821
604	1,276	1,595	252	126	280	292	3,821
Total	6,379	7,973	1,261	631	1,400	1,460	19,104

Table 49. South Portion Livestock BMP Nitrogen Load Reduction by Sub Watershed (pounds)

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Fence off Streams and Ponds	Total Load Reduction
506	2,403	3,004	475	238	527	550	7,196
507	2,403	3,004	475	238	527	550	7,196
509	2,403	3,004	475	238	527	550	7,196
603	2,403	3,004	475	238	527	550	7,196
604	2,403	3,004	475	238	527	550	7,196
Total	12,014	15,018	2,375	1,188	2,637	2,750	35,982

Table 50. North Portion Livestock BMP Cost* Before Cost-Share by Sub Watershed

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Grazing Mgmt Plans	Fence off Streams and Ponds	Total Cost
405	$2,142	$26,484	$13,218	$30,360	$21,000	$6,400	$49,272	$148,876
406	$2,142	$19,863	$13,218	$22,770	$21,000	$4,800	$49,272	$133,065
407	$2,856	$19,863	$17,624	$22,770	$28,000	$4,800	$65,696	$161,609
Total	$7,140	$66,210	$44,060	$75,900	$70,000	$16,000	$164,240	$443,550

**2011 Dollars*

Table 51. North Portion Livestock BMP Cost After Cost-Share by Sub Watershed

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Grazing Mgmt Plans	Fence off Streams and Ponds	Total Cost
405	$1,071	$13,242	$6,609	$15,180	$10,500	$3,200	$24,636	$74,438
406	$1,071	$9,932	$6,609	$11,385	$10,500	$2,400	$24,636	$66,533
407	$1,428	$9,932	$8,812	$11,385	$14,000	$2,400	$32,848	$80,805
Total	$3,570	$33,105	$22,030	$37,950	$35,000	$8,000	$82,120	$221,775

**2011 Dollars*

Table 52. North Portion Livestock BMP Phosphorus Load Reduction by Sub Watershed (pounds)

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Grazing Mgmt Plans	Fence off Streams and Ponds	Total Load Reduction
405	1,914	3,189	378	504	420	1,124	876	8,406
406	1,914	2,392	378	378	420	843	876	7,201
407	2,552	2,392	504	378	560	843	1,168	8,397
Total	6,379	7,973	1,261	1,261	1,400	2,810	2,920	24,005

Table 53. North Portion Livestock BMP Nitrogen Load Reduction by Sub Watershed (pounds)

Sub Watershed	Vegetative Filter Strip	Relocate Feeding Site	Relocate Pasture Feeding Site	Off-Stream Watering System	Rotational Grazing	Grazing Mgmt Plans	Fence off Streams and Ponds	Total Load Reduction
405	3,604	6,007	713	950	791	2,117	1,650	15,832
406	3,604	4,505	713	713	791	1,588	1,650	13,564
407	4,806	4,505	950	713	1,055	1,588	2,200	15,816
Total	12,014	15,018	2,375	2,375	2,637	5,293	5,500	45,213

APPENDIX D

Table 54. Total Annual WRAPS Cost after Cost-Share by BMP Category

Year	Cropland	North Livestock	South Livestock	Total Annual Cost
1	$12,066	$10,962	$8,363	$31,390
2	$12,428	$11,552	$8,613	$32,593
3	$12,801	$11,630	$7,439	$31,869
4	$13,185	$12,255	$9,138	$34,578
5	$13,580	$12,338	$7,892	$33,809
6	$13,987	$13,002	$9,694	$36,684
7	$14,407	$13,089	$8,372	$35,868
8	$14,839	$13,794	$10,285	$38,918
9	$15,284	$13,886	$8,882	$38,053
10	$15,743	$14,634	$10,911	$41,288
11	$16,215	$14,732	$9,423	$40,370
12	$16,702	$15,525	$11,576	$43,802
13	$17,203	$15,629	$9,997	$42,829
14	$17,719	$16,470	$12,281	$46,470
15	$18,250	$16,581	$10,606	$45,437
16	$18,798	$17,473	$13,029	$49,300
17	$19,362	$17,591	$11,251	$48,204
18	$19,943	$18,538	$13,822	$52,302
19	$20,541	$18,662	$11,937	$51,140
20	$21,157	$19,666	$14,664	$55,487