

Total Maximum Daily Load (TMDL) Source Assessment for Upper and Middle Rock Creek Watersheds

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Aerial View of Rock Creek just East of Westmoreland, Kansas

Assessment and Report Completed by:

Blue Earth in cooperation with the Kansas Alliance for Wetlands and Streams (KAWS) and the Pottawatomie County Natural Resource Conservation Service (NRCS)

Areas of Interest: Upper (HUC 10270102010010) and Middle Rock Creek Watersheds (HUC 10270102010020), Pottawatomie County Kansas (Figure 1)

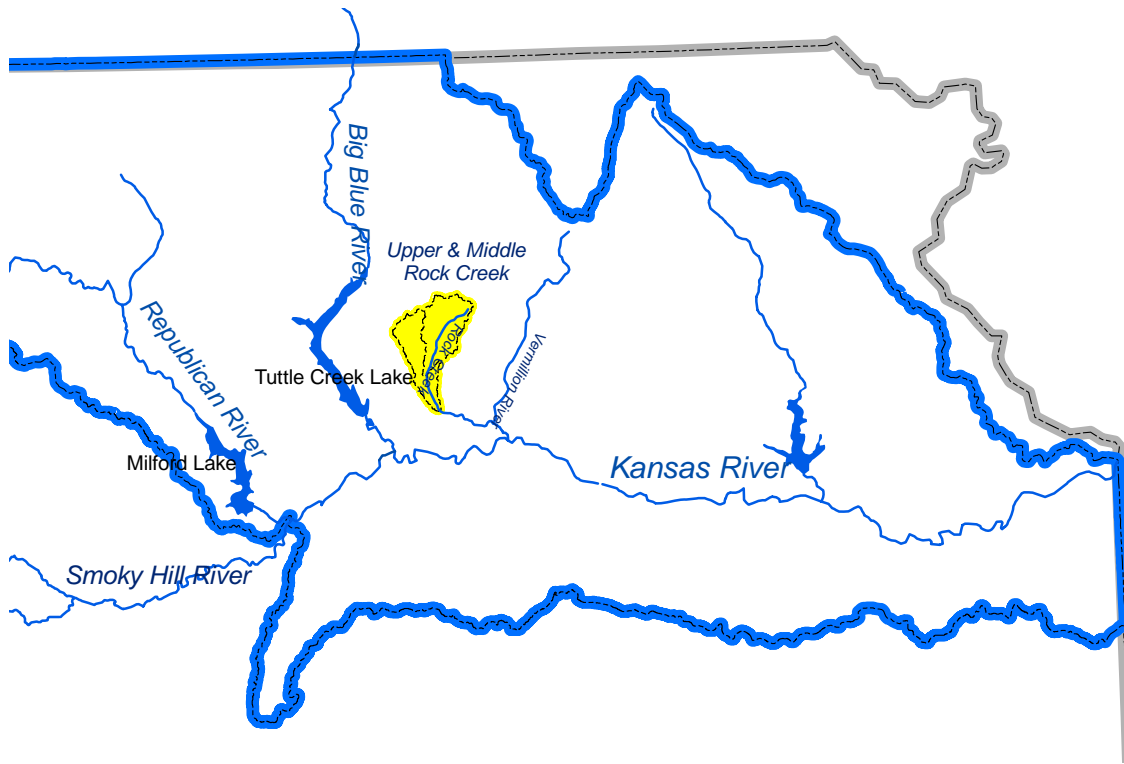


Figure 1. Upper and middle Rock Creek watershed. The upper (right) and middle (left) Rock Creek watersheds are delineated in gold. Rock Creek enters into the Vermillion River east of Wamego, Kansas, as part of lower Rock Creek watershed briefly before flowing into the middle Kansas River.

Issues

Scope of TMDL Issues to be evaluated in this assessment

- Identification of potential sources of fecal coliform bacteria (FCB) including *Escherichia coli* (*E. coli*) to Rock Creek, its tributaries and contributing drainages;
- Identification of potential sources of nutrients contributing to loading in and eutrophication of Pottawatomie County State Fishing Lake No. 1 (Pott. Co. SFL-1);
- Identification of potential sediment sources emanating from “significant” stream and river bank erosion, operationally defined as any horizontal distance running parallel to the stream and greater than 500 feet in extent which could potentially contribute sediment

or appears through visual assessment of aerial photography to represent an “unstable” stream or river bank.

Additional TMDL Issues in Greater Middle Kansas River Basin which will not be specifically addressed by this assessment

- Ammonia (NH₃) and toxic effects on fish and other aquatic organisms;
- Sediment; its contribution to increased turbidity, nutrient loading, and effects on native aquatic organisms; alterations to stream geomorphological dynamics and aggradation of streams and rivers; and decreased storage capacity in lakes and federal reservoirs.

Deliverables

- Summary of methodologies for assessment of aforementioned TMDL issues;
- Assessment of specific, potential animal waste or “cattle in creek” sites located in close proximity to streams and rivers, operationally defined by contractor or within 100 feet of streams or rivers;
- Assessment of potential large stream projects (i.e. potential failing or unstable banks), operationally defined as greater than 500 feet in extent (i.e., length or linear feet of stream);
- Assessment of potential animal feeding operation sites in close proximity to streams and rivers, operationally defined by contractor or determined as grassland/ pasture land use within 100 feet of streams or rivers;
- Present draft and completed assessment to the WRAPS Leadership Team and local watershed group;
- Prepare a summary of potential needs for BMP implementation including the following:
 - Linear extent of stream or river banks reported as greater than 500 feet of bank failure or instability;
 - Potential riparian buffer sites summarized as total acres;
 - Potential animal waste or “cattle in creek” sites located within 100 feet of stream or river, operationally defined as all grassland/ pasture or cultivated land use within 100 feet of stream or river, and reported as total acres.

Report

Summary of methodologies for assessment of aforementioned TMDL issues

1. Potential sources of FCB and nutrients (i.e., P or other nutrients such as nitrogen (N) species) to Rock Creek Watersheds and Pott. Co. SFL-1:

- Identified 100 feet buffer distances (i.e., 30 m) adjacent to all drainages, streams and rivers in the Upper and Middle Rock Creek watersheds. Drainages, streams and rivers were defined as the U.S. Geological Survey (USGS) National Hydrography Dataset (NHD);
- Identified all land use/ land cover located within a 100 feet buffer distance of drainages, streams and rivers based on the USGS 2001 National Land Cover Dataset (NLCD);
- Categorized and coded land use/ land cover operationally into the following five categories:
 - wetland/ water
 - developed/ devegetated
 - riparian forest
 - grassland/ pasture
 - cultivated
- Based on the objectives of the assessment, potential source areas of FCB and nutrients, which were targeted for best management practice (BMP) implementation, included primarily land in grassland/ pasture in 2001.

Developed land (FCB, nutrients and sediment) and cultivated land (nutrients, sediments, FCB if manure or sewage sludge applied) may also have potential to contribute to FCB and nutrients to Rock Creek, but were not a major focus area for this assessment.

- Strengths of assessment procedure:
 - objective; used geographical information system (GIS) analyses and procedural definitions to define potential source areas of concern;
 - consistency; can be duplicated methodologically and was not based on subjectivity or immediate experience of assessor;
 - efficient and cost effective; reduced time and costs to assess watershed.
- Weaknesses of assessment procedure:
 - data dependent; subject to the accuracy and resolution of the data used to generate assessment results; however, post-assessment ground truthing and visual analysis procedures were used to assure and control quality of end-user product;
 - land use/ land cover data are seven years old to date (i.e., USGS 2001 NLCD) and may not have reflected the most current conditions;
 - resolution of land use/ land cover data was a 30 m x 30 m pixel which limited accuracy of assessment to this landscape scale
 - experiential component of assessment only considered during ground truthing and validation processes (however, could also be considered a strength as it represents

an unbiased approach, and no visual analysis of “cattle in the creek” would completely accurate using a single date of imagery or even multiple dates).

2. Potential sources of stream and river bank erosion:

- Visual inspection of 2006 U.S. Department of Agriculture (USDA) Farm Service Agency (FSA) National Agriculture Imagery Program (NAIP) color composite aerial photography was used to identify all land areas in watersheds of interest which had the following operationally defined characteristics:
 - within a 100 feet buffer distance of streams and rivers;
 - indicators of potential or apparent bank erosion or instability (these were defined by assessor during assessment and have been reported in the next section of this report);
 - equal to or greater than 500 feet in extent; however, major sites less than 500 feet in linear extent have been reported.

- Strengths of assessment procedure:
 - allowed for expertise and experience of assessors to be included in all phases of the methodology including assessment, ground truthing and validation processes;
 - assessment results are based on most current conditions and available information (e.g., 2006 NAIP imagery), and approach was potentially more accurate than GIS analyses (i.e., considered expertise and experience of assessors and was more flexible and adaptive to unique site conditions).

- Weaknesses of assessment procedure:
 - less efficient and more time consuming than GIS analyses;
 - subjective, with potential for assessor bias or misinterpretation of assessment results (however, this situation was relaxed by using operational or procedural definitions of “indicators,” etc. during the assessment, with assumptions communicated to end-users in this report).

Assessment of specific, potential animal waste or “cattle in creek” sites located in close proximity to streams and rivers, operationally defined by contractor or within 100 feet of streams or rivers; AND

Assessment of potential animal feeding operation sites in close proximity to streams and rivers, operationally defined by contractor or determined as grassland/ pasture land use within 100 feet of streams or rivers.

Figures 2 & 3 present results of assessing the potential for animal waste delivery (i.e., FCB, or more specifically *E. coli* and associated nutrients) to streams and rivers in the Upper (HUC 10270102010010) and Middle Rock Creek watersheds (HUC 10270102010020) and potential for “cattle in the creek” or animal wintering and loafing sites located in close proximity to streams

and rivers there. Two methods of assessment were used to evaluate this potential and are described in the methodologies section presented in an earlier section of this report.

Briefly, Figure 2 presents assessment results obtained by GIS analytical procedures to document the co-occurrence of grassland (mixed and tall grass prairie), pasture and hayfields within a 100 feet buffer zone extending from center line to either side of all drainages, streams and rivers (as defined by high-resolution NHD). This co-occurrence represents likely potential that cattle (or other animals such as horses) have access to drainages, streams and rivers in these areas (unless animals have been fenced out) and the likely possibility that cattle have grazed these locations and defecated there. Defecation in drainages and on stream and river banks represents a probable delivery mechanism of FCB to streams and rivers. Defecation directly in streams and rivers represents absolute delivery of FCB to streams and rivers by cattle or other animals. Since over 70% of the Upper and Middle Rock Creek watersheds are grassland/pasture (77.3 and 71.1%, respectively), there is a large potential land area contributing diffuse sources of FCB and nutrients in the form of animal waste to drainages, streams and rivers throughout the watershed. The most important and “treatable” source of FCB and nutrients is that located closest to the streams and rivers, or flowing into them through drainages, and should be targeted for BMP implementation to reduce these inputs.

Table 1 presents a break-down of land use/ land cover types located within 100 feet of all streams and rivers in the Upper and Middle Rock Creek watersheds. There are approximately 6010 acres of potential AFO or “cattle-in-the-creek” sites located throughout the Upper and Middle Rock Creek watersheds; this figure excludes cultivated land where animal manure may have been land applied or where cattle may be grazing crop residues along streams and rivers.

Table 1. Land use/ land cover composition of Upper and Middle Rock Creek watershed. Total land use/ land cover was calculated for the entire drainage area (indicated as “Total” in the accompanying table) and buffer land use/ land cover was calculated as the land area located within 100 feet of all drainages, streams and rivers, as defined by the U.S. Geological Survey National Hydrography Dataset (NHD) (i.e., indicated as “Buffer” in the accompanying table).

a) Upper Rock Creek watershed only.

Upper Rock Creek	Total		Buffer	
	<i>Area (acres)</i>	<i>%</i>	<i>Area (acres)</i>	<i>%</i>
Developed	1261.3	4.0	190.7	3.2
Riparian Forest	3317.6	10.5	1613.2	26.8
Grassland/ Pasture	24344.5	77.3	3579.5	59.4
Cultivated	2317.9	7.4	459.7	7.6
Wetland/ Water	266.3	0.8	183.6	3.0
Total	31507.7	100.0	6026.8	100.0

b) Middle Rock Creek watershed only.

Middle Rock Creek	Total		Buffer	
<i>Land Use/ Land Cover</i>	<i>Area (acres)</i>	<i>%</i>	<i>Area (acres)</i>	<i>%</i>
Developed	868.1	3.4	159.8	3.4
Riparian Forest	3061.3	12.1	1486.1	31.6
Grassland/ Pasture	17993.0	71.1	2430.4	51.6
Cultivated	2976.4	11.8	445.9	9.5
Wetland/ Water	406.8	1.6	183.8	3.9
Total	25305.5	100.0	4706.1	100.0

c) Pottawatomie County State Fishing Lake No. 1 only.

Pott. Co. Fishing Lake #1	Total		Buffer	
<i>Land Use/ Land Cover</i>	<i>Area (acres)</i>	<i>%</i>	<i>Area (acres)</i>	<i>%</i>
Developed	47.8	6.1	6.9	5.4
Riparian Forest	138.5	17.8	39.3	30.6
Grassland/ Pasture	564.6	72.7	70.0	54.5
Cultivated	3.6	0.5	0.0	0.0
Wetland/ Water	22.7	2.9	12.2	9.5
Total	777.2	100.0	128.5	100.0

d) Cumulative area for Upper and Middle Rock Creek watersheds.

Cumulative Area	Total		Buffer	
<i>Land Use/ Land Cover</i>	<i>Area (acres)</i>	<i>%</i>	<i>Area (acres)</i>	<i>%</i>
Developed	2129.4	3.7	350.6	3.3
Riparian Forest	6378.9	11.2	3099.3	28.9
Grassland/ Pasture	42337.5	74.5	6009.9	56.0
Cultivated	5294.3	9.3	905.7	8.4
Wetland/ Water	673.1	1.2	367.5	3.4
Total	56813.2	100.0	10732.9	100.0

Figure 3 presents assessment results determined by visual inspection of 2006 NAIP imagery. Landscape images were thoroughly inspected (close-up examination at variable scales down to individual stream reaches) for indicators of livestock operations within close proximity to streams and rivers. Characteristic indicators used to hone in on potential “cattle-in-the-creek” sites included evidence of denuded or de-vegetated land and/or the presence of homesteads and outbuildings, animal pens, farrowing houses, waste stabilization lagoons or ponds, irregular or peculiar breaks in riparian forest or grassland, watershed ponds, etc. located on or within close proximity to drainages, streams and rivers throughout the watershed. One hundred and thirty

five (135) potential animal feeding operation (AFO) sites were identified throughout the Upper and Middle Rock Creek watersheds. As visual inspection of NAIP imagery was based on a single, seasonal image for this assessment and the ability to identify loafing, feeding or wintering activities located in dense riparian forest is limited, the potential for additional AFO sites in the Upper and Middle Rock Creek watersheds is highly likely. Further, there is a distinct likelihood that some AFO sites have been misidentified and potential loafing, feeding or wintering activities associated with livestock either are not present at an identified site or no longer exist at present as identified using the 2006 imagery. Field validation of a subset of identified sites throughout the extent of both watersheds indicated a high degree of compatibility between assessment results and field observations, providing a reasonable degree of confidence that the majority of identified sites have high to very high potential of being an actual AFO site. Implementation of best management practices (BMPs) for grazing operations is highly recommended at these sites and in their vicinity. Fencing or behavioral modifications for improved livestock management are suggested to reduce FCB inputs delivered by overland flow or direct defecation in streams and rivers.

Other AFO and animal waste lagoon systems located within close proximity to streams and rivers (generally 100 feet unless otherwise defined by assessor) were also identified during the assessment. Overflow of waste lagoons during high flow or runoff conditions (i.e., periods of high precipitation or runoff from inundated soil following a consistent supply of precipitation) represent potential pathways for FCB delivery to streams and rivers. Any AFO facility with an animal unit capacity of 300 or more, or any facility that presents a significant water pollution potential, must register with the Kansas Department of Health and Environment (KDHE). Any facility with an animal unit capacity of 1,000 or more must obtain a Livestock Waste Management Permit. AFOs registered with the KDHE represent potential known sources of nutrients and FCB, but these operations are supposed to be managed according to KDHE regulations and permit requirements, and accordingly, may be subject to monitoring and inspection to ensure compliance.

All municipal waste water treatment lagoons were identified during this assessment and are presented in Figure 3; the only waste stabilization ponds within the Upper and Middle Rock Creek watersheds are located southeast of Westmoreland, Kansas. Potential sources of FCB that were not addressed during this assessment were failing septic tanks, land-applied manure or sewage sludge, and wildlife; their contributions to Rock Creek and its drainages are not fully understood at present.

Pottawatomie County State Fishing Lake No. 1 (Pott. Co. SFL-1) and its watershed drainage were specifically evaluated as part of the assessment of the Upper Rock Creek watershed to determine sources of nutrients contributing to eutrophication of and dissolved oxygen levels in the recreational water body (i.e., fishing and/or other recreational uses). Pott. Co. SFL-1 has consistently been placed on the Kansas Section 303(d) List of Impaired Surface Waters and was deemed a specific focus area for this assessment.

Pott. Co. SFL-1 is a relatively small, headwater drainage totaling 777 acres in the upper northwest portion of the greater Upper Rock Creek watershed, representing a total area of 31,508 acres. Figure 4 presents the land use composition of the Pott. Co. SFL-1 drainage, which is almost predominantly grassland/prairie (72.7%), mixed forest (17.8%) and developed land (6.1%). Most of the forested and developed area in the fishing lake drainage is managed by the

Kansas Department of Wildlife and Parks as part of its state park system. The area of the fishing lake is approximately 24 acres in extent, with lake levels dependent on hydrologic inputs. Two potential AFOs and approximately 70 acres of grassland/ pasture are located within 100 feet of drainages, streams and rivers in the drainage area; a large proportion of the 70 acre area are suspected to be ephemeral drainages or streams where cattle have direct access to them. Field reconnaissance confirmed the presence of at least two (2) AFOs in the fishing lake drainage, but positive discovery related to direct access of cattle to forested riparian drainages for wintering, loafing or water sources could not be made without interviewing the landowner or touring the respective properties. At least eight (8) watershed dams could be identified in the drainage area through visual analysis of imagery and likely represent the major source of water for AFOs. As there is no cropland in the drainage at present, nutrient loading to the fishing lake either has originated or is originating from runoff or direct deposition of manure into drainages and streams flowing into the fishing lake, has emanated from an outside source (e.g., historical treatment of the fishing lake with nutrient additions to increase vegetation to improve fish habitat), or may represent a combination of the two possibilities. There is evidence of terracing in two locations in the drainage as well, so a portion of the nutrients could have originated from historical cropping practices and may have been deposited in lake sediments over time. Nutrients delivered to the fishing lake could be potentially remobilized by lake mixing or overturns as a result of natural (e.g., spring and autumnal overturns) or artificial processes (e.g., aeration of the fishing lake to improve fish management). Determining the actual source of nutrients to the fishing lake would require additional research and would likely include sampling or coring of lake bottom sediments and monitoring nutrient runoff from AFOs to drainages and streams supplying the fishing lake. Such an assessment should likely consider seasonal, livestock flushes of nutrients to the fishing lake and evaluation of the timing of runoff events and flushes with the occurrence of eutrophic conditions in the fishing lake.

Figure 4 presents a summary of all water quality information presented in Figures 2 and 3 for the Pottawatomie County SFL-1 drainage area.

Addendum assessment of potential riparian restoration sites, operationally defined as all cultivated and developed land use/ land cover occurring within 100 feet of drainages, streams and rivers.

Assessment of potential large stream projects (i.e. potential failing or unstable banks), operationally defined as greater than 500 feet in extent (i.e., length or linear feet of stream) and located along the main stem of Rock Creek.

Total potential acreage for riparian restoration was calculated as all of the cultivated and developed land area located within 100 feet of all drainages, streams and rivers (Figure 2; Table 1). In Figure 2, cultivated land within the 100 feet buffer distance was coded in yellow and developed land was coded in purple. Riparian restoration should include both the restoration of native grasses and trees located along streams and creeks, and potentially wetland conditions where they might have previously existed. Restoration emphasis should likely be focused on combinations of historical native vegetation, with upland areas supporting more grasses and lower reaches supporting greater extents of deciduous and mixed growth riparian forest. There

are 1256 acres of potential riparian restoration sites in the Upper and Middle Rock Creek watersheds (Table 2).

Table 2. Potential riparian buffer restoration sites in the Upper and Middle Rock Creek watersheds.

Riparian Buffer Sites	Total (Acres)
Cultivated	905.7
Developed	350.6
Total	1256.3

Figure 5 presents a breakdown of linear feet of streambank stabilization projects located along the main stem of Rock Creek in the Upper and Middle Rock Creek watersheds. Projects are differentiated into two categories: 1) streambank stabilization projects greater than 500 linear feet and 2) major streambank stabilization projects less than 500 linear feet.

Present draft and completed assessment to the WRAPS Leadership Team and local watershed group.

The preliminary results of this watershed assessment were presented to a subgroup of the Rock Creek Watershed Planning Group on February 12, 2008, at the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) office in Westmoreland, Kansas. The subgroup took a field tour of the watershed to validate preliminary assessment results and to “calibrate” and revise assessment methodologies. The subgroup consisted of the following individuals: John Bond (KAWS), Jeff Neel (Blue Earth), Bob Lienemann (NRCS), Tom Stiles (KDHE), Deb Baker (Kansas Water Office), Dennis Schwant (Rock Creek Watershed District No. 45. and local landowner), Janice Plummer (NRCS), and Rick Davis (Middle Kansas WRAPS coordinator). Preliminary results of this assessment were also presented to the Wakarusa WRAPS Planning Group on February 20, 2008, at the request of John Bond and Tom Huntzinger; the purpose of this presentation was to demonstrate potential applications of this assessment approach in other priority watersheds. An additional field tour to further validate and ground truth assessment results was completed by John Bond (KAWS), Jeff Neel (Blue Earth) and Bob Lienemann (NRCS) on March 20, 2008. Final results of this assessment will be presented to the Middle Kansas WRAPS Group at a future date.

Prepare a summary of potential needs for BMP implementation including the following:

- Linear extent of stream or river banks reported as greater than 500 feet of bank failure or instability;

Table 3. Extent of potential streambank stabilization sites (linear feet) in the Upper and Middle Rock Creek watersheds.

Streambank Stabilization	Total (Feet)	Mean Size	Std Error
Projects > 500 Feet	43199.4	881.6	86.4
Projects < 500 Feet	14710.1	377.2	15.2
All Projects	57909.5	658.1	30.6

- Potential riparian buffer sites summarized as total acres;

Table 2. Extent of potential riparian buffer restoration sites (area in acres) in the Upper and Middle Rock Creek watersheds.

Riparian Buffer Sites	Total (Acres)
Cultivated	905.7
Developed	350.6
Total	1256.3

- Potential animal waste or “cattle-in-the-creek” sites located within 100 feet of stream or river, operationally defined as all grassland/ pasture or cultivated land use within 100 feet of stream or river, and reported as total acres.

Table 4. Extent of potential animal feeding operation sites (area in acres) in the Upper and Middle Rock Creek watersheds.

Potential AFO Sites	Total (Acres)
Grassland/ Pasture	6009.9
Cultivated	905.7
Total	6915.6

The majority of potential sites where cattle have access to drainages, streams and rivers are likely comprised of grassland/ pasture units located within 100 feet of surface water features. Cultivated land where crop residue may be grazed or manure may be land-applied represents a minor concern as a source of FCB, but is included in the above table, as there is potential for this land to contribute to the FCB TMDL for Rock Creek. Cultivated land within 100 feet of streams and rivers more likely represents a priority area for riparian buffer restoration and streambank stabilization sites and probably does not represent a notable contribution to FCB loading.

One hundred and thirty five (135) specific, potential animal waste or “cattle-in-the creek” sites were identified through visual examination of NAIP imagery and are presented in Figure 3.

Addendum Assessment of Slope and Cultivated Land in Upper and Middle Rock Creek Watersheds

Figure 6 was added to this report as a deliverable addendum per the request of NRCS and presents an analysis of slopes for all cultivated land within 100 feet of drainages, streams and rivers. Cultivated lands with high slopes represent potential streambank and riparian restoration sites along the main stem of Rock Creek.

Figures