MISSOURI RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody/Assessment Unit: Wolf River
Water Quality Impairment: Biology

1. INTRODUCATION AND PROBLEM IDENTIFICATION

Subbasin: Tarkio - Wolf

Counties: Atchison, Brown, and Doniphan

HUC 8: 10240005

Ecoregion: Western Corn Belt Plains [Nebraska/Kansas Loess Hills (47h), Loess and Glacial Drift Hills (47i)]

Drainage Area: 247.8 square miles

Main Stem Segments: WQLS: 53, 54 and 56; starting at the state line and traveling upstream to headwaters in central Brown County (**Figure 1**).

Tributary Segments:
Coon Cr (71)
Striker Branch (72)
Rittenhouse Branch (69)
Cold Ryan Branch (70)
Halling Cr (68)
Unnamed Stream (55)
S. Fork Wolf River (57)
Middle Fork Wolf River (67)
N. Fork Wolf River (66)

Designated Uses: Expected Aquatic Life Support, Primary Contact Recreation; Domestic Water Supply; Food Procurement; Ground Water Recharge; Industrial Water Supply Use; Irrigation Use; Livestock Watering Use for Main Stem Segments.

Expected Aquatic Life Support and Secondary Contact Recreation on all tributary segments. Domestic Water Supply; Ground Water Recharge; Industrial Water Supply Use and Irrigation Use for Unnamed Stream, and North Fork, South Fork and Middle Fork of Wolf River. Food Procurement and Livestock Watering Use for North Fork, South Fork and Middle Fork of Wolf River.

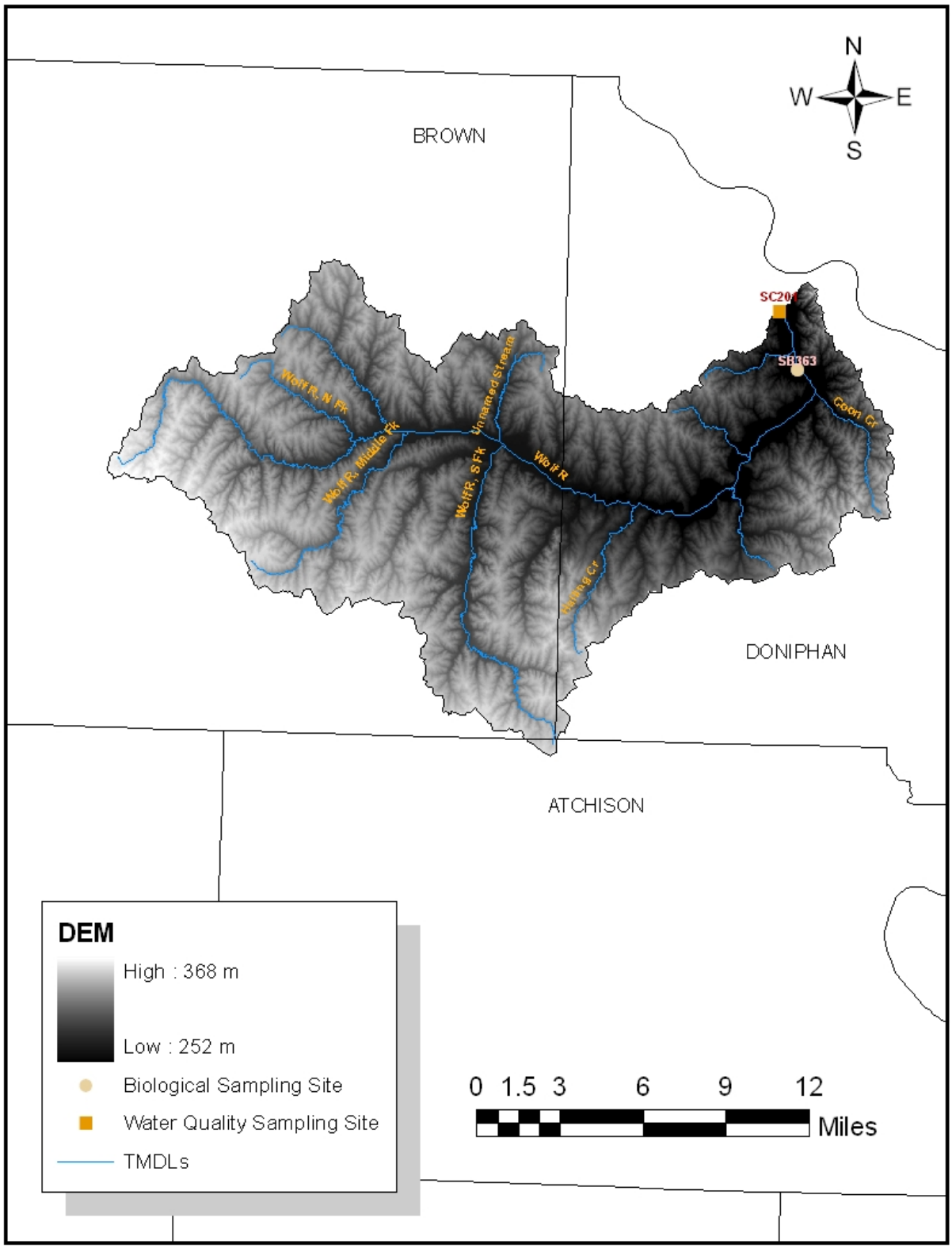

Figure 1. DEM, biological and water quality monitoring stations, and USGS gaging station in Wolf River Watershed.

2004, 2006, 303(d) Listing: Missouri River Basins – Wolf River, Main Stem Segments (53, 54, and 56)

Impaired Use: Expected Aquatic Life Support on Main Stem Segments

Water Quality Standard: Suspended solids – Narrative: Suspended solids added to surface waters by artificial sources shall not interfere with the behavior, reproduction, physical habitat or other factor related to the survival and propagation of aquatic or semi-aquatic or terrestrial wildlife. (KAR 28-16-28e(c)(2)(B)).

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 2006 303(d): Not Supporting Aquatic Life

Monitoring Site: Biological Monitoring Station (SB363) and Permanent Ambient Stream Water Quality Monitoring Station (SC201).

Period of Record Used: Biology (SB363): 1999 – 2005 (6 biological samples); Water Quality (SC201): bimonthly from 1990 to 2005.

Flow Record: Wolf River at Sparks (USGS Gaging Site 06815900) 1968-2000; Delaware River near Muscotah (USGS Station 06890100) 1969 – 2005.

Long Term Flow Conditions: Estimated Median Flow = 39.6 cfs, 7Q10 = 1 cfs, 10% Exceedance Flow = 178 cfs, 95% Exceedance Flow = 11 cfs.

Current Conditions: Biological criteria for stream health in Kansas are based on multi-metric indices: (1) Macroinvertebrate Biotic Index (MBI) developed to assess the impact of oxygen demanding nutrients and organic enrichment on macroinvertebrate populations; (2) Kansas Biotic Index (KBI) developed specifically for Kansas insects (10 orders) to address potential impairment associated with nutrient oxygen demand; (3) EPT index is the portion of aquatic taxa present within a stream belonging to three pollution intolerant orders [Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies)] – the presence of greater numbers of these species is considered indicative of higher water quality because these macroinvertebrates use coarse substrates as habitats; and (4) % EPT Abundance is the percentage of all individuals collected belonging to these three orders. **Table 1** shows average index values from 1999 to 2005 and their associated criteria for SB363.

Table 1. Multi-Metric indices for Biological Monitoring Station SB363 in 1999 – 2005.

Biological Index	Average	Fully Supporting	Partially Supporting	Non-Supporting
MBI	4.85	$\leq$ 4.5	4.51 – 5.39	$\geq$ 5.4
KBI	2.76	$\leq$ 2.6	2.61 – 2.99	$\geq$ 3.0
EPT	15	$\geq$ 13	8 – 12	$\leq$ 8
%EPT	46	$\geq$ 48	31 – 47	$\leq$ 30

For this stream segment, average MBI, KBI, and %EPT values indicate that aquatic life support is partially impaired, while average EPT shows that aquatic life support is fully supported. To holistically address aquatic support, these biological indices were integrated according to 305(b) methodology, with the exception of %EPT index. The exclusion of %EPT index in this biological assessment was because its individual values were highly correlated with EPT values (Table 2) and the metric itself does not measure diversity of community structure.

Table 2. Correlation of the multi-metric indices for Biological Monitoring Station SB363.

Biological Index	MBI	KBI	EPT	%EPT
MBI	1			
KBI	0.944	1		
EPT	-0.776	-0.756	1	
%EPT	-0.945	-0.949	0.808	1

Note: A correlation is a number between 0 and ± 1 that describe the degree of relationship between two variables. A large number value indicates a close relationship. A minus sign indicates a negative relationship between the variables.

Table 3 shows average nutrient (NH_3-N, NO_3-N, organic N, and total P) and biological oxygen demand (BOD) and total suspended solids (TSS) concentrations in SC201. As compared to a relatively less impacted, full-supported biological site (SB529), BOD, organic material, NO_3-N, and, in particular, TSS are considered the main sources for biological impairment for SB363. Average MBI, KBI, EPT, and %EPT values for Station SB529 were 4.31, 2.74, 13, and 54%, respectively. As indicated earlier that the EPT groups like to utilize coarse substrates as habitats in the stream. Excess amount of TSS load deposited on the substrates at Station SB234 imposes a great physical threat to their living conditions. According to the 2006 KDHE 305(b) report, siltation and nutrient enrichment are the key factors contributing to the degradation of stream biological communities. **Table 4** shows average nutrient and TSS concentrations for the composite index groups (> 1.5 and ≤ 1.5) at the streamflow values less than 100 cfs (or flow exceedance > 19%), which they are representative of the typical stream conditions in Wolf River.

Table 3. Comparison of average nutrient and sediment concentrations for Water Quality Monitoring Stations SC201 and SC529.

Station Name	Station ID	BOD mg/L	NH_3-N mg/L	NO_3-N mg/L	Organic N mg/L	Total P mg/L	TSS mg/L
Wolf R. near Sparks	SC201	2.94	0.09	3.51	0.75	0.31	224
Chikaskia R. near Corbin	SC529	2.35	0.05	1.18	1.07	0.23	172

Table 4. Comparison of average nutrient and sediment concentrations for Water Quality Monitoring Stations SC201 (Full support: 1999, 2001 and 2005; Partial/Non-support: the remainder of the water quality records).

Composite Index	Biological Status	BOD mg/L	NH_3-N mg/L	NO_3-N mg/L	Organic N mg/L	Total P mg/L	TSS mg/L
> 1.5	Partial or Non-support	2.82	0.08	2.52	0.71	0.22	81
≤ 1.5	Full Support	2.08	0.07	3.83	0.64	0.19	38

Note: To derive composite index values, the number of 1, 2, and 3 were assigned to full support, partial support, and non-support, respectively, and then these numeric values were averaged based on MBI, KBI, and EPT.

Figure 2 shows the annual distributions of biological indices. The worst biological index values were noted in 2003 when the annual mean and median stream flow were the lowest. The

relationship of the composite index to the annual median flow is shown in **Figure 3**. The composite biological index values corresponded well with the annual median flow. As annual median flow decreased, the index values increased accordingly, indicating that biological communities were under stress when streamflow decreased.

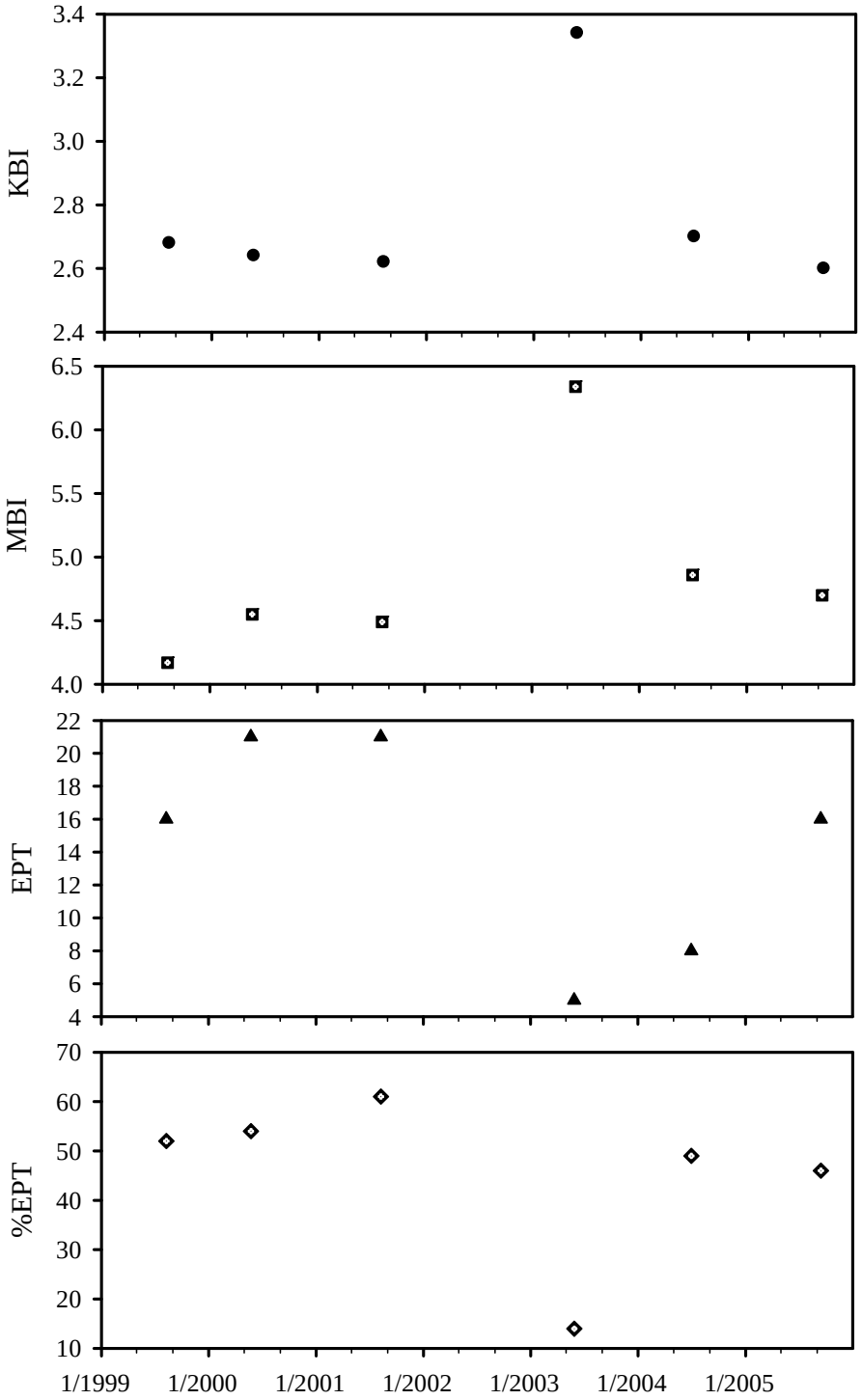

Figure 2. Distribution of biological indices for SB363 during 1999 – 2005.

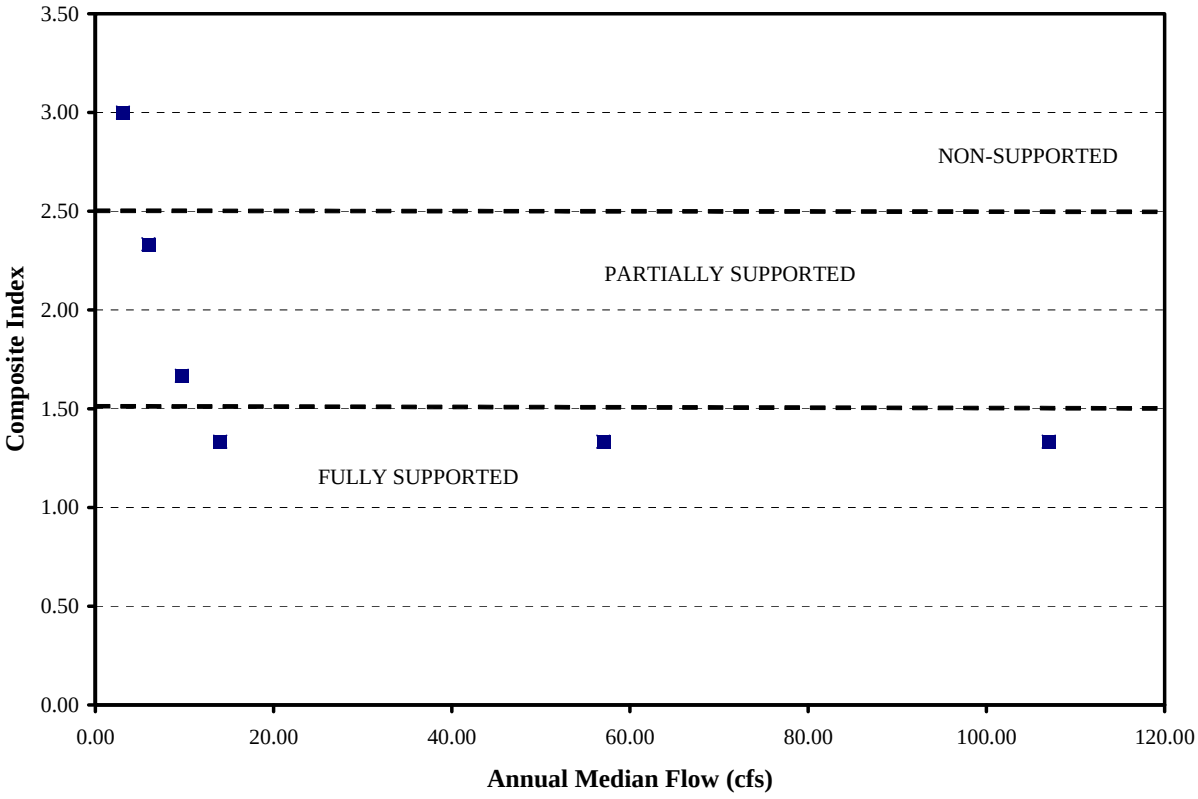

Figure 3. Plot of composite index in relation to annual median flow at SB363 during 1999 – 2005.

Desired Biological Endpoint for Wolf River at Biological Monitoring Station 363:

The use of multiple biological indices allows assessment of the cumulative impacts of dynamic water quality on aquatic communities present within the stream. As such, these index values serve as a baseline of biological health of the stream. Sampling occurs during open water season (April to November) within the aquatic stage of the life cycle of the macroinvertebrates. As such there is no described seasonal variation of the desired endpoint of this TMDL. The endpoint would be average composite value of 1.49 or less, based on KBI, MBI, and EPT, over 2008 – 2012.

Achievement of this endpoint would be indicative of full support of the aquatic life use in the stream reach. The paired watershed assessment approach is adopted and thus SB529 (Chikaskia River) serves as a biological benchmark to determine the desirable biological endpoint for SB363. The narrative water quality standards of suspended solids derived from SB529 may therefore be placed on Wolf River Watershed. While this narrative water quality standard pertaining to suspended solids is utilized by this TMDL, there is no direct linkage between composite index values and suspended solids levels. A number of factors, including drought conditions and habitat and stream modifications, may contribute to the occasional excursion in index values above 1.5. As a result, the link between composite index values and suspended solids levels on Wolf River remains qualitative at this phase of the TMDL.

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: Originally there were four NPDES permitted wastewater dischargers within the watershed. These systems are outlined in **Table 5**. The city of Hiawatha has converted the two old plants to a single treatment facility (activated sludge with UV disinfection) and discharged its effluent to the North Fork the Wolf River (stream segment 66) with initial operation in the fourth quarter of 2005, and achieved compliance with final effluent limitations on February 1 2006. As a result, there are three NPDES permitted wastewater dischargers within the watershed. Population projections for Hiawatha and Robinson to the year 2020 indicates slight to moderate growth (5% and 45% increase, respectively). Population projections for Willis indicate slight declines. Projections of future water use and resulting wastewater appear to be within the design flow for each of the current systems' treatment capacity. The excursions from the water quality standards appear to occur under a variety of flow conditions but particularly under the higher flows associated with runoff events in the Spring and Summer/Fall seasons. Of significance to point sources are the excursions under low flow in all seasons, indicating that point sources may have impacts (e.g., nutrient enrichment and ammonia toxicity) on macroinvertebrate communities in the stream.

In 1987, a biological study was conducted by KDHE Environmental Field Services. Several monitoring sites were established to collect chemical and biological samples as well as toxicity test samples in September, 1987 (**Figure 4**). The results of this study showed that macroinvertebrate community composition at the first site, 0.25 mile below the Hiawatha South WWTP, was moderately affected by the effluent (**Table 6**). No biological impacts were observed at the sampling site 1.25 miles below the Hiawatha North WWTP. However, toxicity tests indicated that a potential threat of ammonia toxicity to aquatic life from the North WWTP was noted. Despite these WWTP-related biological impacts, the Wolf River seemed to recover quickly and no residual effects, including toxic effects, were observed at the sampling site 3 miles downstream from the South WWTP.

Table 5. Municipal wastewater treatment plants (WWTPs) and their associated mean effluent ammonia (NH_3) and TSS concentrations ($\pm$ standard deviation) during 2004 – 2005 (Hiawatha New South plant in 2006). Permitted monthly TSS concentrations are 30 mg/L for Hiawatha (North, South, and Upgraded) WWTPs and 80 mg/L for Robinson and Willis WWTPs.

WWTP Facility	NPDES #	Stream Reach	Designed Flow	NH_3 (mg/L)	TSS (mg/L)	Type	Expired Date
Hiawatha, North†	KS0023698	Wolf R via unnamed trib.	1.1 mgd	8.04 ($\pm$5.11)	15.5 ($\pm$23.2)	Mech.	10/31/2008
Hiawatha, South†	KS0080667	N.F. Wolf R.	0.95 mgd	4.42 ($\pm$2.02)	4.3 ($\pm$1.4)	Mech.	10/31/2008
Hiawatha, New South	KS0096440	N.F. Wolf R.	0.85 mgd	2.94 ($\pm$6.38)	3.8 ($\pm$2.7)	Mech.	12/31/2008
Robinson	KS0047546	Wolf R.	0.072 mgd	--	25 (--)	Lagoon	6/30/2008
Willis	KS0092037	M.F. Wolf R. via Hazel Cr.	0.010 mgd	4.03 ($\pm$4.33)	38.3 ($\pm$4.2)	Lagoon	12/31/2008

(† indicates that *the operations of both Hiawatha North and South WWTPs were abandoned in March 2006.*)

Table 6. Comparison of multi-metric biological indices and water chemistry data measured in an unmanned tributary, North Fork Wolf River, and Wolf River during 1987.

Biological Index	SB409	SB449	SB450	SB451	SB452	SB453	SB454	SB455
	Wolf R.	Unnamed	Unnamed	N.F. Wolf	N.F. Wolf	N.F. Wolf	N.F. Wolf	Wolf R.
MBI	4.37	4.93	4.40	6.01	6.64	4.80	4.94	4.33
KBI	2.50	3.01	2.55	3.33	3.41	2.59	2.84	2.55
EPT	12	8	16	0	0	8	8	14
%EPT	31	27	66	0	0	31	47	51
Water Chemistry								
Total NH_3 (mg/L)	0.02	0.16	0.05	0.07	1.42	ND	-	ND
NO_2+NO_3 (mg/L)	4.0	7.6	4.1	3.2	7.2	4.2	-	3.5
BOD (mg/L)	5.1	9.0	7.5	3.3	8.1	3.0	-	4.6
DO (mg/L)	8.3	6.3	8.0	7.9	6.7	7.8	-	7.5

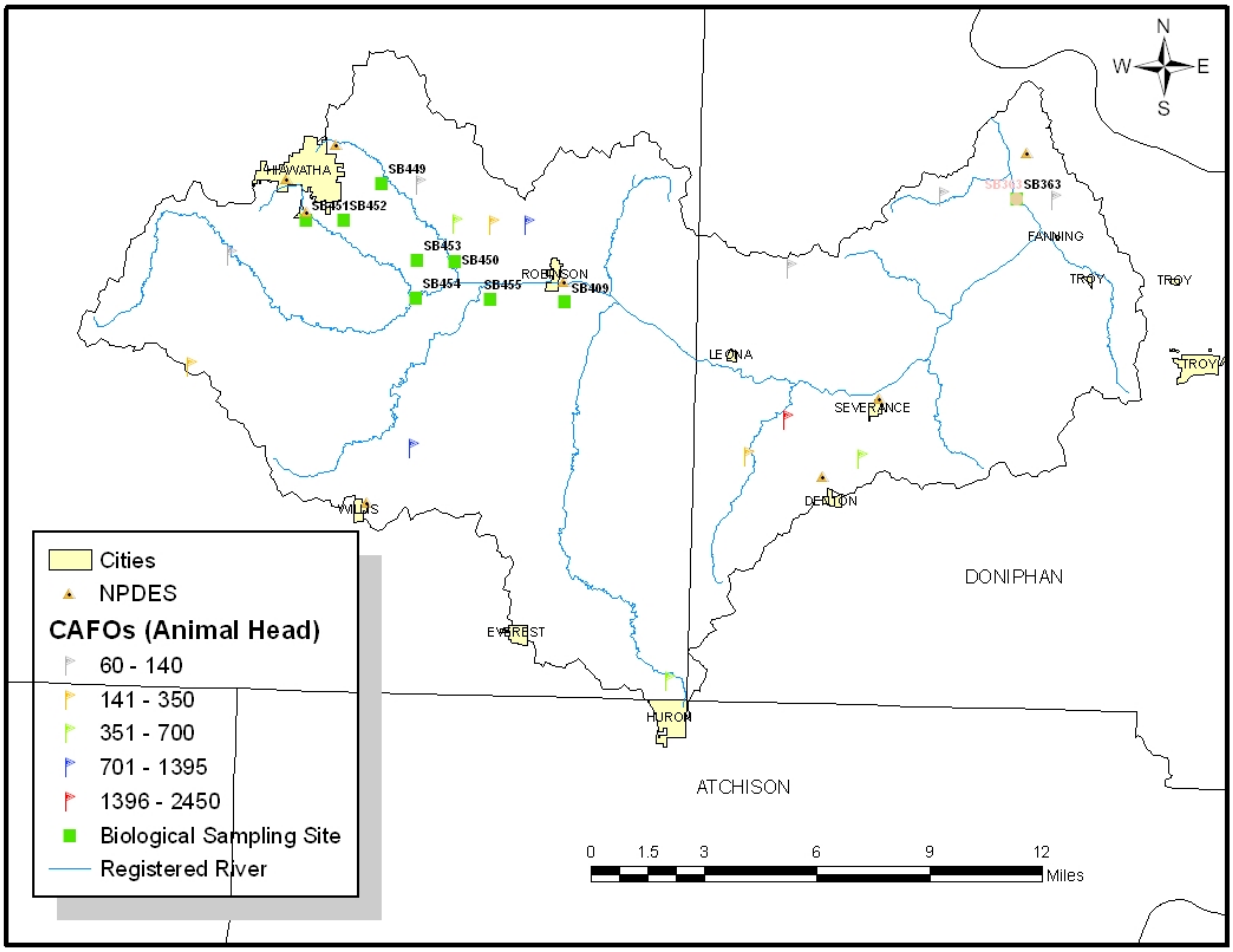

Figure 4. NPDES and CAFO sites and biological sampling sites in Wolf River Watershed.

Livestock Waste Management Systems: Fourteen active operations are either certified (6) or permitted (8) within the watershed (**Figure 4**). These facilities are either swine, dairy, or beef. Most of these facilities are evenly distributed across the upper two thirds of the watershed. Potential animal units for all facilities in the watershed total 7,893. The actual number of animal units on site is variable, but typically less than potential numbers (**Appendix A**).

All of the permitted livestock facilities have waste management systems designed to minimize runoff entering their operation or detain runoff emanating from their facilities. In addition, they are designed to retain a 25-year, 24-hr rainfall/runoff event as well as an anticipated two weeks of normal wastewater from their operations. Typically, this rainfall event coincides with streamflow that exceeds less than 1-5% of time. Events of this type, higher flows that are infrequent and of short duration, might likely contribute certain total suspended solids/sediment to Wolf River. Therefore, maintaining the water level of a waste lagoon at a sufficient level below the lagoon berm is required to ensure retention of the runoff from such intense, local storm events to prevent nutrient and sediment loads to the river.

Land Use: Based on Kansas GAP Land Cover Data, the predominant land use is cultivated cropland, which accounts for about 72% of the total land area in the watershed (**Figure 5**). Urban area, such as residential, commercial and industrial uses, comprises only less than 1% of the watershed. Approximately 12% of the land is occupied by forest. Tall grass prairie occupies approximately 4% of the watershed area. Non-native grassland and the areas under NRCS Conservation Reserve Program (CRP) are about 3.5% and 4% of the total watershed area, respectively. According to the National Agricultural Statistics Service, the estimated number of all cattle, based on the watershed area in each county, is 27,819 (13,631 and 14,188 for Brown and Doniphan Counties, respectively).

On-Site Waste Systems: The upper third of the watershed's population density is average (25 – 38 persons/sq mile) when compared to the averages for the Marais des Cygnes and Missouri Basins while the lower two thirds is low (10 – 13 persons/sq mile). The rural population projections for Brown and Doniphan Counties through 2020 indicates substantial declines (22 – 19% decrease, respectively).

According to the 1992 and 1998 summary of the onsite wastewater systems in the United States from the National Environmental Service Center (EPA Region 5), there were 1,034 septic tank systems in the two watersheds that cover the Wolf River Watershed; 448 of which were in the Brown County while the others were located in Doniphan County. Though failing on-site systems can contribute sediment and nutrients, the effects of these sediment and nutrient loads on the macroinvertebrates in the stream are likely associated with the low flow conditions

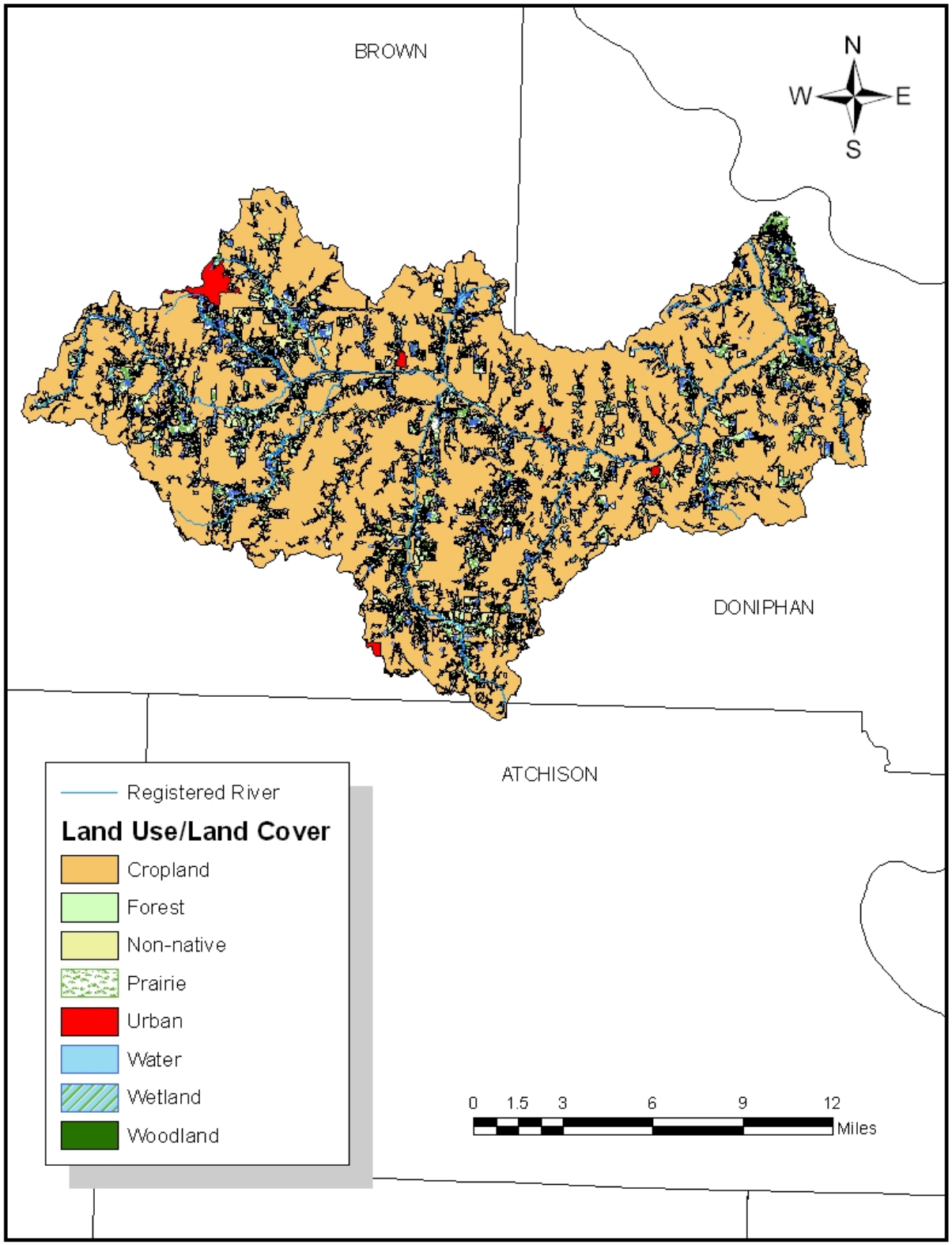

Figure 5. GAP land use and land cover types in the Wolf River Watershed.

Contributing Runoff: The Little Osage River watershed's average soil permeability is 0.9 inches/hour according to NRCS STATSGO data base. One hundred percent of the watershed produces runoff even under relatively low (1.71"/hr) potential runoff conditions. Under very low (1.14"/hr) potential conditions, this potential contributing area is reduced by almost half (54%). Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.57"/hr of rain will generate runoff from 38% of this watershed, chiefly along the stream channels and the upper third of the watershed.

Background Levels: Though the forest occupies roughly 30% of the 30-m riparian area, the total grassland (prairie and non-native grassland) accounts for 10% of the stream buffer areas, where cattle might have access to stream channels and likely contribute certain amounts of sediment and/or nutrient loads to Wolf River. Most of background levels of total suspended solids and associated organics come from natural sheet and rill erosions from overland runoff. Stream bank and bed erosions may be another important source during high flow events. In addition to sediment, drought conditions may have significant stress effects on macroinvertebrate communities. According to the USGS, the average streamflow measured at the northeast of Kansas during 2001 – 2006 is the lowest 5-year average flow in the history.

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

There is an indirect, yet un-quantified relationship between sediment loading and biological integrity. Decreased sediment loads, indicative of improved water quality, should result in better aquatic communities. The ability of biological data to integrate the various physical and chemical impacts of the entire watershed on the aquatic community defies allocation of specific suspended solid loads between point and nonpoint sources. Because biological integrity is a function of multiple factors, the initial pollution load reduction responsibility will be to decrease the average concentration of sediment over the range of flows encountered on the Wolf River.

Figure 6 shows TSS concentrations and streamflow measured at SC201 and SC529 in the Wolf and Chikaskia Rivers, respectively. For the final stage of the TMDL the desired TSS concentrations at SC201 should be set towards the TSS concentrations observed across the seasons at SC529 to improve stream habitat conditions for macroinvertebrate communities. For the interim, TSS concentration should be maintained at the biological composite index values that show the full support of aquatic community in Wolf River.

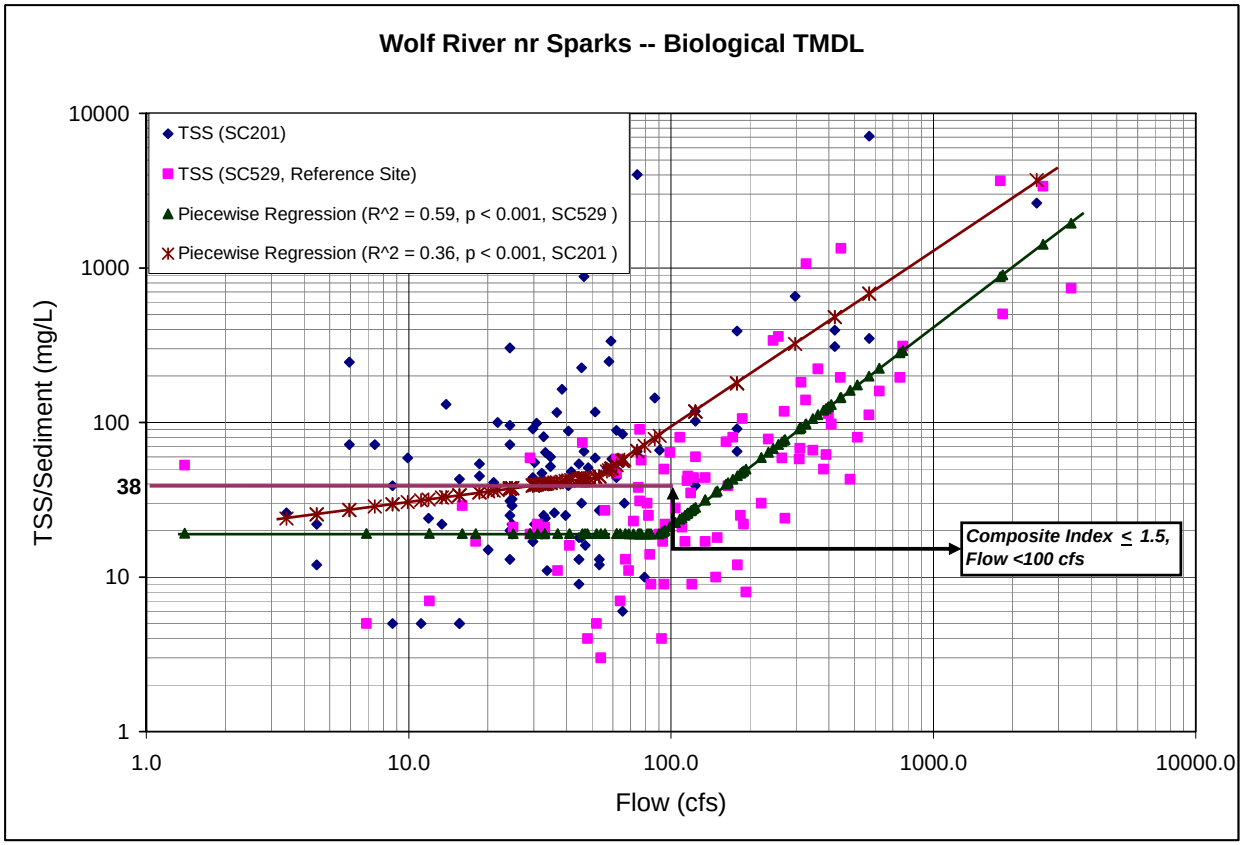

Figure 6. TSS concentrations measured at SC201 and SC529 [Reference Site (Chikaskia River)] in relation to streamflow values. TSS concentration of 38 mg/L is the interim TMDL goal developed, based on the composite index values $\leq$ 1.5 and streamflow < 100 cfs.

Point Sources: There are three NPDES dischargers in the watershed, all with permit limits for TSS. The exact loads contributed by these facilities are unknown and will need to be determined in the future through monitoring of effluent and ambient receiving streamflow. Assuming the total effluent volume (1.4 cfs, total designed flow) arrives at the monitoring site, this total flow would only constitute a flow which was exceeded 99% of the time in the Wolf River. However, the point source influence on water quality could extend to higher flows as well. Therefore, the allocation for point sources is demarcated by the area under each respective load duration curve bounded from 95% to 100% (**Figure 7**). At this stage of the TMDL, the assumed condition is maintenance of current conditions at those low flows, presuming an offset of lower loading at higher flows. The Wasteload Allocation represents the load in the stream which the point sources contribute. In most cases, this is a function of permit limits; in the case of TSS, monthly permit limits are set at 30 mg/L for Hiawatha New South WWTP and 80 mg/L for both the Robinson and Willis WWTPs. In addition, NH_3 concentrations of the effluent from the Hiawatha New South WWTP should be kept in compliance with their monthly and maximum daily discharge limits.

Should future wasteloads increase in the watershed and discharge into the impaired segments, the wasteload allocation will be revised by increasing the critical flow volume and if necessary, adjusting the current load allocation to tradeoff loads with these new point source dischargers.

Non-Point Sources: Given the runoff characteristics of the watershed, overland runoff can easily carry sediment from the watershed into the stream reaches. The composition of the watershed indicates a mixture of urban and, in particular, rural non-point sources which may contribute to the downstream impairment. Because cultivated cropland accounts for more than 70% of the entire watershed, thus the effect of channelization and the resultant sediment impact on stream macroinvertebrate communities may be evident even under slightly elevated flow. As a result, these nonpoint sources become dominant under higher flow conditions. Therefore, the area under the load duration curves bounded from 0 – 95% (**Figure 7**) constitutes the Load Allocation for this TMDL.

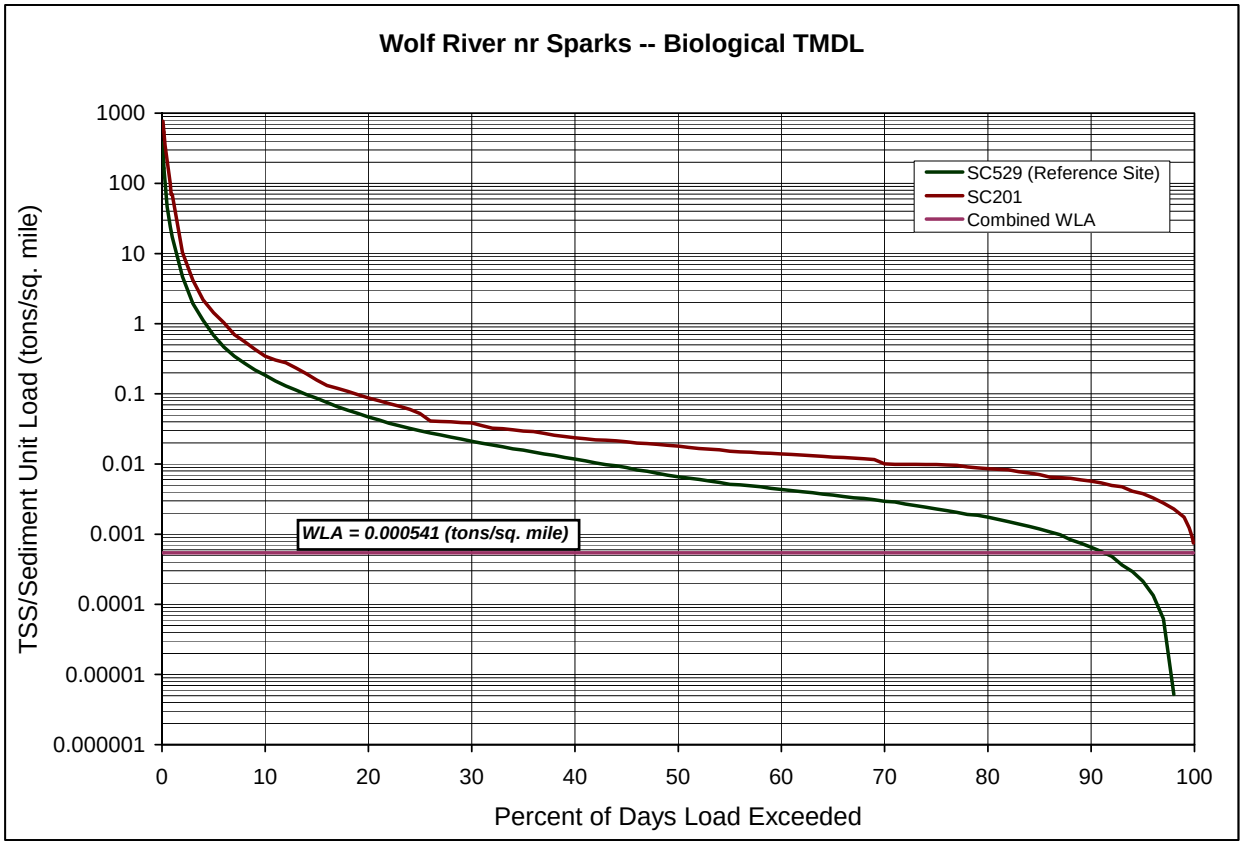

Figure 7. TSS (or sediment) unit loads for SC201 and SC529 (Chikaskia River). Combined WLA was the sum of Hiawatha, Robinson and Willis' TSS loads calculated at their designed flow capabilities and permitted TSS values.

Figure 8 shows the TSS (sediment) TMDL, based on the Reference Site SC529, and seasonal sediment loads measured at SC201 during 1990-2005. Ultimate Load Allocations are listed in **Table 7**. The ultimate Load Allocations were the differences between the SC201 and SC529 TSS loads calculated, based one their regression lines in **Figure 6**. The individual Wasteload Allocations for three WWTPs and CAFOs are listed in **Appendix A**.

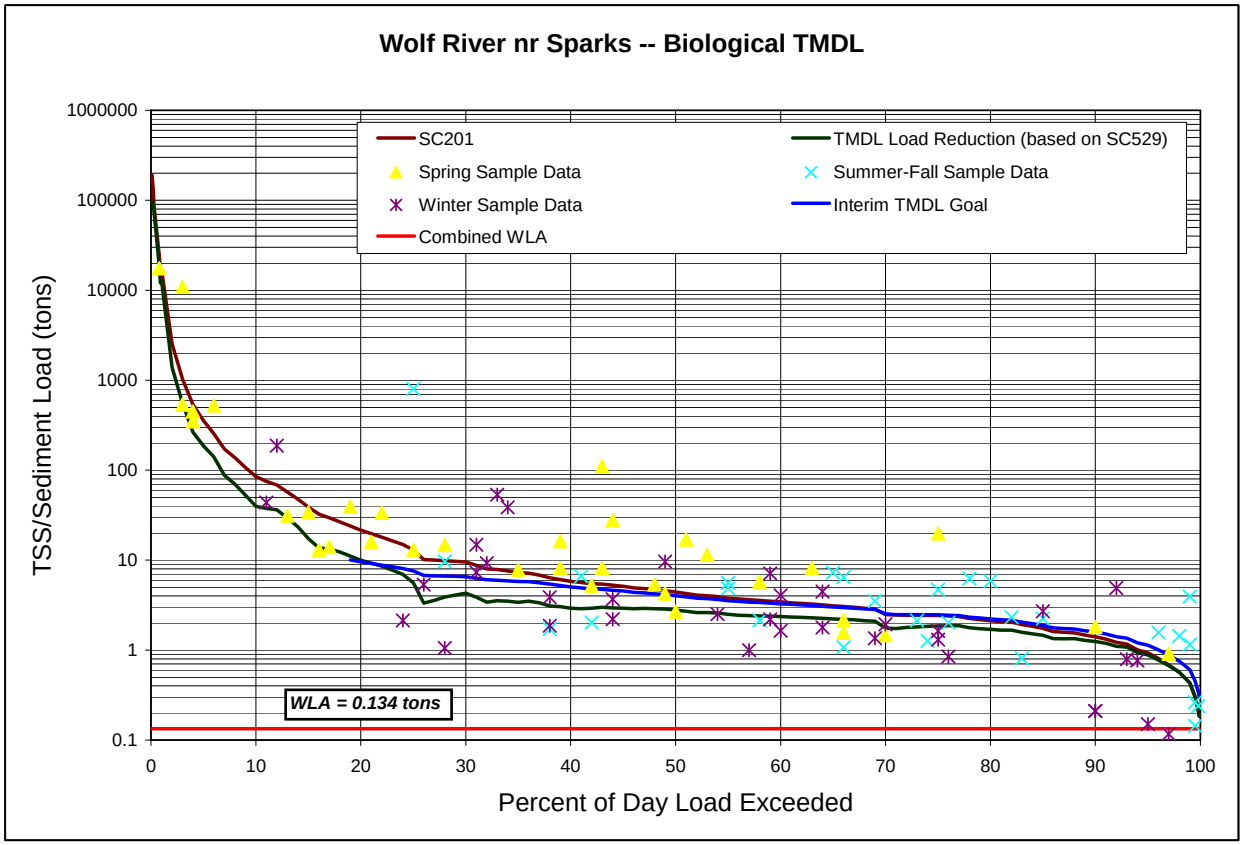

Figure 8. Biological TMDL for Wolf River near Sparks, with seasonal loading at SC201 during 1990-2005 (Spring = Apr – Jul, Summer – Fall = Aug – Oct; Winter = Nov – Mar).

Table 7. Daily TSS Load Allocations and their associated load reductions calculated for Wolf River at SC201 based on the reference site data (SC529).

Flow Exceedance (%)	Estimated Flow (cfs)	Ultimate Load Allocation (tons/day)	Ultimate TSS Reduction (tons/day)
90	15.6	0.2	1.3
80	21.8	0.4	1.7
70	24.8	0.7	1.8
60	32.2	1.1	2.4
50	39.6	1.6	2.8
40	49.6	2.9	2.9
30	64.4	5.2	4.3
20	94.2	11.6	10.0
10	178.4	45.4	39.7

Defined Margin of Safety: The calculation and use of multiple biological metrics provides a margin of safety that aquatic life support has been fully attained, and the designated use has been restored. A consistently compliant suite of scores for KBI, MBI, and EPT indices will be regarded as the requisite criteria for this TMDL. Fully supporting scores for these metrics will stand as evidence that plant nutrients entering the river from artificial sources have been

controlled and are preventing the accelerated succession or replacement of aquatic biota and the production of undesirable quantities or types of aquatic life.

State Water Plan Implementation Priority: Because the Wolf River is a major tributary to the Missouri River and the biological impairment on the Wolf River indicates a baseline of non-support of the designated use based on the recent state 305(b) report, this TMDL will be a High Priority for implementation.

United Watershed Assessment Priority Ranking: This watershed lies within the Tarkio-Wolf Subbasin (HUC 8: 10240005) with a priority of 13 (Highest Priority for restoration work).

5. IMPLEMENTATION

Desired Implementation Activities

1. Implement and maintain conservation farming, including conservation tilling, contouring strips and no till farming to reduce suspended solids loads from tributaries to Wolf River.
2. Improve riparian conditions along stream systems by installing grass and/or forest buffer strips to trap suspended solids, and reduce livestock activities within riparian areas to reduce stream bank erosion.
3. Install pasture management practice, including proper stock density, to reduce soil erosion and storm runoff.
4. Minimize road and bridge construction impacts on streams.
5. Monitor wastewater discharges for excessive suspended solids loadings.
6. Incorporate this TMDL into the Missouri River Basin WRAPS projects.

Implementation Programs Guidance

NPDES - Municipal Program – KDHE

a. Monitor effluent from wastewater treatment plants to determine their suspended solids and nutrient contributions.
b. Ensure proper monitoring, permitting, and operations of municipal wastewater systems to reduce suspended solids and nutrient discharges.

Watershed Management Program – KDHE

a. Develop a Watershed Restoration and Protection Strategy project for the Missouri River Basin to target Wolf River's sediment issue.
b. Provide technical assistance on management practices geared to livestock operations which minimize their impact to stream channels.
c. Provide technical assistance on pesticide management to minimize agrochemical impact aquatic organisms, and vegetative buffer development in the vicinity of the stream.

Environmental Field Services – KDHE

a. Work with the Department of Wildlife and Parks and the State Biological Survey to evaluate stream habitat and other environmental factors affecting aquatic communities throughout Wolf River.

Livestock Waste Management Program – KDHE

a. Ensure waste lagoons for animal feeding operations have adequate capacity to minimize spills during wet seasons.

Water Resource Cost Share & Non-Point Source Pollution Control Programs - SCC

a. Apply conservation farming practices, including terraces and waterways, sediment control basins, and constructed wetlands within the watershed.
b. Provide sediment control practices to minimize erosion and sediment and nutrient transport from cropland and grassland in the watershed.

Riparian Protection Program - SCC

a. Establish or restore natural riparian systems, including vegetative filter strips and streambank vegetation along Wolf River and its tributaries.
b. Develop riparian restoration projects along targeted stream segments, especially those areas with baseflow.
c. Promote wetland construction to reduce runoff and assimilate sediment loadings.
d. Coordinate riparian management within the watershed.

Buffer Initiative Program - SCC

a. Install vegetative buffer strips along Wolf and its tributaries.
b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of agricultural production

Time frame for Implementation: Sediment reduction practices should be installed within the priority subwatersheds of Wolf River during the years 2008 – 2015.

Targeted Participants: Primary participants for implementation will likely be agricultural producers operating within the drainage of priority subwatersheds. Initial work over 2008 – 2009 should include an inventory of activities in those areas with greatest potential to impact the stream, including, within a mile of the stream:

1. Total rowcrop acreage and gully locations
2. Conservation compliance on highly erodible areas
3. Acreage of poor rangeland or overstocked pasture
4. Livestock use of riparian areas and condition of riparian areas
5. Unvegetated or graded roadside ditches
6. Construction projects without erosion control techniques
7. Uncontrolled entry points for urban runoff
8. Impervious area generating increased runoff

Some inventory of local needs should be conducted in 2008 – 2009 to identify such activities. Such an inventory would be done by local program managers with appropriate assistance by

commodity representatives and state program staff in order to direct state assistance programs to the principal activities influencing the quality of the streams in the watershed during the implementation period of this TMDL.

Milestone for 2012: The year 2012 marks the next visit into Missouri River Basin for TMDL development and revision. At that point in time, adequate source assessment should be completed which allows for an allocation of resources to responsible activities contributing to the sediment impairment. Additionally, biological data from the Wolf River over 2008 –2012 should not indicate trends of reduced support of the aquatic community. Quantitative relationships between suspended sediment and biological measures should be established by 2012 and sampled data from Wolf River should indicate evidence of reduced sediment levels relative to the conditions seen over 1990 – 2005.

Delivery Agents: The primary delivery agents for program participation will be conservation district for programs of the State Conservation Commission, and the Natural Resources Conservation Service. Producer outreach and awareness will be delivered by Kansas State Extension and agricultural interest groups such as Kansas Farm Bureau and Kansas Livestock Association and grain crop associations. On-site waste system inspections will be performed by Local Environmental Protection Program personnel for Brown and Doniphan Counties.

Reasonable Assurances:

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollution.

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the waters of the state.

2. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.

3. K.S.A. 2002 Supp. 82a-2001 identifies the classes of recreation use and defines impairment for streams.

4. K.A.R. 28-16-69 to -71 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas on a watershed basis.

5. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

6. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control non-point source pollution.

7. K.S.A. 82a-901, *et seq*. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

8. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan*.

9. The *Kansas Water Plan* and the Missouri River Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollution reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are a High Priority consideration.

Effectiveness: Sediment control has been proven effective through conservation tillage, contour farming and use of grass waterways and buffer strips. The key to success will be widespread utilization of conservation farming within the watersheds cited in this TMDL.

6. MONITORING

As quantified sediment-biology relations become established, KDHE will continue to collect seasonal biological samples from Wolf River for three years over 2008 – 2012 to evaluate achievement of the desired endpoint. Should the impairment status be verified, the desired endpoint under this TMDL will be refined and more intensive sampling will be conducted over the period 2013 – 2017 to assess progress in this TMDL's implementation. Periodic monitoring of sediment or solid content of wastewater discharged from treatment systems will be expected under reissued NPDES and state permits. Further biological sampling sites may be established to address conditions throughout the reach segments and direct subwatershed priorities.

Additional source assessment needs to be conducted and local program management needs to identify its targeted participants of state assistance programs for implementing this TMDL. This information should be collected in 2008 – 2012 in order to support appropriate implementation projects.

7. FEEDBACK

Public Meetings: Public meetings to discuss this TMDL in the Missouri Basin have been held since 2001. An active Internet Web site was established at www.kdheks.gov/tmdl/ to convey information to the public on the general establishment of TMDLs in the Missouri Basin and this specific TMDL.

Public Hearing: A Public Hearing on this Missouri Basin TMDL was held in Hiawatha on May 30, 2007.

Basin Advisory Committee: The Missouri Basin Advisory Committee met to discuss this TMDL on June 26, 2006 in Atchison, December 1, 2006 and January 26, 2007 in Highland, March 16, 2007 in Atchison and May 14, 2007 in Hiawatha.

Milestone Evaluation: In 2012, evaluation will be made as to implementation of management practices to minimize the non-point source runoff contributing to this impairment. Subsequent decisions will be made regarding the implementation approach, priority of allotting resources for implementation and the need for additional or follow up implementation in this watershed at the next TMDL cycle for this basin in 2012.

Consideration for 303(d) Delisting: The river will be evaluated for delisting under Section 303(d), based on the monitoring data in 2008 – 2015. Therefore, the decision for delisting will come about in the preparation of the 2016 303(d) list. Should modifications be made to the applicable water quality criteria during the intervening implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process (CPP), the next anticipated revision will come in 2007 which will emphasize revision of the Water Quality Management Plan (WQMP). At that time, incorporation of this TMDL will be made into both of the CPP and WQMP documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process during Fiscal Years 2008 – 2015.

Revised, October 23, 2007

Bibliography

KDHE, 1987. A water quality assessment of the influence of the north and south Hiawatha wastewater treatment plants on the Wolf River and its tributaries. Environmental Field Services, KDHE. 23 pp.

Appendix A. Wasteload allocations for WWTPs and active CAFO facilities.

Facility	Permit #	Wasteload Allocation (tons/day)
WWTP		
Hiawatha New South	M-MOO08-OO03	0.106
Robinson	M-MO17-OO01	0.024
Willis	M-MO31-OO01	0.003
CAFO		
Dairy (Total Animal Head, 95, Brown CO)	A-MOBR-MA05	0
Dairy (213, Brown)	A-MOBR-M007	0
Swine (900, Brown)	A-MOBR-S006	0
Dairy (60, Brown)	A-MOBR-M008	0
Swine (350, Brown)	A-KSBR-S021	0
Swine (550, Brown)	A-MOBR-S038	0
Beef (600, Brown)	A-MOBR-B006	0
Swine, Beef, Horses (1395, Brown)	A-MOBR-S013	0
Dairy (70, Doniphan CO)	A-MODP-MA03	0
Beef (700, Doniphan)	A-MODP-BA02	0
Dairy (70, Doniphan)	A-MODP-MA07	0
Dairy (140, Doniphan)	A-MODP-MA06	0
Beef (300, Doniphan)	A-MODP-BA03	0
Swine (2450, Doniphan)	A-MODP-S007	0