SOLOMON RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: Lower Solomon River
Water Quality Impairment: Total Suspended Solids

Subbasin: Solomon **County:** Ottawa & Cloud

	HUC 8:	**HUC 10**	**HUC 12**
	10260015	07	01, 02, 03
		06	All
		03	06, 07, 08

Included Segments	
CUSEGA	**River Name**
102600151	Solomon R
1026001512	Solomon R
102600152	Coal Cr
102600153	Solomon R
102600154	Sand Cr
1026001548	Cris Cr
1026001549	Mortimer Cr
102600155	Solomon R
1026001557	Battle Cr
1026001558	Antelope Cr
102600157	Lindsey Cr
102600158	Solomon R

Ecoregion: Central Great Plains, Smoky Hills (27a)

Drainage Area: 555 square miles in included HUC 12s

Designated Uses: Primary Contact Recreation (B); Primary Contact Recreation (C); Expected Aquatic Life Support; Domestic Water Supply; Food Procurement; Industrial Water Supply; Irrigation Use; Livestock Watering, Groundwater Recharge

303(d) Listings: 2008 Solomon Basin Streams, Total Suspended Solids

Impaired Use: Aquatic Life Use Support

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)).

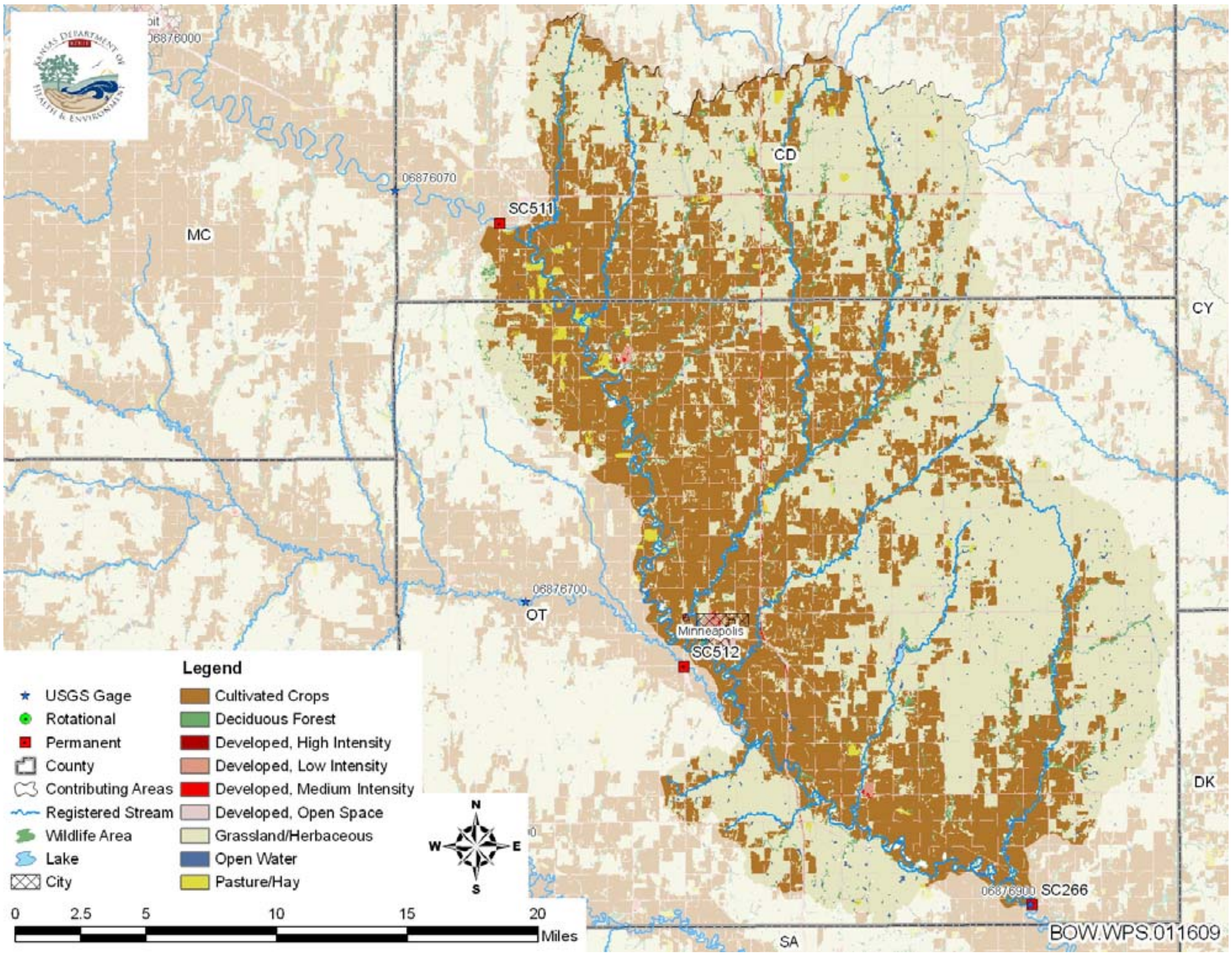

Figure 1- Land uses along the lower Solomon River. Salt Creek (SC512) and the Solomon River upstream of SC511 are monitored separately, and are not included in this TMDL.

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Monitoring Sites: SC266 – Solomon River near Niles

Not included, but draining to the area included in this TMDL are

SC511 – Solomon River near Glascow

SC512 – Salt Creek

USGS Gage Station(s): 06876900 – Solomon River near Niles

Period of Record Used: 1985 – 2009.

Current Condition: Water quality with regard to total suspended solids (TSS) in the Solomon River is consistently poor through all seasons except winter. Summary statistics from KDHE monitoring data indicates that in all seasons except winter the TSS median concentration at SC266 exceeds 50 mg/L, and the overall median is also greater than 50 mg/L. Summer median concentrations are nearly 300 mg/L (Table 1).

Interim Endpoints of Water Quality (Implied Load Capacity) over 2010 - 2015: Because the water quality standard is narrative, it is necessary to determine an appropriate screening value for TSS concentrations that are likely to fully support aquatic life uses. The 2008 Kansas 303(d) List of Impaired Waters used a screening value of 50 mg/L based on an extensive analysis of data collected by KDHE biological and chemical monitoring programs. Because this value is based on data that is otherwise unpublished, we revert in this document to the previously published suggestion from "Ambient Water Quality Criteria Recommendations" EPA 822-B-01-014 (2001) that turbidity not exceed 22.13 NTU.

Because the water quality standard is narrative and specific to suspended solids, we converted the proposed limit of 22.13 NTU into TSS (mg/L) by comparison to a regression of NTU & TSS from two monitoring stations on the Solomon downstream from Waconda Lake. The strong relationship (R^2 = 85.5%) is characterized on a log/log regression as Log10TSS = 0.549 + 0.900(Log10NTU). This would result in an acceptable concentration of 57.5 mg/L TSS, which is greater than the value calculated for the downstream receiving water. Therefore, this document shall use the guidance from the Smoky Hill River TMDL to ensure that contributions from the Solomon River do not cause water quality exceedences on the Smoky Hill River. The endpoint established is 50 mg/L, used hereafter in this document to indicate an initial acceptable objective. Conversion of this concentration to daily loads shall be accomplished by application of a concentration goal to the mean daily flow measured by USGS gage stations. Evaluation of this goal shall be applied to median concentrations, as wide variation exists across the flow duration curve.

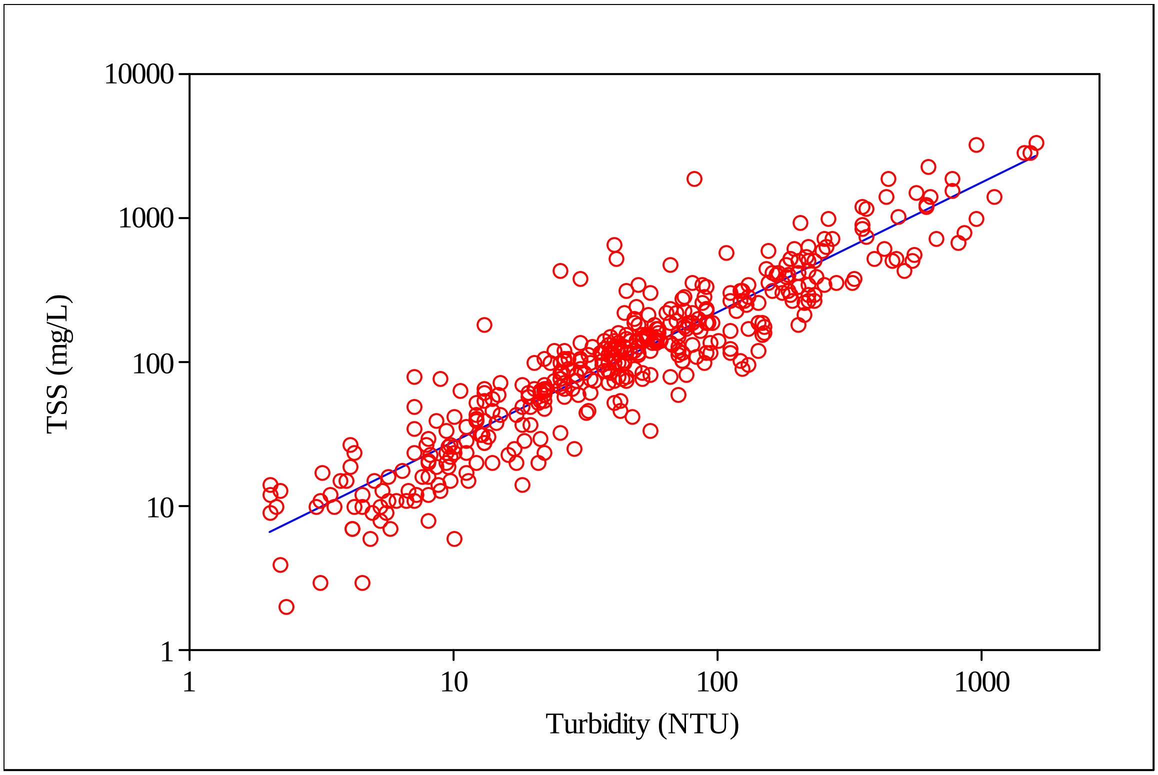

Figure 2- The regression line for Log10 turbidity and Log10 total suspended solids from the Solomon River at Niles.

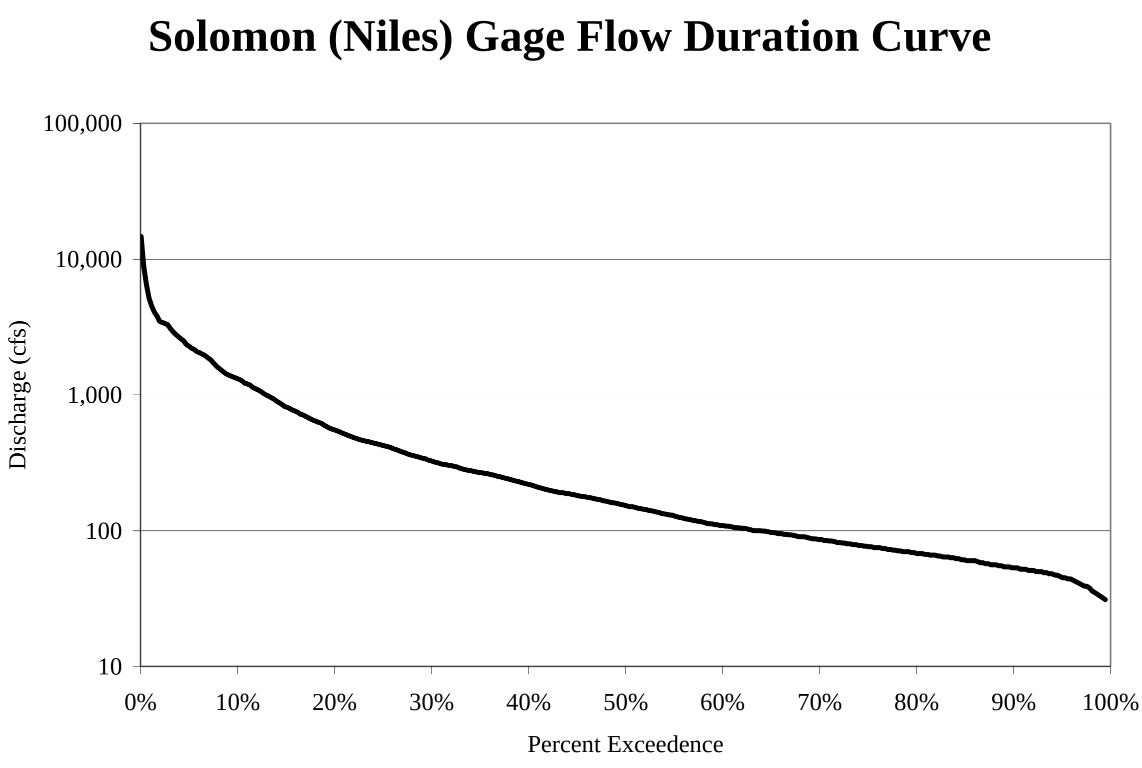

Figure 3- Flow duration curve for the Solomon River at Niles as monitored by USGS station 06876900.

Site	Minimum Flow	Maximum Flow	90% Exceedence Flow	75% Exceedence Flow	Median Flow	25% Exceedence Flow	10% Exceedence Flow	Mean Flow	Period of Record
Solomon- Niles	22	26,200	53	77	153	424	1,320	516	1971-2009

Site	Minimum TSS	Maximum TSS	75%ile	Median	25%ile	Mean	Period of Record	Sample Size
Solomon- Niles	4	3,400	54	132	292	269	1973-2009	299

Solomon- Niles	Minimum TSS	Maximum TSS	75%ile	Median	25%ile	Mean	Period of Record	Sample Size
Fall	7	2,900	35	102	192	216	1973-2009	93
Spring	15	2,290	73	126	267	240	1973-2009	72
Summer	42	3,400	158	296	565	470	1973-2009	85
Winter	4	524	14	25	80	63	1973-2009	49

Table 1- Summary statistics for TSS and discharge at SC266. All TSS values are in mg/L, all discharge values are in cubic feet per second.

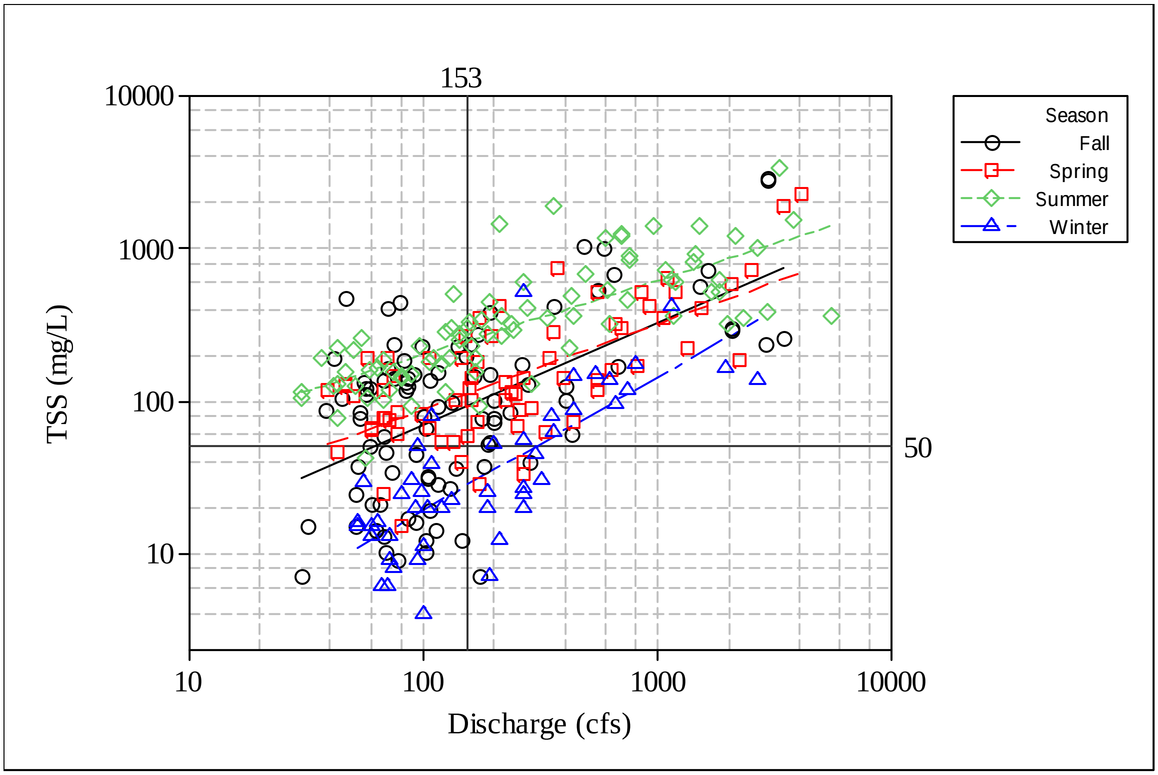

Figure 4- TSS concentrations at SC266 by flow condition measured by USGS gage. Generally only fall and winter samples at less than median flow (153 cfs) plot below the TMDL of 50 mg/L.

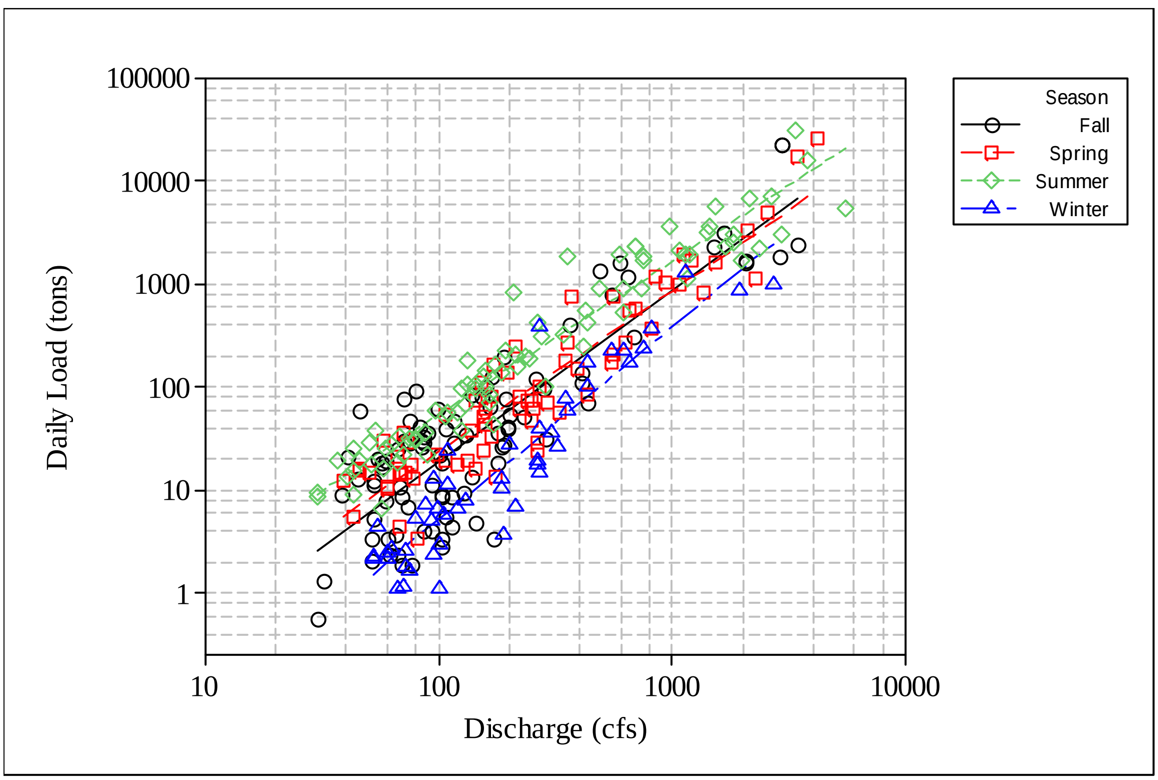

Figure 5- TSS Load as a function of discharge (cfs) at SC266. Summer loads are typically higher for any given discharge value than all other seasons.

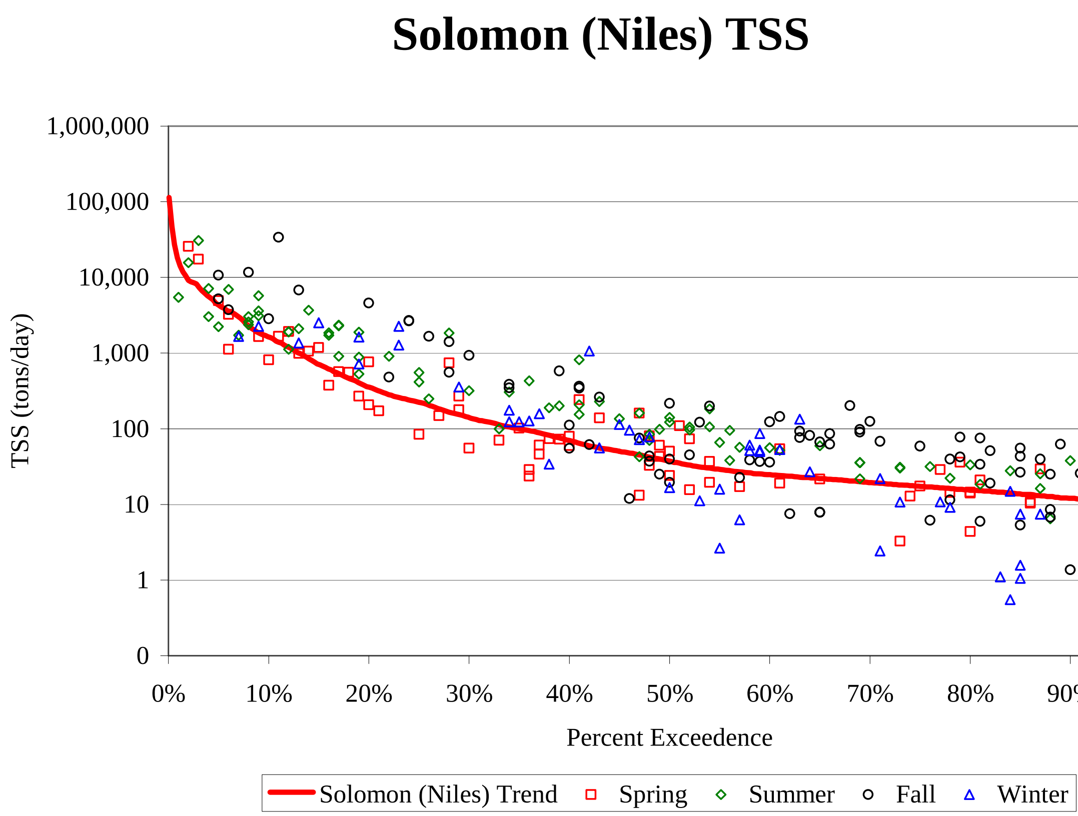

Figure 6- Existing KDHE samples at SC266 plotted by season and estimated loads, as calculated by multiplying sample concentration times calculated USGS mean daily discharge.

Interim Endpoints of Water Quality (Implied Load Capacity) at Niles over 2010 - 2020: This TMDL will be a phased TMDL, with interim endpoints for both sample locations as a median concentration not to exceed 50 mg/L TSS to protect aquatic life. To accomplish this we adopted an approach of best available reference site to determine what relationship between discharge and TSS concentration would adequately protect aquatic life. While reference site is often used to determine acceptable conditions in smaller watershed, large rivers like the Solomon pose unique challenges, as few large rivers anywhere remain minimally impacted by human activities. Therefore we selected a nearby large river site, the Republican River at Clay Center, with the lowest median TSS values, and calculated a regression of the monitoring data and discharge to determine an acceptable concentration limit for each daily discharge value. The Republican River was selected because the range of discharge values experienced is more similar to the Solomon discharge than other nearby options. The details of the method are explained later, but in broadest terms the interim endpoint shall be to reduce concentration of TSS at any given discharge value to less than Log10TSS=(- 0.472 + 0.679*(Log10Discharge), with TSS measured in mg/L and discharge measured in cubic feet per second for discharges greater than 750 cfs and 30 mg/L for discharge values less than 750 cfs (Figure 16).

These concentrations and loads should provide support for downstream reductions needed on the Smoky Hill River, while also protecting aquatic life within the Solomon River.This interim endpoint shall be understood to potentially protect aquatic life from the harmful effects of suspended solids and will serve as a numeric translator of the narrative criteria. Full compliance with water quality standards shall be evaluated by the Department (KDHE) based on recovery of aquatic life diversity.

3. SOURCE INVENTORY AND ASSESSMENT

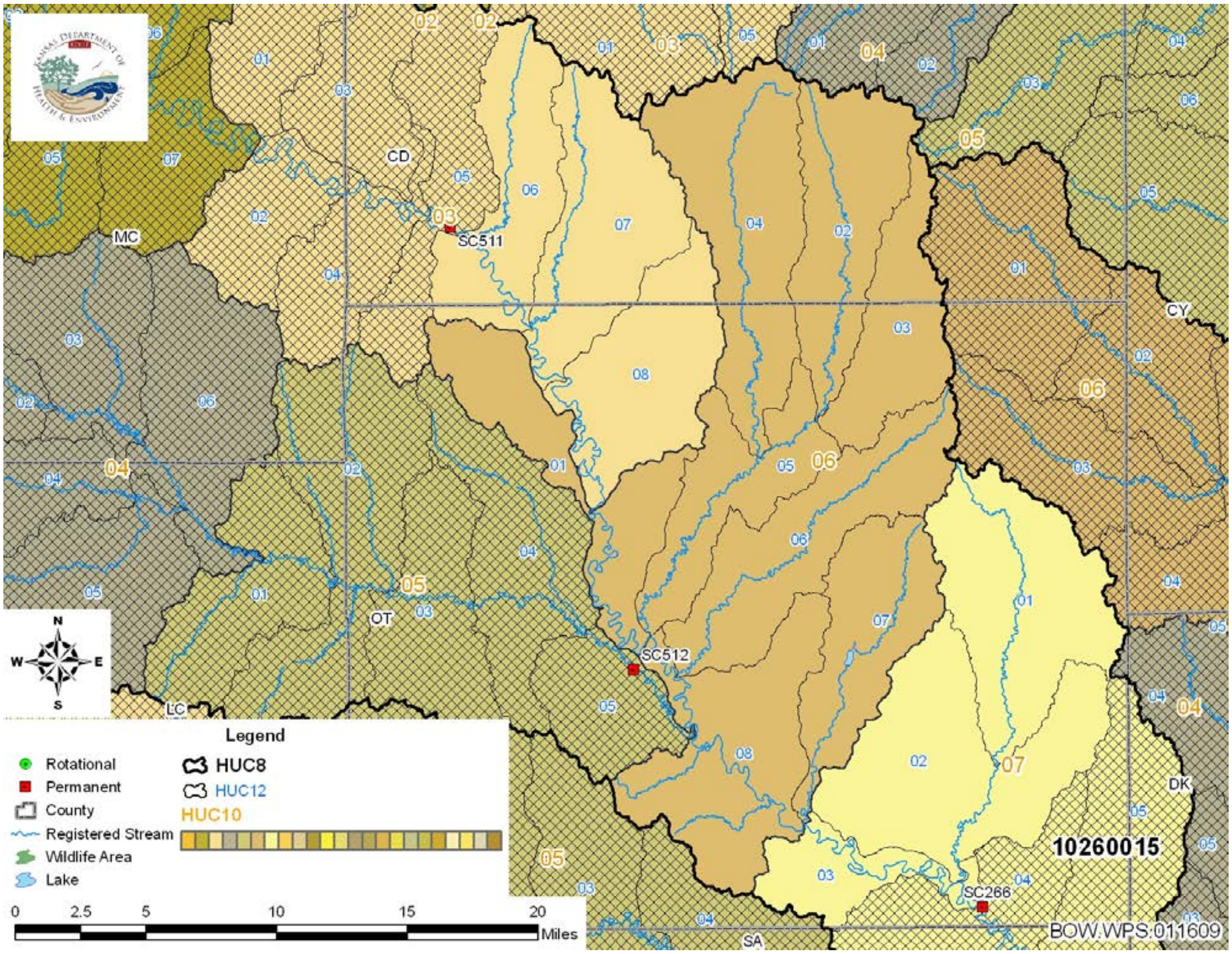

Figure 7- HUC12 boundaries in the TMDL area. HUC12 identification codes are constructed by appending the HUC10 and HUC12 sub-codes to the HUC8 code.

Land Use: Land use in this TMDL area (Table 2) is dominated by cropland uses, particularly in the alluvial valley of the major rivers, and grassland in the upland areas. Concentrations of developed land are minimal, mostly in the city of Minneapolis, other developed lands are largely roads. The lands directly adjacent to the rivers (Table 3) generally have concentrations of both timbered areas that exceed the HUC12 averages. Timbered lands are expected to be sources of reductions in sediment, and cropland is expected to result in increased sediment delivery, suggesting that these areas near the rivers are contributors to the elevated TSS concentrations observed in the rivers. Erosion on cropland areas can be expected to be greater when gully formations and low residue planting practices (Figure 8) occur.

HUC 12	Grassland	Cropland	Forest	Open Water	Roads/ Developed	Developed	Wetlands
102600150306	37.2%	53.8%	3.4%	1.0%	3.8%	0.3%	0.5%
102600150307	40.8%	49.9%	3.1%	0.7%	4.1%	0.6%	0.8%
102600150308	20.1%	69.1%	3.1%	1.3%	3.9%	1.4%	1.1%
102600150601	24.6%	66.4%	2.2%	1.8%	3.7%	0.2%	1.2%
102600150602	67.9%	22.8%	3.8%	0.8%	4.2%	0.2%	0.2%
102600150603	72.2%	20.6%	2.7%	0.8%	3.4%	0.1%	0.2%
102600150604	51.9%	37.3%	5.0%	0.4%	4.5%	0.6%	0.4%
102600150605	37.6%	51.4%	3.6%	0.4%	3.9%	1.8%	1.3%
102600150606	44.3%	46.7%	2.2%	0.7%	4.4%	1.2%	0.4%
102600150607	64.3%	25.9%	3.6%	1.3%	3.9%	0.3%	0.7%
102600150608	39.2%	49.3%	2.3%	2.1%	4.5%	1.3%	1.2%
102600150701	81.9%	11.6%	2.6%	0.9%	2.6%	0.0%	0.3%
102600150702	47.5%	44.5%	2.5%	0.6%	3.6%	0.5%	0.8%
102600150703	53.0%	29.0%	4.2%	5.6%	3.4%	0.3%	4.5%

Table 2- Land use in the TMDL area by HUC12 extracted from the 2001 National Land Cover Dataset.

HUC12	Grassland	Cropland	Forest	Open Water	Developed	Wetlands
102600150306	15.3%	23.8%	35.4%	16.2%	0.1%	7.4%
102600150307	26.2%	23.5%	25.6%	10.2%	0.5%	11.4%
102600150308	10.6%	11.6%	23.2%	40.2%	0.3%	13.3%
102600150601	5.6%	12.9%	19.0%	48.9%	0.4%	12.3%
102600150602	21.6%	15.4%	56.6%	0.3%	0.3%	2.3%
102600150603	0.0%	0.0%	83.3%	0.0%	0.0%	16.7%
102600150604	17.1%	21.8%	54.0%	0.1%	0.3%	3.7%
102600150605	4.9%	23.2%	41.9%	1.1%	1.0%	24.6%
102600150606	29.5%	20.6%	37.0%	1.8%	0.3%	7.4%
102600150607	37.3%	9.6%	37.9%	2.8%	0.7%	8.1%
102600150608	19.5%	14.2%	21.1%	31.2%	0.8%	11.1%
102600150701	47.8%	5.5%	36.5%	0.8%	0.0%	7.7%
102600150702	2.4%	24.5%	25.9%	2.5%	0.4%	41.5%
102600150703	1.9%	7.2%	20.8%	54.8%	0.3%	14.5%

Table 3- Land use in a 100 foot buffer adjacent to registered streams. Ibid.

Figure 8- Low residue cropping practices that can contribute to sediment loading. Visible on the left is an area of exposed soil where planted corn apparently failed to establish in a waterway, leaving a bare soil conveyance for overland flow.

KDHE developed a Spreadsheet Tool for Estimating Pollutant Load reductions (STEPL) model (Figure 11) of the area downstream of Waconda Lake to the monitoring station at Niles. Waconda Lake likely acts as an effective sediment trap, releasing water that is low in suspended solids. A comparison of the load estimated by STEPL modeling and the load modeled as a discharge/measured TSS regression model (Figure 10) allows us to compare the potential contributions of upland sources and streambank/channel sources. The STEPL model was developed using 2007 National Agricultural Statistics Service crop cover data, and additional measured and estimated data as detailed in the appendix.

A regression based model of total annual loads and individual daily loads was built based on all available monitoring data and the discharge record for SC266. The regression approach determines the central tendency of measured TSS for all flow conditions, then assigns TSS and discharge data to a full range of potential flows from 0% exceedence to 99.9% exceedence over the period of record (water year 1971-current) in a year-like distribution (i.e. 365 estimated measurements).

The specifics of the methodology are similar to the approach taken for total phosphorus modeling in Banner et al. (2009), but are briefly explained here. A composite “year” was generated using percentile discharge data for all mean daily discharge values from water year 1971-2009. This generates 365 individual values, equivalent to the long-term range of values observed. Then using a segmented regression program, SegRegW, all log normalized discharge and TSS data for the site were analyzed to determine if a breakpoint occurred. For SC266 a breakpoint was found at Log10(Discharge(cfs)) = 1.98, or 95 cfs (Figure 21). The median value for all samples with discharge less than 95 cfs (84 mg/L) was assigned to each "day" of the "year" generated earlier. For "daily" discharges greater than 95 cfs a regression approach was used to estimate the concentration expected for a given discharge (Log10TSS = 0.297 + 0.759 * Log10Discharge, Adj. R^2 = 37.7%, p=0.000). Because the regression produces values less than the current low flow median, all discharge values greater than 95 cfs and less than 139 cfs were also assigned 84 mg/L TSS concentration. Model fitting may be somewhat less reliable for extreme high flows (<1% exceedence flows), for which no monitoring data were available.

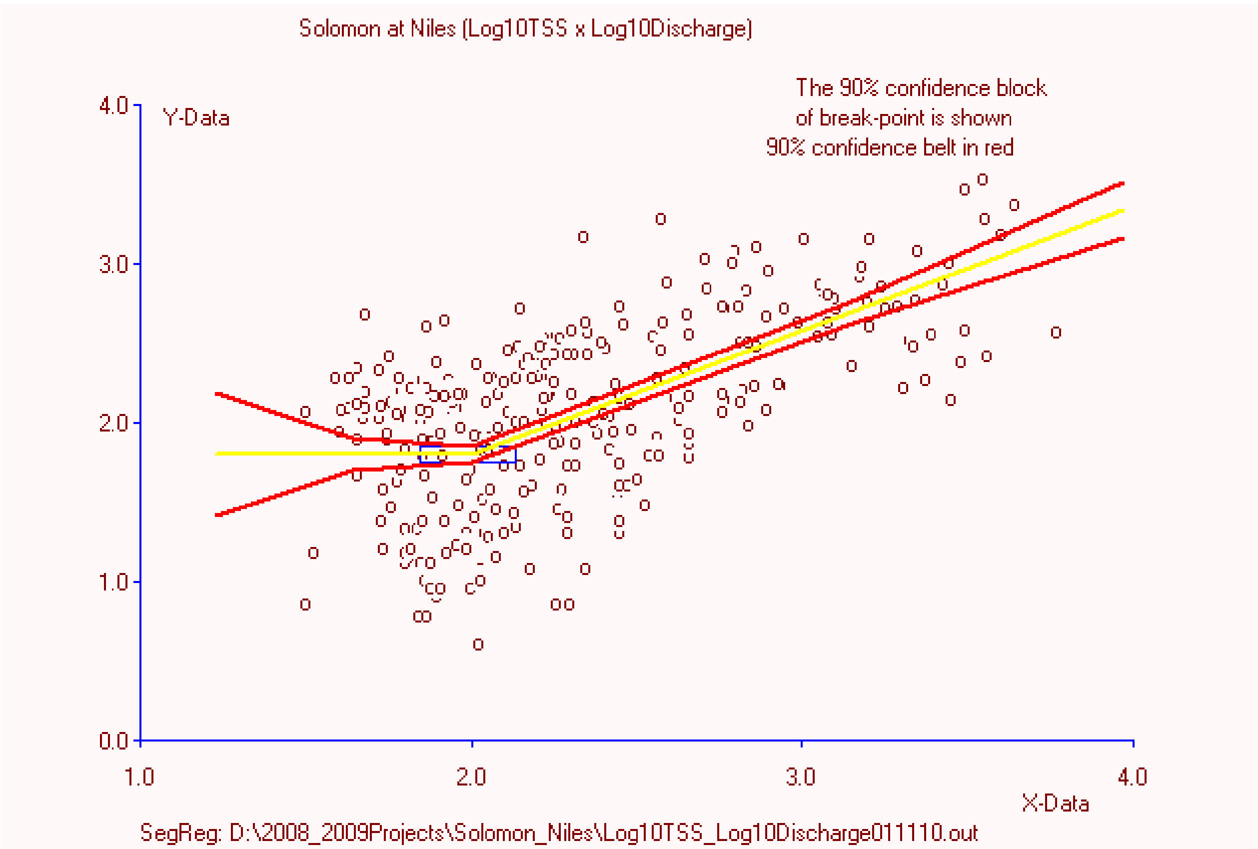

Figure 9- Breakpoint determination for the Solomon River at Niles, as determined using the Log10 TSS concentration and the Log10 Discharge values.

Regression based model results generated an average annual total TSS load of 418 thousand tons per year (Figure 10). Using the regression model indicates that 76% of the annual TSS load observed at the Enterprise monitoring station will move during only 5% of the flow events, with substantially lower loads during the remaining 95% of the time when discharges are less than 2,280 cfs. It is likely that some of the sediment mobilized during the high flow events is deposited in the channel and is released over time, linking high flow and base flow concentrations as a yet un-specified relationship between the two conditions.

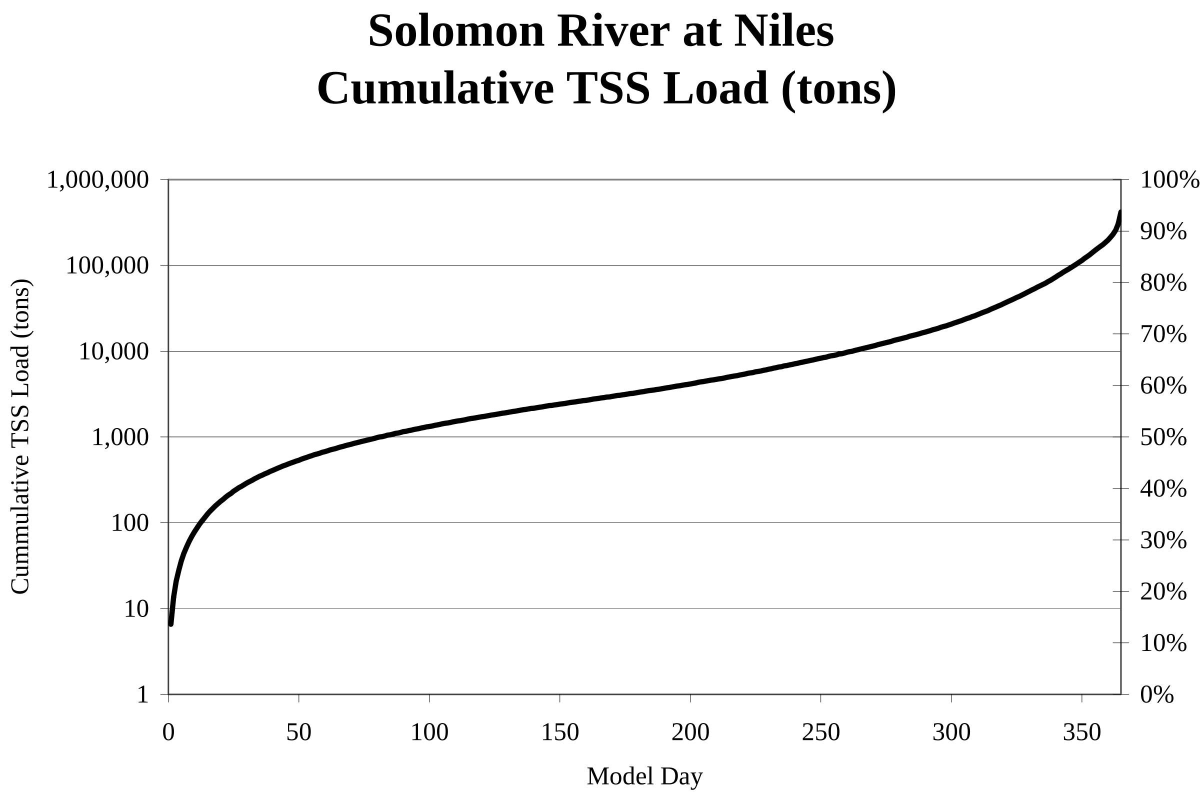

Figure 10 – Regression modeled sediment load at the Enterprise gage and SC265 as a cumulative annual load.

STEPL estimated a total annual load of 208,000 tons of sediment delivered per year at the Niles gage (Figure 11). The regression model estimates an annual average load at Enterprise of 418,000 tons/year. The wide disparity in the STEPL model estimate, which does not take into account streambank sources, and the measured/modeled data seen at Niles suggest that the sediment supply sources in this watershed is fairly balanced between stream channel mobilization and field supply.

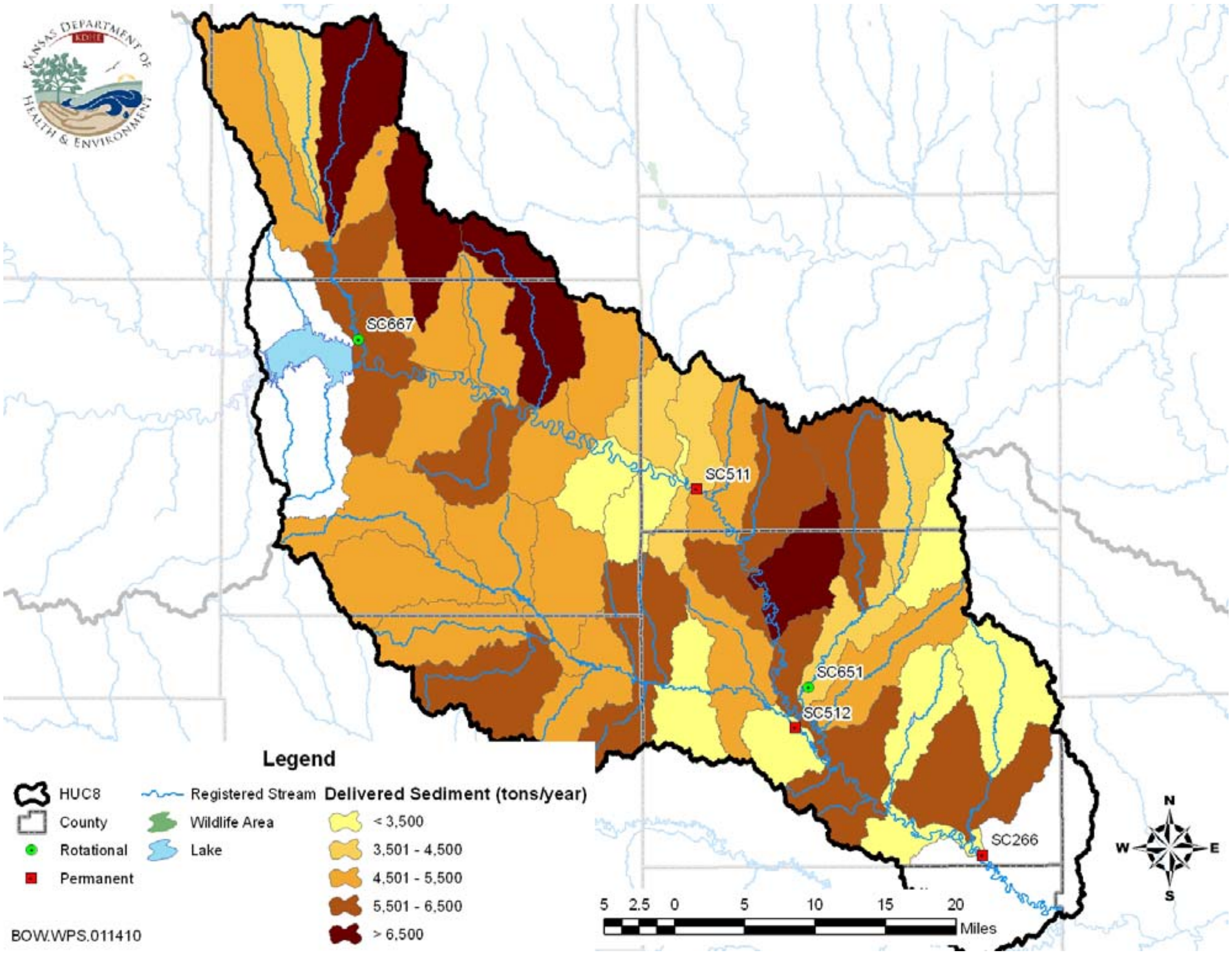

Figure 11 – STEPL modeled sediment delivery rates by HUC12 for all areas downstream of Kanapolis, Waconda and Wilson reservoirs.

Bed load/Resuspension- An unknown quantity of TSS is the result of resuspension of fine materials located on the river bed (Figure 12). No determination was possible at this time of the age or origin of the bed silt, or the rate of supply and release. The river was historically described as a "clear stream, flowing over a sandy bottom" (General Land Office Surveyor's Notes, November 17, 1858), with "banks about 16 feet high, composed of bluffs. The bed of the stream a coarse, firm sand. The water is transparent, pure and limped" (General Land Office Surveyor's Notes, August 25, 1858). The records suggesting that a sand/gravel bottom was the historic condition, with relatively low rates of bed silt supply. These factors suggest that absent a new supply of bed silt the existing legacy load in the channel would eventually wash out, eliminating this source of TSS.

Figure 12- Current channel bed condition along much of the Solomon River is similar to the material seen in this photograph. Some rock, sand and gravel is present, typically overlain with a layer of fine, silty/clay material.

Upstream/Contributing Tributaries- KDHE monitoring stations (Table 4 & 5, Figure 13) provide monitoring data on the Solomon River at Glasco, Pipe Creek and Salt Creek, which contribute water and sediment to this reach of the river. While gage data is not available for all monitoring stations, USGS estimated median and mean flow (Perry et al., 2004) can be used to estimate loads originating from segments without gage data. To ensure consideration of both typical flows and high flows, a two pronged approach was adopted to estimate the relative sources of the TSS load observed at the outlet of the Solomon River. Table 4 shows the load estimated by use of median concentrations and median flows. Table 5 shows the same calculations done with average concentrations and average flows. Both tables show the mainstem river transporting the majority of the load, however they disagree regarding the expected contribution from upstream of the Glasco station. The largest contributor to the total load observed at SC266 is the Solomon River at between Glasco (SC511), which is the upstream end of the reach covered by this TMDL document, and the Solomon River at Niles. The TSS concentration entering this reach of the Solomon from the upstream portions monitored at SC511 have substantially lower TSS median concentrations than those found at SC266. Salt Creek (SC512) also has elevated concentrations, but a relatively small portion of the total volume of water passing SC266 comes from the Salt Creek watershed, so only about 6% of the load at SC266 is estimated to have originated in Salt

Creek at median flow.

Site	Site Name	Median Flow	TSS overall median	Estimated load (tons/day)	% of Flow	% of Load	Tons/day/fc
SC667	Limestone Creek	6.76	31	0.57	4.42%	1.04%	0.08
SC511	Solomon at Glasco	97	76	19.88	58.98%	35.46%	0.20
SC651	Pipe Creek	6.37	36	0.62	4.16%	1.14%	0.10
SC512	Salt Creek	14	87	3.28	9.15%	6.03%	0.23
SC266	Solomon at Niles	153	132	54.47	23.29%	57.37%	0.36

Table 4- Upstream sediment concentrations and estimated median flow. All data presented in "% of Flow" and "% of Load" were generated by division of the unique contribution of the monitored area to the total load observed at SC266.

Site	Site Name	Mean Flow	TSS overall Mean	Estimated load (tons/day)	% of Flow	% of Load	Tons/day/fc
SC667	Limestone Creek	30.73	145	12.03	5.96%	3.21%	0.39
SC511	Solomon at Glasco	450	167	202.90	81.25%	50.94%	0.45
SC651	Pipe Creek	33.74	96	8.71	6.54%	2.33%	0.26
SC512	Salt Creek	70	142	26.73	13.57%	7.13%	0.38
SC266	Solomon at Niles	516	269	374.68	-7.31%	39.60%	0.73

Table 5- Upstream sediment concentrations and estimated mean flow. All data presented in "% of Flow" and "% of Load" were generated by division of the unique contribution of the monitored area to the total load observed as SC266.

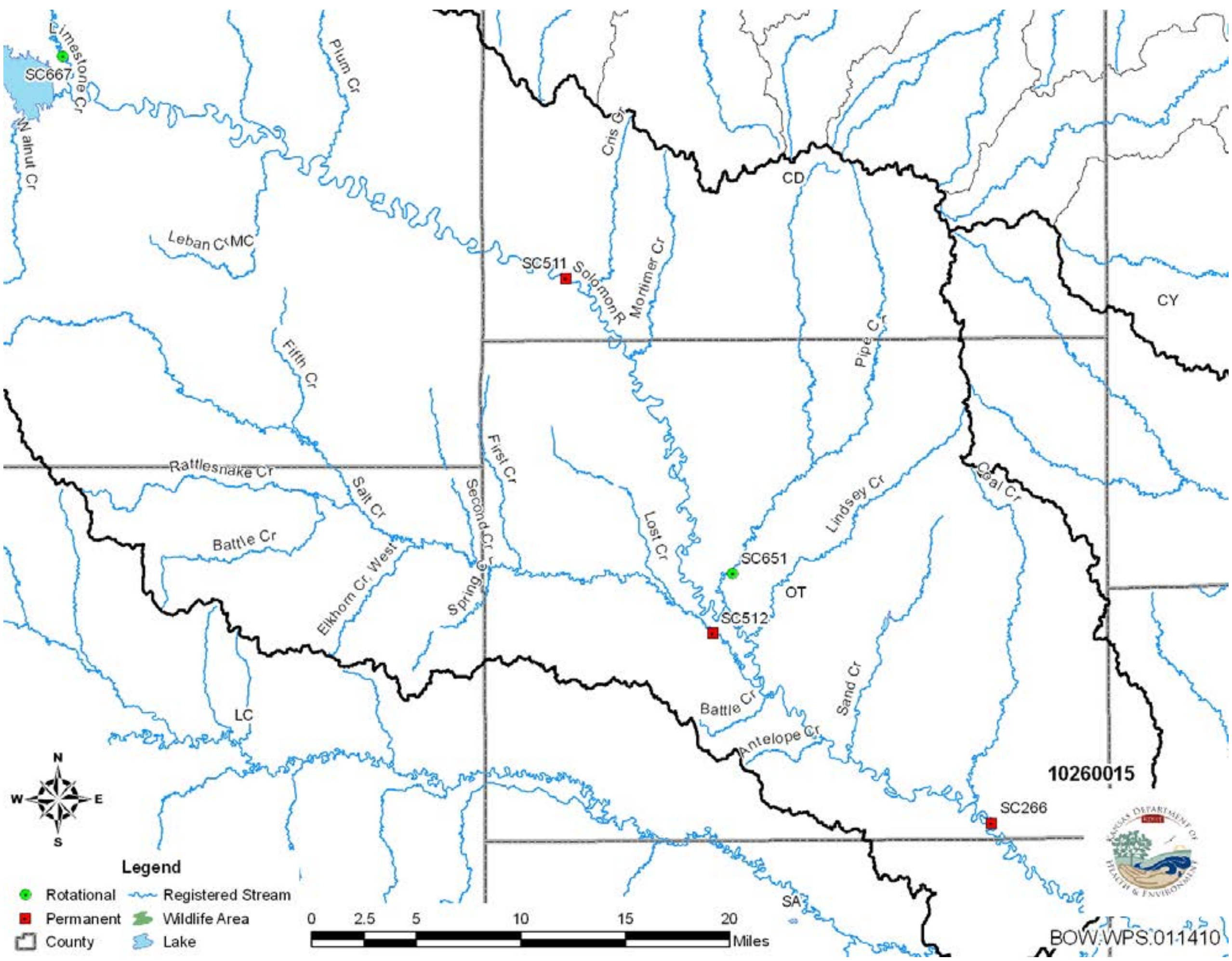

Figure 13- KDHE monitoring stations on the Solomon River and tributaries.

Other Sources: Forty four confined animal feeding operations exist in the contributing area (Figure 14). The largest number are small beef operations (33), all but three of them with less than 1000 head at any time. The remaining facilities include small swine operations (5), dairies (3) and a few other small operations. These facilities are likely to contribute relatively little to the sediment loads observed in the Solomon due to existing pollution prevention and containment requirements, which include containing all runoff from a 25 year-24 hour storm. Eight facilities with NPDES permits exist within the contributing area (Figure 15). Three are small municipal wastewater treatment lagoons, one is a peaking power plant using non-contact cooling water, and the remainder are expect to discharge only under storm conditions, or to municipal systems that further treat the effluent before release. These facilities are unlikely to contribute significantly to the TSS load observed in the Solomon River due to a combination of factors, including limited discharge (concrete) and small discharge volumes (< 1 cfs) on lagoon facilities. Facilities details are presented in the appendix.

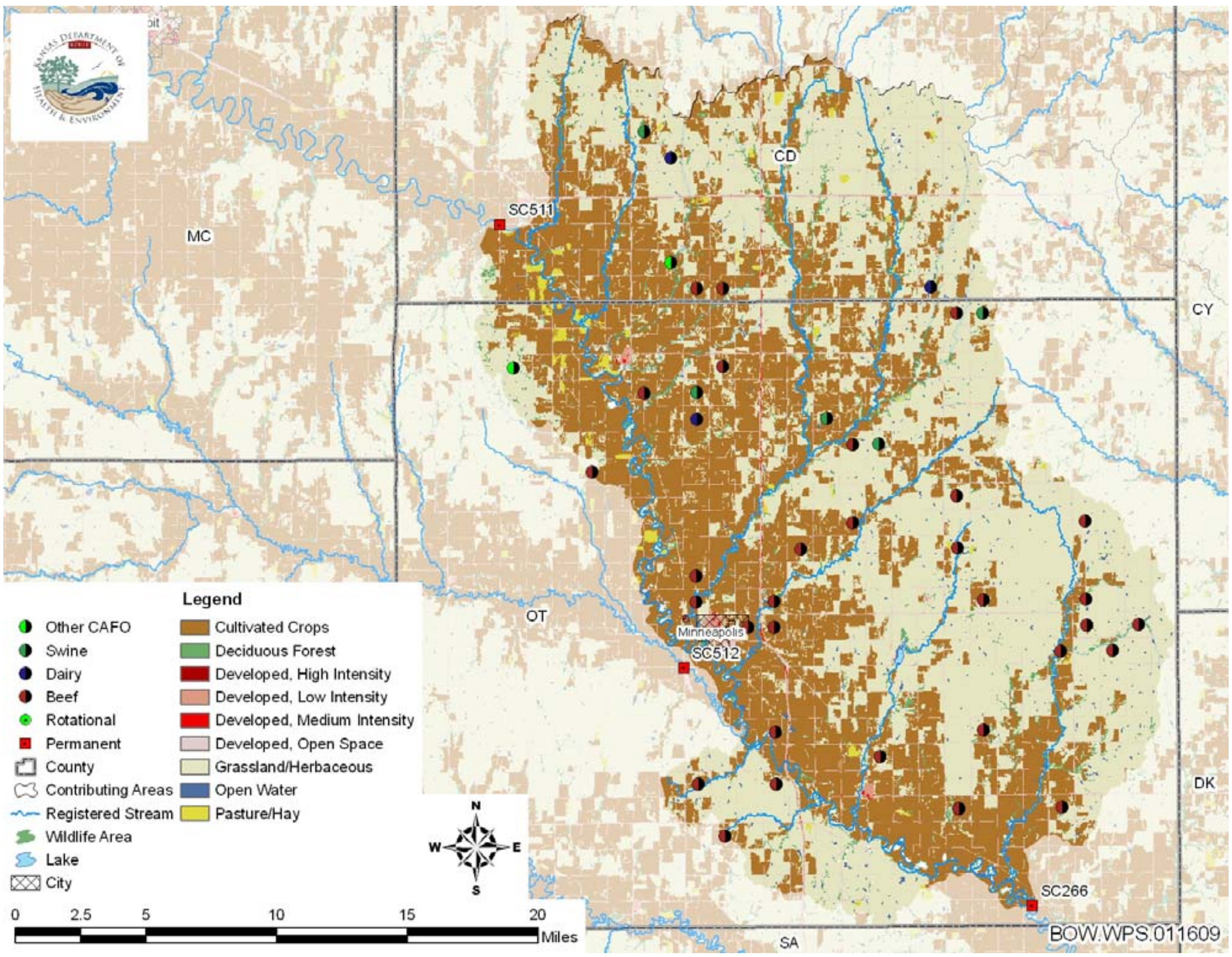

Figure 14 – Permitted confined animal feeding operations in the TMDL area.

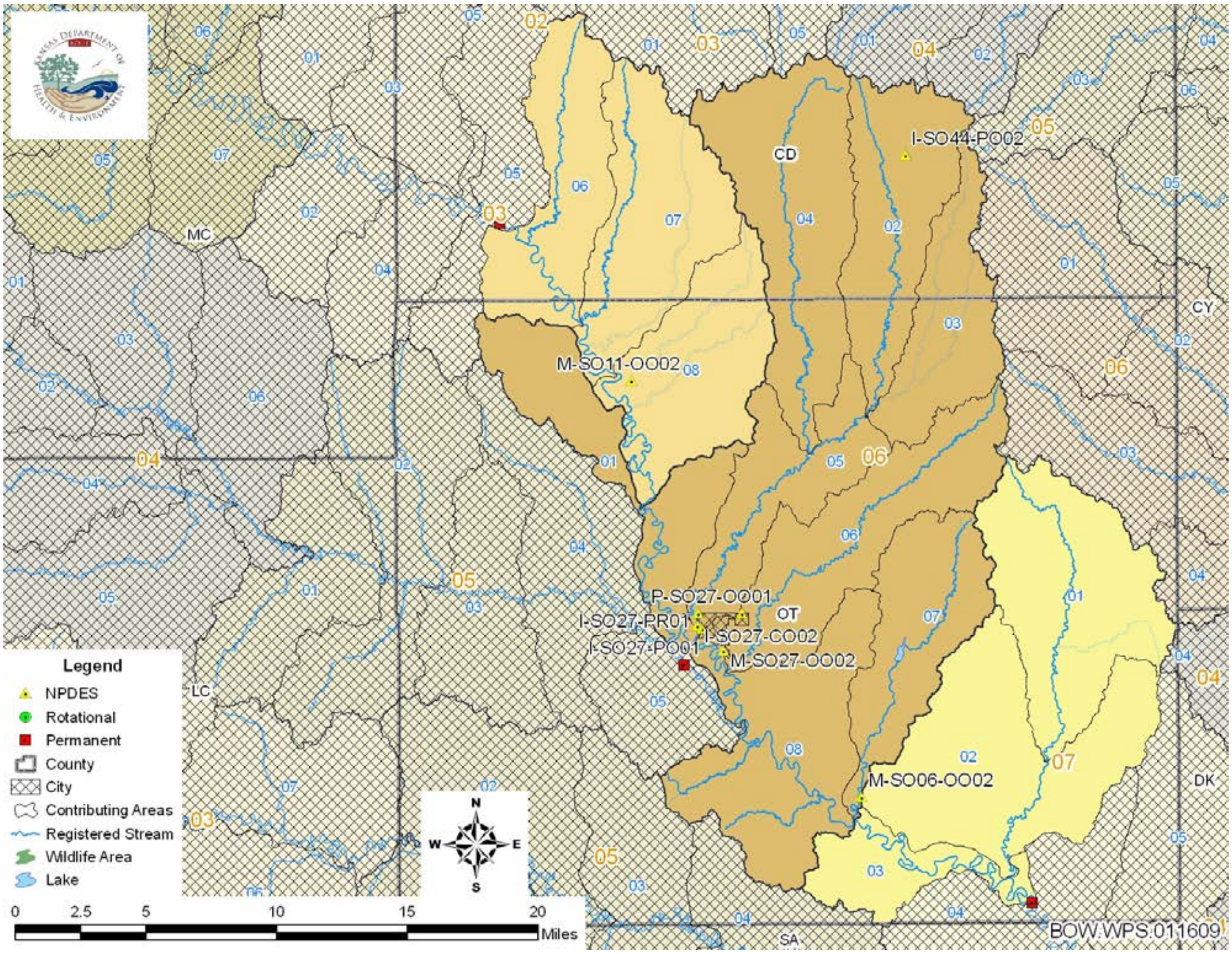

Figure 15 – Permitted NPDES facilities in the TMDL area.

Background Levels: Some TSS load is expected from natural sources in rivers of all sizes. The overall background level without the impacts of bank erosion/sloughing and overland flow erosion events is likely a very small portion of the total load that occurs in this river. Pre-settlement records indicate the stream was a sand bedded stream with clear water during early survey periods.

Critical Conditions/Seasonality- TSS concentrations are highest in the summer months, though they begin to rise during the spring. TSS loads generally exceed acceptable levels during all seasons, and the impacts of sediment on aquatic life are likely present through the year. Strategies that reduce TSS loads during their peak periods will likely also result in reductions during other seasons.

Uncertainty- A number of sources of uncertainty exist that affect the ability of this TMDL document to completely characterize the sediment pollution issues affecting the Solomon River in this area. No analysis has yet been done to determine the magnitude of legacy sediment loads within the active channel. While pre-settlement records indicate a sand/gravel bedded river, by 1887 O.P. Hays reported that a small tributary of the Solomon was “like all others in this part of the State, flows in a deep ravine, is very sluggish, and so filled with ooze as to make the dragging of a seine a very difficult and disagreeable task." If this description also described the Solomon River itself, there may be more than 100 years accumulated sediment load present in the active channel, whose volume cannot be properly estimated at this time. Other sources of uncertainty exist because a number of tributary streams do not have their own monitoring sites, limiting our ability to characterize their contribution to the total load observed at SC266. Seasonal variation in the concentration of TSS is consistent with monitoring data from other locations in Kansas, but the relative source contributions can only be estimated at this level of analysis.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

TSS is the primary pollutant of concern in this TMDL area and is allocated as follows.

Point Sources: NPDES permitted dischargers are collectively allocated 0.15 tons per/day, as detailed in the Appendix.

Nonpoint Sources: Water quality violations are predominantly due to nonpoint source pollutants. Reduction of TSS levels to below 50 mg/L in the rivers should protect water quality and maintain the designated uses. To reduce total suspended solids concentrations to this level will require a reduction of loading by 25 tons/day at median flow including the defined margin of safety.

Defined Margin of Safety: The Margin of Safety provides some hedge against the uncertainty in suspended solids loading in the Solomon River. For this TMDL, the margin of safety will be 10% of the TSS load capacity at SC266, which accounts for 1.2 tons/day of TSS at median flow. In addition, there is an implied implicit margin of safety for this TMDL which relies on the conservative assumption that future wasteload allocations are set based on current permit limits which do not cause the TSS impairment at SC266. Additionally, although the target median is 50 mg/l of TSS, the endpoint for this TMDL at the 10% flow exceedance condition is based on a median concentration of 44.34 mg/l and for flow less than the average flow condition this is based on a median concentration of 30 mg/l.

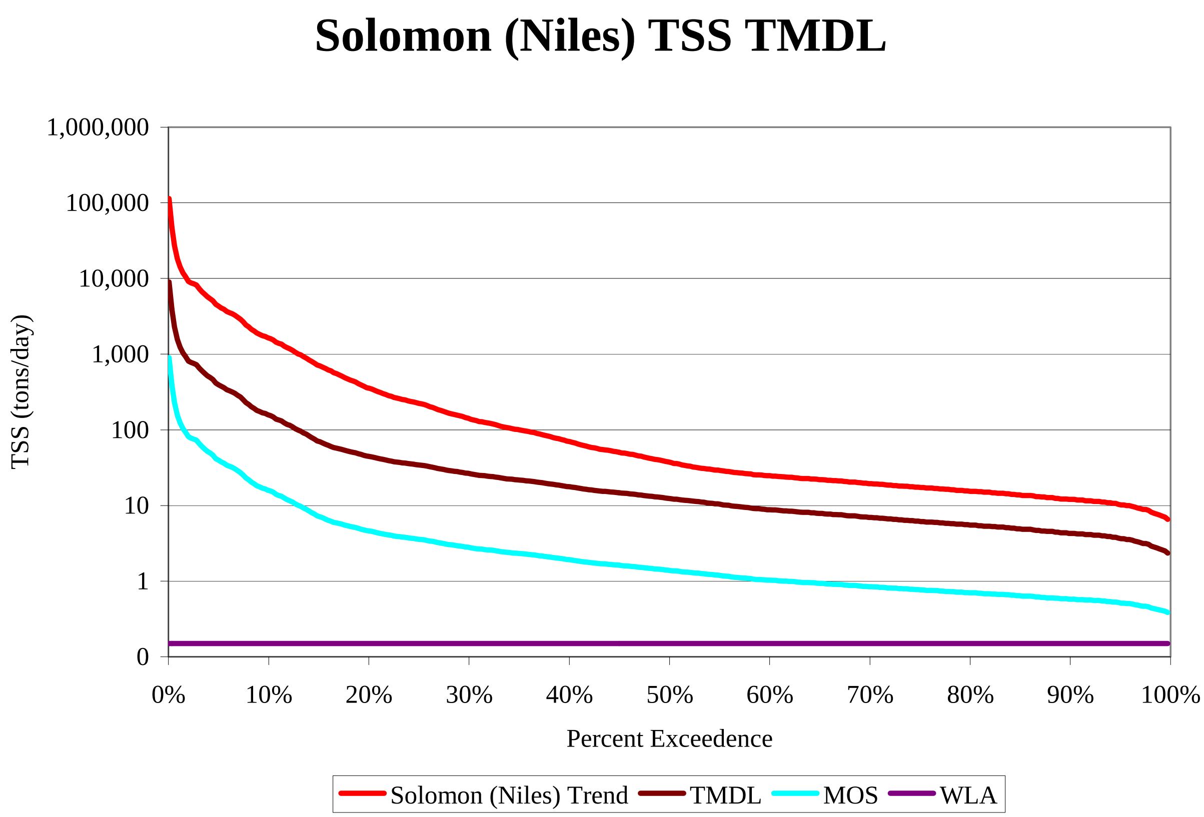

Figure 16- The TMDL for SC266, including wasteload allocation, margin of safety and the total maximum daily load across all flow conditions. A red trendline for current samples is included for reference.

Solomon River-Niles	NPDES Q (cfs)	WLA (tons/day)	Discharge (cfs)	MS4 WLA (tons/day)	LA (tons/day)	MOS (tons/day)	TMDL (tons/day)	Median Conc.
90% Exceedence	1.53	0.15	53	NA	4	0	4	30
75% Exceedence	1.53	0.15	77	NA	5	1	6	30
50% Exceedence	1.53	0.15	153	NA	11	1	12	30
25% Exceedence	1.53	0.15	424	NA	31	3	34	30
10% Exceedence	1.53	0.15	1,320	NA	142	16	158	44.34

Table 6- Annual load allocations for SC266 at specified discharge values.

State Water Plan Implementation Priority: Because SC266 has the second highest median TSS concentration statewide, and because this river contributes to the publicly accessible recreation resources on the Kansas River downstream, this TMDL will be a **High Priority** for implementation.

Unified Watershed Assessment Priority Ranking: This TMDL area lies within the Solomon River Watershed with a priority ranking of 23 (Medium Priority for restoration).

Priority Areas: Implementation of land use practices should be targeted to those areas within 300 feet of the Solomon River.

5. IMPLEMENTATION

Desired Implementation Activities

Stabilization of actively eroding streambanks and re-establishment of a wooded riparian corridor along the Solomon River will substantially reduce TSS loading in this area. Conversion of cropland in sensitive areas, particularly areas within 300 feet of the rivers, to permanent vegetation has the potential to limit new loading from these areas with high delivery potential for newly eroded soils.

Implementation Programs Guidance

Non-Point Source Pollution Technical Assistance - KDHE

a. Support Section 319 demonstration projects for reduction of siltation runoff from agricultural or road construction activities
b. Provide technical assistance on practices geared to establishment of vegetative buffer strips.
c. Provide technical assistance on road construction activities in vicinity of streams.
d. Support the development, assessment, planning and implementation of a developing WRAPS to comprehensively reduce the loading and delivery of pesticides, sediment and nutrients to the stream system throughout its watershed.

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

a. Apply conservation farming practices, including terraces and waterways
b. Provide sediment control practices to minimize erosion and sediment transport

Riparian Protection Program - SCC

a. Establish or reestablish natural riparian systems, including vegetative filter strips and streambank vegetation.
b. Develop riparian restoration projects

Buffer Initiative Program - SCC

a. Install grass buffer strips near streams.
b. Leverage Conservation Security Program to hold riparian land out of production.

CRP Enrollment- NRCS

a. Enroll highly erodable lands in the conservation reserve program.

Extension Outreach and Technical Assistance - Kansas State University

a. Educate agricultural producers on sediment and pasture management
b. Provide technical assistance on buffer strip design and minimizing cropland runoff

Time Frame for Implementation: Bank stabilization and re-forestation within a 300 foot buffer along the Solomon Rivers should occur through 2020. During 2010-2020 monitoring of flow adjusted TSS concentrations should show reductions.

Delivery Agents: The primary delivery agents for program participation will be the Ottawa and Cloud County Conservation Districts for programs of the State Conservation Commission and the Natural Resources Conservation Service. Producer outreach and awareness will be delivered by Kansas State Extension.

Targeted Participants: Primary participants for implementation shall be land-owners with property abutting the Solomon River.

Milestone for 2020: The year 2020 marks the midpoint of the twenty-year implementation window for the watershed. At that point in time, sampled data from SC266 will be reexamined to confirm the impaired status of the rivers. Should impairment remain, more aggressive techniques will be examined to remove potential sources of sediment from the river.

Reasonable Assurances:

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

1. 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.

2. 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.

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

4. 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.

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

6. The *Kansas Water Plan* and the Solomon 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 is a **High Priority** consideration. Priority should be given to activities which reduce loadings of sediment to the rivers by 2020.

Effectiveness: Reduction of bank sloughing and field erosion will substantially reduce the total load of TSS in this area.

6. MONITORING

KDHE will continue to monitor water quality on the prescribe schedule at each of these monitoring stations. SC266 will continue to be sampled bi-monthly.

7. FEEDBACK

Public Meetings: Public Meetings to discuss TMDLs in the Solomon Basin have been held since 2002. An active Internet Web site was established at http://www.kdheks.gov/tmdl/index.htm to convey information to the public on the general establishment of TMDLs in the Solomon Basin and these specific TMDLs.

Public Hearing: A Public Hearing on these Solomon Basin TMDLs was held in Assaria on February 11, 2010.

Basin Advisory Committee: The Solomon Basin Advisory Committee met to discuss these TMDLs on September 29, 2009 in Stockton and March 4, 2010 in Beloit.

Public Comment: Only one public comment was received on this TMDL. The comment encouraged KDHE to delay adoption of TMDLs until such time as a set of approved numeric standards existed for pollutants such as total suspended solids and total phosphorus. KDHE responded by reiterating the importance of compliance with any approved regulation, including narrative criteria.

Milestone Evaluation: In 2020, evaluation will be made as to implementation of management practices to minimize the nonpoint 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 with consultation from the Solomon Basin WRAPS teams.

Consideration for 303d Delisting: The Solomon River will be evaluated for delisting under Section 303d, based on the monitoring data over 2010-2020. Therefore, the decision for delisting will come about in the preparation of the 2022-303d list. While TSS concentrations will be evaluated as consideration for delisting of these waters, ultimate delisting shall be dependent on demonstration of full aquatic life support, as measured by macroinvertebrate sampling, and recovery of extirpated unionid mussel species. Should the endpoints in this TMDL fail to result in full aquatic life support, this TMDL will be revisited and revised with more stringent limits needed to fully support aquatic life.

Incorporation into Continuing Planning Process, Water Quality, Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision would come in 2010, which will emphasize implementation of WRAPS activities. At that time, incorporation of this TMDL will be made into the WRAPS. Recommendations of this TMDL will be considered in the *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2010-2020.

Revised March 7, 2011

References:

Banner, EBK, AJ Stahl, WK Dodds, 2009. Stream Discharge and Riparian Land Use Influence In-Stream Concentrations and Loads of Phosphorus from Central Plains Watersheds. Env. Mngmnt. 44 (552-565).

Perry, C.A., Wolock, D.M., and Artman, J.C., 2004. Estimates of flow duration, mean flow, and peak discharge frequency values for Kansas stream locations, U.S. Geological Survey Scientific Investigations Report 2004-5033.

Appendix:

Regression models for TSS and discharge in comparison rivers-

Republican River at Clay Center

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The regression equation is
Log10TSS = - 0.472 + 0.679 Log10Discharge


Predictor          Coef  SE Coef      T      P
Constant        -0.4719   0.3826  -1.23  0.220
Log10Discharge   0.6787   0.1092   6.22  0.000


S = 0.509061   R-Sq = 25.5%   R-Sq(adj) = 24.8%
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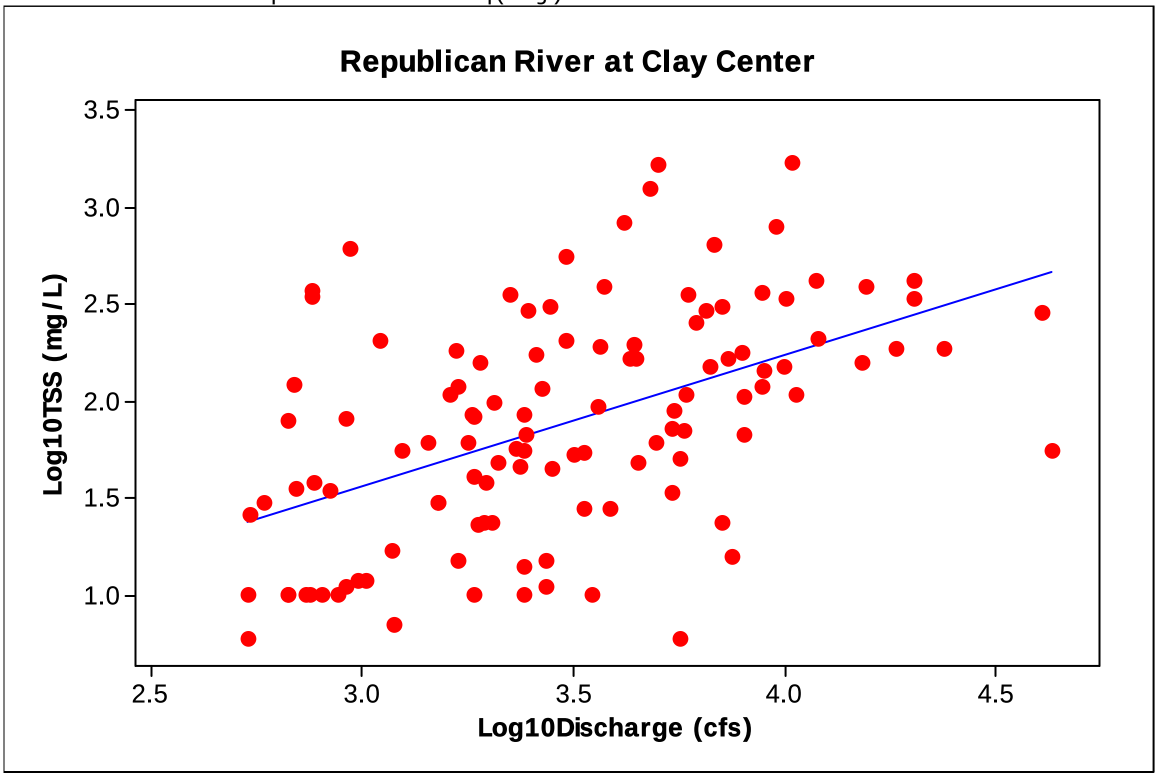
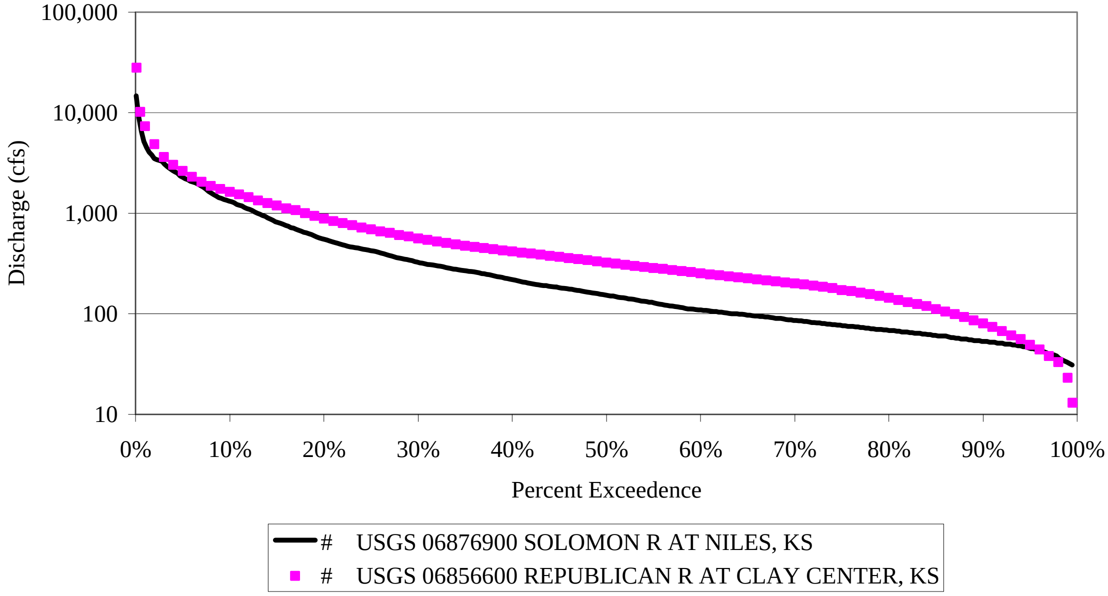


Solomon (Niles) Gage & Republican (Clay Center) Flow Duration Curve



Permit Number	Facility Name	Design Flow (MGD)	TSS Limit (mg/L)	Notes	WLA (tons/day)
I-SO27-PR01	ABRAM READY MIX - MINNEAPOLIS PLANT	0	*		*
I-SO27-PO01	ADA GRAIN ELEVATOR (GRNDWTR REMED)	0	*		*
M-SO06-OO02	BENNINGTON, CITY OF	0.0877	80	Lagoon	0.03
M-SO27-OO02	MINNEAPOLIS, CITY OF	0.2342	80	Lagoon	0.08
I-SO27-CO02	MINNEAPOLIS MUNICIPAL POWER PLANT	0.603	10	Peaking	0.03
P-SO27-OO01	C&R PLATING	0	*		*
M-SO11-OO02	DELPHOS, CITY OF	0.065	80	Lagoon	0.02
I-SO44-PO02	CLOUD CERAMICS - #C-53 & #C-54, #184	0	*		*

Permitted NPDES discharges in the contributing area. Specific daily loads are noted elsewhere in the appendix. *- meet compliance levels specified in permit when discharges occur.

Permit Number	Total Animals	Animal Type
956	85	Beef
A-SOCD-B001	400	Beef
A-SOCD-B003	999	Beef
A-SOOT-B002	600	Beef
A-SOOT-B005	600	Beef
A-SOOT-BA01	300	Beef
A-SOOT-BA02	300	Beef
A-SOOT-BA06	500	Beef
A-SOOT-BA09	100	Beef
A-SOOT-BA10	560	Beef
A-SOOT-BA11	200	Beef
A-SOOT-BA12	290	Beef
A-SOOT-BA14	100	Beef
A-SOOT-BA15	220	Beef
A-SOOT-BA16	100	Beef
A-SOOT-BA17	400	Beef
A-SOOT-BA18	500	Beef
A-SOOT-BA20	300	Beef
A-SOOT-BA23	100	Beef
A-SOOT-BA24	250	Beef
A-SOOT-BA26	300	Beef
A-SOOT-BA27	400	Beef
A-SOOT-BA28	400	Beef
A-SOOT-BA32	800	Beef
A-SOOT-BA33	500	Beef
A-SOOT-BA35	185	Beef
A-SOOT-BA36	200	Beef
A-SOOT-BA37	350	Beef
A-SOOT-BA38	400	Beef
A-SOOT-C001	8000	Beef
A-SOOT-C003	2000	Beef
A-SOOT-C004	2500	Beef
N-SOOT-6360	700	Beef
A-SOOT-C002	1904	Beef,Horses
A-SOOT-B004	700	Beef,Kennel
A-SOCD-M002	50	Dairy
A-SOCD-MA01	30	Dairy
A-SOOT-M002	110	Dairy
A-SOCD-K001	100	Kennel
A-SHOT-S001	210	Swine
A-SOCD-S004	1125	Swine
A-SOOT-S008	802	Swine
A-SOOT-S012	1389	Swine
A-SOOT-S014	1100	Swine

Permitted confined animal feeding operations in the contributing area.