

SMOKY – SALINE RIVER BASIN TOTAL MAXIMUM DAILY LOAD
Water Body: Smoky Hill River near Mentor
Water Quality Impairment: *Escherichia coli* Bacteria (ECB)

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Lower Smoky Hill **Counties:** Ellsworth, McPherson, Rice, and Saline

HUC 8: 10260008 **HUC 10 (HUC12):** 01 (01, 02, 03, 04, 05)
03 (01, 05)

Ecoregion: Central Great Plains/Smoky Hills (27a)
Central Great Plains/Wellington-McPherson Lowland (27d)

Drainage Area: Approximately 335 square miles (**Figure 1**)

Main Stem Segments: WQLS: 13, 14 and 15 (Smoky Hill River) starting near Mentor and extending upstream to headwaters below Kanopolis Lake in south-east Ellsworth County.

Designated Uses: Expected Aquatic Life Support; Primary Contact Recreation (Class B); Drinking Water; Food Procurement; Industrial Water Supply; Groundwater Recharge; Irrigation; Livestock Watering for Smoky Hill River (13, 14 & 15).

Expected Aquatic Life Support; Secondary Contact Recreation (Class b); Drinking Water; Food Procurement; Industrial Water Supply; Groundwater Recharge; Irrigation; Livestock Watering for West Kentucky Creek (54).

Expected Aquatic Life Support; Secondary Contact Recreation (Class b) for Sharps Creek (16), Sand Creek (46), Wiley Creek (47), Paint Creek (52), and Pewee Creek (56).

Expected Aquatic Life Support; Secondary Contact Recreation (Class b) for Kentucky Creek (17).

2008 303(d) Listing: Impaired Lower Smoky Hill River

Impaired Use: Primary Contact Recreation

Water Quality Standard: 262 colony forming units (CFUs) per 100 ml (geometric mean) for Primary Contact Recreation (Class B) in April-October and 2,358 CFUs per 100 ml in Nov-March (KAR 28-16-28e(c)(7)(D)) on the Smoky Hill

River; 3,843 CFUs per 100 ml for Secondary Contact Recreation (Class b) on the tributaries (KAR 28-16-28e(c)(7)(E)).

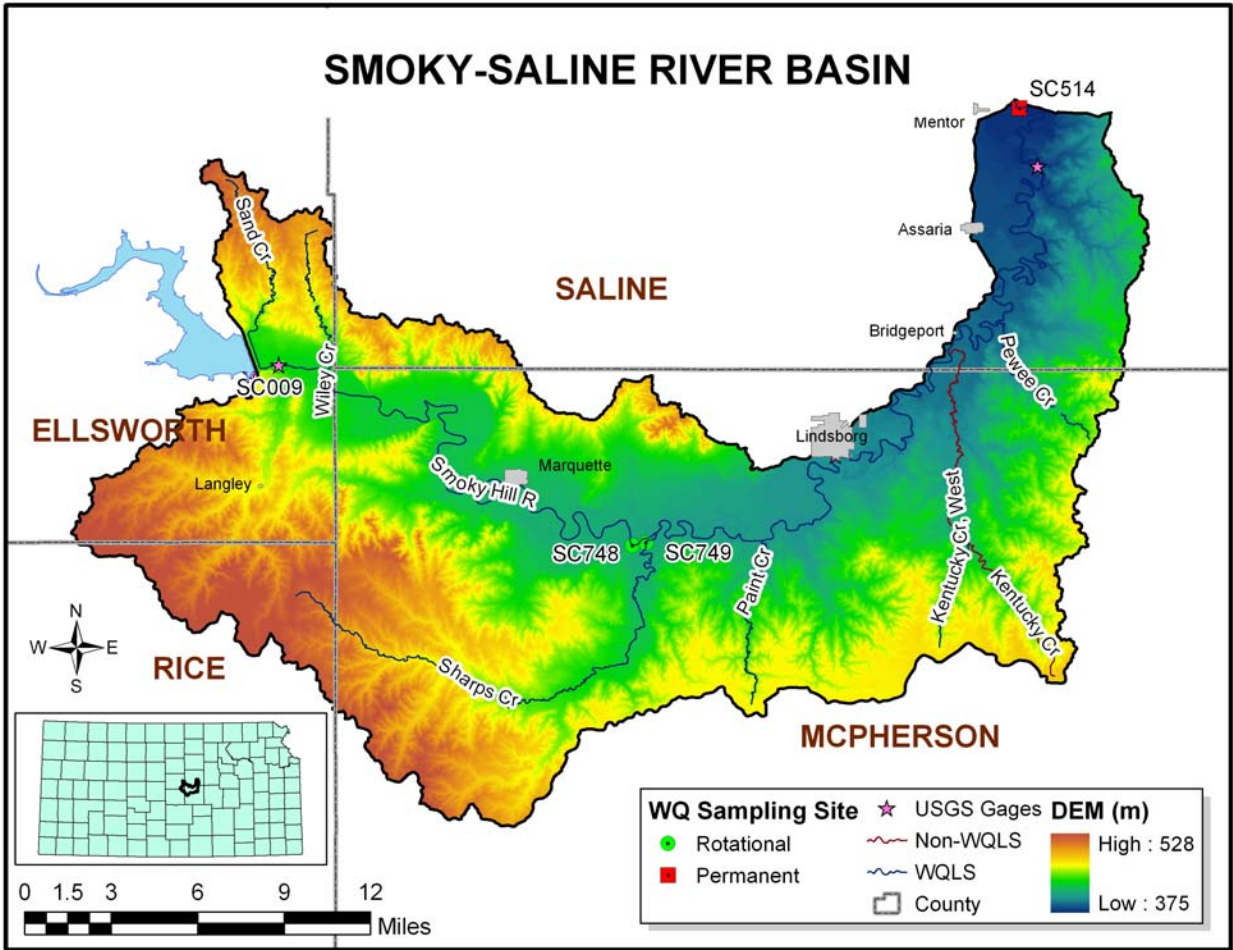


Figure 1. DEM and water quality sampling sites of the Lower Smoky Hill River Watershed.

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 2008 303(d): Not Supporting Primary Recreation Use. Average geometric mean of ECB between April and October from 2003 to 2008 is 282 CFUs/100 ml, ranging from 598 CFUs/100 ml in 2004 to 150 CFUs/100 ml in 2006.

Stream Chemistry Sites: Station SC514, located near Mentor (Figure 1), is a permanent monitoring site and has bimonthly water quality data from 1990 to 2008 [ECB data: August, 2003 – December, 2008 (31 samples); fecal coliform bacteria (FCB) data: March 1990 – June 17, 2003 (78 samples)]. In 2006, four intensive ECB surveys were conducted at this site. Stations SC748 and SC749, located near the confluence of the Smoky River and Sharps Creek, are rotational water quality sampling sites, which have been sampled bimonthly since 2007; Station SC009 (inactive site), located just below Kanopolis Lake, has bimonthly water data from 1985 to 1997.

Flow Record: Smoky Hill River near the city of Mentor (USGS Gaging Station 06866500; 1950 – 2008) was used to determine the flow for Water Quality Monitoring Station SC514. In 2002, USGS relocated this gaging station 11.8 miles upstream, where it is presently located two miles southeast of Mentor. Prior to relocating this station it was located downstream of the Dry Creek tributary near Salina. Flow for station SC514 near Mentor for dates prior to 2002 was determined by utilizing the flow from the USGS 06866500 and subtracting a regression based flow estimate for the Dry Creek tributary derived from USGS (Perry, 2004) since this sampling station is located just upstream of the confluence with Dry Creek. Since 2002 the actual gage readings reflect the flow condition at SC514. For future analysis, the stream flow data from the USGS gaging station 06866500 will be utilized for the flow at KDHE sampling station SC514. USGS did not rename the gage when it was moved since “the contributing drainage area did not increase appreciably” (Rasmussen, 2010).

Long Term Flow Conditions: Smoky Hill River at SC514 near Mentor: Estimated Median Flow = 120 cfs during 1950 – 2008; 10% Exceedance Flow = 1,010 cfs; 25% Exceedance Flow = 315 cfs; 75% Exceedance Flow = 65 cfs; and 90% Exceedance Flow = 40 cfs (**Figure 2**). Monthly streamflow values are shown in **Figure 3**.

Smoky Hill R. Flow near Mentor

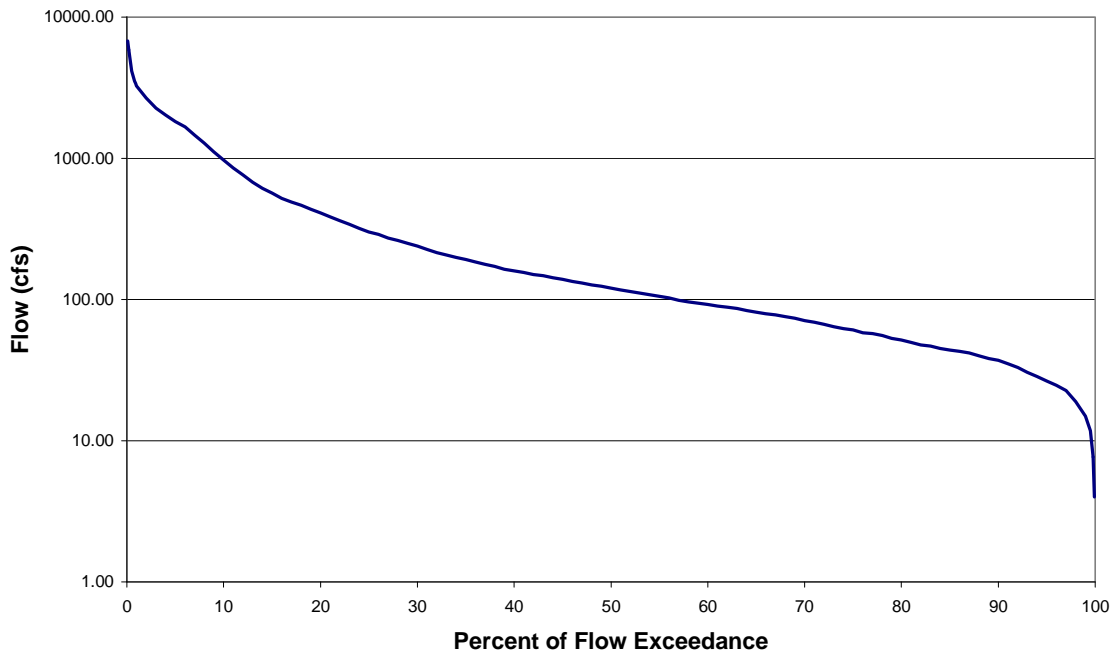


Figure 2. Flow duration curves for Smoky Hill River Mentor for the period of record (1950-2008).

Current Condition: The Kansas Department of Health and Environment adopted ECB criteria recommended by EPA to replace FCB in 2003 because ECB are a better health indicator for human illness (USEPA, 1986). Geometric means of ECB concentrations during the April – October period are 598 CFUs/100 ml for 2004, 238 CFUs/100 ml for 2005, 150 CFUs/100 ml for 2006, 189 CFUs/100 ml for 2007, and 233 CFUs/100 ml for 2008. The Smoky Hill River at Site SC514 was sampled intensively (5 times in a 30 day period) four times (April, June, Aug, and October) in 2006 to determine impairment under the new standard. Of these intensive surveys, June’s survey had a geometric mean of 393 CFUs/100 ml, which was over the ECB criterion of 262 CFUs/100 ml for the Primary Contact Recreation “Class B” use. In order to have a complete data analysis and develop a comprehensive bacteria TMDL, the previous FCB data was converted to the ECB using a recent comparative FCB and ECB study (Rasmussen and Ziegler, 2003) (**Figure 4**). The regression equation used in this study for estimating the ECB from 1990 to 2003 was $\text{Log}_{10} \text{ ECB} = 0.960 * \text{log}_{10} \text{ FCB} + 0.00780$ ($p < 0.01$, $R^2 = 0.93$). Approximately, 80% of FCB are ECB.

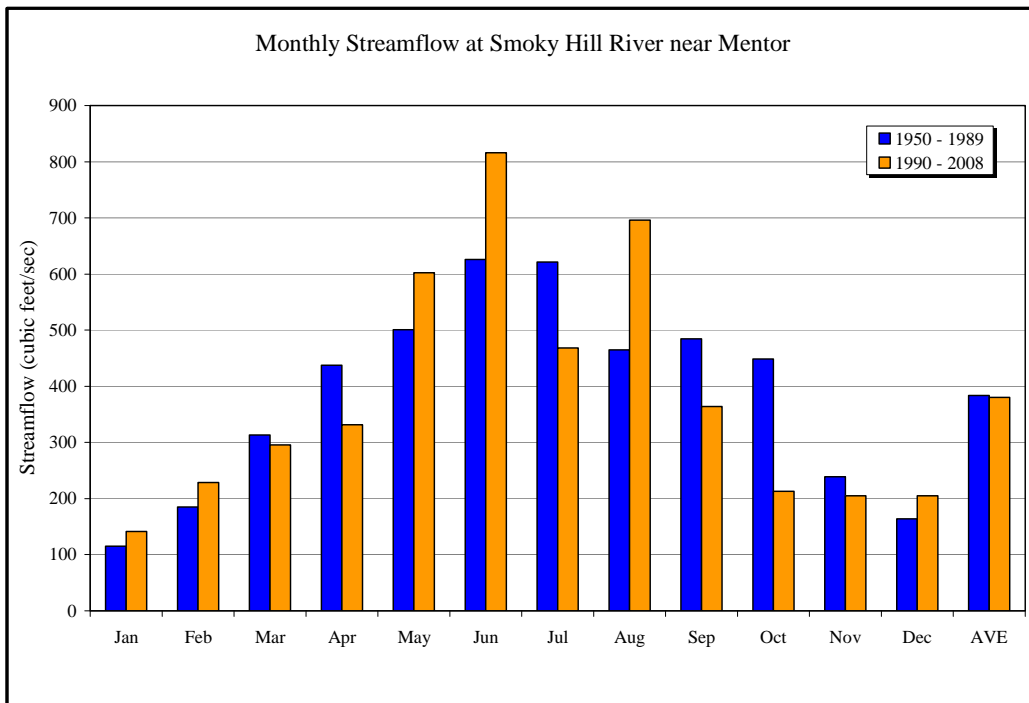


Figure 3. Monthly streamflow at Smoky Hill River near Mentor.

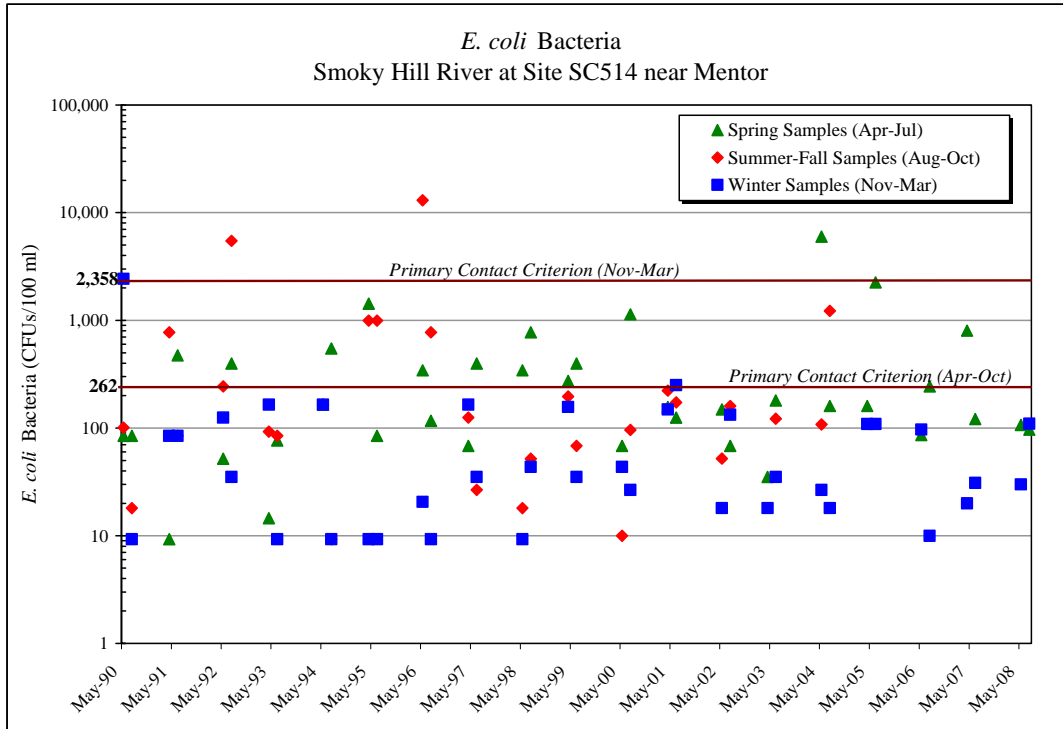


Figure 4. *E. coli* bacteria for Site SC514 near Mentor during the period of 1990 – 2008. The primary contact recreation criteria are a geometric mean of 262 CFUs/100 ml for Apr – Oct and 2358 CFUs/100 ml for Nov – Mar.

Because loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. Sample data for the sampling sites were categorized for each of the three defined seasons: Spring (Apr – Jul), Summer-Fall (Aug – Oct), and Winter (Nov – Mar). High flows and runoff equate to lower flow durations; baseflow influences generally occur in the 75-100% exceeded flow range while the effect of point sources primarily occur in the 95-100% exceeded flow range. Load curves were established for the ECB criteria by multiplying the flow values along the curves by the applicable criterion and converting the units to derive a load duration curve of billions of CFUs of ECB per day. These load curves represent the TMDL since any point along the curves represents water quality for the associated standard at that flow. The digressions from the water quality standards are seen as plotted points above the load curves. Water quality standards are met for those points plotting below the applicable load duration curves.

Figure 5 shows ECB for the Ambient Monitoring Station (Site SC514) in the Smoky Hill River near Mentor from 1990 to 2008, along with the four intensive bacteria surveys conducted in 2006 (**Appendix A**). There were a total of twenty-three ECB digressions recorded during the period of 1990 – 2008. The percentage of ECB samples over the criteria of 262 colonies/100 ml in Apr – Jul was about 61% (**Table 1**). Seventy-four percent of these bacteria digressions occurred during the high flow conditions between 10 and 50% flow exceedance.

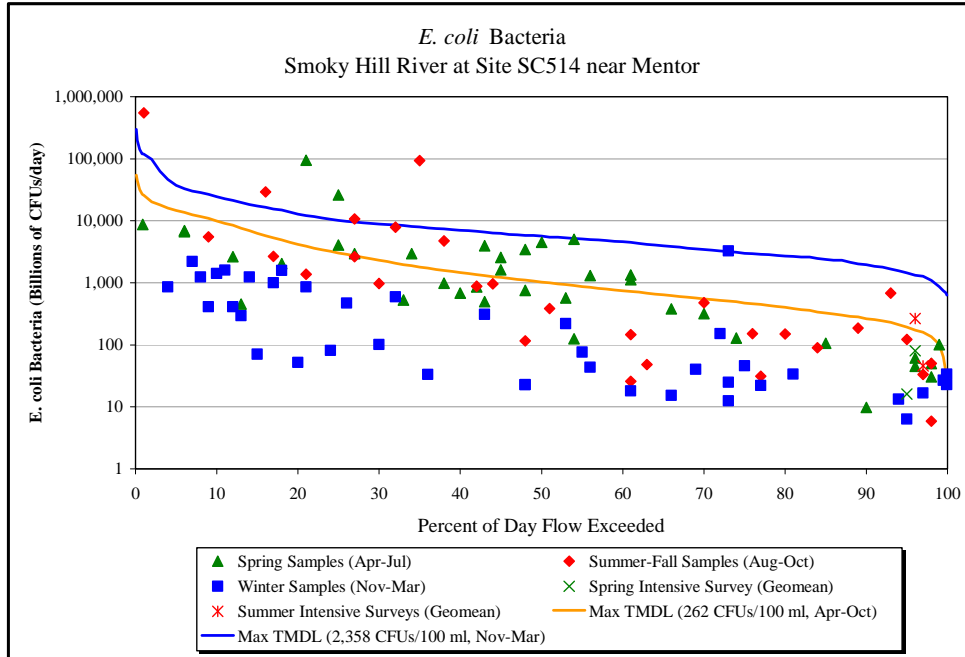


Figure 5. *E. coli* bacteria values at Site SC514 near Mentor during the period of 1990 – 2008. The Primary Contact Recreational Class B criteria are a geometric mean of 262 CFUs/100 ml for Apr – Oct and 2,358 CFUs/100 ml for Nov – Mar for five samples collected in a 30-day period.

Table 1. Number of samples above the ECB criterion of 262 CFUs/100 ml by flow exceedance.

Month	Flow	Number of samples above the Primary Contact Recreation Criterion						Cum. Freq
		0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	
Apr – Jul		0	5	7	0	2	0	14/23 = 61%
Aug – Oct		1	2	3	0	0	2	8/23 = 35%
Nov – Mar		0	0	0	0	1	0	1/23 = 4%

Changes in ECB levels are closely associated with total suspended solids (TSS) concentrations (**Figure 6**). The ECB levels increase as the TSS concentrations increase, suggesting that hydrology (i.e., storm runoff) plays an important role affecting the ECB levels. The appearance of the highest seasonal geometric mean of ECB (186 CFUs/100 ml) in the spring coincides with the highest streamflow (11,374 cfs) while the lowest ECB levels (45 CFUs/100 ml) occurs when the streamflow is the lowest during the winter (3,158 cfs) (**Figure 7a**).

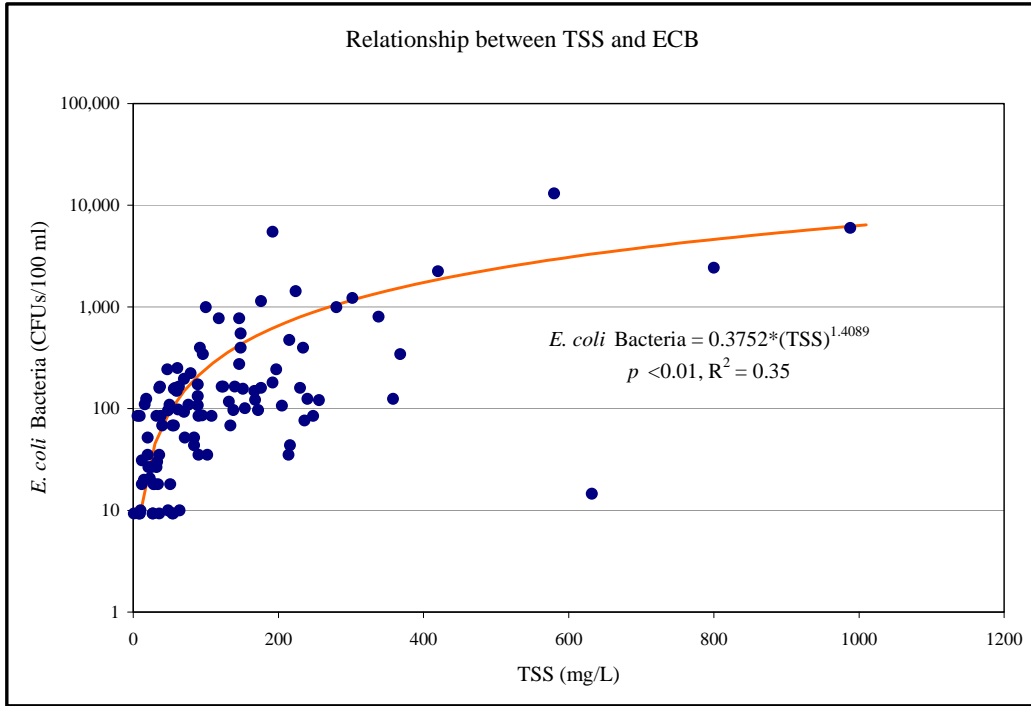


Figure 6. The relationship between TSS and ECB at Site SC514 near Mentor during the period of 1990 – 2008.

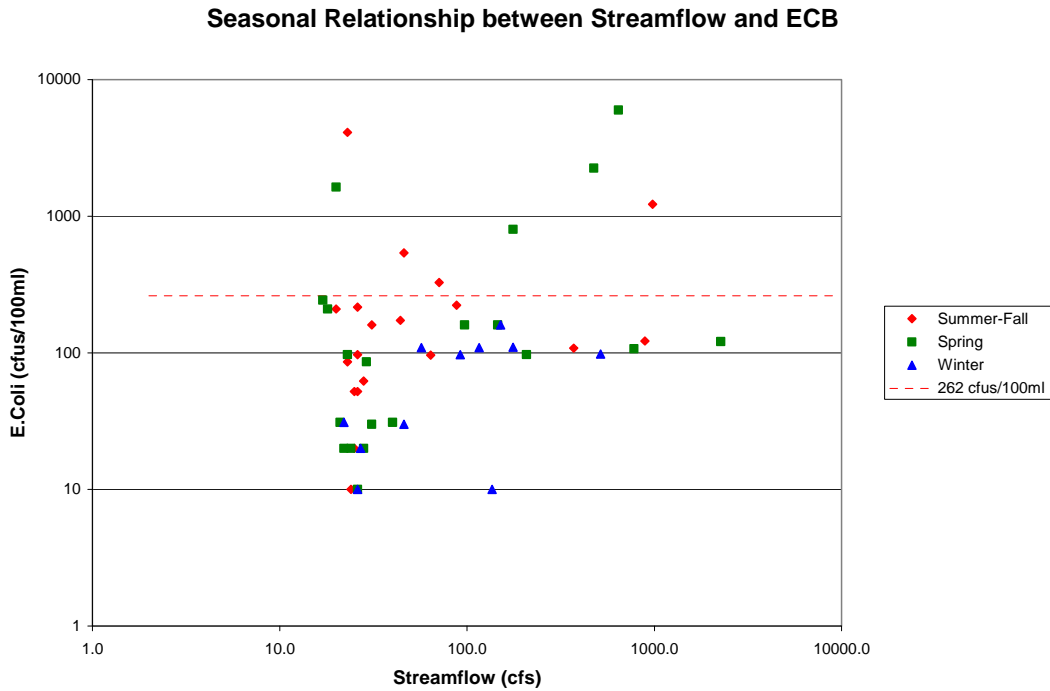


Figure 7a. The seasonal relationship between streamflow and detected ECB at Site SC514 (near Mentor) during the period of 2003 - 2008.

Rotational Water Quality Sites SC748 and SC749 are located on the Smoky Hill River near Marquette and Sharps Creek, respectively. Both sampling sites were sampled starting in 2007. Sharps Creek is designated as a Secondary Contact Recreation stream and the State has a Secondary Contact Recreation standard of a geometric mean of 3,843 CFUs per 100 ml (Jan – Dec) taken from at least five samples taken within a 30-day period for Class b stream segments. **Table 2** summarizes ECB and other selected water quality parameters for these two monitoring sites. As indicated in the table, high flow appears to be a factor that contributes to the elevated ECB in July.

Table 2. Summary of flow exceedance and selected water quality parameters for Sites SC748 and SC749 located on the Smoky Hill River and Sharps Creek, respectively.

Date	% flow Exceed	ECB (CFUs/100 ml)	Conductivity (µS/cm)	Total P (mg/L)	TSS (mg/L)	TOC (mg/L)	TKN (mg/L)	Total Hardness (mg/L as CaCO ₃)
<i>SC748</i>								
1/29/2007	97.0	10	1339	0.125	90	6.52	0.96	353
3/26/2007	97.0	63	1156	0.041	15	5.82	0.59	319
5/21/2007	4.0	41	627	0.201	100	7.63	1.25	182
7/30/2007	23.0	19179	286	1.065	1308	8.28	3.52	243
9/24/2007	26.0	122	766	0.178	10	5.92	0.64	241
11/26/2007	66.0	41	1001	0.053	14	4.98	0.49	346
<i>SC749</i>								
1/29/2007	97.0	359	586	0.211	10	7.59	1.07	267
3/26/2007	97.0	862	753	0.222	10	7.19	0.97	354
5/21/2007	4.0	110	838	0.256	16	10.19	1.19	359
7/30/2007	23.0	4352	249	0.714	124	10.17	1.93	115
9/24/2007	25.0	134	849	0.375	18	5.66	0.58	399
11/26/2007	66.0	52	974	0.104	10	5.46	0.47	477

E. Coli Index values for individual samples are computed as the ratio of the sample count to the contact recreation criteria. An index value of one or below indicates the sample was below the criterion. The calculated index is the natural logarithm of each sample value taken during the April-October primary recreation season, divided by the natural logarithm of the bacteria criteria (262 cfus/100ml). Plotting the ECB ratio against the percentile for each individual sample within the respective data set illustrates the frequency distribution and magnitude of the bacteria impairment for the sampling location. Higher bacteria frequencies are evident when the ECB index values (or ratios) are over one for an extended percentage of the data set. The E. Coli index values for the Smoky Hill River at Mentor and Salina are illustrated in Figure 7b, which indicates the frequency of E.Coli concentrations over the criteria are similar between the sampling locations at Salina and Mentor along the Smoky Hill River. The magnitude is assessed by noting how high the ratios are for the samples with ratios greater than one within the data set. Currently, about 80% of the ECB index values along the Smoky Hill River at Mentor are below one.

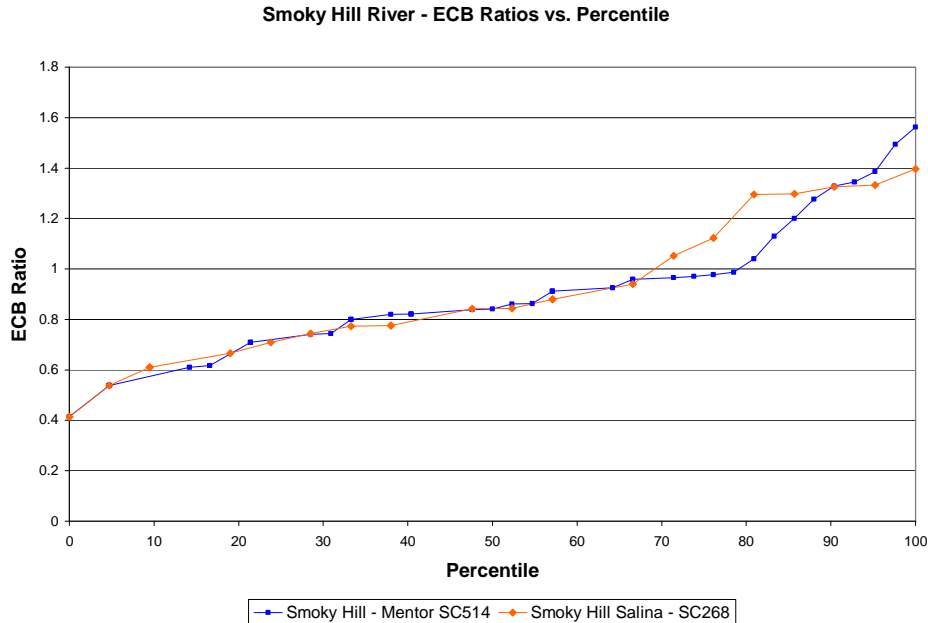


Figure 7b. The relationship between the ECB ratio and the respective percentile within the datasets for each ECB sample collected at KDHE stream chemistry Stations SC514 and SC268 during the Primary Contact Recreational season (Apr-Oct).

Desired Endpoints of Water Quality at Site 514 Over 2011 – 2016:

The endpoints for this TMDL will be to achieve the Kansas Water Quality Standards which fully support Primary Contact Recreation Uses. Under Kansas Law, stream segments classified for the Primary Contact Recreation Use (class B) shall support moderate full body contact from activities including kayaking, mussel harvesting, swimming, skin diving, water skiing, and wind surfing during the recreational season (Apr – Oct). During the non-recreational season, the Primary Contact Recreation Use non-recreational season criteria will apply. The 30-day geometric means, particularly during April-October, should be seen under all flow conditions on the Smoky Hill River.

The endpoints will be reached as a result of collective reductions in bacteria loading from the various sources in the watershed, resulting from the implementation of corrective actions and best management practices, as directed by this TMDL. Achievement of the endpoints indicates either bacteria loads are within the loading capacity of the stream, water quality standards are attained, or full support of the designated uses of the stream has been restored. For the Smoky Hill River, these endpoints are 262 CFUs/100 ml for the recreation season from April to October and 2,358 CFUs/100 ml for non-recreational season between November and March. As a result, the ECB index values will shift downward over an extended period of time and the percentage of samples below the index value of one will increase.

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: There are five NPDES permitted facilities (four municipal and one industrial) within the watershed (**Figure 8**). Three municipal wastewater treatment plants (Assaria, Lindsborg, and Marquette) directly discharge to the Smoky Hill River and may contribute significant ECB loads that can affect downstream water quality at Site 514 during the baseflow and in particular low flow periods (**Table 3**).

The permit for the City of Lindsborg is a two phase permit that has a description and design flow for their current facility, along with a description of an upgraded design with additional improvements. The upgraded facility expands their design flow to 0.55 MGD when this is completed.

The Post Rock RWD Public Water Supply permit does not have any bacteria limits and does not require any sort of bacteria monitoring. This facility treats raw water with lime, aluminum, various polymers, chlorine dioxide, fluoride, ammonia sulfate, and polyphosphate as it passes through the various treatment processes.

Table 4 shows the observed ECB values and permits for the three municipal wastewater NPDES facilities. The NPDES permits for Assaria and Marquette WWTP facilities requires quarterly *Escherichia coli* bacteria sampling, but there are no specific ECB limits within the permits. The City of Marquette typically only discharges one quarter out of the year based on their discharge monitoring reports. They have only sampled for ECB twice, with both samples being high for the respective times of the year. The bacteria permit limit for Lindsborg is a monthly geometric average of 160 CFUs/100 ml during April through October and a monthly geometric average of 2,358 CFUs/100 ml during November through March. The Lindsborg permit requires the city to monitor their effluent ECB concentrations every month.

Table 3. NPDES permitted facilities located upstream from Site 514 in the Smoky Hill River Watershed.

WWTP	Permit #	Stream Reach	Segment	Design Flow	Type	Permit Expired
Assaria	M-SH02-OO01	Smoky Hill R.	14	0.0414 MGD	2-Cell Lagoon	9-30-2014
Ellsworth Co. RWD	I-SH53-PO01	Unnamed Tributary to	15	0.0255 MGD	Single Cell Lagoon	12-31-2010
1 – Post Rock		Smoky Hill R.				
Lindsborg	M-SH21-OO01	Smoky Hill R.	14	0.4180 MGD**	Oxidation ditch	9-30-2014
Marquette	M-SH25-OO01	Smoky Hill R.	15	0.0670 MGD	3-Cell Lagoon	6-30-2014
MP CO. Rest Area	M-SH21-NO02	Non-Discharging	-	-	Non-Overflowing	12-31-2014

* - Assaria has a design flow of 0.060 MGD, but only has permitted flow of 0.0414 MGD

** - Lindsborg has a current design flow of 0.418 MGD. When upgrades and improvements take place their design flow will be 0.55 MGD.

The McPherson County Rest Area permit is a non-overflowing facility and is prohibited from discharging, though it may contribute a nutrient load under extreme precipitation or flooding events. Such events would not occur at a frequency or for duration sufficient to cause impairment in the watershed.

Table 4. Observed ECB values for the three municipal wastewater NPDES facilities.

WWTP	Recreational Season Measured Values (CFUs/100 ml) April – October		Winter Season Measured Values (CFUs/100ml) November - March	
	Date of Sample	ECB	Date of Sample	ECB
		(CFUs/100ml)		(CFUs/100ml)
Assaria	7/09/2008	345		
	10/13/2008	345		
	09/07/2009	2428		
	10/06/2009	345		
Lindsborg	07/01/2008	2	11/04/2008	<1
	08/12/2008	<1	12/03/2008	<1
	09/09/2008	<1	01/06/2009	2
	10/09/2008	1	02/03/2009	<1
	04/06/2009	2	03/03/2009	<1
	05/05/2009	<1	11/03/2009	<1
	06/09/2009	1	12/02/2009	2
	07/07/2009	<1	01/05/2010	1
	08/05/2009	<1	02/09/2010	<1
	09/09/2009	1		
	10/13/2009	1990		
Marquette	4/20/2009			980
	10/21/2008			2420

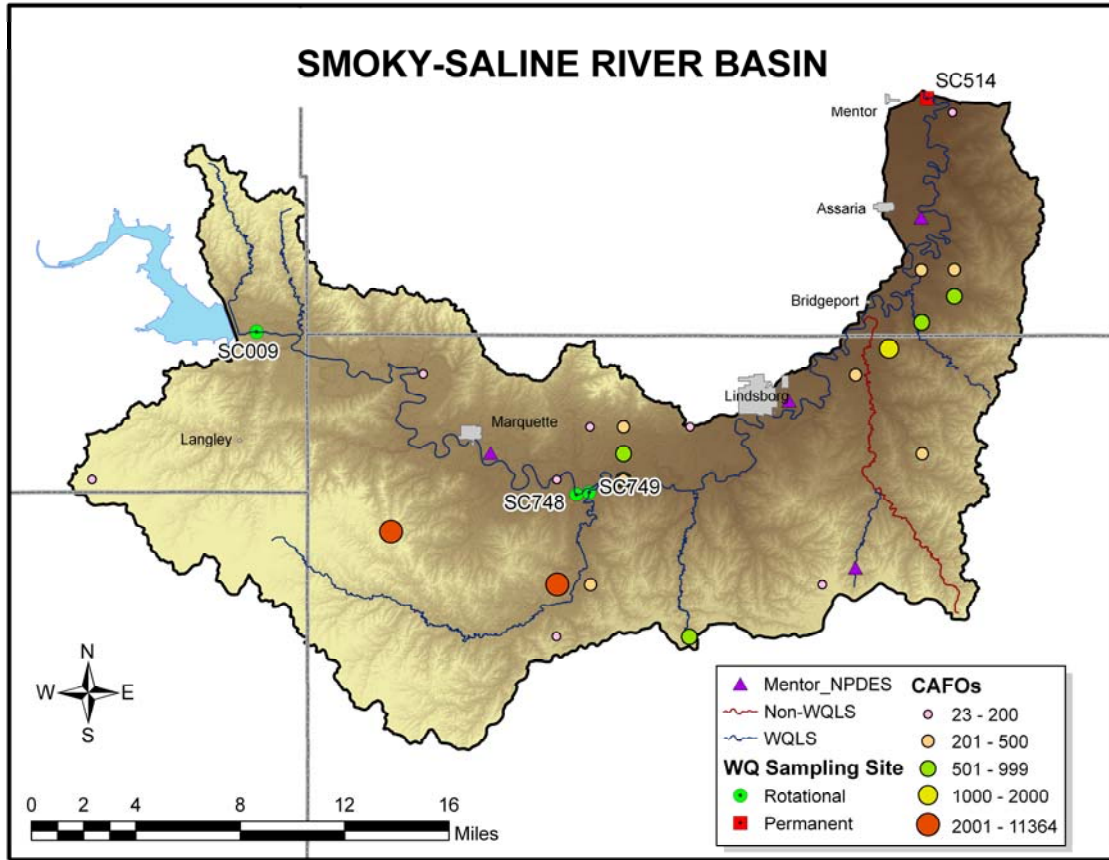


Figure 8. Location of NPDES and CAFO sites in the Smoky Hill River Watershed.

Livestock Waste Management Systems: There are 22 confined animal feedlot operations (CAFOs) that are either certified or permitted, which are primarily located in the east and central portions of the watershed (**Figure 8**). Three of these facilities are also federally permitted facilities. All of these livestock facilities (2 dairy, 16 beef, 3 swine, and 1 mixed of beef and horses) have waste management systems designed to minimize runoff entering their operation or detaining 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 occurring less than 1-5% of time. Though the total potential number of animals is 31,079 head in the watershed, the actual number of animals at the feedlot operations is typically less than the allowable permitted number.

Land Use: The predominant land uses in the Smoky Hill River Watershed are grassland (52%) and cultivated cropland (37%), according to 2001 National Land Cover Data. Together, they account for 89% of the total land area in the watershed. Approximately 4% of the land is occupied by deciduous forest, whereas pasture/hay accounts for about 0.5% of the total watershed area. Urban area, such as residential, commercial and industrial uses as well open space like roads and lawn grasses, comprises about 5% of the watershed (**Figure 9**).

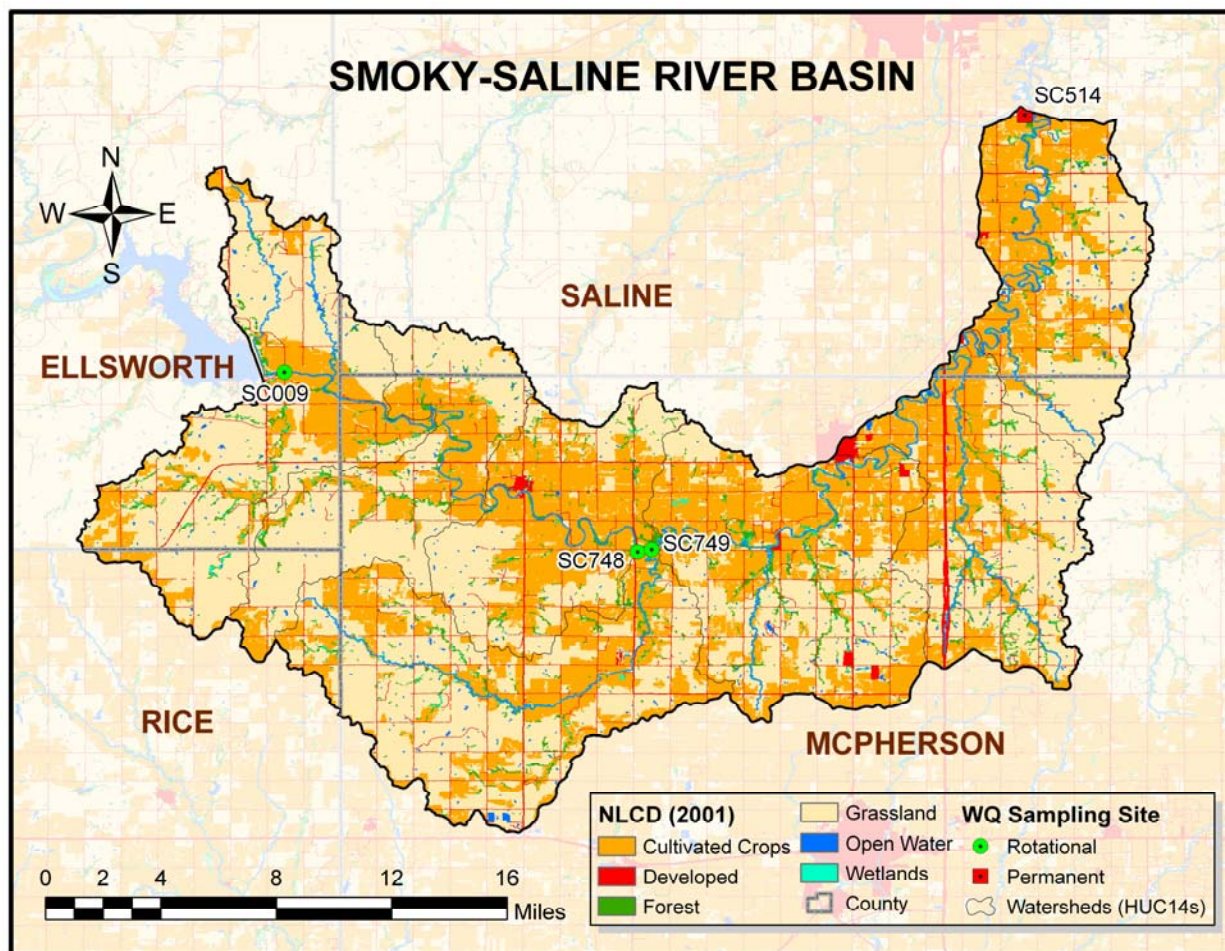


Figure 9. Land use and land cover map (2001 NLCD) of the Smoky Hill River Watershed.

The grassland and pastured areas occupy more than half of the watershed area (52%), and therefore the grazing density of livestock is moderate in summer and high in winter. According to the National Agricultural Statistics Service, numbers of agricultural animals in the watershed are shown in **Table 5**. The watershed area located in the McPherson County has the highest livestock number (12,922 head), with a grazing density of 0.18 head/acre. The grazing density values for the areas located in Ellsworth, Rice and Saline Counties are 0.06, 0.07, and 0.10 head/acre, respectively.

Table 5. Agricultural animals in the Smoky Hill River Watershed, based on USDA, 2002 Census of Agriculture.

County	Beef	Dairy	Swine	Sheep	Horse	Chicken	Turkey	Duck
Ellsworth	1,152	0	29	46	26	29	0	0
McPherson	3,781	294	7,502	1,101	239	0	0	6
Rice	244	1	279	14	9	0	0	0
Saline	1,163	11	59	37	64	48	0	0
Total	6,340	306	7,869	1,198	338	77	0	6

On-Site Waste Systems: The population density of the watershed is 11.5 people per square mile. Most of the people live in the urban areas where the public sewer systems are used. The population changes for the three cities within the watershed are shown in **Table 6**. Though many septic systems are scattered in the watershed, the failing rate of these systems is 0.93% (National Environmental Service Center, 1998). The failing septic systems are seen as a minor source of ECB loading to the Smoky Hill River.

Table 6. Expected population change for the cities of Assaria, Lindsborg, and Marquette from 2000 – 2020.

City	Population (2000)	Changes (%)
Assaria	408	2.2
Lindsborg	3,501	24.9
Marquette	589	-1.5

Contributing Runoff: **Figure 10** shows soil permeability values across the watershed, based on NRCS STATSGO database. The watershed-wide soil permeability averages 1.07"/hr. According to an USGS open-file report (Juracek, 2000), the threshold soil-permeability values that represent very high, high, moderate, low, very low, and extremely low rainfall intensity, were set at 3.43, 2.86, 2.29, 1.71, 1.14, and 0.57"/hr, respectively. The lower rainfall intensities generally occur more frequently than the higher rainfall intensities. The higher soil-permeability thresholds imply a more intense storm during which areas with higher soil permeability potentially may contribute runoff. Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As soil profiles become saturated, excess overland flow is produced.

For the Smoky Hill River Watershed, about 98% of the total area has soil permeability value either less than or equal to 1.71"/hr. Under the very low (1.14"/hr) runoff condition, the potential contributing area is about 43%. Storms that produce 0.57"/hr of rain will generate runoff from 20% of the watershed area, which is dominated by both cropland (47%) and grassland (42%).

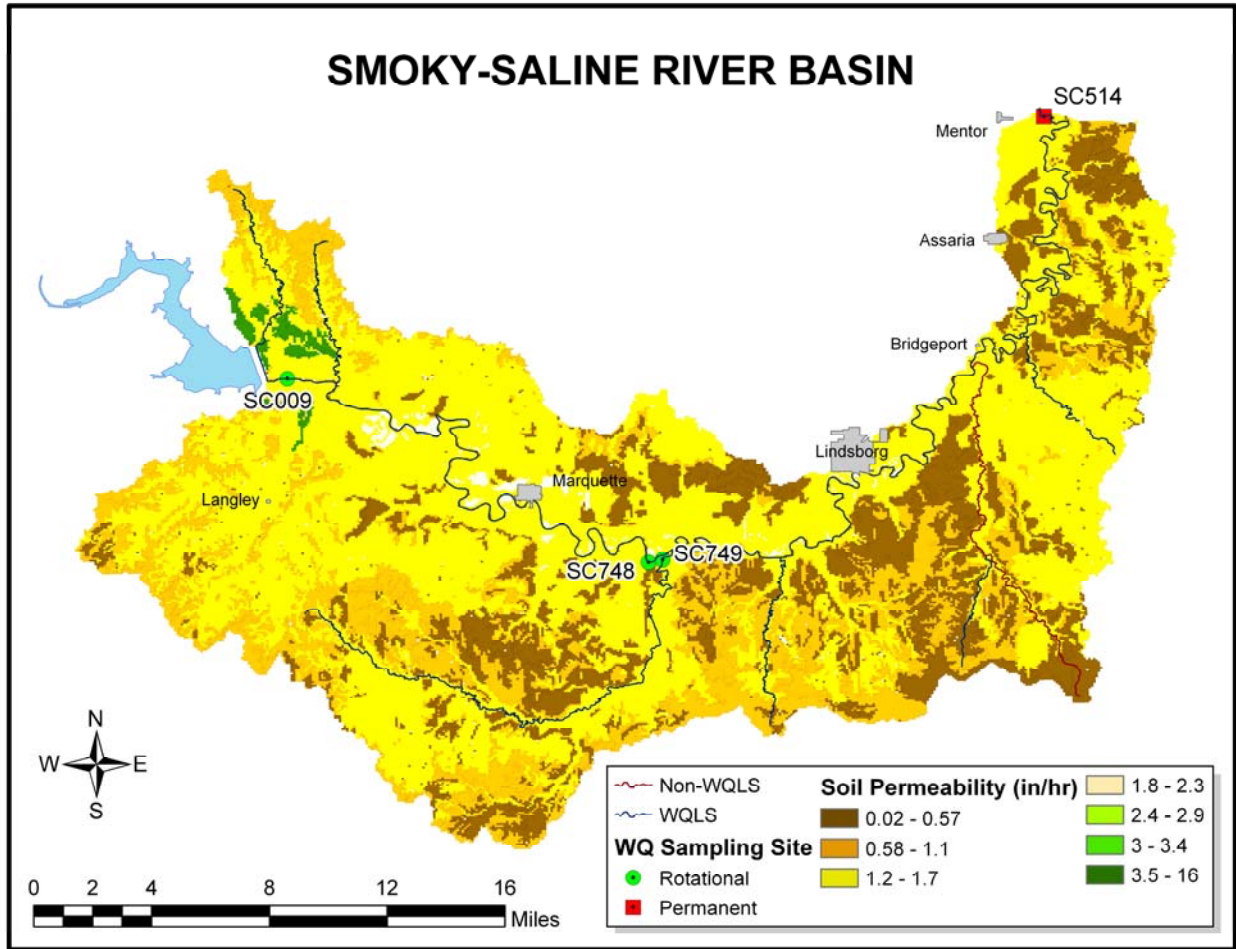


Figure 10. Soil permeability of the Smoky Hill River Watershed.

Background Levels: Approximately 3% of land in the watershed is forest. Therefore, waste from wildlife animals (e.g., deer, birds, and raccoons) that run off the landscape during rain storms may be minor contributors to the ECB loading.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

Point Sources: This allocation is associated with the wastewater treatment facilities and is based on the bacteria limits established in the City of Lindsborg’s NPDES permit. Ongoing inspections and monitoring of these NPDES sites will be made to ascertain the contributions that have been made by the source. These wastewater treatment facilities should comply with any future permit conditions. The total Waste Load Allocation (WLA) for the four wastewater treatment facilities is 3.19 billion CFUs per day from April through October, based on a discharge limit of 160 CFUs/100ml. The WLA for these facilities is 47 billion CFUs per day from November to March (**Figure 11**), based on a discharge limit of 2,358 CFUs/100ml. The WLAs for these individual facilities are listed in **Appendix B**. In general, WLA is established for the low flow conditions which are most susceptible to impact from point source discharges. For the Smoky Hill River, the 7Q10 value (10.2 cfs, 1950 – 2008) occurs 0.3% of time and is an

order of magnitude greater than the combined designed flow (0.85 cfs). Therefore the effect of point sources typically occur in the 95-100% exceeded flow range.

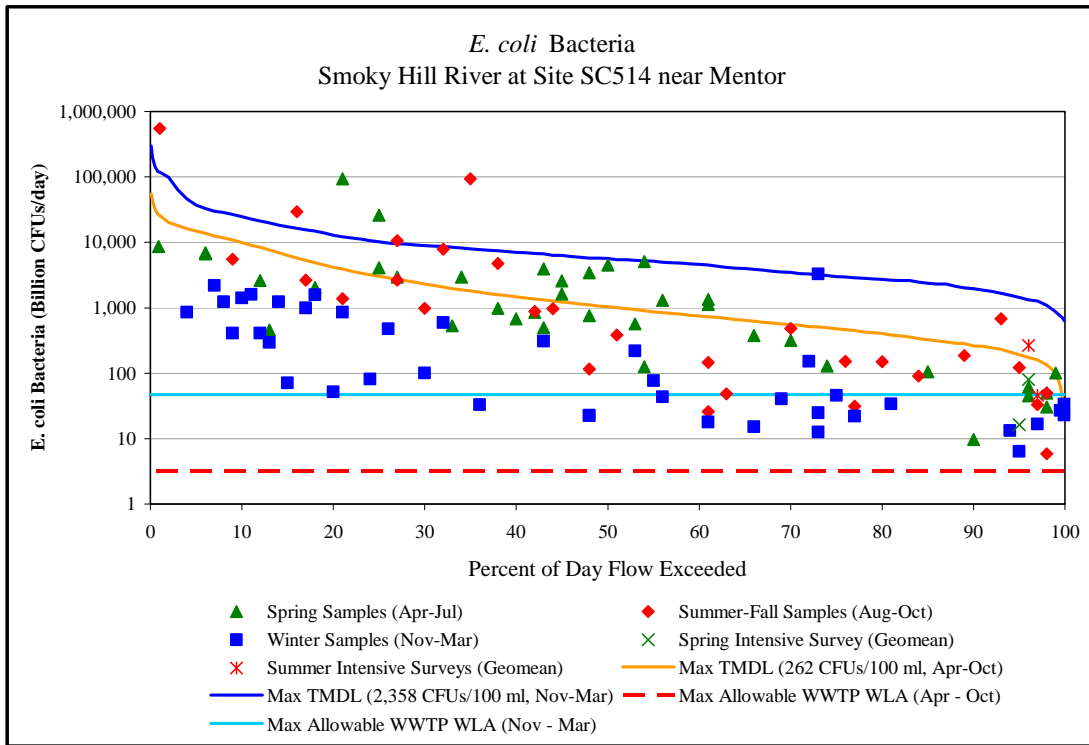


Figure 11. TMDL with WLA for the Smoky Hill River at Site 514.

NPDES and state certified or permitted non-discharging livestock waste management facilities will have a WLA of zero, given that these facilities will not discharge to receiving streams throughout the majority of hydrologic conditions, defined by the curve ranging from 5% to 100% of the time. Depending on the real extent of the storm creating a 25 year, 24-hour precipitation event, the associated stream flows would be exceeding less than 1 – 5% of the time.

Given the large contributions from any CAFO bypass and non-point sources, substantial reductions would be necessary. There is a need to maintain zero discharge from CAFOs or state permitted facilities to protect water quality, but under extreme high flow conditions, the ability to retain all the runoff from these feeding areas is hydrologically exceeded. Additionally, the ability of best management practices to reduce non-point source contributions under these conditions to levels where the TMDL might be met is elusive. Fortunately, the frequency of such events is low and their duration short, because of the passing of the high flow crest. Recreation use of the stream is unlikely under these extreme high flow conditions. Recreation in and on the stream has been observed in the vicinity of Salina.

One violation was observed in the range of 95-100% flow exceedance during the 2006 intensive summer surveys, suggesting that it was likely associated with direct loading such as effluent from the WWTPs or cattle in the stream. As a result, effluent limits on NPDES permits will

remain in force and any state permits will be conditioned such that discharges from the permitted facilities will not cause violations of applicable bacteria criteria. Ongoing inspections and monitoring of these systems will be made to ensure that minimal contributions have been made by these sources.

Nonpoint Sources: **Table 7** shows the flow conditions occurring in the Smoky Hill River at Site SC514 near Mentor. High flow determined by bankful discharge (1.5-year recurrence interval flow, $Q_{1.5}$) reflects the flood discharging capacity of river channels (Simon et al., 2004), which it indicates that the ECB impairment beyond this discharge value may not be technically and/or economically feasible for management. The bankful discharge of the Smoky Hill River is 1,670 cfs and its corresponding flow exceedance is approximately 6%. Similarly, Stiles and Tate (2008) indicated that in-stream recreation decreased as flow increased, suggesting that an effective bacteria TMDL should emphasize its management activities at lower flows when the probability of human contact with a stream is highest. For example, swimming is constrained by high velocity in the 2-3 feet per second (or a product of velocity and depth exceeds 6) while wading is discouraged when a product of velocity and depth exceeds 10. These respective values are equivalent to 23% and 15% of flow exceedance seen in the river, respectively (**Figure 12**). For management purposes, the upper limit of emphasis will be at 15% flow exceedance for the recreation period from April to October.

Table 7. Smoky Hill River flow conditions and their associated depth and velocity values.

1950 – 2008	Flow Condition					
	Q_2	$Q_{1.5}$	Mean	Median	90 th	7 Q_{10}
Flow (cfs)	2,680	1,670	370	120	37	10.2
Depth (ft)	7.36	5.82	2.74	1.58	0.89	0.46
Velocity (f/s)	3.05	2.62	1.65	1.15	0.79	0.53
Flow Exceedance (%)	2	6	22	50	90	99.7

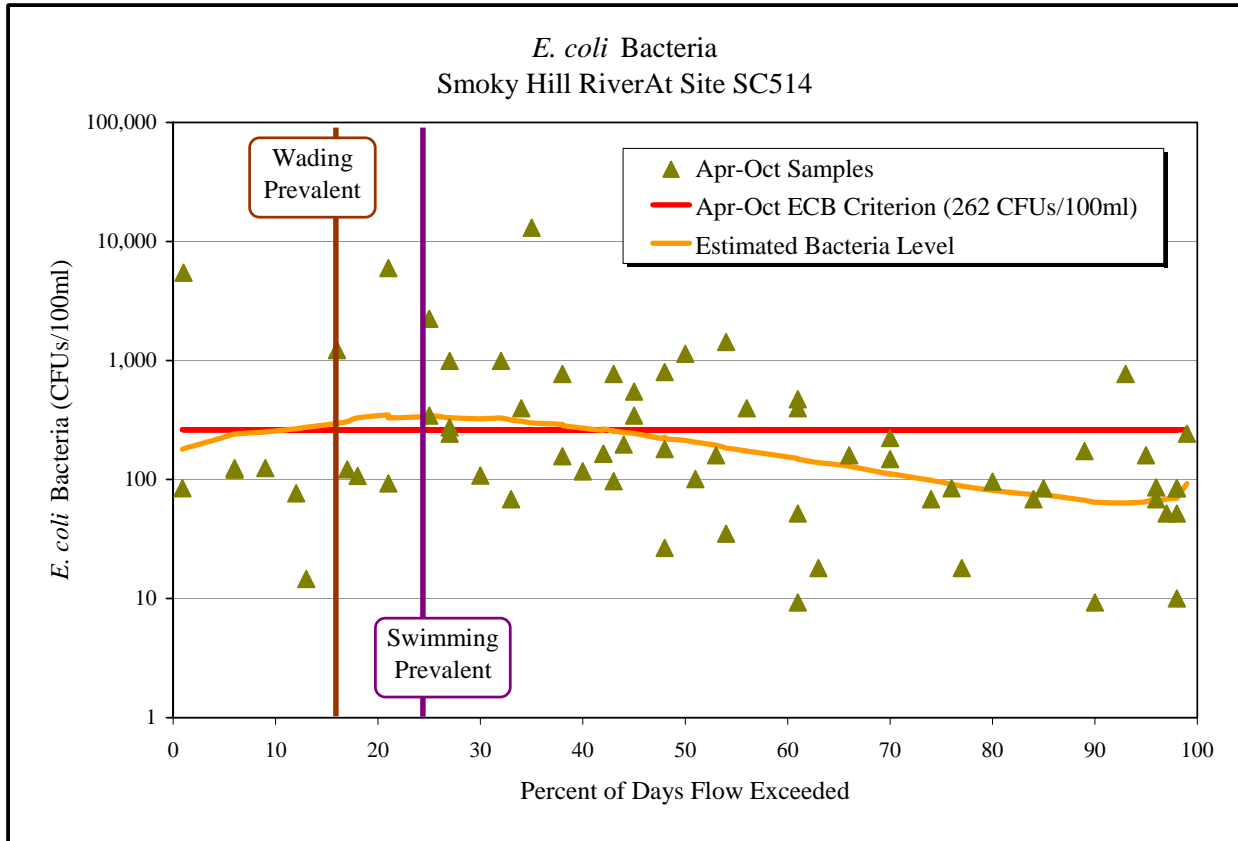


Figure 12. The recreational use (e.g., wading and swimming) of Smoky Hill River in relation to the percent of streamflow exceedance and *E. coli* bacteria levels at Site SC514 near Mentor.

Based on **Figure 11**, excess ECB loadings predominantly come from nonpoint pollution sources. The source assessment suggests that any cropland with manure application and the grazing areas primarily contribute to the elevated ECB pollution in the Smoky Hill River. The bacteria pollution frequently occurs in spring and likely originates from winter feeding areas. The winter feeding operations are agricultural operations where livestock are congregated and raised in small areas in cold weather. As a result, the concentrated feeding sites have a much higher potential than the typical grazing areas to contribute ECB loadings to the streams.

As indicated in **Figure 13**, to manage the nonpoint source ECB loadings, the flow exceedance range from 10% through 60% should be emphasized during the recreation period. A 61% (flow weighted average for the flow exceedance between 15 – 60%) reduction of ECB loadings is required to establish the desired stream conditions in the Smoky Hill River. There has not been any bacteria sample detections over the primary contact recreation (Class B) criterion of 2,358 CFUs/100ml during the months from November to March at SC514.

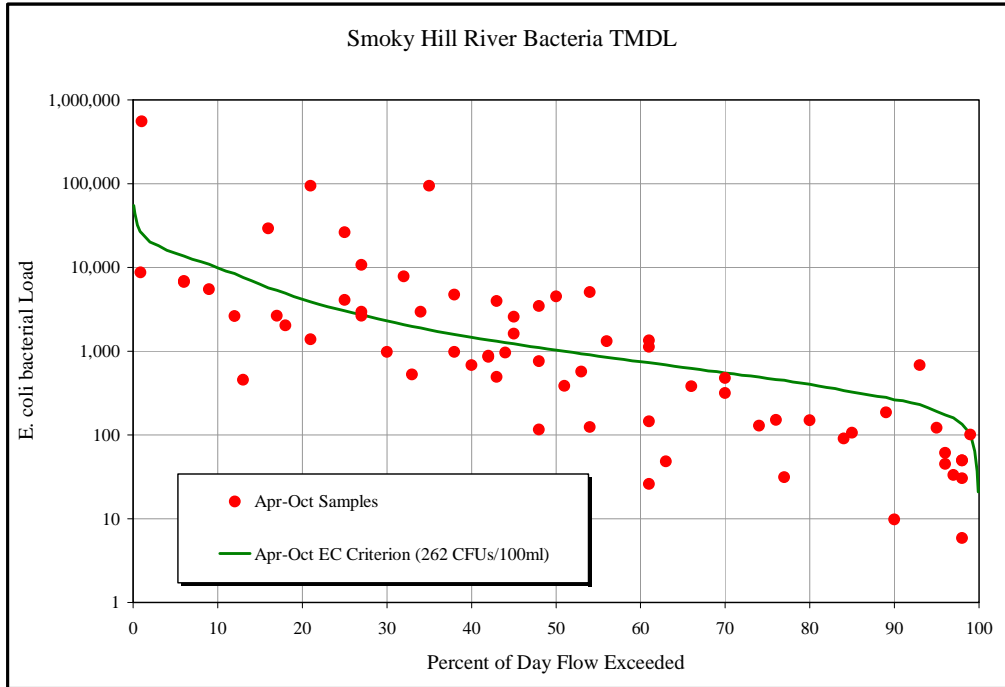


Figure 13. TMDL for the recreational period from April to October based on the flow duration for the recreational season.

Table 8. ECB TMDL for the Smoky Hill River at Site 514 during the Recreational Season from April to October. Flow duration derived from the recreational period from April to October.

Percent Flow Exceedance	Flow (cfs)	TMDL (Billion CFUs/day)	Wasteload Allocation (Billion CFUs/day)	Load Allocation (Billion CFUs/day)
99	15.95	102	3.19	98.81
95	29	186	3.19	183.81
90	40	257	3.19	253.81
60	112.4	721	3.19	717.81
50	155.8	999	3.19	995.81
40	221.4	1419	3.19	1415.81
30	348.2	2232	3.19	2228.81
20	628.4	4028	3.19	4024.81
15	952.5	6106	3.19	6102.81
10	1494.5	9581	3.19	9577.81

Defined Margin of Safety (MOS): The Margin of Safety provides some hedge against the uncertainty in bacteria loading into the Smoky Hill River, predominantly from wet weather sources in the watershed. The margin of safety for this TMDL is implicit, which accounts for conservative assumptions tied to assessing attainment to the primary recreation Class B criterion (262 CFUs/100ml). The TMDL is established using profiles of individual samples against that criterion over time, although the criterion is meant to be assessed by geometric means of samples taken in short (30-day) periods of time. This conservative approach ensures that the water quality standard will be attained as assessing individual sample profiles is much more stringent than assessing the geometric mean. Finally, the waste load allocations were calculated at the existing permit limits (160 CFUs/100 ml) associated with the City of Lindsborg rather than the water quality criterion (262 CFUs/100 ml) for the discharge associated with the three wastewater treatment facilities during the recreational season. The non-recreational season WLA has been established based on the water quality standard of 2,358 CFUs/100ml.

State Water Plan Implementation Priority: Because the Smoky Hill River is a Primary Contact Recreation stream and has a high magnitude of ECB digressions from the water quality standards and apparent actual recreation use, this TMDL will be a High Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Lower Smoky Hill River (HUC 8: 10260008) with a priority ranking of 35 (Medium Priority for restoration).

Priority HUC 12s: There are seven HUC12 subwatersheds in the Smoky Hill River Watershed. **Table 7** summarizes selected watershed conditions that may influence the ECB levels. Site SC748, located at the main stem of Smoky Hill River, is a new monitoring site in Subwatershed 41, which was established on the Smoky Hill River in 2007. The levels of ECB at SC748 were 41 CFUs/100 ml on 5/21/2007, 19,179 CFUs/100 ml on 7/30/2007, and 122 CFUs/100 ml on 9/22/2007 during the recreational period from April through October. The digression at Site SC748 in July was 4 times greater than the digression recorded at Site SC749 (**Table 2**) and three times greater than the largest digression observed at SC514 for the direct ECB measurements during the period from 2003 to 2008 (**Figure 4**). Therefore, Subwatershed 41, along with its upper Subwatershed 39, which has the large percent grassland areas for livestock grazing but very few riparian grassy buffers, is ranked the top priority for management (**Table 9 and Figure 14**). Subwatershed 45 is ranked the lowest priority because the Sharps Creek is a secondary contact recreational stream that has a higher bacteria criterion (3,843 CFUs/100 ml) from January through December and provides little flow contribution to the Smoky Hill River. The medium priorities are given to Subwatershed 25, 40, and 43 because there are high numbers of agricultural animals raised in the counties and moderate amounts of riparian buffer in grassland (**Table 5**).

Table 9. Selected watershed characteristics for prioritizing subwatershed management.

ID	Watershed (%)		100-ft Riparian (%)		WWTP	Rank	Remark
	Cropland	Grassland	Cropland	Grassland			
25	44	46	30	18	Yes	2	Medium Animal # in Co (Table 5)
40	36	50	16	14	Yes	2	High Animal # in Co (Table 5)
43	47	41	6	14	Yes	2	High Animal # in Co (Table 5)
41	48	42	15	3	Yes	1	High ECB Level in 2007 (Site 748)
45	35	56	23	25	-	3	Low ECB Level in 2007 (Table 2)
39	28	65	14	4	-	1	High ECB Level in 2007 (Site 748)
35	26	65	11	56	-	3	Heavy influence of outflow from Kanopolis Reservoir and large grassy buffer area

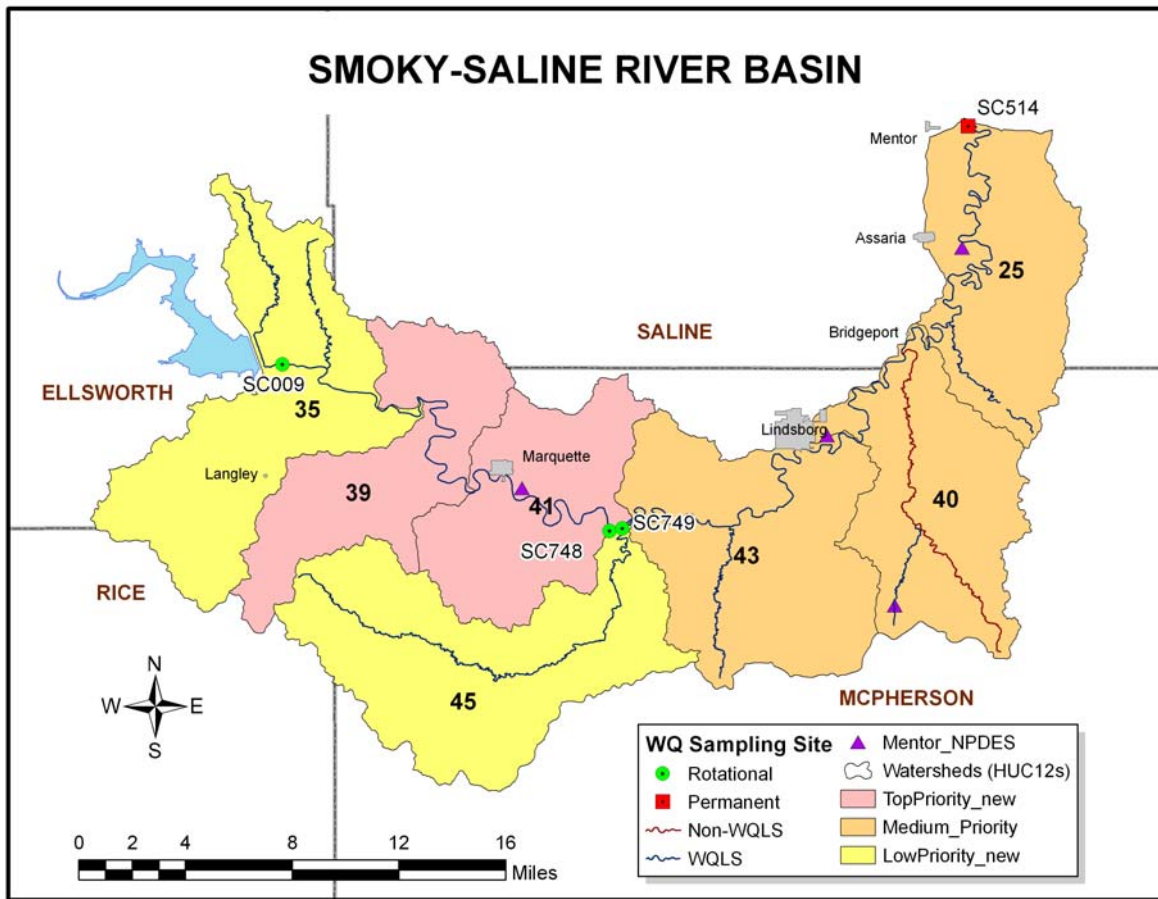


Figure 14. Management priority for the Smoky Hill River Watershed.

5. IMPLEMENTATION

The ECB contamination in the Smoky Hill River primarily occurs in spring and summer-fall seasons, and may be closely associated with livestock operation activities, including winter feeding operations and manure application on cropland. To reduce bacteria contamination and achieve water quality standards, there is a good potential that agricultural best management

practices will improve the water quality in the Smoky Hill River. Some of the recommended practices are as follows.

Desired Implementation Activities

1. Identify winter animal feeding sites and cultivated areas with manure application,
2. Manure management plans need to be developed and implemented to prevent bacteria loading to the river and its associated tributaries,
3. Install grass buffer strips along streams,
4. Remove livestock activities within riparian areas,
5. Maintain the proper size of non-confined animal feeding operations (or develop improve grazing management plans) to minimize their contributions to ECB loadings,
6. Inspect permitted livestock facilities for permit compliance,
7. Identify and restore the failing septic systems,
8. Continue to monitor WWTP facilities for permit compliance with effective disinfection,
9. Initiate comprehensive sampling surveys to provide future information needed for revising this TMDL and direct follow-up correction actions.
10. Initiate stormwater management in Lindsborg to abate bacteria loads.

Implementation Programs Guidance

NPDES-KDHE

- a. Evaluate ECB loadings from all permitted dischargers in the watershed,
- b. Work with dischargers to eliminate individual loadings through disinfection and detention storage.
- c. Initiate stormwater management with Lindsborg.

Local Environmental Protection Program (LEPP) - KDHE

- a. Conduct sanitary survey along the Smoky Hill River to identify potential bacteria sources.

Nonpoint Source Pollution Technical Assistance - KDHE

- a. Support Section 319 demonstration projects for reduction from livestock operations,
- b. Provide technical assistance on practices geared to establishment of vegetative buffer strips,
- c. Provide technical assistance on manure and pasture management in vicinity of streams,
- d. Support Watershed Restoration and Protection Strategy (WRAPS) efforts for the Upper portion of the Lower Smoky Hill River Watershed,
- e. Incorporate the provisions of this TMDL into any Upper Lower Smoky Hill River WRAPS documents, including the 9-element watershed plan.
- f. Support supplemental water quality monitoring and assessment to identify central areas.

Water Resource Cost Share Nonpoint Source Pollution Control Program - SCC

- a. Develop improved grazing management plans,
- b. Install livestock waste management systems for manure storage,
- c. Implement manure management plans,

- d. Install replacement for failing on-site waste systems
- e. Coordinate with USDA/NRCS Environmental Quality Improvement Program in providing educational, technical, and financial assistance to agricultural producers.

Riparian Protection Program - SCC

- a. Design winter feeding areas away from streams,
- b. Develop riparian restoration projects.

Buffer Initiative Program - SCC

- a. Install grass buffer strips near streams,
- b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance - Kansas State University

- a. Educate livestock producers on riparian and waste management techniques,
- b. Provide technical assistance on livestock waste management design
- c. Continue Section 319 demonstration projects on livestock management,
- d. Support outreach efforts by the Upper Lower Smoky Hill River WRAPS.

Time Frame for Implementation: Pollutant reduction practices should be installed within the priority subwatersheds (39 and 41) before 2014, with follow-up implementation, including other subwatersheds over 2014 – 2019. Achievement of the 262 CFUs/100 ml of ECB goal for the Smoky Hill River is set from April through October for 2016 – 2019.

Targeted Participants: Primary participants for implementation will be small livestock producers operating without need of permits within the priority watershed. Implemented activities should be targeted at those areas with greatest potential to impact the river. Nominally, this would be activities located within one mile of the river including:

1. Facilities with inadequate water quality controls,
2. Unpermitted permanent feeding/holding areas,
3. Sites where drainage runs through or adjacent to livestock areas,
4. Sites where livestock have full access to contributing tributaries and the river is primary water supply,
5. Grazed acreage, overstocked acreage and acreage with poor range condition,
6. Poor riparian sites,
7. Near stream feeding sites,
8. Failing on-site waste systems in proximity to listed segments and feeder tributaries.

Some inventory of local needs should be conducted in 2010 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 river and its tributaries in the watershed during the implementation period of this TMDL.

Milestone for 2014: The year 2014 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, sampled data from the Smoky Hill River should indicate evidence of reduced ECB levels relative to the conditions seen over 2003 – 2008.

Delivery Agents: The primary delivery agents for program participation will be 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 and Lower Smoky Hill River WRAPS. Implementation decisions and scheduling will be guided by planning documents prepared through Lower Smoky Hill River WRAPS.

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.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.
4. 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.
5. 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.
6. 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.
7. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan*.
8. The *Kansas Water Plan* and the Smoky Hill 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 through the WRAPS program. This watershed and its TMDL are a High Priority consideration.

Effectiveness: Bacteria reduction has been proven effective through livestock waste management and use of buffer strips. The key to success will be widespread utilization of riparian management within the subwatersheds cited in this TMDL.

6. MONITORING

Ongoing monitoring at Site SC514 will continue and water quality samples will be collected bimonthly. Future stream sampling will also occur bimonthly at rotational sites (SC748 and SC749) in 2011, 2015, and 2019. Monitoring of tributary levels of ECB during runoff events will help direct abatement efforts toward major contributors. Additionally, tracking of ECB loadings from the existing municipal systems should be done to confirm their small contribution to the river. Intensive geomean sampling will occur in 2018.

7. FEEDBACK

An active Internet Web site was established at <http://www.kdheks.gov/tmdl/> to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Smoky Hill – Saline River Basin. The draft TMDL was posted on January 25, 2010.

Public Hearing: Public Hearings on this TMDL will be held in Assaria on February 11, 2010.

Discussion with Interest Groups: The Watershed Management Section staff of KDHE was briefed on the implications of this TMDL in October, 2009, and the Upper Lower Smoky Hill River WRAPS on August 13 and October 22, 2009.

Basin Advisory Committee: The Smoky Hill – Saline River Basin Advisory Committee met to discuss the TMDLs in the basin on July 7, 2009 in Hays and October 1, 2009 in Hays.

Milestone Evaluation: In 2014, evaluation will be made as to the degree of implementation which has occurred within the watershed. Subsequent decisions will be made through the Upper Lower Smoky Hill River WRAPS, regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The Smoky Hill River will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2010 – 2019. Therefore, the decision for delisting will come about in the preparation of the 2020 303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year

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 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 after Fiscal Years 2012 – 2019.

Developed August 3, 2010

Bibliography

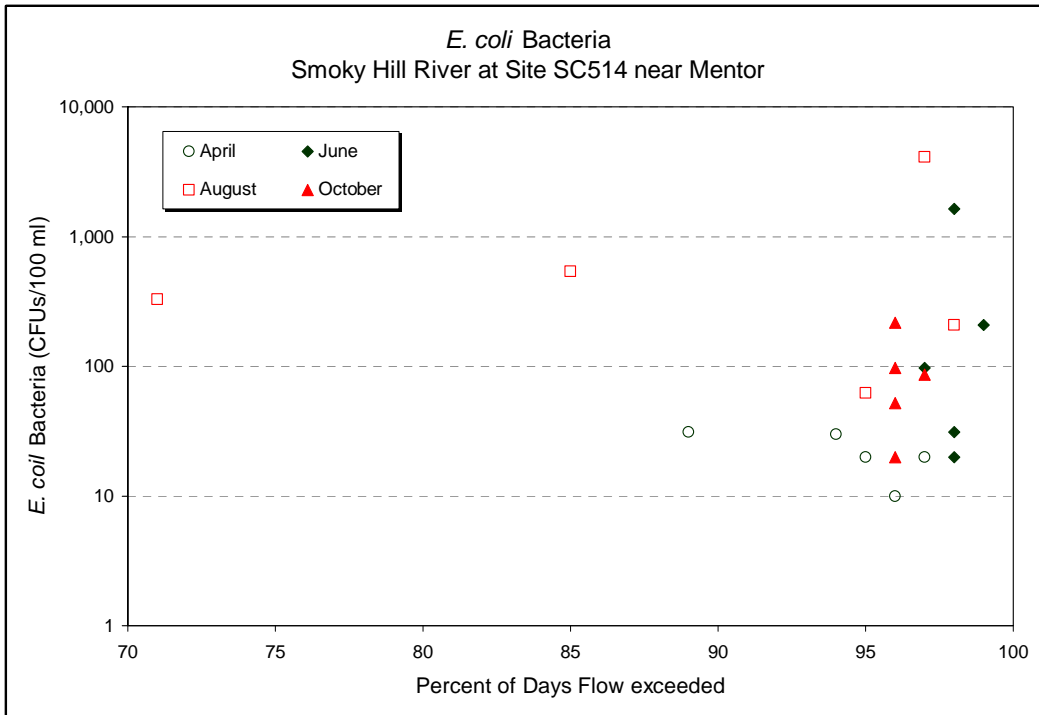
Rasmussen, P.P. & A.C. Ziegler, 2003. Comparison and continuous estimates of fecal coliform and *Escherichia coli* bacteria in selected Kansas streams, May 1999 through April 2002. U.S. Geological Survey, Water-Resources Investigations Report 03–4056, Lawrence, KS. 87pp.

Simon, A., W. Dickerson, & A. Heins, 2004. Suspended-sediment transport rates at the 1.5-year recurrence interval for ecoregions of the United States: Transport conditions at the bankful and effective discharge? *Geomorphology* 58: 243-262.

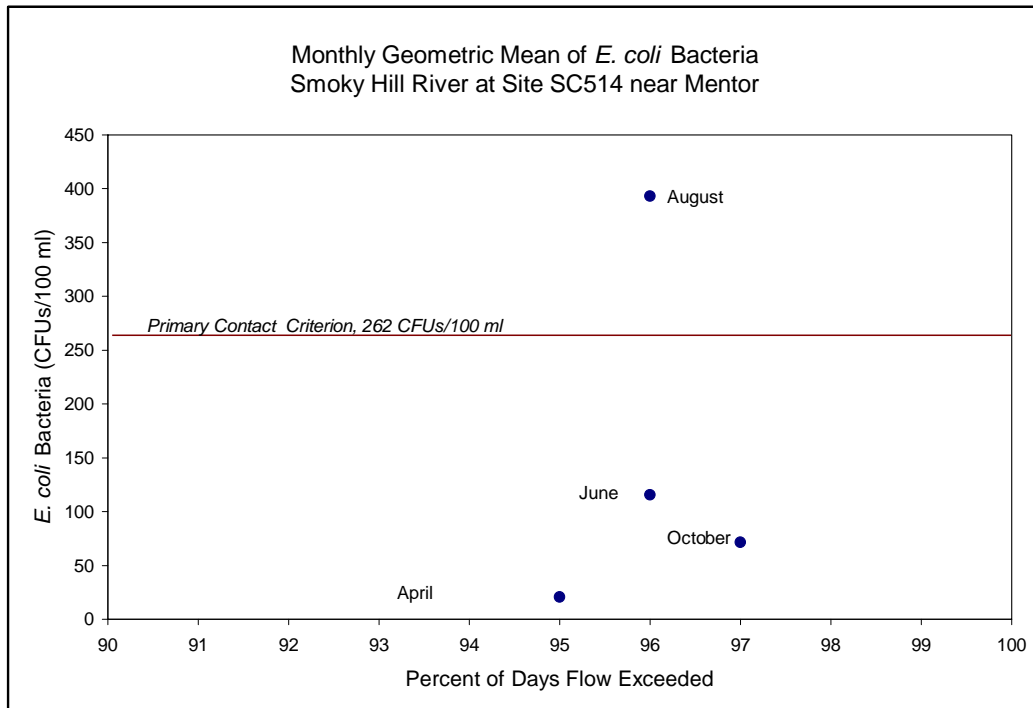
Stiles, T.C. & M.B. Tate, 2008. Managing bacteria TMDLs by overlaying water quality, hydrology and corrective measures on stream recreation. *Water Practice* 2: 1-13.

United State, EPA (USEPA), 1986. Ambient water quality criteria for bacteria – 1986. EPA-440/5-84-002. Office of Water, Regulations and Standards, USEPA, Washington, DC.

Appendix A. Intensive bacteria surveys in 2006.



Bacteria samples were collected 5 times in April, June, August, and October.



Geometric means of *E. coli* bacteria count for April, June, August, and October.

Appendix B. Wasteload allocation for WWTP and CAFO facilities.

Facility	Permit #		Apr - Oct (Billion CFUs/day)	Nov - Mar (Billion CFUs/day)
WWTP				
Assaria	KS-0082295 (M-SH02-OO01)		0.25	3.70
Lindsborg	KS-0022462 (M-SH21-OO01)		2.53	37.3
Marquette	KS-0021873 (M-SH25-OO01)		0.41	6.0
Ellsowrth Co. RWD 1- Post Rock	KS0099287 (I-SH53-PO01)		0	0
MP Co. Rest Area	KSJ000652 (M-SH21-NO02)		0	0
CAFO				
Beef (600)	A-LAMP-BA20	Certification	0	0
Dairy (60)	A-SHEW-MA01	Certification	0	0
Beef (2,000)	A-SHMP-C002 (KS0099597)	Permit	0	0
Beef, Horses (603)	A-SHMP-B003	Permit	0	0
Beef (800)	A-SHMP-B004	Permit	0	0
Beef (999)	A-SHMP-B005	Permit	0	0
Beef (450)	A-SHMP-BA01	Certification	0	0
Beef (140)	A-SHMP-BA02	Certification	0	0
Beef (150)	A-SHMP-BA03	Certification	0	0
Beef (300)	A-SHMP-BA04	Certification	0	0
Beef (23)	A-SHMP-BA05	Certification	0	0
Beef (150)	A-SHMP-BA07	Certification	0	0
Beef (200)	A-SHMP-BA09	Certification	0	0
Beef (460)	A-SHMP-BA10	Certification	0	0
Beef (10,000)	A-SHMP-C001 (KS0116351)	Permit	0	0
Swine (11,364)	A-SHMP-H001 (KS0086291)	Permit	0	0
Dairy (80)	A-SHMP-M004	Permit	0	0
Swine (300)	A-SHMP-S001	Permit	0	0
Beef (250)	A-SHSA-B006	Permit	0	0
Beef (750)	A-SHSA-B007	Permit	0	0
Beef (300)	A-SHSA-B008	Permit	0	0
Swine (600)	A-SHSA-S004	Permit	0	0