LOWER ARKANSAS BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Lower Chikaskia River
Water Quality Impairment: E. coli

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Chikaskia **Counties:** Sumner, Harper, Kingman

HUC 8: 11060005
HUC 10 (12): 02 (04, 05, 06, 07)
03 (01, 02, 03, 04, 05)

Ecoregion: Central Great Plains, Wellington-McPherson Lowland (27d)

Drainage Area: 415 square miles

Main Stem Water Quality Limited Segments: Chikaskia River (Segment 9 in Harper and Sumner Counties and Segment 8 in Sumner County).

Main Segment	**Tributaries**
Chikaskia River (9)	Sandy Creek (30) Spring Creek (31) East Sand Creek (12)
Chikaskia River (8)	Silver Creek (29) Shore Creek (35) Beaver Creek (28) Prairie Creek (512) East Prairie Creek (516) West Prairie Creek (527) Long Creek (529) Spring Creek (25)

Designated Uses: For Chikaskia River (9): Primary Contact Recreation Class C; Special Aquatic Life Support; Domestic Water Supply; Food Procurement; Ground Water Recharge; Industrial Water Use; Irrigation Use; Livestock Watering Use.

For Chikaskia River (8): Same designated uses as Chikaskia River (9) with the exception of being classified as Primary Contact Recreation Class B.

For East Prairie Creek (516): Same designated uses as Chikaskia River (8) with the exception of being classified as Expected Aquatic Life Support.

For East Sand Creek (12), Shore Creek (35), Prairie Creek (512), West Prairie Creek (527), Sandy Creek (30), Spring Creek (31), Silver Creek (29), Beaver Creek (28) and Spring Creek

(25): same designated uses as Chikaskia River (9) with the exception of being classified as Secondary Contact Recreation Class b.

For Long Creek (529): Secondary Contact Recreation Class b; Expected Aquatic Life Support and Livestock Watering Use.

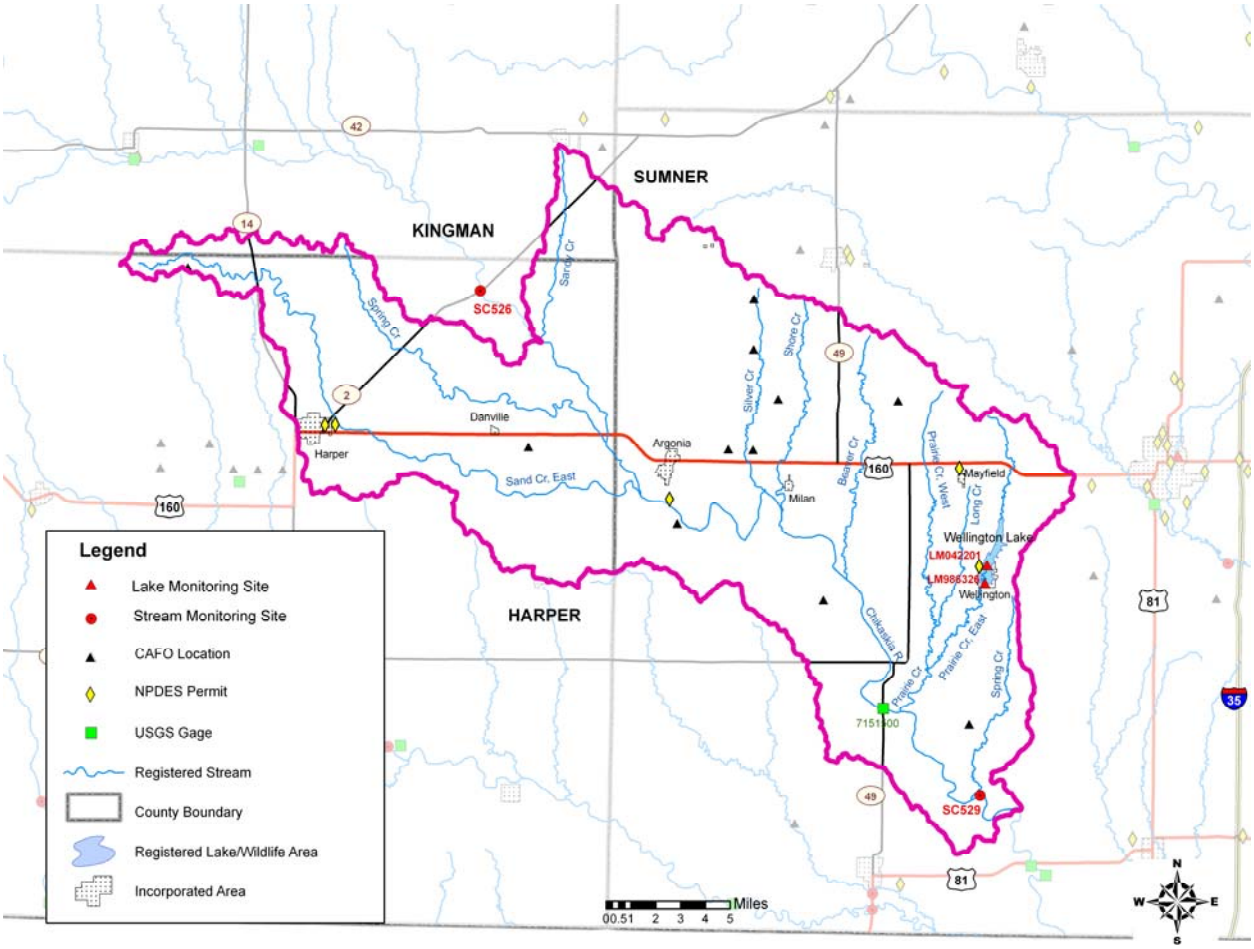
303(d) Listings: Station SC529, Chikaskia River near Corbin
E. coli: 2008, 2010 and 2012 Lower Arkansas River Basin Streams.

Impaired Use: Primary Contact Recreation Class 'B'

Water Quality Criteria: Primary Contact Recreation Class 'B':
Geometric Mean April – October:
262 Colony Forming Units (CFU)/100 mL
Geometric Mean November – March:
2,358 Colony Forming Units (CFU)/100 mL

K.A.R. 28-16-28e(c)(7):
(D) Primary contact recreation for classified stream segments. At least five samples shall be collected during separate 24-hour periods within a 30-day period. A geometric mean analysis of these samples shall not exceed the criteria in table 1i, as adopted in subsection (d) of this regulation, beyond the mixing zone.
(E) Secondary contact recreation for classified stream segments. The following criteria shall be in effect from January 1 through December 31 of each year. At least five samples shall be collected during separate 24-hour periods within a 30-day period. A geometric mean analysis of these samples shall not exceed the criteria in table 1i, as adopted in subsection (d) of this regulation, beyond the mixing zone.
(F) Wastewater effluent shall be disinfected if it is determined by the department that the discharge of non-disinfected wastewater constitutes an actual or potential threat to public health. Situations that constitute an actual or potential threat to public health shall include criteria supporting the assigned recreational use designation or if a water body is known or likely to be used for either of the following:
(i) Primary or secondary contact recreation; or
(ii) Any domestic water supply.

Figure 1. Chikaskia River Watershed.



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Uses under 2012-303(d): Bacteria levels in Chikaskia River near Corbin exceeded the geometric mean criteria in 2009 with routine data over 2003-2011 indicating regular digression from the criterion during the primary contact recreation season (April – October).

Stream Monitoring Site and Period of Record:
KDHE permanent ambient Stream Chemistry sampling station SC529 (Figure 1) located on Chikaskia River near Corbin sampled bi-monthly from 7/22/03 through 11/3/2009 and quarterly from 3/29/2010 through 5/21/2012 for E. coli. Supplementing the routine KDHE sampling, intensive sampling (five samples in 30 days) was conducted four times in 2009 during the primary contact recreation season at SC529, Chikaskia River near Corbin.

KDHE permanent ambient Stream Chemistry sampling station SC526 located on the Chikaskia River near Runnymede, above SC529 (Figure 1) sampled bi-monthly 10/31/2003 through 12/24/2009 and quarterly from 4/2/2010 through 10/21/2011.

Flow Record: USGS Gage 07151500, Chikaskia River near Corbin, 1990-2011.

Flow Conditions: The USGS has maintained a gaging station on the Chikaskia River near Corbin since 1950. The gage is located above KDHE sampling station SC529 and has a contributing drainage area of 794 mi^2 while the contributing drainage area at the segment of the Chikaskia River where SC529 is located is 893 mi^2 (Perry et al., 2004). The ratio of the watershed size at SC529 to watershed size at USGS Gage 07151500 (893 mi^2/794 mi^2=1.125) was used to estimate the flow at KDHE sampling station SC529. Figure 2 displays the flow duration curve for the estimated flow at SC529 while Table 1 details an average and median flow of 351 cfs and 143 cfs, respectively, on Chikaskia River at the KDHE sampling site SC529.

Figure 2. Flow duration for Chikaskia River (1990-2011) based on USGS gage 07151500.

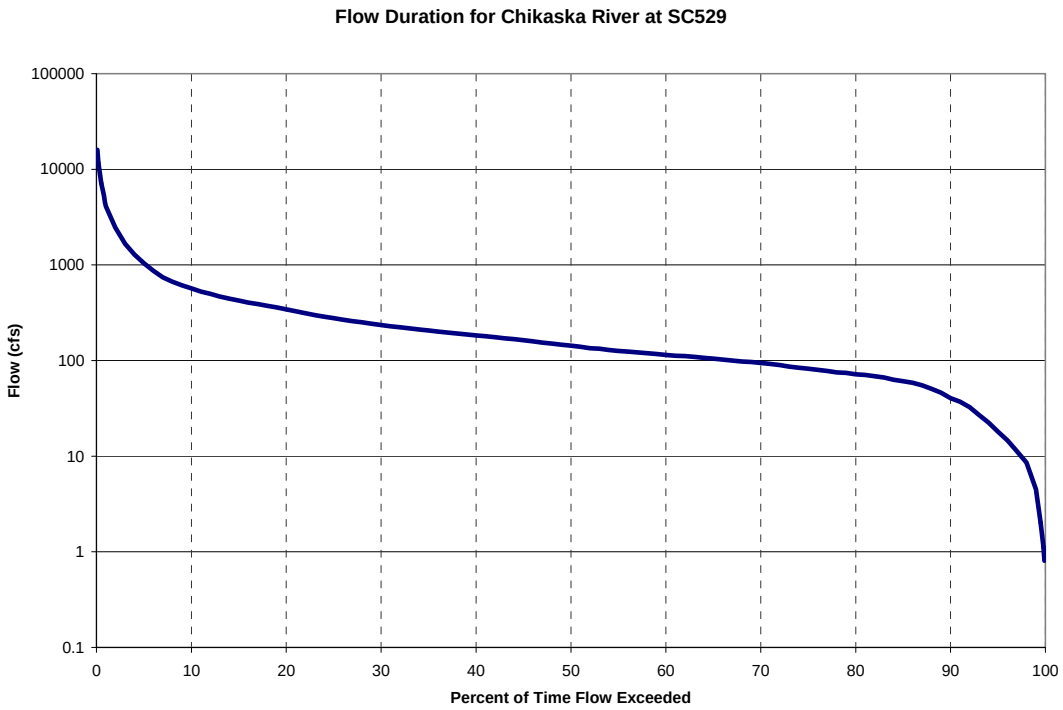


Table 1. Long term flow conditions (cfs) for the Upper Chikaskia River at SC526, the Lower Chikaskia River at SC529 and USGS gage 07151500, 1990-2011.

Stream Name	Drainage Area (mi^2)	Mean Flow	90%	75%	50%	25%	10%
Upper Chikaskia River at SC526	463	182	21.0	42.6	74.1	143	294
Chikaskia River at USGS Gage 07151500	794	312	36.0	73.0	127	246	504
Lower Chikaskia River at SC529	893	351	40.5	82.1	143	277	567

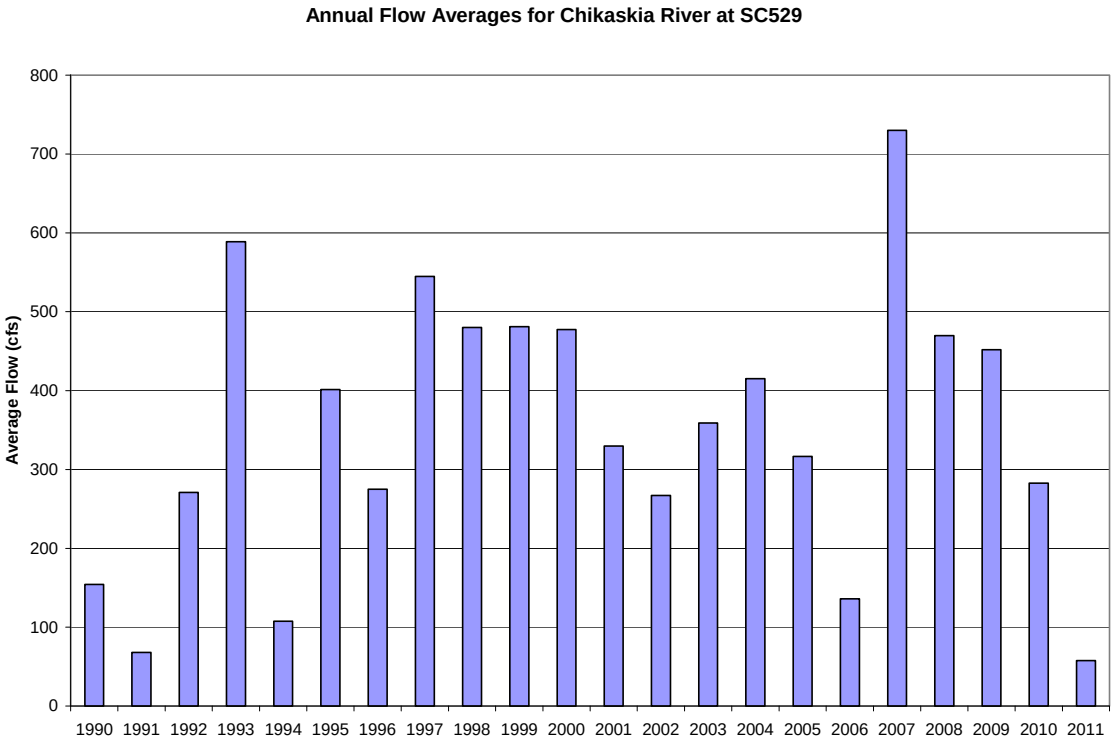
Flow values for the streams contributing flow to the Chikaskia River between KDHE sampling stations SC526 (Upper Chikaskia River) and SC529 (Lower Chikaskia River) are shown in Table 2. According to Perry, et al., flow for the tributaries to the Lower Chikaskia River average between 5.48 and 21.1 cfs.

Table 2. Long term estimated flows for Chikaskia River and its tributaries (Harper and Sumner Counties, Perry et al.).

Stream (USGS Segment ID)	County	Drainage Area (mi^2)	Flow (cfs)						
			Mean	90%	75%	50%	25%	10%	2-year Peak
Sandy Creek (4812)	Kingman Harper	42.3	8.84	0.06	0.82	1.89	3.83	9.29	1,574
Chikaskia River (4813)	Harper	463	115	9.57	23.4	46.0	89.0	192	4,278
Spring Creek (4894)	Kingman Harper	47.8	11.6	0.11	1.26	2.89	5.98	13.8	1,324
Chikaskia River (4893)	Harper	526	136	11.2	27.2	53.5	105	228	5,008
East Sand Creek (4953)	Harper Sumner	87.7	21.1	0.97	2.95	6.10	12.6	27.9	1,852
Chikaskia River (5007)	Sumner	688	198	15.6	38.3	76.1	151	337	6,892
Silver Creek (4948)	Sumner	36.9	8.87	0.01	0.40	1.49	3.44	9.13	1,558
Chikaskia River (4969)	Sumner	725	213	16.7	40.9	81.4	163	364	7,379
Shore Creek (4968)	Sumner	22.6	5.48	0.01	0.02	0.45	1.31	4.58	1,163
Chikaskia River (5049)	Sumner	757	227	17.5	43.2	86.2	173	389	7,792
Beaver Creek (5048)	Sumner	27.8	6.85	0.01	0.02	0.52	1.71	5.96	1,345
Chikaskia River (5177)	Sumner	808	250	19.0	47.0	94.0	190	430	8,530
Prairie Creek (5173)	Sumner	60.9	17.0	0.00	0.65	2.51	6.91	19.1	1,558
Chikaskia River (5255)	Sumner	878	268	20.1	49.0	99.3	202	462	9,009
Spring Creek (5269)	Sumner	23.6	6.57	0.00	0.00	0.54	1.64	5.68	1,353
Chikaskia River (5277)	Sumner	893	272	20.3	49.4	100	204	469	9,097

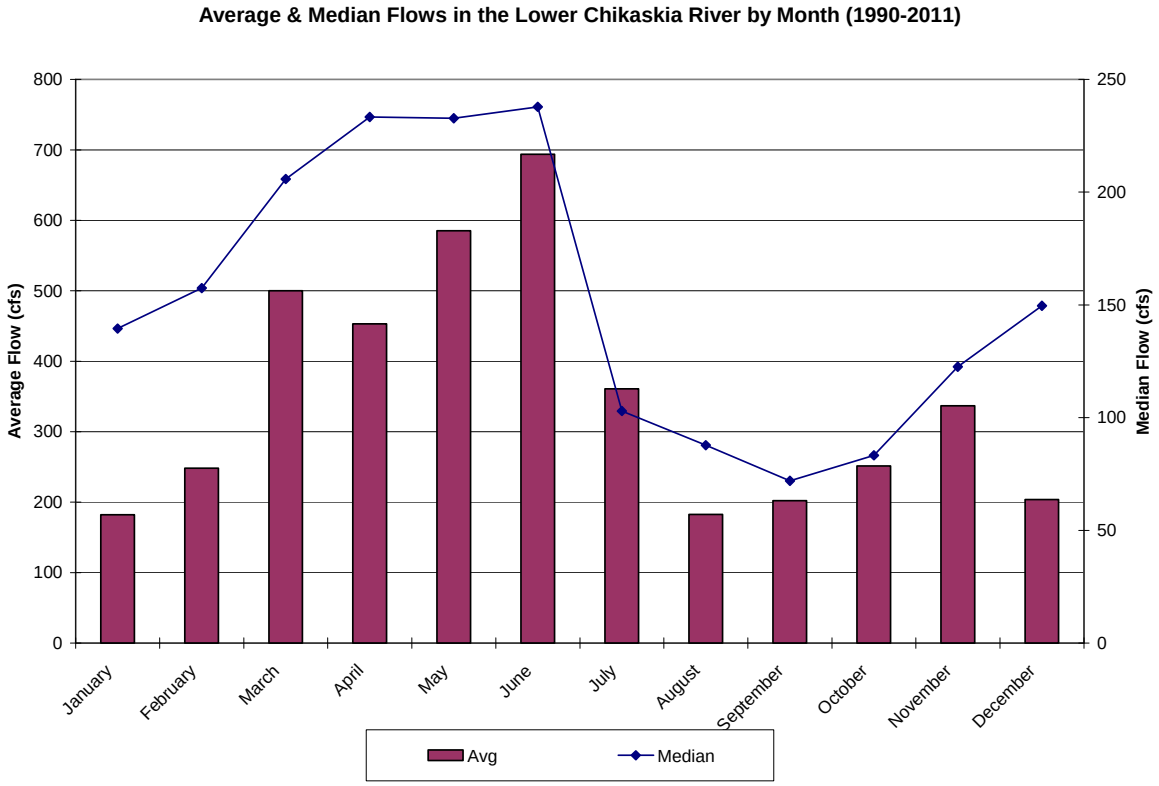
Annual flow averages in the Chikaskia River are variable with periods of extended dryness occurring in 1990, 1991, 1994, 2006 and 2011 when average annual flow fell to less than half of the long term average of 351 cfs (Figure3).

Figure 3. Average annual flow in Chikaskia River near Corbin based on USGS gage 07151500.



Average monthly flows in the Chikaskia River reflect seasonal rainfall patterns with the high average flow in May and June reflecting high intensity spring rainfall events while the higher median flows during April, May and June indicate more frequent spring and early summer rains (Figure 4). The average and median flow in the Chikaskia River at SC529 for the primary contact recreation season of April through October is 389 cfs and 132 cfs, respectively. November though March, the primary contact recreation off-season, has a higher median flow at 153 cfs but a lower average flow of 295 cfs reflecting the diminished frequency of high intensity rainfall events coupled with diminished consumptive use in the watershed during the primary contact recreation off season.

Figure 4. Average and median monthly flows in Chikaskia River at SC529.



Current Conditions: Fecal coliform bacteria (FCB) have been sampled in Chikaskia River near Corbin from March 1990 through May 2003 (Figure 5). The geometric mean of all FCB data is 148 CFU/100 mL while geometric mean for samples collected during the primary contact recreation season months of April through October reached 214 CFU/100 mL in the river.

KDHE adopted E. coli bacteria (ECB), recommended by the US EPA, to replace FCB in 2003 since E. coli bacteria are seen as a better indicators for potential human illness. Routine collection of E. coli bacteria samples in the Chikaskia River near Corbin has occurred since mid-2003 and has resulted in an overall geometric mean of 122 Most Probable Number (MPN)/100 mL, rising to a geometric mean of 206 MPN/100 mL during the primary contact recreation season of April through October (Figure 6).

For the remainder of this TMDL, the term “counts” will represent the units of Colony Forming Unit (CFU)/100 mL as expressed in the water quality standards or Most Probable Number (MPN)/100 mL, the measured equivalent parameter for ECB.

Figure 5. Fecal Coliform Bacteria in Chikaskia River, 1990 – 2003.

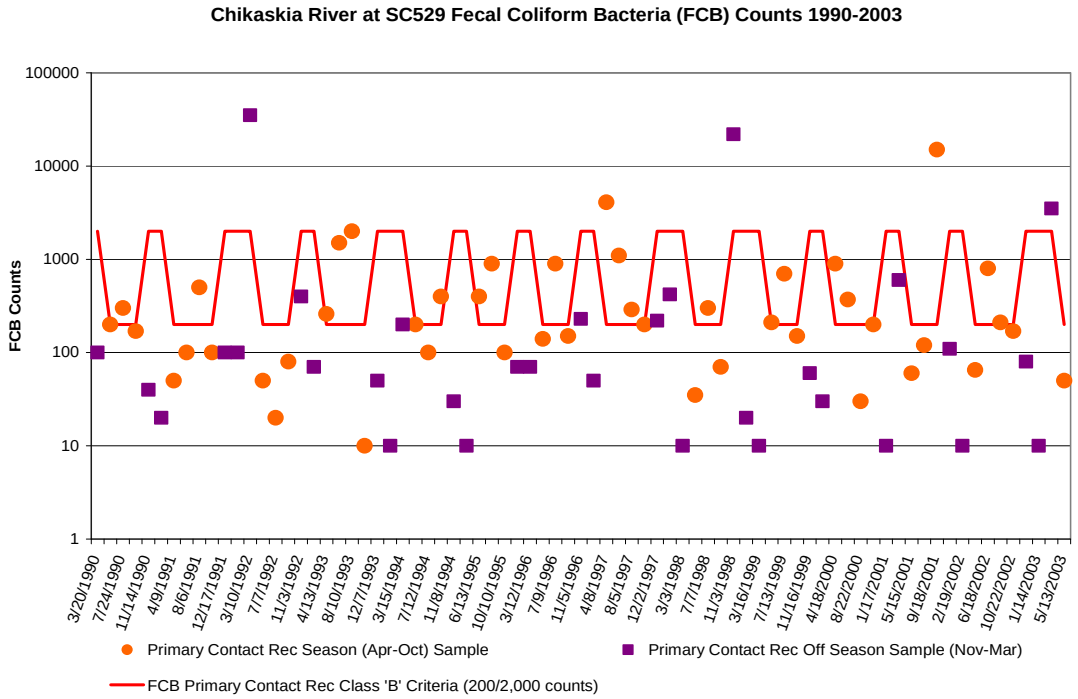
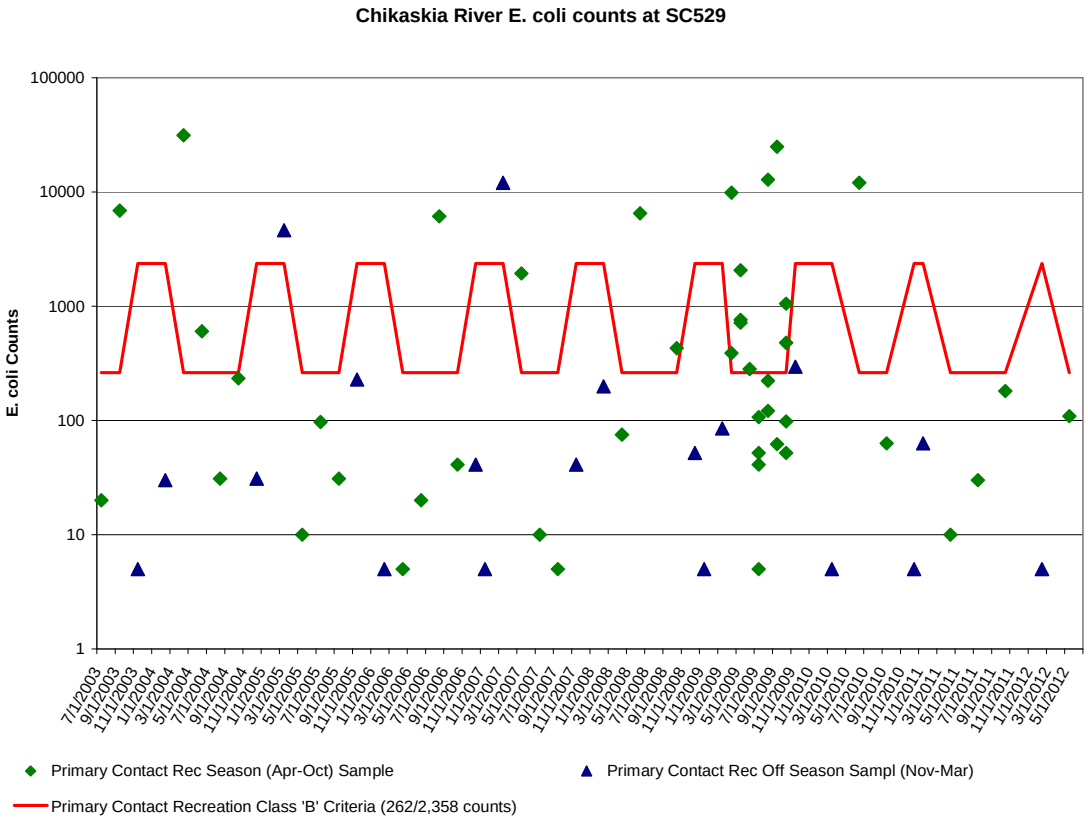


Figure 6. E. coli counts in Chikaskia River near Corbin by sampling date, 7/22/2003 – 5/21/2012.



Sample collection occurred across the range of flow conditions with increased flow in the Chikaskia River generally leading to higher E. coli counts (Figure 7). Samples collected from November through March were greater than the off-season recreation value of 2,358 counts twice over the period of record with one exceedance occurring during high flow conditions and one occurring near median flow conditions. Single sample digressions above the primary contact recreation value of 262 counts for the April through October season occurred 18 times (41%) with 16 of the exceedances occurring when flow was at or above 25% exceedance indicating they were primarily caused by overland runoff generated by rain events (Table 3). Samples taken at flows less than the 40th percentile flow were always below the criterion value.

Figure 7. E. coli counts vs. Percent Flow Exceedance in Chikaskia River (SC529).

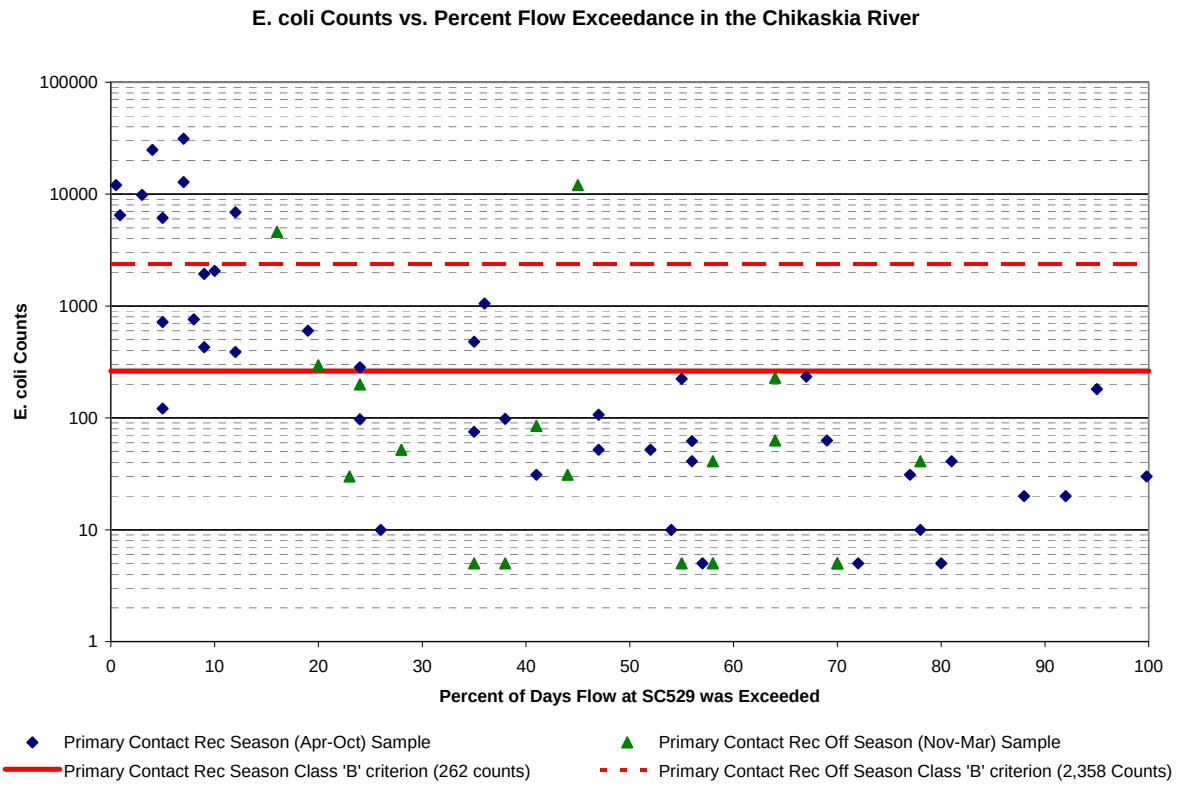
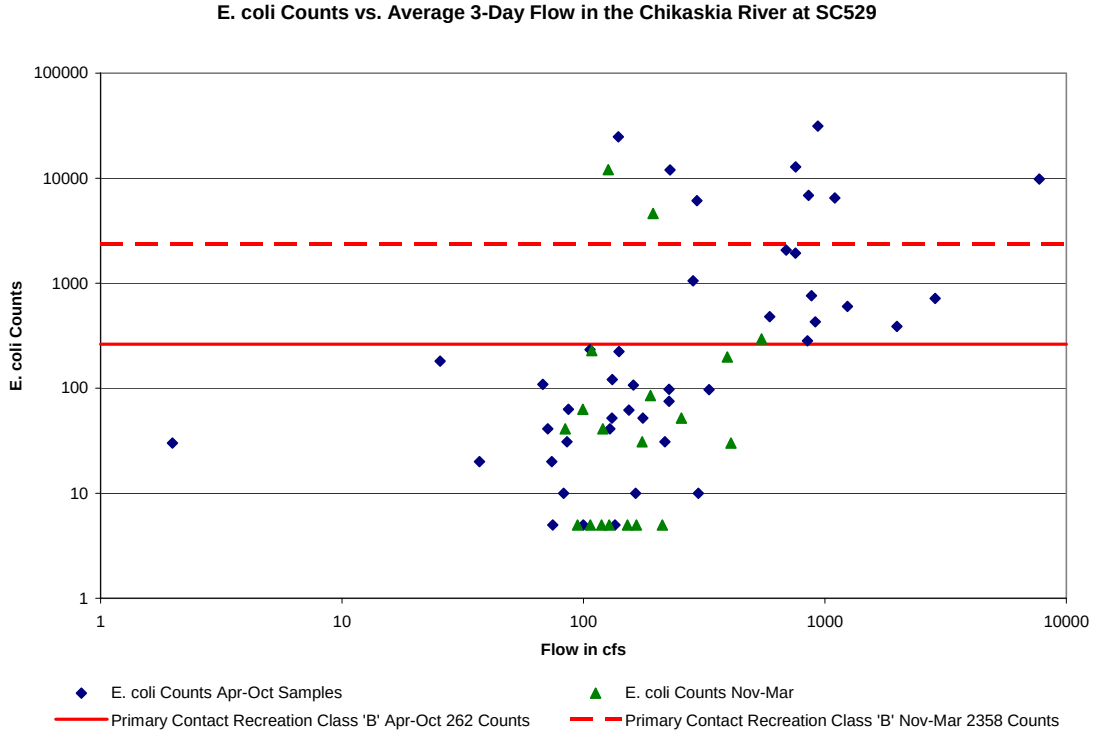


Table 3. Single sample excursions from the April-October water quality standard of 262 counts and the November-March water quality standard of 2,358 counts by flow.

	Low Flow		Moderate Flow		High Flow		Total for All Flow Conditions	
Percentile	75-100%		26-74%		0.1-25%			
Flow (cfs)	82.1- 0.81 cfs		267-84.4 cfs		15,974 -277			
Season	**Apr-Oct**	**Nov-Mar**	**Apr-Oct**	**Nov-Mar**	**Apr-Oct**	**Nov-Mar**	**Apr-Oct**	**Nov-Mar**
# Exceeds/# Samples	0/8	0/1	2/19	1/14	16/17	2/4	18/44	3/19
Percentage of Exceedances	0%	0%	11%	7.1%	94%	50%	41%	16%
E. Coli Geometric Mean	24.7	41.0	60.6	26.3	2,372	300	212	45.0

Figure 8 displays E. coli counts versus the average of flow for three days prior to sampling. The majority of the samples with values greater than the 262 or 2,358 criterion value can be attributed to precipitation runoff events as the frequency of excursions increases with increased flow in the river.

Figure 8. E. coli counts in Chikaskia River vs. Average Flow (cfs) for 3 days prior to sampling.



KDHE conducted intensive sampling (5 samples in 30 days) on the Chikaskia four times in 2009 and although the last sample for Period 4 was collected on November 3rd, the beginning of the contact recreation off-season, it was included in the analysis as a primary contact recreation season sample (Figure 9). Samples collected in April/May and August/September exceeded the water quality standard with geometric means of 1,338 and 881 counts, respectively, while the June/July and October/November sampling resulted in geometric means of 50.3 and 238 counts, respectively (Table 4).

Figure 9. Intensive sampling for E. coli bacteria at SC529, Chikaskia River near Corbin. Geometric mean (Geomean) values are in terms of counts/100 mL.

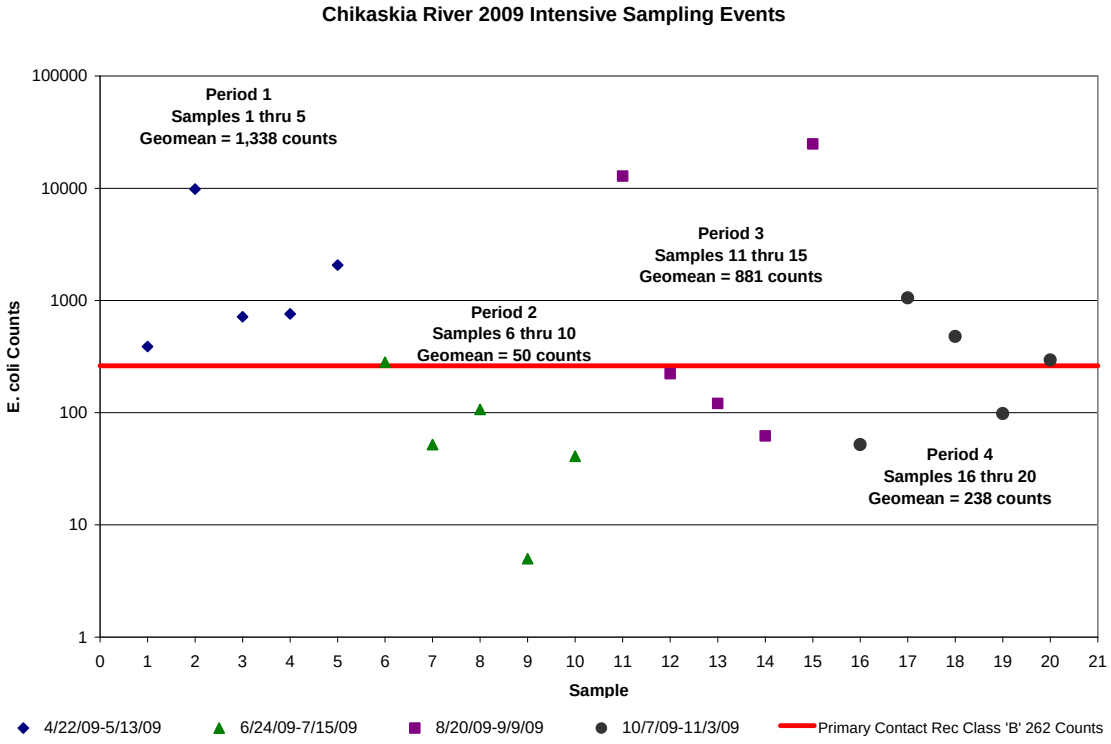
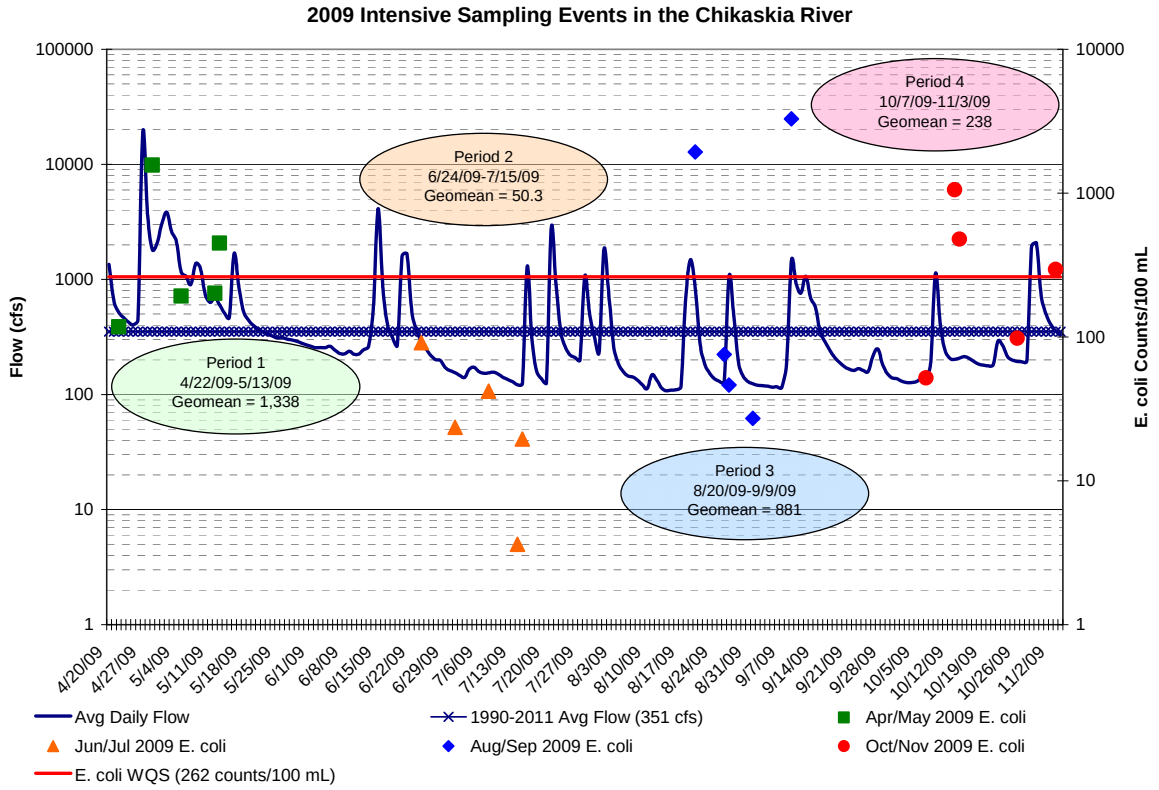


Table 4. Individual sample results and geometric mean values for intensive sampling periods on the Chikaskia River at SC529 along with daily average flow for individual samples and the average flow for the days the stream was sampled.

Period 1			Period 2			Period 3			Period 4		
Sample Date	E. coli Counts	% Flow	Sample Date	E. coli Counts	% Flow	Sample Date	E. coli Counts	% Flow	Sample Date	E. coli Counts	% Flow
4/22/09	288	12	6/24/09	282	24	8/20/09	12,809	7	10/7/09	52	52
4/29/09	9,842	3	7/1/09	52	47	8/26/09	223	55	10/13/09	1,054	36
5/5/09	717	5	7/8/09	107	47	8/27/09	121	5	10/14/09	479	35
5/12/09	759	8	7/14/09	<10	57	9/1/09	62	56	10/26/09	98	38
5/13/09	2,064	10	7/15/09	41	56	9/9/09	24,809	4	11/3/09	295	20
Geometric Mean 1,338 counts		Avg Flow 959 cfs	Geometric Mean 50.3 counts		Avg Flow 169 cfs	Geometric Mean 881 counts		Avg Flow 720 cfs	Geometric Mean 238 counts		Avg Flow 220 cfs

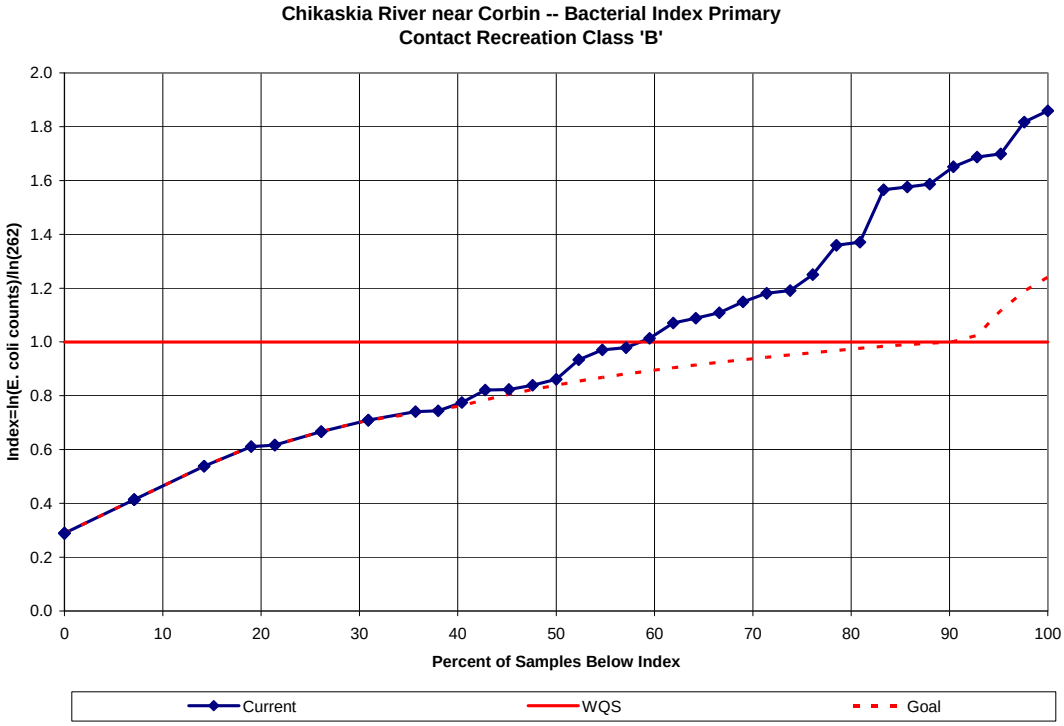
As seen in figure 10, flow during Period 1 was above average for the sampling period and resulted in the highest E. coli geometric mean while flows were below average for Period 2 which had the lowest geometric mean. Sampling Periods 3 and 4 occurred when stream flow varied around the average flow. Higher E. coli count samples were collected after flows peaked higher than average on the sampling day or one day prior to sampling, highlighting the effect of precipitation runoff events on E. coli loads in the river.

Figure 10. 2009 Intensive sampling for E. coli in the Chikaskia River at SC529 vs. Average Daily Flow.



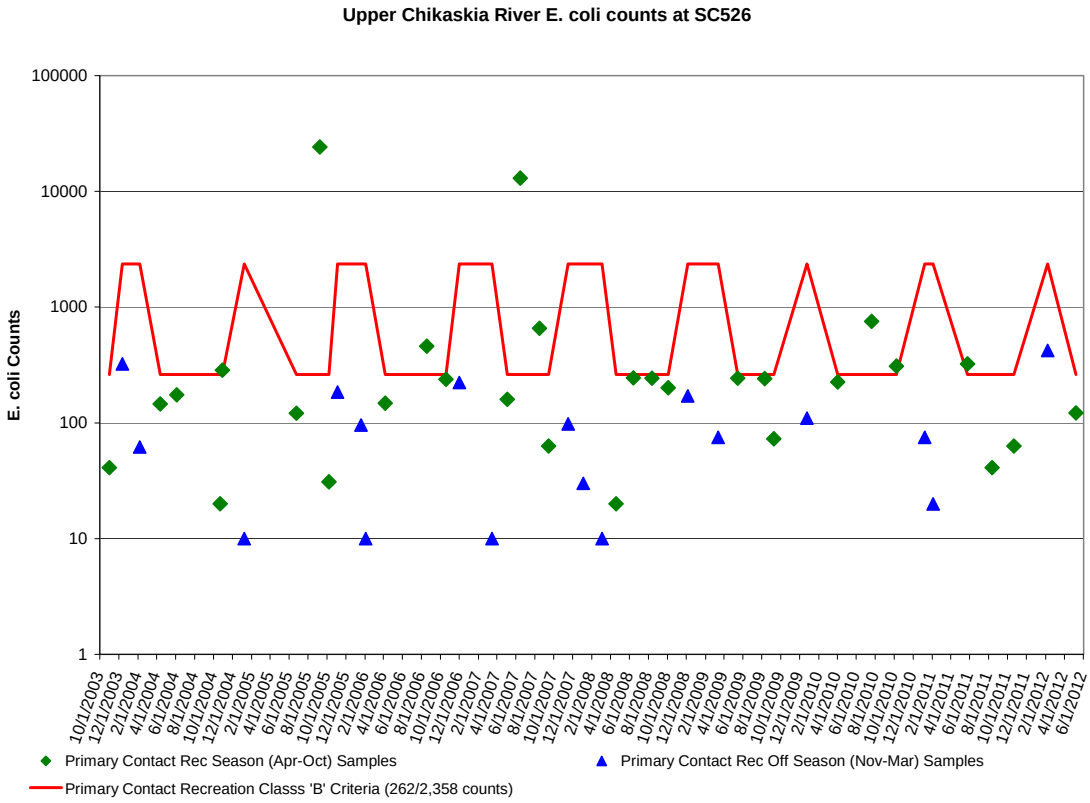
E. Coli Index values for individual samples are computed as the ratio of the sample count to the contact recreation criteria. An index value of one or below indicates the sample was below the criterion. The calculated index is the natural logarithm of each sample value taken during the April-October primary contact recreation season divided by the natural logarithm of the bacteria criteria (262 counts/100 mL). 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 magnitude of the E. coli index is assessed by noting how high the ratios are for the samples with ratios greater than one within the data set. Currently, about 60% of the ECB index values for the Chikaskia River are below one (Figure 11).

Figure 11. E. coli bacteria profile for the Chikaskia River for April – October.



KDHE sampling station SC526, on the Chikaskia River near Runnymede and located above SC529, has undergone routine sampling for FCB (March 1990-June 2003) resulting in a geometric mean of 114 counts for all data and a geometric mean of 231 counts for samples collected during the primary contact recreation season months of April through October. ECB samples were collected from October 2003 through October 2011 at SC526, resulting in a geometric mean of 125 counts for all data and 202 counts for samples collected during the primary contact recreation season of April through October (Figure 12). E. coli geometric means downstream at SC529 for comparable time periods are in the same range at 122 MPN/100 mL (all data) and the 206 MPN/100 (Apr-Oct). SC526 is not listed as impaired for bacteria and is held to the Primary Contact Recreation Class 'C' criteria as Segment 8 of the Chikaskia River is classified as such although the remainder of classified stream segments in the SC526 watershed are classified as Secondary Contact Recreation Class 'b'. For the purposes of this analysis, however, the criterion of 262 counts is used to identify exceedances in Table 5 in order to assess the potential contribution to E. coli counts at SC529. Daily average flow at SC526 was estimated using the ratio (0.583) of the watershed size at SC526 (463 mi^2) and USGS 07151500 (794 mi^2) multiplied by the daily average flow values for USGS 07151500.

Figure 12. E. coli counts in Upper Chikaskia River near Runnymede (SC526) by sampling date, 10/31/2003 – 5/18/2012.

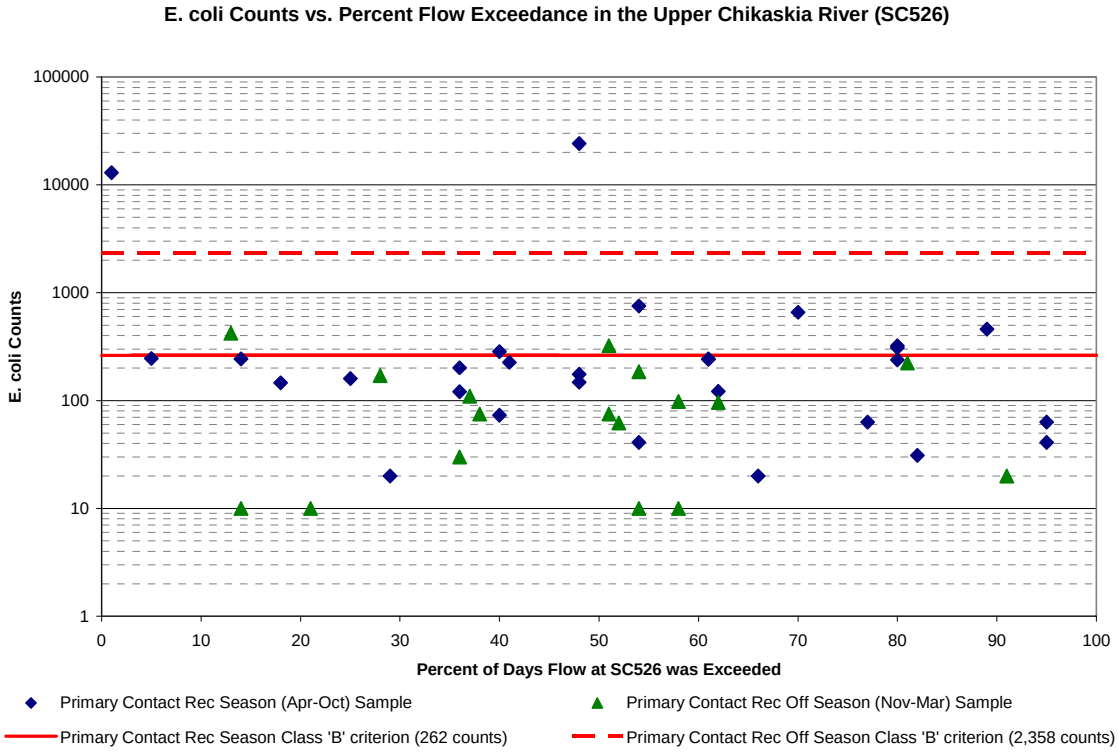


The E. coli geometric mean at SC526 for both the primary contact recreation season (202 counts) and recreation off season (53.8 counts) are similar to the seasonal geometric means at SC529 (216 & 51.8 counts) with exceedances in the April through October season occurring at a rate of 42% at SC529 and 29% at SC526 while November through March exceedances were 29% and 6%, respectively, at SC529 and SC526. E. coli loading at SC529 generally increases with increases in flow while exceedances at SC526 occur across the range of flow conditions (Figure 13).

Table 5. E. coli data and estimated flow for the Upper Chikaskia River at SC526. E. coli values exceeding the criteria of 262 counts/100 mL are counted as an 'Exceeds'.

	Low Flow		Moderate Flow		High Flow		Total for All Flow Conditions	
Percentile	75-100%		26-74%		0.1-25%			
Flow (cfs)	42.6-0.42 cfs		138-43.7 cfs		8,281 -144			
Season	**Apr-Oct**	**Nov-Mar**	**Apr-Oct**	**Nov-Mar**	**Apr-Oct**	**Nov-Mar**	**Apr-Oct**	**Nov-Mar**
# Exceeds/# Samples	3/8	0/2	4/15	1/12	1/5	0/2	8/28	1/16
Percentage of Exceedances	38%	0%	27%	0.89%	20%	0%	29%	6.3%
E. Coli Geometric Mean	124	66.8	201	68.7	448	10	202	53.8

Figure 13. E. coli counts vs. Percent Flow Exceedance at SC526, Chikaskia River near Runnymede.



Desired Endpoints of Water Quality in Chikaskia River (SC529): The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards fully supporting primary contact recreational uses in the Chikaskia River. This requires the geometric mean of five samples taken within a 30 day period to be below the primary contact recreation class 'B' criterion of 262 counts during April to October.

The endpoints will be reached as a result of cumulative reductions in bacteria loading from 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 Chikaskia River, these endpoints are 262 counts/100 mL for the recreation season from April to October and 2,358 counts/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 toward 90%.

3. SOURCE INVENTORY AND ASSESSMENT

Point Sources: There are five NPDES permitted facilities in the lower Chikaskia River watershed (Table 6). Of these facilities, one is a ready-mix concrete plant and two are non-overflowing lagoon systems. These three facilities are prohibited from discharging to the

Chikaskia River and would only contribute a waste load under extreme precipitation or flooding events.

The remaining two, the City of Harper and the City of Argonia are permitted to discharge to the watershed and are required to monitor for E. coli when discharging. The City of Harper has a four cell lagoon that regularly discharges to Chikaskia River via Sand Creek. While no limits are present for E. coli, there is a quarterly monitoring requirement and the facility has discharged eleven times since October 2008 with E. coli counts ranging from less than 10 in February 2009 to 1,660 in October 2009. Discharge monitoring reports for the Harper treatment facility show an E. coli geometric mean of 92.7 for the primary contact recreation season and 10.0 for the off-season.

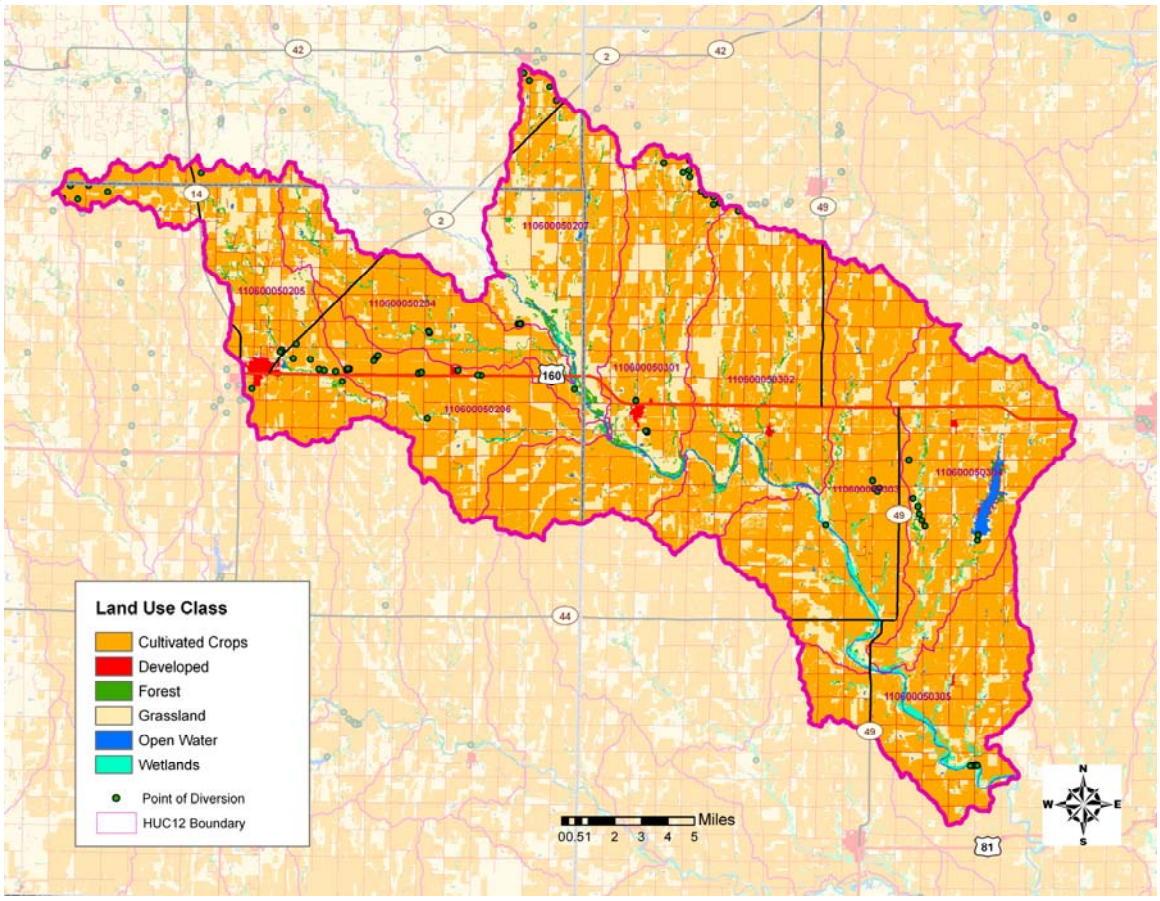
The City of Argonia has a two cell lagoon that regularly discharges to the Chikaskia River. While no limits are in place for E. coli, there is a monthly monitoring requirement and the facility has discharged thirteen times since between July 2008 and December 2011 with E. coli counts ranging from 7 in December 2008 to 1,046 in June of 2010. Discharge monitoring reports for the Argonia treatment facility show an E. coli geometric mean of 156 for the primary contact recreation season and 41.5 for the off-season. Since high bacteria counts on the Chikaskia is associated with high flows, the wastewater from Harper and Arogonia is not likely to be a cause of the impairment.

Table 6. NPDES permitted facilities in the Chikaskia River watershed.

Name	NPDES Permit #	State Permit #	Type	Design Capacity (MGD)	Monitoring Frequency	E. Coli Geometric Mean Apr-Oct
City of Harper WWTF	KS0024872	M-AR40-OO01	4 Cell Lagoon	0.309	Quarterly when discharging	92.7
City of Argonia WWTF	KS0031461	M-AR05-OO01	2 Cell Lagoon	0.104	Monthly	156
City of Wellington WWTF	KSJ000433	M-AR92-NO06	2 Cell Lagoon	N/A	N/A	N/A
City of Mayfield WWTF	KSJ000444	M-AR-59-NO01	2 Cell Lagoon	N/A	N/A	N/A
Concrete Enterprises	KSG110041	G-CONC-2007-1	Concrete Settling Basin	N/A	N/A	N/A

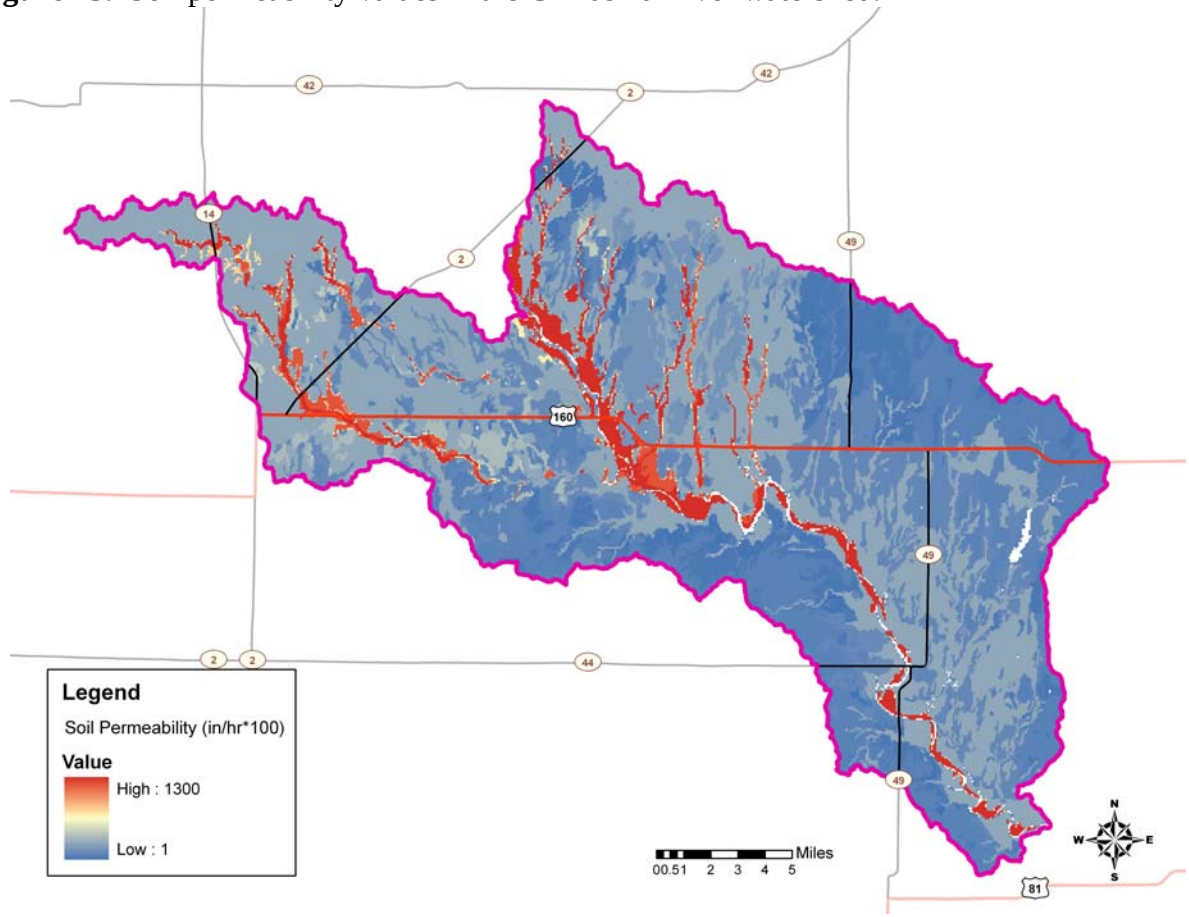
Land Use: The predominant land uses in the Chikaskia River watershed are cultivated cropland (69%) and grassland (21%), according to the 2001 National Land Cover Data. Together they account for 90% of the total land area in the watershed with the remaining land area composed of developed land (7.0%), forest (1.6%), wetlands (1.0%), and open water (0.40%) (Figure 14).

Figure 14. Land use in the Chikaskia River watershed.



Contributing Runoff: The watershed of Chikaskia River has a mean soil permeability value of 1.46 inches/hour, ranging from 0.01 inches/hour to 13.0 inches/hour according to NRCS STATSGO database (Figure 15). About 50% of the watershed has a permeability value less than 1.29 inches/hour, which contributes to runoff during very low and low intensity rainfall events while over 25% has a permeability value of 13.0 inches/hour which contributes runoff primarily during extremely high intensity rainfall events. According to a USGS open-file report (Juracek, 2000), the threshold soil-permeability values are set at 3.43 inches/hour for very high, 2.86 inches/hour for high, 2.29 inches/hour for moderate, 1.71 inches/hour for low, 1.14 inches/hour for very low, and 0.57 inches/hour for extremely low soil-permeability. Runoff is primarily generated as infiltration excess when soil profiles become saturated and produce excess overland flow due to rainfall intensities that are greater than soil permeability.

Figure 15. Soil permeability values in the Chikaskia River watershed.



Livestock and Waste Management Systems: There are twelve certified or permitted confined animal feeding operations (CAFOs) within Chikaskia River watershed (Table 7). These livestock facilities 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 stream flow occurring less than 1-5% of the time. According to the 2002 USDA Census of Agriculture there were 5,665 head of cattle contributing to a total of 8,762 head of livestock in the HUC 12s that make up the Chikaskia River watershed indicating there are small, unregistered livestock operations in the watershed (Table 8).

Table 7. Animal feeding operations in the Chikaskia River watershed.

Kansas Permit Number	Type	County	Animal Total
N-ARHP-6450	Beef	Harper	550
A-ARHP-BA02	Beef	Harper	950
A-ARSU-M006	Dairy	Sumner	150
A-ARSU-M004	Dairy	Sumner	100
A-ARSU-S011	Swine	Sumner	1,560
A-ARSU-B001	Beef	Sumner	999
A-ARSU-BA15	Beef	Sumner	200
A-ARSU-BA05	Beef	Sumner	400
A-ARSU-BA13	Beef	Sumner	840
A-ARSU-M003	Dairy, Beef	Sumner	200
A-ARSU-BA11	Beef	Sumner	150
A-ARSU-BA07	Beef	Sumner	300

Table 8. Livestock numbers by HUC 12 in the lower Chikaskia watershed. USDA, 2002.

HUC 12	Beef Cattle	Dairy Cattle	Hogs	Sheep	Horses	Chickens	Ducks	Animal Total
110600050204	439	5	4	25	12	4	0	488
110600050205	602	6	16	39	20	7	0	692
110600050206	496	6	7	29	12	4	0	555
110600050207	505	17	129	68	20	18	0	758
110600050301	723	46	317	133	4	33	1	1,257
110600050302	727	57	407	160	0	41	1	1,394
110600050303	732	57	410	161	0	41	1	1,403
110600050304	630	49	353	139	0	35	1	1,208
110600050305	526	41	295	116	0	30	1	1,008
Watershed Total	**5,380**	**285**	**1,939**	**871**	**68**	**213**	**6**	**8,762**

Population: The population in the watershed is approximately 3,975 people (10 people/mi^2) according to the 2000 U.S. Census Block information with 1,567 people residing within the City of Harper and 534 people in the City of Argonia. Population in Harper and Sumner Counties diminished at a rate of 7.7 and 7.1%, respectively, between 2000 and 2010 with 2010 U.S. Census data showing a loss of 94 people in Harper and 33 people in Argonia over the decade.

On-Site Waste Systems: The Lower Chikaskia River watershed is a rural agricultural area that falls into Harper, Kingman and Sumner counties. It can be assumed that all of the rural residences in the watershed are not connected to public sewer systems and failing on-site septic systems may contribute nutrient and bacteria loadings. Additionally, it is unclear what controls are in place that assure proper disposal of the septic tank waste collected by septage haulers in Sumner County. According to 1990 census data from the U.S. Census Bureau, there are 1,040 septic systems in Harper County, 1,535 septic systems in Kingman County and 3,336 septic systems in Sumner County.

Background and Nonpoint Sources: Bacteria are present from wildlife, but typically dispersed enough to not be a significant source of loading. If high densities of wildlife, particularly geese, settle in a confined area, the background levels of bacteria can be expected to increase significantly.

Plum Thicket landfill is a Subtitle D landfill that came online in January 2006 and is located northwest of SC526 (Chikaskia River near Runnymeade) in the Upper Chikaskia River watershed. As mentioned earlier in the document, SC526 has never been listed as impaired for bacteria. It is not expected that the Chikaskia River will see any bacteria load from Plum Thicket as it has a composite liner and is not allowed to release any liquids that have had contact with waste for any storm event less than or equal to a 25-year, 24-hr rainfall/runoff event. Analysis of the rate of exceedance of the E. coli criteria (262/2358 counts) at SC526 and SC529 shows no significant variation in the data prior to 2006 and the data from 2006 through 2011.

4. ALLOCATION OF POULLUTANT REDUCTION RESPONSIBILITY

This TMDL will be established to meet the Primary Contact Recreation class 'B' geometric mean criteria for bacteria counts in Chikaskia River at SC529. For Chikaskia River, the geometric mean of five samples taken within 30 days should be below 262 counts during the primary contact recreation season of April through October and below 2,358 counts during the recreation off-season of November through March.

While the legal standards are the geometric means, this TMDL will look to reduce the duration, frequency and magnitude of individual E. coli samples taken during the primary contact recreation season such that a majority will be below the nominal value of the criterion. Figure 12 displays the distribution of E. coli samples taken during the primary contact recreation months since 2003 over the range of flow percentages at SC529. Generally, elevated bacteria do not occur in Chikaskia River until flows are greater than 20% exceedance flow, coinciding with estimated runoff conditions.

Point Sources: In accordance with the Surface Water Quality Standards at K.A.R. 28-16-28e(c)(7)(F), "Wastewater effluent shall be disinfected if it is determined by the department that the discharge of non-disinfected wastewater constitutes an actual or potential threat to public health". Therefore, wastewater released from the two lagoon systems should have sufficient retention time prior to discharge to ensure bacteria die-off.

Because there is not an E. coli limit set in the discharge permits for the wastewater lagoons operated by the City of Harper and the City of Argonia they are assigned a limit of 262 counts at the end of the outfall (Table 9). The other three permitted facilities in the watershed will have a wasteload allocation of zero as two of the facilities operate non-discharging wastewater treatment lagoons and one is a dry mix ready mix concrete plant with a settling basin.

Table 9. Bacteria Wasteload Allocation for cities in the Chikaskia River watershed.

Name	State Permit #	Design Flow (MGD)	Design Flow (cfs)	E. coli counts/100 mL	WLA E. coli giga-counts/day
City of Harper	M-AR40-OO01	0.309	0.478	262	3.06

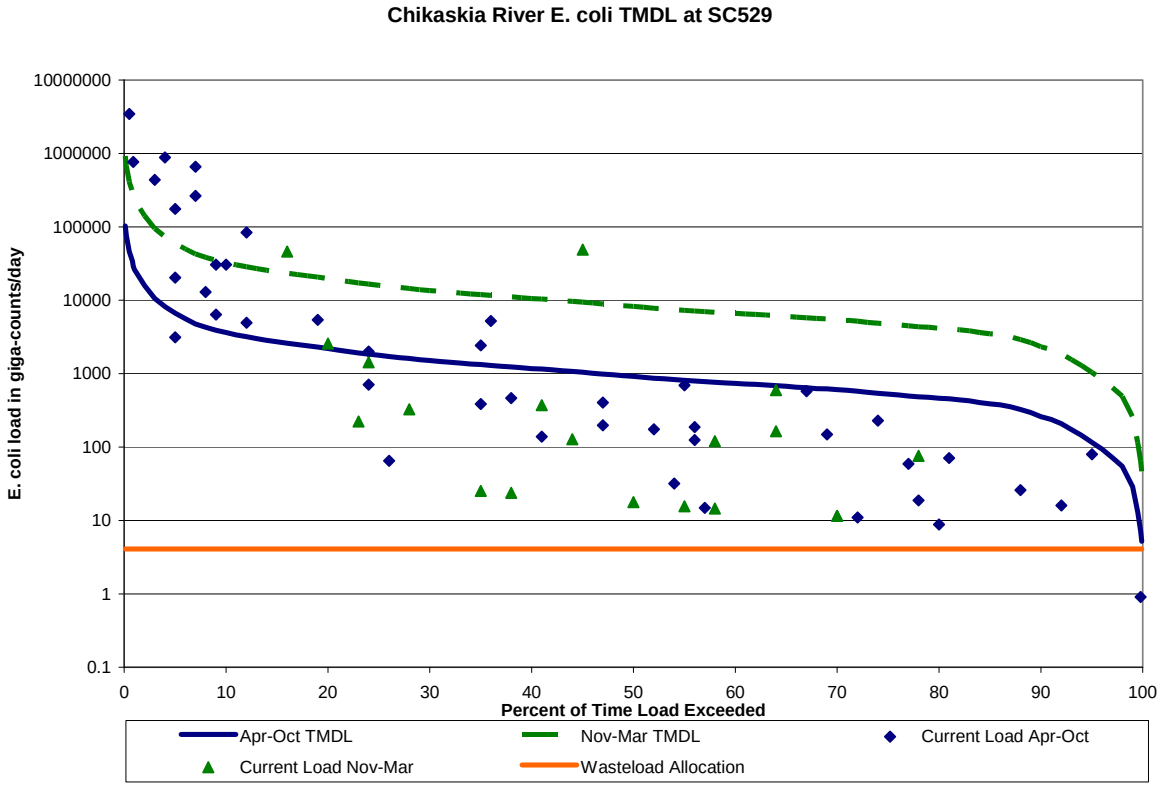
WWTF					
City of Argonia WWTF	M-AR05-OO01	0.104	0.161	262	1.03
City of Wellington WWTF	M-AR92-NO06	Non-Discharging	Non-Discharging	N/A	0
City of Mayfield WWTF	M-AR-59-NO01	Non-Discharging	Non-Discharging	N/A	0
Concrete Enterprises	G-CONC-2007-1	Non-Discharging	Non-Discharging	N/A	0

Nonpoint Sources: The Load Allocation (LA) assigns responsibility for nonpoint source contributors for the bacteria input into Chikaskia River from rural settings. The Load Allocations in Table 10 lie between wasteload allocations and the TMDL line for both the primary contact recreation season and the recreation off-season water quality criteria for Chikaskia River. Figure 16 shows the bacteria load duration TMDL for Chikaskia River with the wasteload allocation from the two municipal dischargers.

Table 10. Wasteload allocation, non-point source load allocation and TMDL for the Chikaskia River at SC529 for both the primary contact recreation season of April through October and the recreation off-season of November through March under varying flow conditions.

	Percent of Time Flow Exceeded	**Flow (cfs)**	**Bacteria Giga-Counts/Day**		
			WLA	**LA**	**TMDL**
April-October WQS 262 CFU/100 mL	90	40.5	4.09	255	260
	75	82.1	4.09	521	526
	50	143	4.09	911	916
	25	277	4.09	1,769	1,774
	10	567	4.09	3,629	3,634
November-March WQS 2,358 CFU/100 mL	90	40.5	4.09	2,331	2,336
	75	82.1	4.09	4,732	4,737
	50	143	4.09	8,235	8,240
	25	277	4.09	15,956	15,961
	10	567	4.09	32,696	32,701

Figure 16. Bacteria TMDL curve for the Chikaskia River at SC529.



Defined Margin of Safety: The Margin of Safety provides some hedge against the uncertainty of bacteria loading into Chikaskia River, predominately 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 contact recreation Class B criteria (262 CFU/100 mL). 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. The 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 wasteload allocation for the cities of Harper and Argonia were calculated as if their lagoon systems consistently discharge at their respective design rate when in actuality the facility discharges less regularly.

State Water Plan Implementation Priority: Due to the concurrent mechanisms of loading bacteria into the Chikaskia River along with phosphorus and sediment during wet weather, this TMDL will be designated as **High Priority** for implementation to direct stormwater and non-point source management to abate such pollutant loads.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Chikaskia Basin (HUC 8: 11060005) with a priority ranking of 30 (Medium Priority for restoration work).

Priority HUC 12: Due to relative low soil permeability this TMDL will initially concentrate on conditions in the lower portion of the watershed in the HUC 12 subwatersheds 110600050302, 110600050303, 110600050304 and 110600050305 along with any riparian stretches along the Chikaskia River and its tributaries identified as winter feeding or summer watering grounds. As improved conditions are noted at KDHE site SC529, implementation of this TMDL will expand to the upper portion of the watershed. Livestock management may be a principal driver of the bacteria impairment so implementation will involve both livestock access and isolation of livestock areas from runoff events.

5. IMPLEMENTATION

Desired Implementation Activities:

a. Maintain disinfection through operations under state and federal permits, inspect permitted facilities, continue monitoring requirements and evaluate compliance with permit limits.
b. Improve riparian conditions along stream systems by limiting overuse from grazing livestock along and in the stream.
c. Provide alternative water sources for livestock to limit their use of streams as a water source.
d. Ensure land applied manure is being properly managed and is not susceptible to runoff into nearby streams.
e. Install pasture management practices, including proper stock density, to reduce soil erosion and storm runoff.
f. Ensure proper on-site waste system operations in proximity to the main stream segments.

Implementation Programs Guidance:

NPDES and State Permits – KDHE

a. Monitor effluent from the discharging permitted wastewater treatment facilities, continue to encourage wastewater reuse and ensure compliance and proper operation to control bacteria in wastewater discharges.
b. Maintain permit limits after 2015 and effective operation of lagoons.
c. Inspect permitted livestock facilities to ensure compliance.
d. New livestock permitted facilities will be inspected for integrity of applied pollution prevention technologies.
e. New registered livestock facilities with less than 300 animal units will apply pollution prevention technologies.
f. Manure management plans will be implemented to include proper land application rates and practices that will prevent runoff of applied manure.

Nonpoint Source Pollution Technical Assistance – KDHE

a. Provide technical assistance on practices geared to the establishment of vegetative buffer strips.

b. Provide technical assistance on bacteria management for livestock facilities in the watershed and practices geared toward small livestock operations which minimize impacts to stream resources.

Water Resource Cost Share and Nonpoint Source Pollution Control Program – Kansas Department of Agriculture, Division of Conservation

a. Install livestock waste management systems for manure storage.
b. Implement manure management plans.
c. Support terracing, grass waterways and buffers along cropland,
d. Repair or replace failing septic systems which are located with 100 feet of the Chikaskia River or its tributaries.

Riparian Protection Program – Kansas Department of Agriculture, Division of Conservation

a. Establish or reestablish natural riparian systems, including vegetative filter strips and stream bank vegetation.
b. Develop riparian restoration projects along targeted stream segments, initially along the Chikaskia River and its tributaries in the lower four HUC12s, then moving upstream in the watershed.
c. Promote wetland construction to reduce runoff and assimilate loadings in the Chikaskia River.

Buffer Initiative Program – Kansas Department of Agriculture, Division of Conservation

a. Install and maintain grass buffer strips near Chikaskia River, beginning in the lower four HUC 12s, then moving upstream in the watershed.
b. Mitigate removal of riparian lands from Conservation Reserve Program to hold streamside land out of production.

Extension Outreach and Technical Assistance – Kansas State University

a. Educate agricultural producers on sediment, nutrient, bacteria and pasture management.
b. Educate livestock producers on livestock waste management and land applied manure applications.
c. Provide technical assistance on livestock waste management systems.
d. Provide technical assistance on buffer strip design and minimizing rural runoff.
e. Educate residents, landowners, and watershed stakeholders about homestead waste management.

Time Frame for Implementation: Implementation of abatement practices and rural runoff management should commence in 2013 and should continue through 2017. Additional implementation may be required over 2018 to 2021 to achieve the endpoints of this TMDL.

Targeted Participants: The primary participants for implementation will be the Sumner County Conservation District directed toward agricultural and livestock operations immediately adjacent to the lower portions of Chikaskia River and tributaries within the priority sub watershed and the Sumner County Environmental Health unit directed toward the assessment of septic tank waste disposal practices and protocols. All will be encouraged to implement appropriate practices. Watershed coordinators along with Conservation District Personnel and county extension agents should target possible sources adjacent to the Chikaskia River over 2012. Non-point source implementation activities should focus onto those areas with the greatest potential to impact bacteria concentrations along the Chikaskia River.

Targeted activities to focus attention toward include:

1. Overused grazing land adjacent to the stream.
2. Sites where drainage runs through or adjacent to livestock areas.
3. Sites where livestock have full access to the stream and it is their primary water supply.
4. Poor riparian area and denuded riparian vegetation along the stream.
5. Assessment of waste disposal practices by septage haulers.

Milestone for 2016: Because bacteria daily loads are nonsensical, the preferred manner to track progress in implementing this TMDL is through alterations to the ECB index profile for KDHE sampling station SC529 (Figure 11). As the ECB index profiles decline, it will indicate reductions in duration, frequency and magnitude of future E. coli bacteria samples such that a majority will be below the nominal criterion value applied at both stations. As the profile approaches the desired distribution indicated in the figure, intensive sampling during the primary contact recreation season can be done to ascertain whether the primary contact season geometric means are in compliance with the bacteria criterion.

In accordance with the TMDL development schedule for the State of Kansas, the year 2016 marks the next cycle of 303(d) activities in the Lower Arkansas Basin. At that point in time, the bacteria profile from site SC529 should show decline.

Delivery Agents: The primary delivery agents for program participation will be the Kansas Department of Health and Environment, State Extension Service and the Sumner and Harper County Conservation Districts.

Reasonable Assurances:
Authorities: The following authorities may be used to direct activities in the watershed to reduce pollutants and to assure allocations of pollutant to point and nonpoint sources can be attained.

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.S.A. 2-1915 empowers the Kansas Department of Agriculture – Division of Conservation to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

5. 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.

6. K.S.A 75-5657 empowers the Kansas Department of Agriculture – Division of Conservation to provide financial assistance for local project work plans developed to control nonpoint 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*, including selected Watershed Restoration and Protection Strategies.

9. The Kansas Water Plan and the Lower Arkansas 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 pollutant 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 and should receive support for pollution abatement practices that lower the loading of bacteria and associated pollutants of sediment and nutrients to the Chikaskia River.

Effectiveness: Use of retention and buffers that isolate streams from nearby uses and potential loadings ahs been effective in reducing the bacteria levels in streams, including under wet weather conditions. In addition, the proper implementation of comprehensive livestock waste management plans have proven effective at reducing runoff associated with livestock facilities.

6. MONITORING

KDHE will continue to collect quarterly to bimonthly samples every year at station SC529 in the watershed. The streams in the watershed will be evaluated for possible delisting during the development of the 2022 303(d) list. Once bacteria index profiles (Figure 13) decline sufficiently, a series of intensive (5 in 30 days) samplings will commence to evaluate if impairment remains.

7. FEEDBACK

Public Notice: An active Internet Web site was established at www.kdheks.gov/tmdl/ to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Lower Arkansas Basin.

Public Hearing: A Public Hearing was held on September 21, 2012 in Wellington to receive comments on this TMDL.

Basin Advisory Committee: The Lower Arkansas River Basin Advisory Committee met to discuss these TMDLs on May 31, 2012 in Hutchinson and September 12, 2012 in Halstead.

Milestone Evaluation: In 2016, evaluation will be made as to the degree and impact of implementation which has occurred within the watershed. 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 2016 with consultation form local stakeholders.

Consideration for 303d Delisting: The Chikaskia River will be evaluated for delisting under section 303(d), based on the monitoring data over 2012-2020. Therefore, the decision for delisting will come about in the preparation of the 2022-303(d) list. Should modifications be made to the applicable water quality criteria during the implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities might 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, the next anticipated revision would come in 2012. Recommendations of this TMDL will be considered in the Kansas Water Plan implementation decisions under the State Water Planning Process for Fiscal Years 2012-2021.

Developed 1/2/13

References

Juracek, K.E., 2000. Soils – Potential Runoff. U.S. Geological Survey Open-File Report 00-253.

National Agricultural Statistics Service. December 14, 2011. State and County Data. http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats_1.0/index.asp

Perry, C.A., D.M. Wolock and J.C. Artman, 2004. Estimates of Flow Duration, Mean Flow, and Peak-Discharge Frequency Values for Kansas Stream Location, USGS Scientific Investigations Report 2004-5033.

US Department of Agriculture. Census of Agriculture, 2002.

WIMAS Query. Kansas Geological Survey. December 14, 2011. http://hercules.kgs.ku.edu/geohydro/wimas/query_setup.cfm