SMOKY HILL-SALINE BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Big Creek
Water Quality Impairment: E coli Bacteria

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Big **Counties**: Russell, Ellis, Trego, Gove, and Sheridan

HUC8: **10260007**
HUC10 (HUC12): **01** (01, 02, 03, 04)
02 (01, 02, 03, 04)
03 (01, 02, 03, 04, 05)
04 (01, 02, 03, 04, 05)

Ecoregion: Central Great Plains, Rolling Plains and Breaks (27b); minor portion in Western High Plains, Flat to Rolling Cropland (25d)

Drainage Area: 862 square miles

Main Stem Water Quality Limited Segments: Big Creek (Segment 1 in Russell County); (Segments 3 & 5 in Ellis County); (Segment 7 in Trego & Gove Counties)

Main Segment	**Tributaries**
Big Creek (1)	Walker Cr (2)
Big Creek (3)	North Fork Big Creek (4) Mud Cr (9)
Big Creek (5)	Chetolah Cr (8)
Big Creek (7)	Ogallah Cr (6)

Designated Uses: For Big Creek – all segments (1, 3, 5, & 7): Expected Aquatic Life Support, Food Procurement, Domestic Water Supply, Industrial, Irrigation and Livestock Watering and Ground Water Recharge. Primary Contact Recreation "C" on Segment 1; Primary Contact Recreation "B" on Segment 5; Secondary Contact Recreation "b" on Segments 3 and 7.

For tributaries – Expected Aquatic Life Support and Secondary Contact Recreation "b" on all tributaries (Secondary "a" on Chetolah Creek); Domestic Water Supply, Industrial and Irrigation Water Supply, Livestock Watering and Ground Water Recharge also on Walker Creek and North Fork Big Creek; Food Procurement also on North Fork Big Creek.

303(d) Listings: Kansas Stream segments monitored by Station SC540 cited as impaired by E coli bacteria in the 2008-303(d) list for the Smoky Hill – Saline Basin. Station SC541, located above the Chetolah Creek confluence was not cited for bacteria, nor was Station SC715 on the North Fork Big Creek.

Impaired Use: Primary Contact Recreation (Classes "B" and "C")

Water Quality Criteria: K.A.R. 28-16-28d. Surface water classification and use designation. (a) Surface water classification. Surface waters shall be classified as follows:

(1) Classified stream segments shall be those stream segments defined in K.S.A. 82a-2001(a), and amendments thereto. (K.S.A. 82a-2001(a) provided in Appendix A)

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 instances in which there is a reasonable potential for the discharge to exceed the applicable 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.

Table 1i. Escherichia coli Criteria For Classified Stream Segments.

USE	Colony Forming Units (CFUs)/100mL	
PRIMARY CONTACT RECREATION	Geometric Mean April 1 – Oct. 31	Geometric Mean Nov. 1 – March 31
Class A	160	2358
Class B	262	2358
Class C	427	3843
SECONDARY CONTACT RECREATION	Geometric Mean Jan. 1 – Dec. 31	
Class a	2358	
Class b	3843	

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Uses under 2008- 303(d): Bacteria levels on Big Creek at Munjor (SC540) exceeded the geometric mean criteria in 2006, data collected by the Big Creek WRAPS during 2007 thru 2009 indicated routine exceedance of the criteria, particularly during storm events occurring between April and October.

Stream Monitoring Sites and Period of Record: KDHE permanent ambient Stream Chemistry sampling station SC540, located on Big Creek 0.5 miles east of Munjor has E coli data from 2003-2009 **(Figure 1)**. A permanent sampling station SC541, located on Big Creek at the U.S. 183 Bypass bridge on the west edge of Hays similarly has E coli data from 2003-2009. The rotational sampling station, SC715, on the North Fork of Big Creek, located southwest of Walker, yielded no samples in 2006 because of lack of flow. Additionally, probabilistic monitoring sites on Big Creek at Ogallah, Ellis and Russell were sampled 4 times in 2008-09.

Supplementing the routine KDHE sampling, the Big Creek-Middle Smoky Hill Watershed Restoration and Protection Strategy (WRAPS) group has sampled throughout the basin since 2007. This sampling fills in the spatial gaps of the state network and also provides more targeted sampling of runoff events.

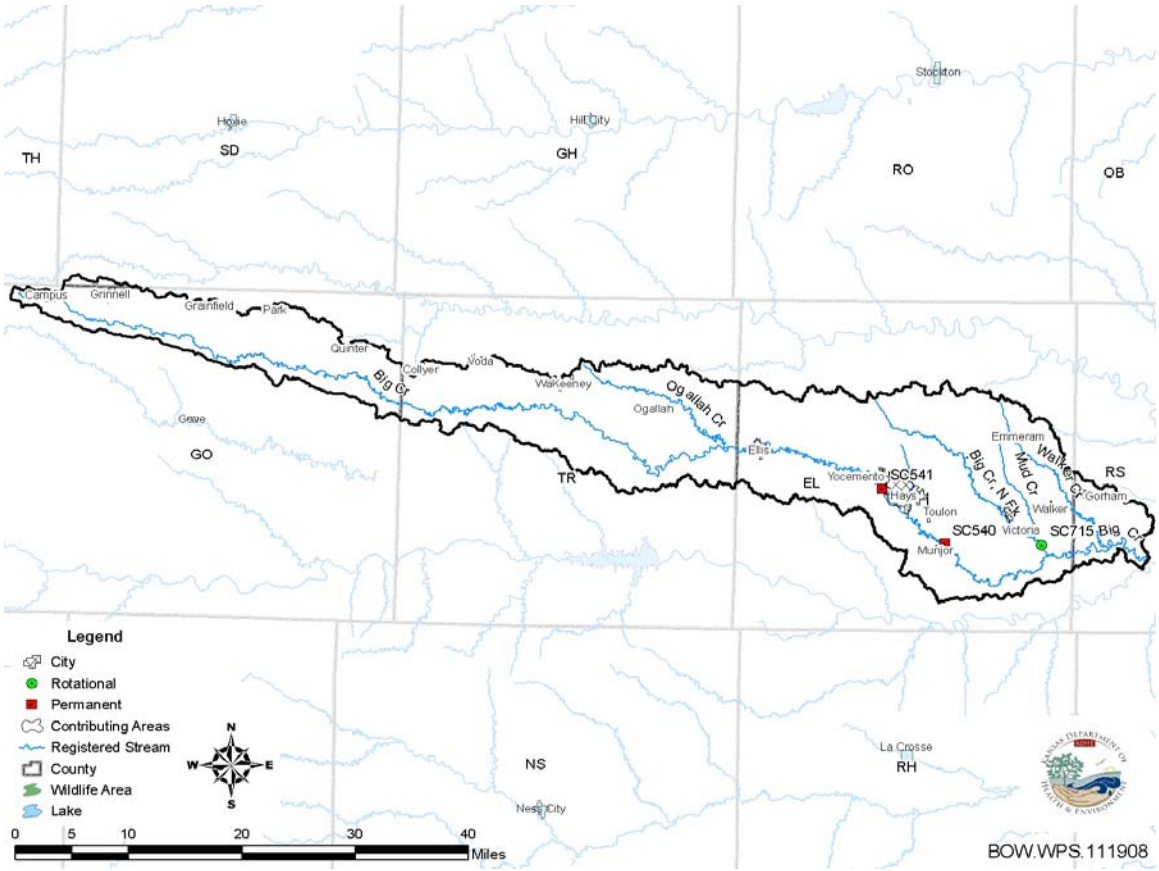

Figure 1. **Big Creek Subbasin with KDHE monitoring stations.**

Hydrology: The USGS has maintained a gaging station (06863500) on Big Creek at Highway 183 south of Hays over 1946-2009. Shorter term stations recorded flow on Big Creek at Ogallah (1955-1968) and near Russell (1962-1964). A gaging station was operated on the North Fork of Big Creek near Victoria over 1962-1987. Table 1 displays the general flow conditions estimated at locations along Big Creek. Approximately half the flow is generated west of the Ellis-Trego county line. However, a comparison of daily flows over a 14-year period on Big Creek between Hays and Ogallah indicates substantially lower flows in Trego County than those seen at Hays **(Figure 2).** Conversely, in the brief time flow was measured at Hays and at Russell, there was consistent downstream gain in flow (**Figure 2**). The most severe drought seen on Big Creek occurred in 2006 **(Figure 3).** Between July 2005 and December 2006, only two visits out of eight on Big Creek above Hays yielded water samples. Ground water support of flow in Big Creek is nominal in Gove and Trego counties where the High Plains Aquifer underlies the stream channel; however, the saturated thickness in those areas is only roughly 50 feet with declines of 0-5 feet over 2002-2007 **(Figure 4).** Ground water support in Ellis and Russell counties is restricted to the alluvium of Big Creek. Upstream flows tend to be retained in Ellis by the city lake (formed by damming Big Creek). Ellis wastewater discharges average 0.34 cfs over 2004-2009. Hays wastewater averages 2.94 cfs over 2003-2009.

Table 1. **Long Term Estimated Flows on Big Creek at certain locations (from Perry, 2006).**

Location	Drainage Area	Mean Flow	90%	50%	10%	2-yr Peak
Gove-Trego County Line	186 sq.mi	9.4 cfs	0.08 cfs	0.86 cfs	5.3 cfs	811 cfs
Above Ogallah Crk	339 sq.mi	23 cfs	0.41 cfs	3.5 cfs	18.6 cfs	1340 cfs
Trego-Ellis County Line	432 sq.mi	27 cfs	0.97 cfs	5.1 cfs	25 cfs	1340 cfs
Above Chetolah Creek	521 sq.mi	31 cfs	1.5 cfs	6.7 cfs	33 cfs	1310 cfs
Above North Fork Big Creek	620 sq.mi	35 cfs	1.9 cfs	8.3 cfs	41 cfs	1320 cfs
Ellis-Russell County Line	788 sq.mi	45 cfs	1.9 cfs	10.4 cfs	54 cfs	1610 cfs
Mouth	862 sq.mi	51 cfs	1.9 cfs	11.7 cfs	62 cfs	1760 cfs

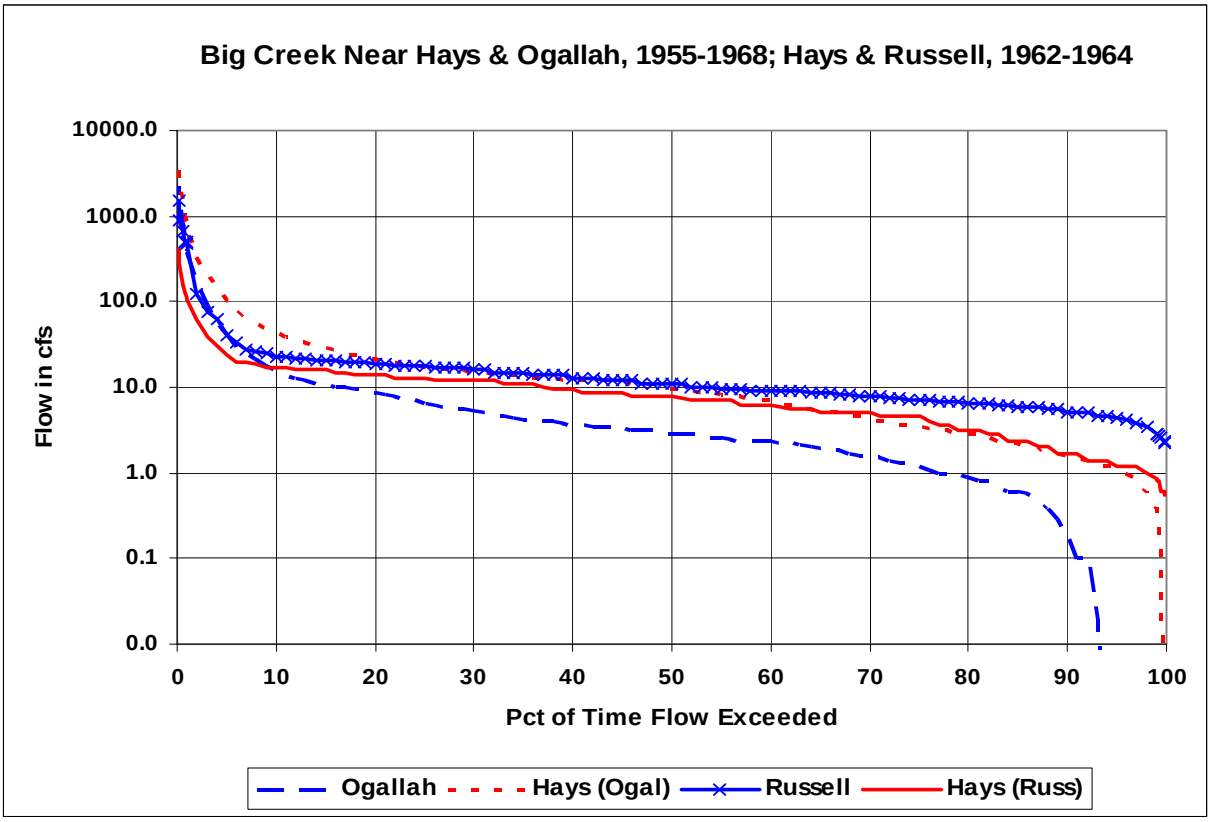

Figure 2. Flow Duration on Big Creek at Hays, Ogallah & Russell in Similar Years

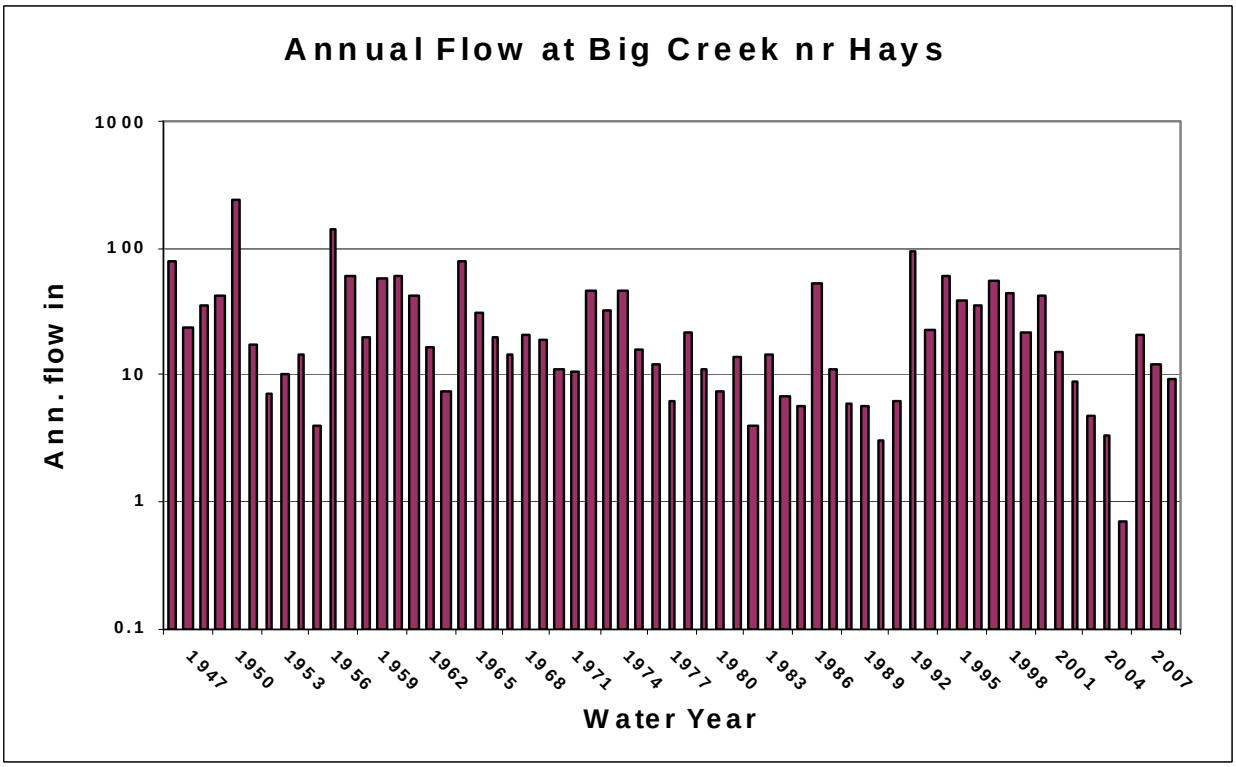

Figure 3. Average Annual Flow on Big Creek; 1947 - 2008

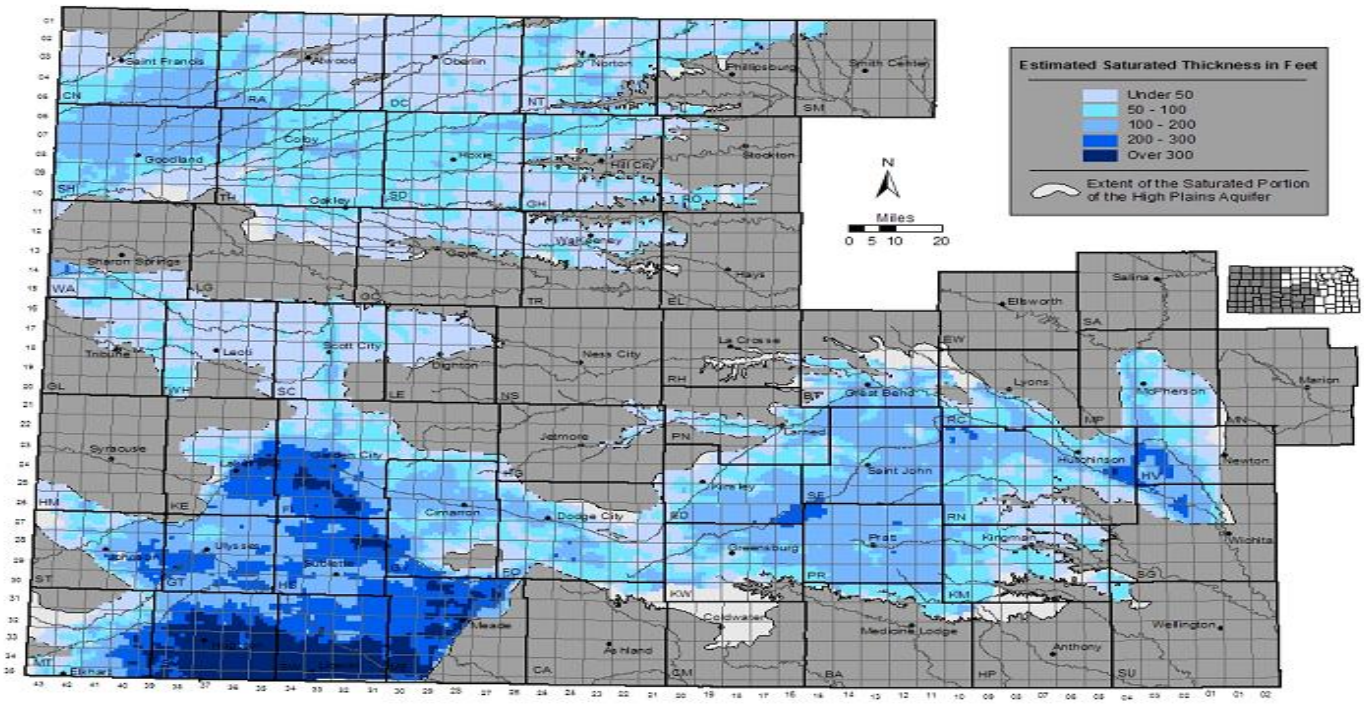

Figure 4. High Plains Aquifer Saturated Thickness

Use attainability analysis surveys conducted by KDHE staff over 2004-2008 along Big Creek and its tributaries provided a picture of steady flow along the creek in Ellis and Russell counties, but intermittent flows, channel pools and dry channel beds in Trego and Gove counties. Field observations by Division of Water Resources staff from the Stockton Field Office indicate that flow on Big Creek is very intermittent (~50% of the time) at Ellis, increases slightly toward Yocemento and then declines as the creek enters Hays.

Wastewater effluent from Ellis typically does not flow into the Hays area. However, flows are nearly continual below the confluence with Chetolah Creek and Hays wastewater. Peak flows, comprised of runoff from the rural watershed and urban stormwater occurs routinely on the lower portions of Big Creek. Annual peak flows seen at the USGS gaging station show peaks orders of magnitude greater than the long term daily average flow **(Figure 5**). Since 1973, peak flows have diminished in volume and frequency. This may reflect a drying of the watershed because of ground water lowering and a proliferation of watershed impoundments and conservation practices on cropland retaining rainfall (Koelliker, 1998).

Flow duration data at the USGS gaging station at Hays indicate flows during the period of record for overall KDHE sampling on Big Creek (1990-present) have declined under dry conditions relative to the 45 years prior to sampling **(Figure 6).** Conversely, flows in the mid-range condition were elevated compared to the past. While chemistry sampling covers most of the flow range seen on Big Creek, E coli bacteria sampling since 2003 has been concentrated in the middle to lower flow ranges.

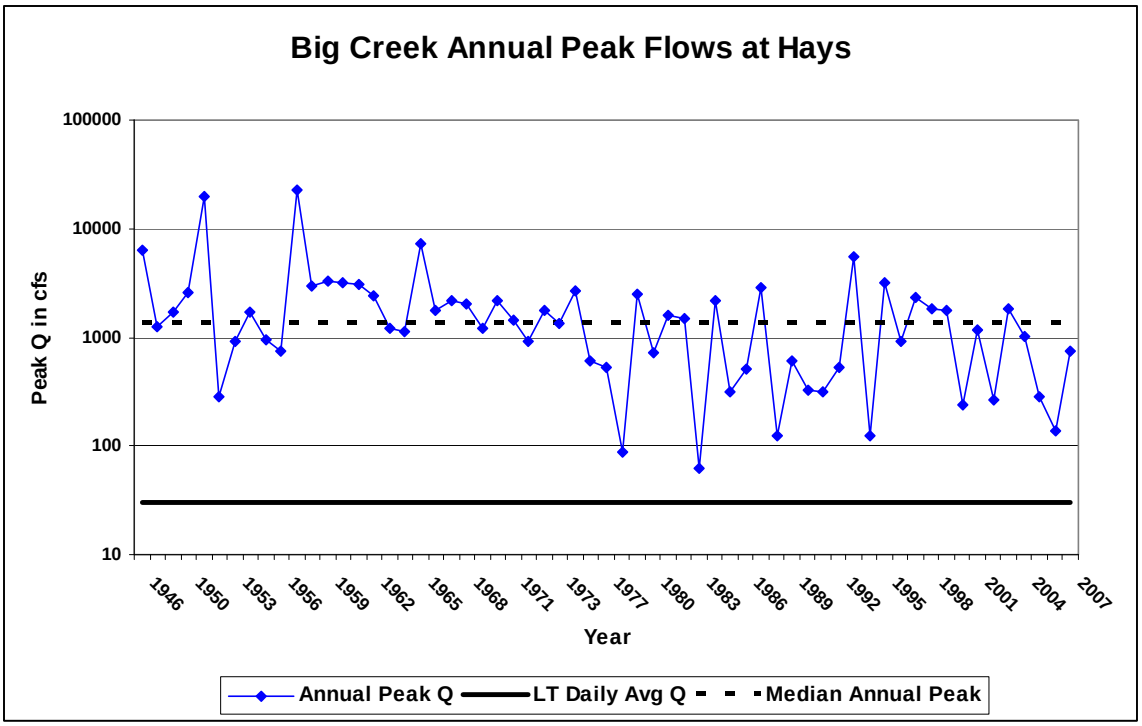

Figure 5. Annual peak flows on Big Creek at Hays

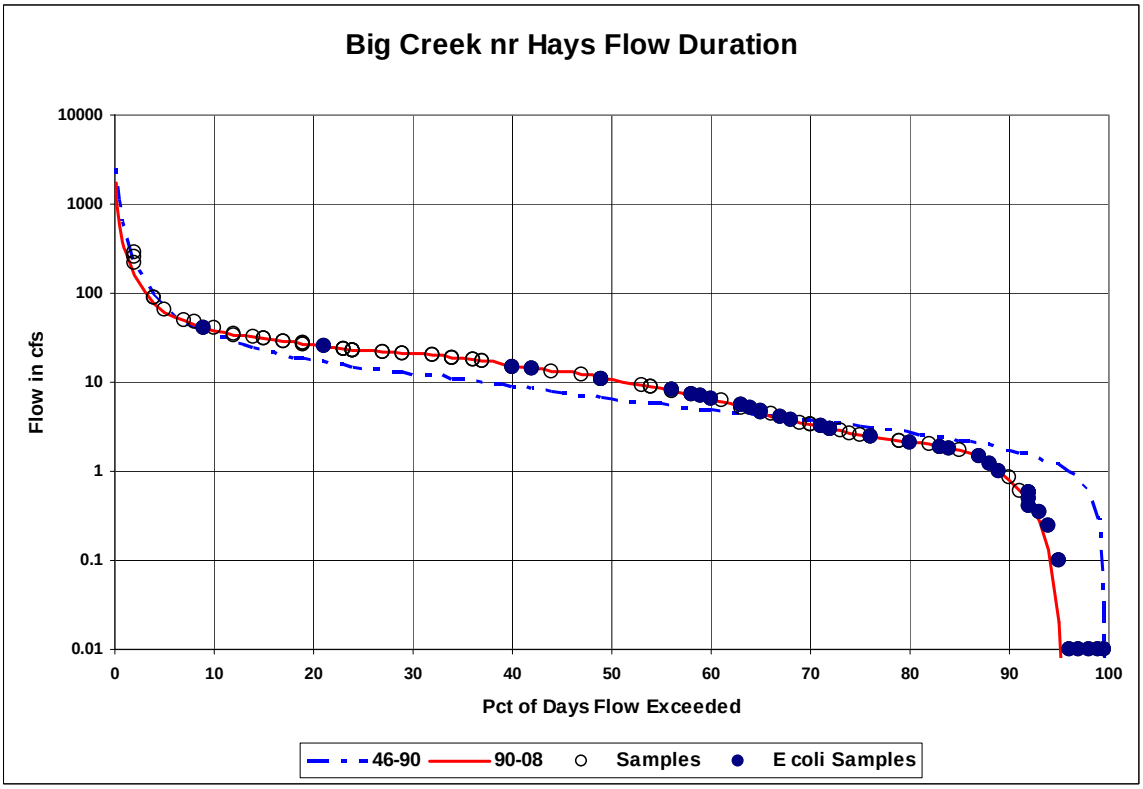

Figure 6. Big Creek Flow Duration Before and During KDHE Sampling

The distribution of monthly average flows before and after 1990 is fairly similar with the exception of significant decline in flows during June and July, indicating reduced runoff from the upstream watershed **(Figure 7).** Hydrograph separation of daily flow records for the two periods indicates the average annual runoff for 1946 – 1989 was 0.74 inches; while the runoff averaged 0.59 inches for 1990 – 2008. Baseflow made up 44 percent of the flow prior to 1990 and has proportionately increased in the recent decades, comprising 59 percent of streamflow since 1990. Within the sampling period of record, the current decade is drier than the 1990's **(Figure 8).** Some recovery of flow occurred in 2007 and 2008. Very dry conditions returned in 2009, such that average monthly flows in June through November were an order of magnitude less than the recent average flows over the sampling period of record **(Figure 7).**

Because this TMDL will address bacteria impairments on Big Creek below Hays to the confluence with the Smoky Hill River, the anticipated hydrology used to compute load capacity and load allocations was adjusted for Segments 1, 3 and 5. The gaged flow was used for Segment 5, but was increased by 26% for Segment 3. The adjusted Segment 3 flow was increased by 0 – 50% for Segment 1. These adjustments were based on the increase in flow estimates provided by Perry, et al (2004).

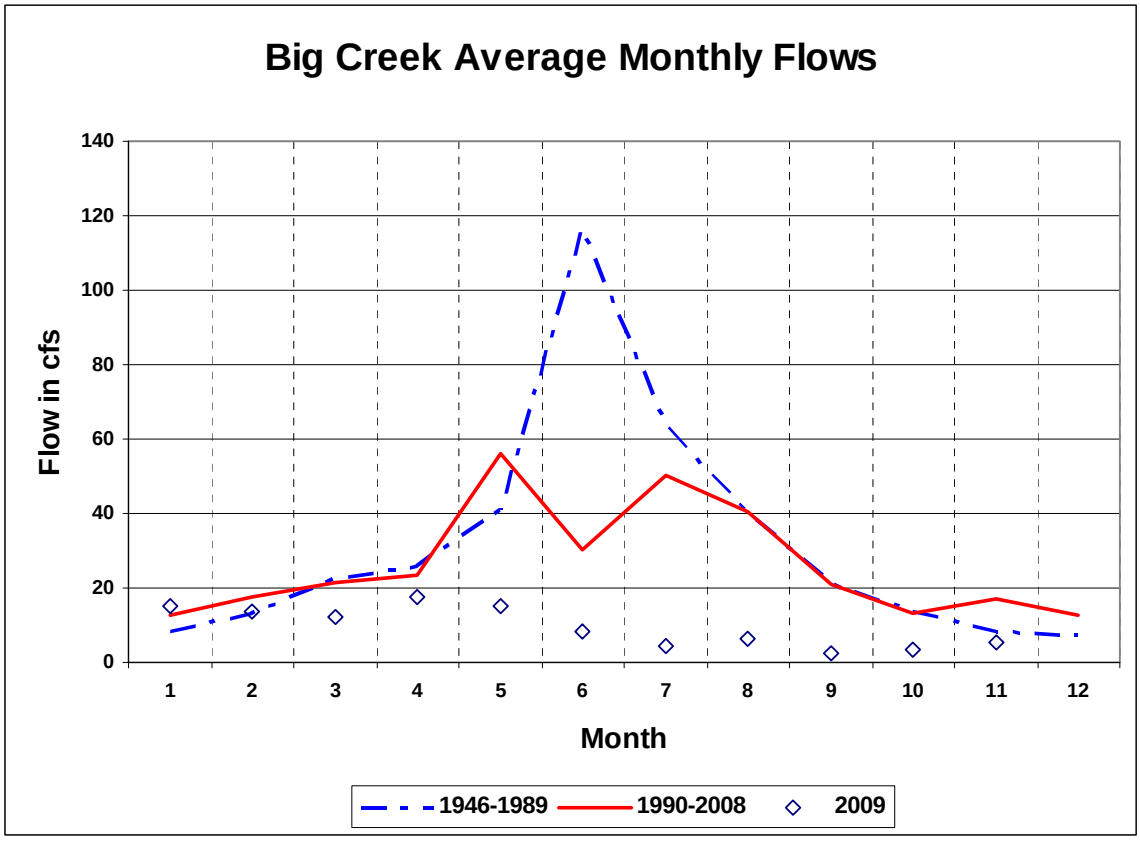

Figure 7. Average Monthly Streamflows on Big Creek Prior to and After 1990.

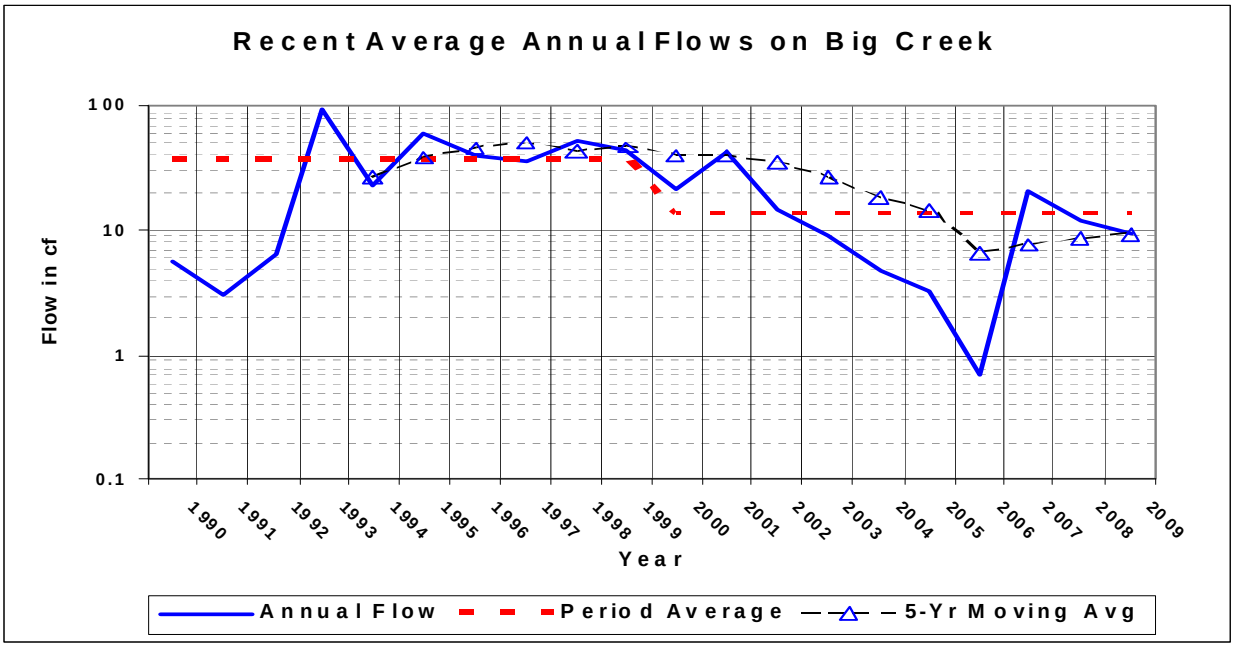

Figure 8. Average Annual Streamflows on Big Creek During KDHE Sampling Period

Bacteria Concentrations: Fecal coliform bacteria (FCB) was sampled at both Big Creek sites prior to 2003 and E coli (ECB) was sampled from July 2003 on (**Figure 9**). Geometric means of overall FCB data was 116 colonies/100 ml above Hays (SC541) and 221 colonies/100 ml at Munjor (SC540). The geometric means of the overall ECB data were 76 colony forming units (CFUs)/100 ml upstream of Hays and 216 CFUs/100ml below Hays. Isolating on the primary recreation season (April – October), the geometric FCB means rose to 286 CFUs/100 ml above and 671 CFUs/100 ml below Hays. Likewise, the ECB geometric means for the primary recreation season increased to 131 CFUs/100 ml above Hays to 431 CFUs/100 ml at Munjor. For the remainder of this TMDL, the term "counts" will represent CFUs/100 ml as expressed in the water quality standards or Most Probable Number (MPN)/100 ml, the measured parameter for ECB.

While there is considerable spread in bacteria values, regardless of site or indicator, the downstream geometric means are significantly higher than those at the upstream site **(Figure 10**). More flow, more susceptibility to runoff and more possible contributing sources likely cause higher bacteria levels in the lower reaches of Big Creek. Variable sources of bacteria may be contributing because the bacteria values cover a broad range at all flow conditions, although there is a slight uptick in bacteria at the highest flows (**Figure 11**).

More intensive sampling (five times within 30 days) was conducted at Station SC540 in 2006. The sampling occurred during and in the aftermath of some runoff events over April and June (**Figure 12**). The geometric mean in April was 382 counts and 788 counts in June, which exceeded the criteria for primary recreation on Primary Class B and C streams (262 and 427, respectively). These data were the justification for listing Big Creek on the 2008 303(d) list.

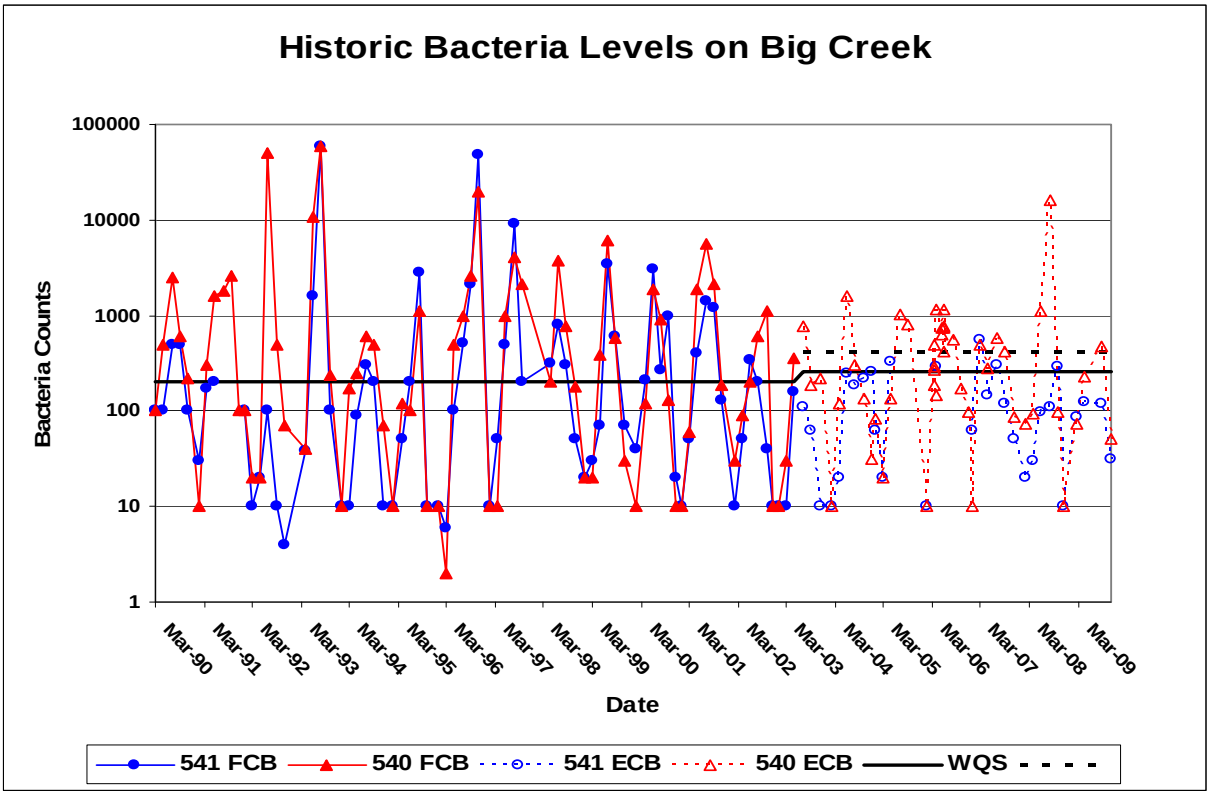

Figure 9. Bacteria Levels Above and Below Hays Since 1990

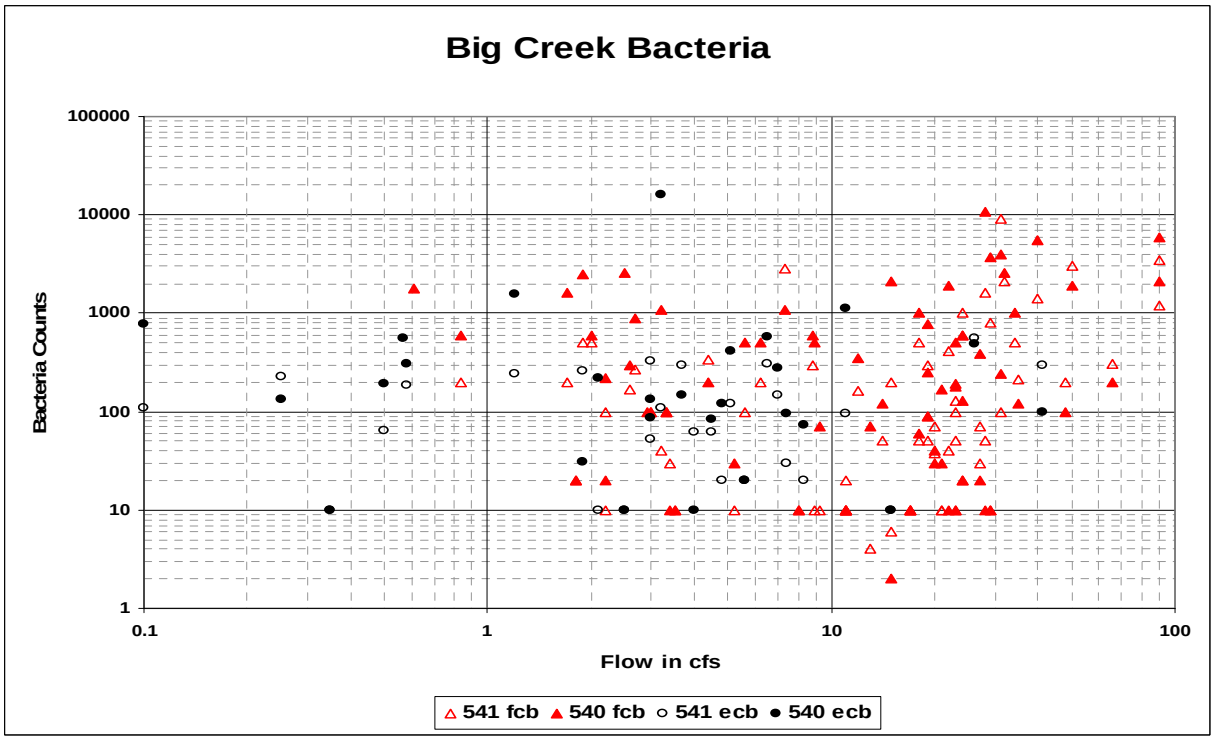

Figure 10. Bacteria – Flow Relations on Big Creek, 1990-2009

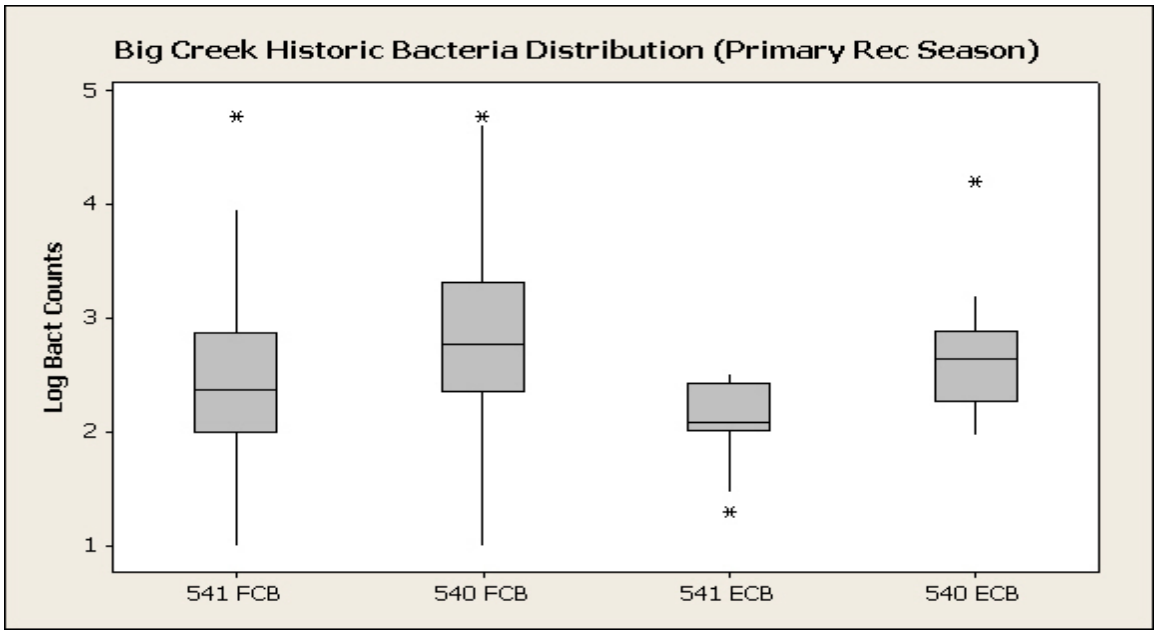

Figure 11. Historic Bacteria Distribution Above and Below Hays During Apr-Oct

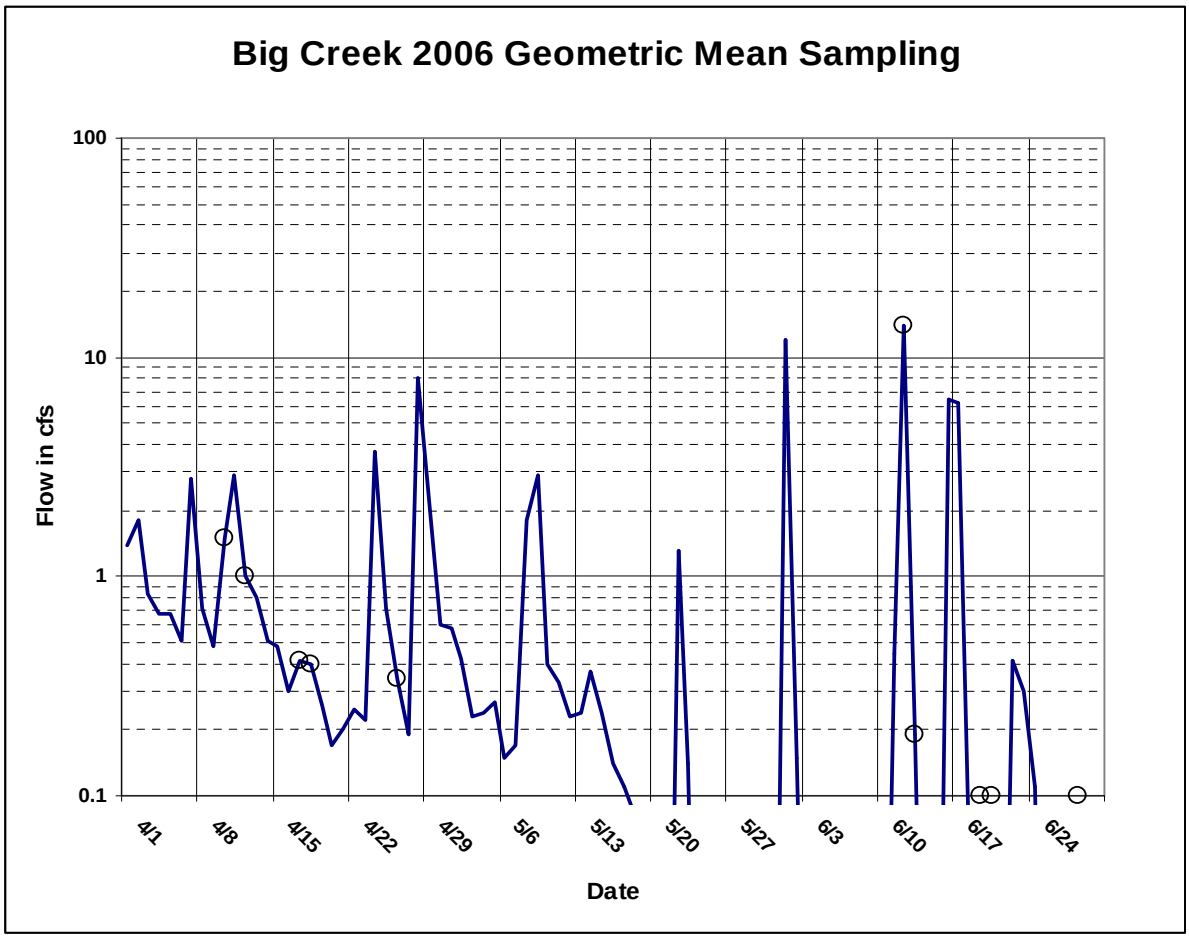

Figure 12. Flow Conditions During Intensive Bacteria Sampling on Big Creek in 2006

One way to look at the pattern of E coli presence along Big Creek is to plot the respective ECB index profiles for both stations **(Figure 13).** The index is computed for the samples taken during the primary (April – October) period and is the natural log of each sample's bacteria count, divided by the natural log of the applicable criterion, in this case, 262 counts. The resulting values normalize each bacteria sample to the criterion and profiles can be derived by the cumulative frequency distribution of those index values.

In the case of Big Creek, the lower station at Munjor is above the nominal criterion value much more frequently than the station above Hays. The upper Hays station approaches a desired profile where 90% of the index value is at or below 1, indicating a preponderance of acceptable bacteria conditions. As an interim step toward managing the bacteria in Big Creek, control measures should lower future Munjor bacteria values such that the Munjor profile begins to approach that of Hays.

The lowering of the profile would indicate reductions in the magnitude, duration and frequency of bacteria levels in the lower reaches. The utility of the index profile is to use routine sample data to assess bacteria conditions until such time that use of the more intensive (five times in 30 days) sampling is conducted to assess compliance with water quality standards.

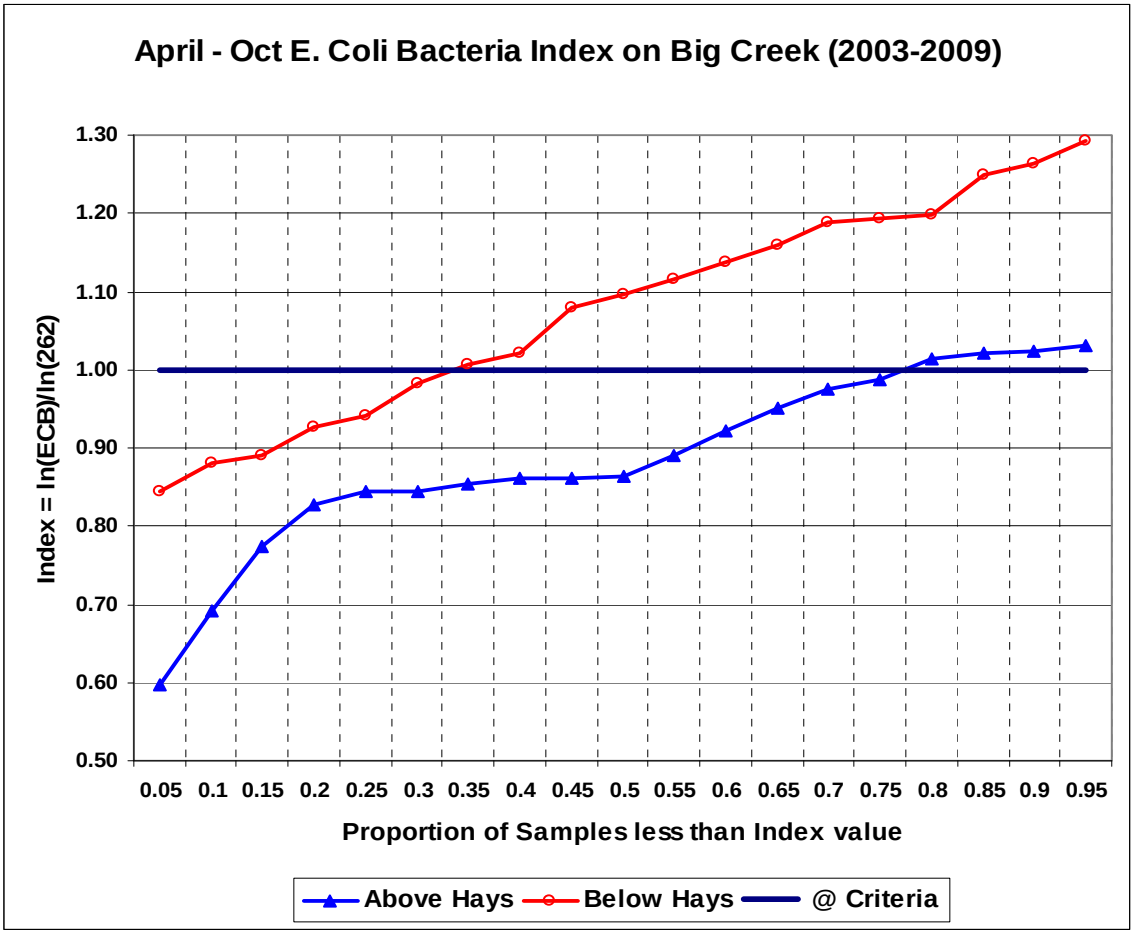

Figure 13. E coli Bacteria Index Profiles for Big Creek at Hays and Munjor

The Probabilistic Stream Monitoring Program collected samples along Big Creek at Ogallah in 2008 and at Ellis and Russell in 2009. Concurrent samples were taken at the routine KDHE stations. **Figure 14** displays the summary of bacteria levels along Big Creek during these samplings. Although each site has values similar in magnitude, divergence occurs frequently among concurrent samples, implying that local conditions dictate bacteria levels at any given site during that snapshot in time. The watershed does not necessarily respond as a unit, but typically reflects the impact of storm placement within the watershed.

The Big Creek/Middle Smoky Hill Watershed Restoration and Protection Strategy (WRAPS) group has conducted fine resolution sampling within the watershed since 2007. Sampling sites are located throughout Big Creek in Ellis County with a few sites in lowest reach before entering the Smoky Hill River (**Figure 15**). A number of sites were located within the city limits of Hays in an attempt to pin down locations of significant pollutant contributions. Their sampling tended to be oriented towards storm events, thus, the bacteria values they found were usually elevated. **Figure 16** shows the bacteria levels over the past two years at the primary stations on Big Creek. There is a definite seasonality to the pattern, with low bacteria values during winter, but clearly, the main driver is rain events. It would appear that 2008 was a much wetter year than 2009 and the number of sites with high bacteria was greater in 2008 and the magnitude of the bacteria levels was greater in 2008 than in the drier 2009. There is no clear cut geographic demarcation of high bacteria sites. Generally, in wet years, all sites are susceptible to spiking in bacteria and in dry years, the proximity of the site to the storm will dictate where the spikes occur.

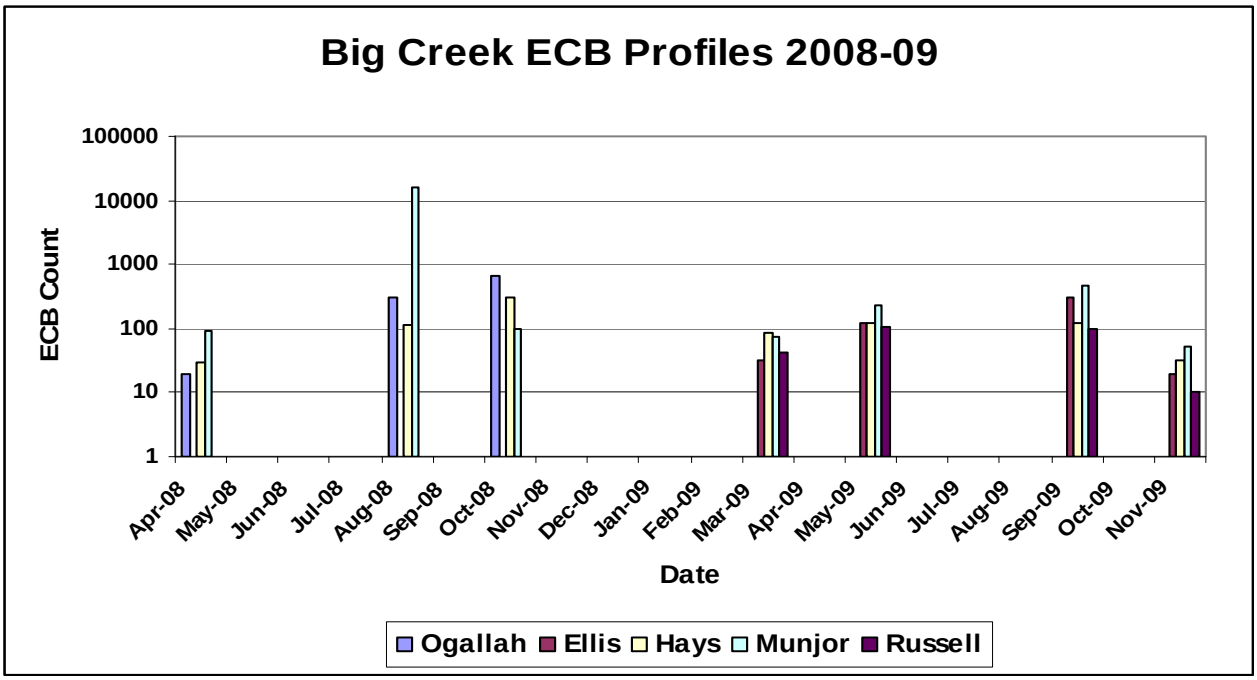

Figure 14. Synoptic Bacteria Sampling along Big Creek in 2008 and 2009

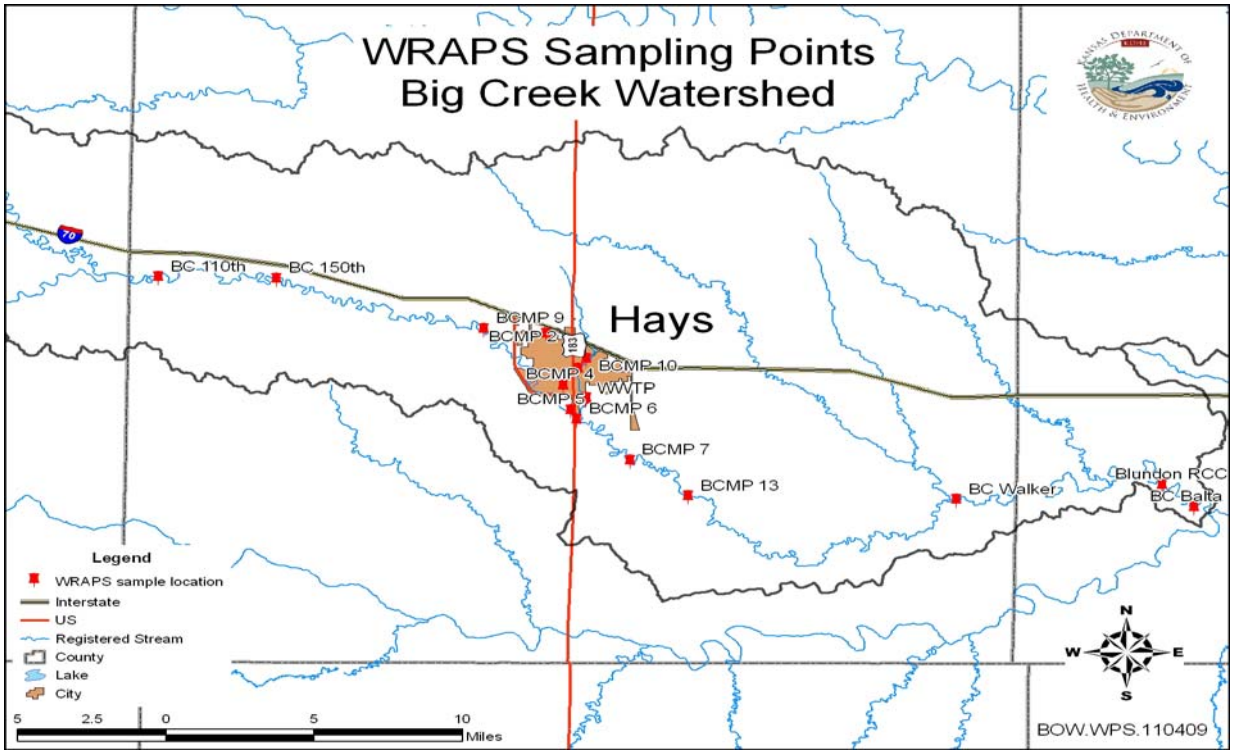

Figure 15. WRAPS Monitoring Sites along Big Creek

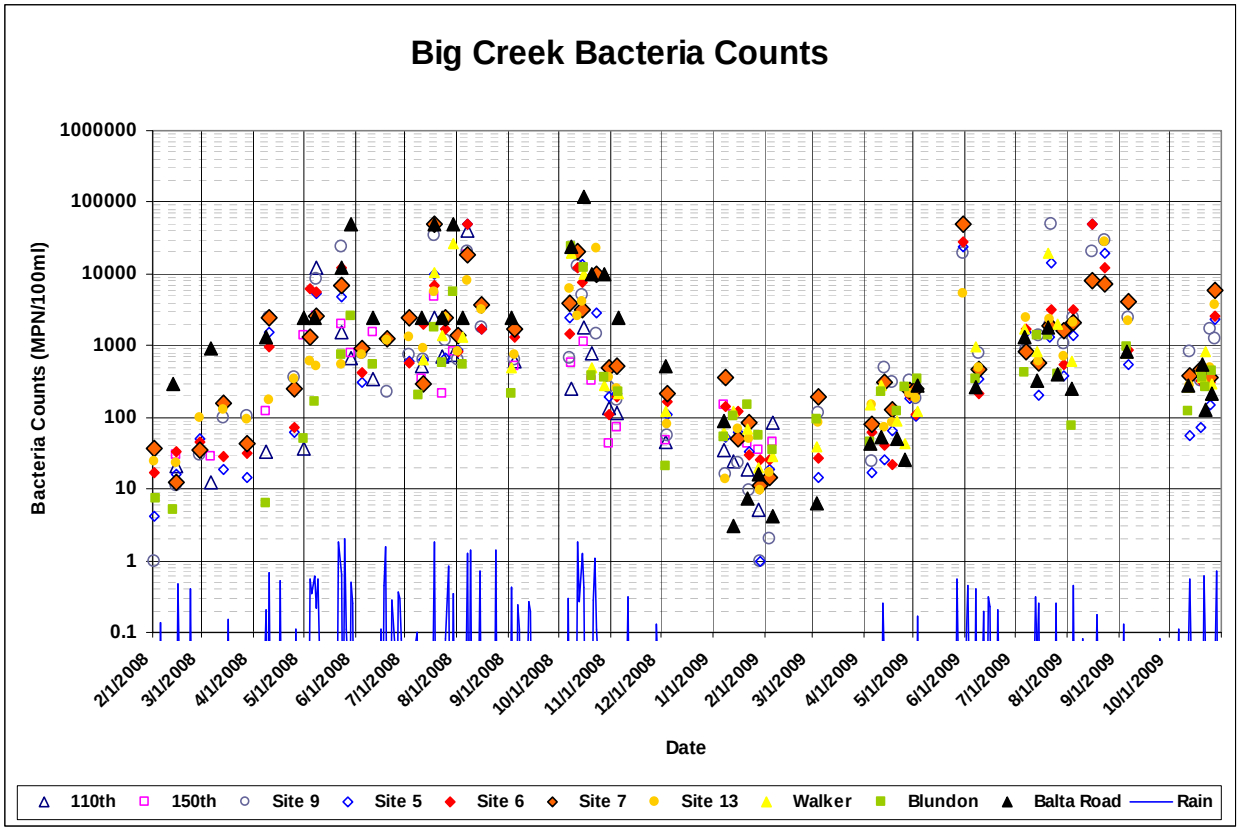

Figure 16. WRAPS Bacteria Sampling Results over 2008-2009 along Big Creek

If the time period is broken out into three portions of each primary recreation season, the seasonal geometric means for the five main stations on Big Creek, sampled by the WRAPS, show similar values with some divergence in certain situations **(Figure 17).** Stations 9 and 5 are located above Chetolah Creek and the Hays wastewater outfall; Station 6 is located immediately below Chetolah Creek and Stations 7 and 13 are downstream near Munjor. Although the largest seasonal geometric mean occurred at the most upstream Station 9 during the June-August 2009 period, reflecting opportune sampling of sporadic runoff, the remaining geometric means in 2009 were at or well below their seasonal counterparts in 2008. Rain and flow conditions were markedly greater in 2008.

If the ECB index profiles are examined for the main stations, the magnitude, duration and frequency of high bacteria are higher than that seen with the KDHE data **(Figure 18).** This is primarily a result of the stormflow orientation of the WRAPS sampling. Nonetheless, the five stations located across Ellis County show the same general pattern. Station 5 has the highest proportion of samples below the criterion, followed by Station 6. These stations represent the Hays vicinity. The most downstream Station 13 generally has the lowest magnitude of sample values seen on Big Creek, suggesting some die off or retention of higher bacteria loads in the upstream reaches. Regardless, a very high proportion of samples taken at that station exceed the criterion value. **Table 2** indicates the overall and primary season geometric means for all the WRAPS stations.

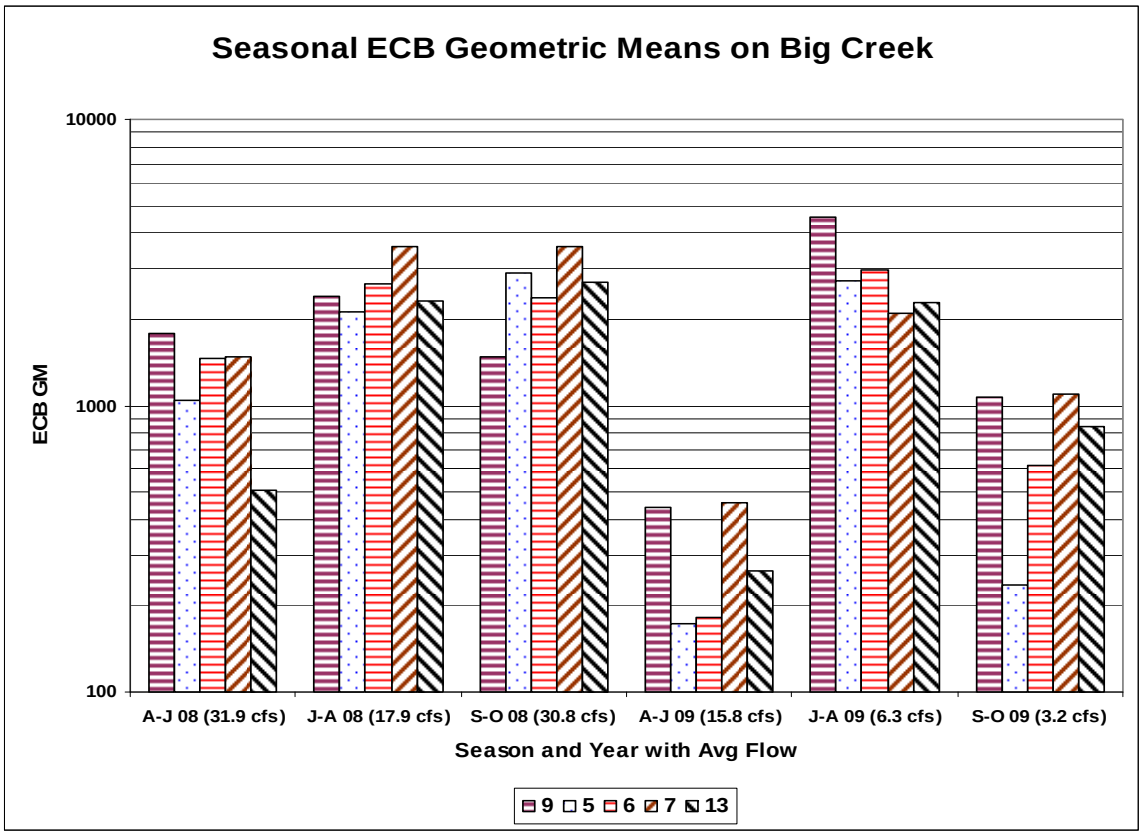

Figure 17. Seasonal Geometric Means for Main WRAPS Stations on Big Creek

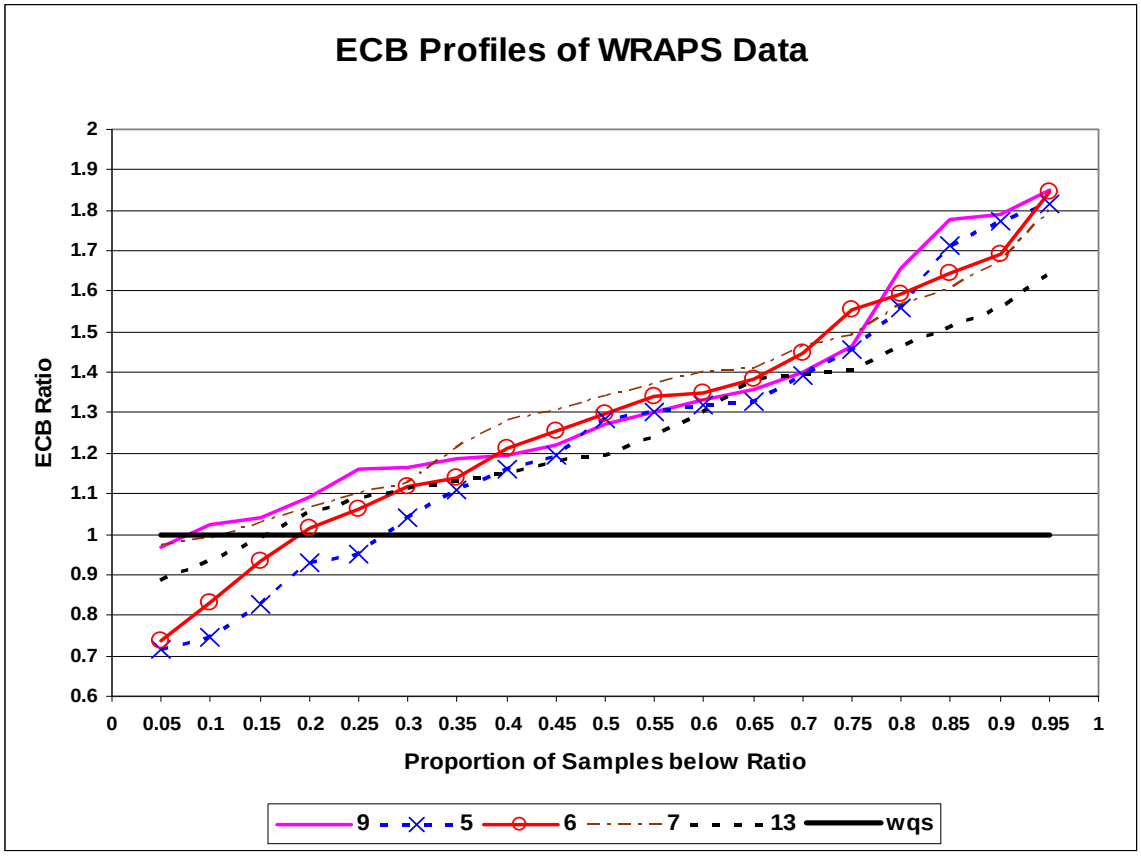

Figure 18. ECB Index Profiles of WRAPS Data taken along Big Creek

Bacteria levels tended to be higher on the creek in 2008, but Lincoln and Chetolah Draws within Hays (Stations 1, 2, 4,10-12) showed a susceptibility of exceedingly high bacteria, likely reflecting very flashy storm flows and high density of potential sources in a small area. Those high values, particularly in 2009, were dampened down within Big Creek. The generally lower overall geometric means implies that bacteria levels diminish substantially during the November thru March period. The geometric means for the five main stations show a decline between Stations 9 and 5, followed by an increase from Station 5 to Station 7 and then another drop off at Station 13. It would appear that the greatest increase might occur between Stations 6 and 7, followed by the Chetolah drainage bracketed by Stations 5 and 6.

Table 2. Overall and Seasonal Geometric Means for WRAPS Bacteria Stations

Site	9	1	2	4	10	11	12	5	6	7	13
Overall GM	528	805	24061	13185	1327	729	8824	401	563	742	481
2008 Primary GM	1886	805	17568	7176	2610	3611	5871	1818	2084	2641	1425
2009 Primary GM	1404	NA	48825	51829	26898	NA	24438	562	757	1011	753

Use Attainability: Use Attainability Analyses were conducted over 2004 -2005 in the Big Creek Subbasin. The stream segments in the sub basin are displayed in **Appendix B**. The lowest segment, 1, was assessed in 1988 and found to have adequate flow and depth to support primary contact recreation. Because of limited access, it has been designated as Class C. The next segment, 3, runs from the confluence of Walker Creek upstream to the confluence of Chetolah Creek. It was assessed at three locations in April 2005. It averaged 4-12 inches in depth with maximum depths of 20-22 inches. With restricted access and shallow depths it is designated Class b, supporting only Secondary contact recreation.

The next segment, 5, includes Big Creek from Chetolah Creek upstream to Ogallah Creek and includes the impoundment that creates Ellis City Lake. The free flowing portions of the segment averaged 10-12 inches in depth with maximum pools of 20-22 inches in April, 2005. But the impounded portions of the segment supports two feet depth on average with a maximum depth of four feet, therefore, supporting Primary Recreation and its accessibility through the city park, requires the segment to be designated as Class B, the most stringent of stream recreation designations. Finally, Segment 7 flowing through Gove and Trego counties was assessed in September, 2004 and was dry or pooled with no flow at four locations. Its designation was relegated to Class b. Observations by WRAPS volunteers indicate in-stream recreation on Big Creek appears to be limited to areas where the lake has been impounded to create depth (Ellis City Lake, Hays Frontier Park).

The tributaries to Big Creek all have shallow depths, therefore, they support secondary contact recreation. All but Chetolah Creek have restricted access and are Class b. Chetolah Creek flows through Hays, including parkland and therefore is a Class a recreation stream.

Following Stiles and Tate (2008), streamflow measurements at the USGS gage (06863500) were used to establish a dataset of flow, depth and velocities across a wide range of flow conditions. Regression equations were used to establish hydraulic geometry relations for depth and velocity:

Velocity = 0.472 * Flow^0.24 (R2 = 57%)
Depth = 0.242 * Flow^0.455 (R2 = 90%)

These relations were used to convert the flow duration curve into duration curves for specific depths and velocities. For this TMDL, average depths over one foot were required to support primary recreation and average velocities over two feet per second constrain primary recreation because of safety concerns. Additionally, USGS protocols for stream wading suggest if the depth-velocity product (dxv) exceeds the wader's height, nominally, six feet, the stream is not safe to enter (J.Putnum, USGS, pers comm., 2008).

Figure 19 displays the estimated depth and velocity conditions seen over time in Big Creek. Because of its relatively flat slopes, wide channels and marginal hydrology, optimal conditions for primary contact recreation do not occur until flows exceed the

upper quartile (25%) flows. Unsafe conditions only occur a very small percentage of time. Therefore, in-stream primary recreation is conservatively suggested to take place during flows occurring 5-40% of the time. This relation tends to support the designation of most of the streams in the watershed as supporting secondary contact recreation.

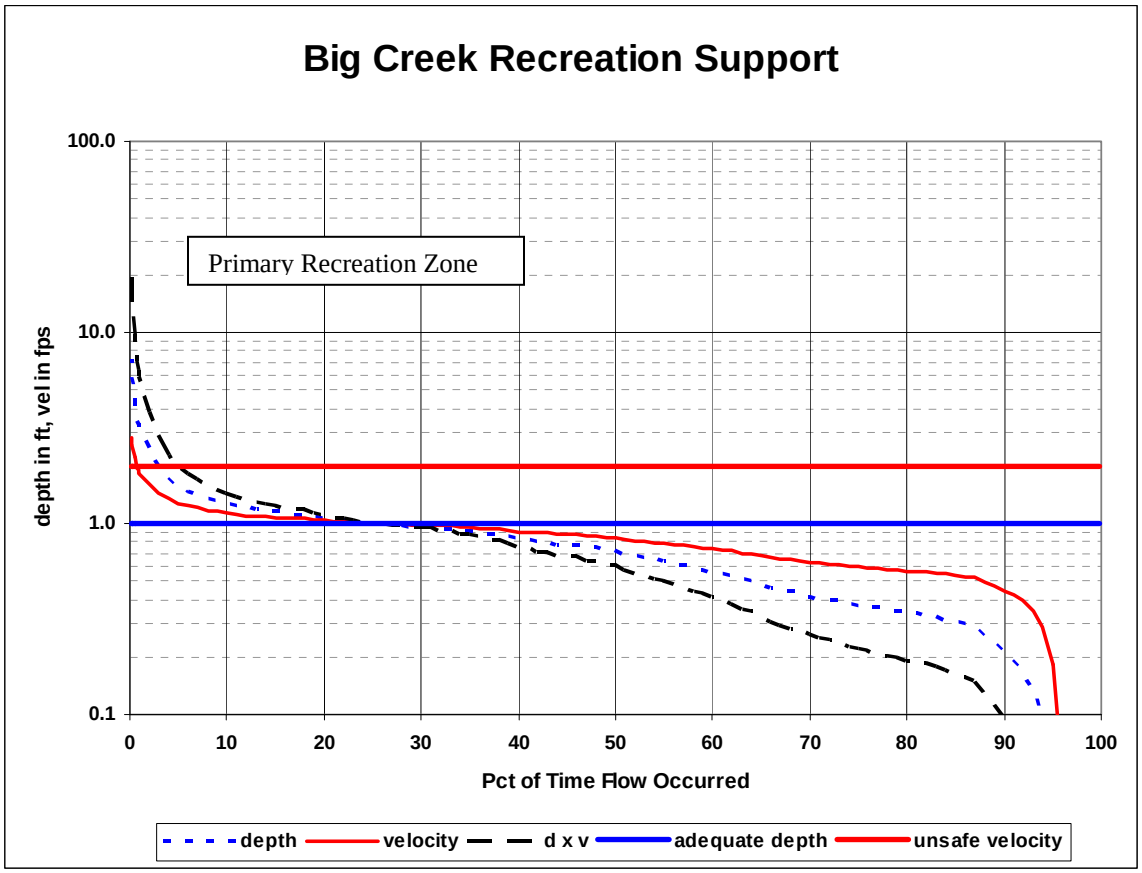

Figure 19. Hydraulic Geometry of Big Creek Supporting Primary Recreation

Desired Endpoint: The ultimate endpoint of this TMDL will be to achieve the Kansas Water Quality Standards and support primary recreation on Big Creek. This requires geometric means of five samples taken within a 30-day period to be below the applicable criterion during April to October. For the purposes of this TMDL, the criterion will be 262 counts of E coli bacteria on Segment 5 including Frontier Park and Ellis City Lake and 427 counts along lower stream segments 1 and 3 in Ellis and Russell counties. These dual endpoints reflect the primary recreation "C" designation for Segment 1 in Russell County and accounts for the marginal but accessible primary recreation ("B") opportunities present along Big Creek within Ellis County above Hays. Reduction in bacteria loading along the tributaries of Big Creek will be conducted with the objective of reducing the ambient bacteria concentrations seen in Big Creek, particularly below Hays. Because of the limited existence of flow in Big Creek in Trego and Gove counties, this TMDL will effectively begin at the Trego-Ellis County Line and downstream reaches of Big Creek.

Achievement of these endpoints indicate any loads of bacteria are within the loading capacity of the stream, water quality standards are attained and full support of the designated uses of the stream has been restored.

3. SOURCE INVENTORY AND ASSESSMENT

Point Sources: There will be six NPDES permitted facilities potentially discharging to Big Creek **(Table 3)**. There are an additional eight non-discharging facilities that do not influence the quality of Big Creek. By design or through circumstance, only the City of Hays consistently discharges into Big Creek and impacts its water quality. The City of Wakeeney now operates a three-cell lagoon wastewater system in place of its old mechanical plant. The effluent from Wakeeney does not appear to flow consistently down channel toward Ellis. Observations made during use attainability analysis found the channel of Big Creek to be dry in Trego County. The City of Ellis operates a low volume activated sludge treatment plant, whose effluent typically does not reach Hays according to observations by Division of Water Resources field personnel. Gorham has a non-discharging system that is being updated to discharge into Walker Creek in late 2010.

Two dry batch, ready mix concrete plants are permitted to discharge, but their operations collect any wash water for subsequent re-use or dust suppression. Domestic wastewater at both plants is directed toward the City of Hays wastewater collection and treatment system. Neither has discharged over the period 2003 – 2009.

Wakeeney is required to monitor for E coli bacteria on a quarterly basis, and has a limit of 3843 colonies per 100 ml. Wastewater has been sampled five times since 2008 and four of those samples were below the detection limit of 10 colonies. Gorham will monitor quarterly for E coli bacteria but will have no limits on its wastewater discharge initially.

The City of Ellis Wastewater Treatment Plant discharges to Big Creek and is required to monitor monthly E. coli bacteria with limits of 160 colonies/100 ml during April – October and 2358 colonies/100 ml during November through March. Effluent can be diverted to the municipal golf course for irrigation purposes. When Ellis sends effluent to the golf course, it is required to monitor E coli weekly and the limit for reused effluent is 160 colonies, regardless of time of year. Sampling at the end of the irrigation system on the golf course is required when in use, but no limits are placed on those locations. Numerous supplemental conditions are applied to the reuse of treated wastewater for golf course irrigation, including avoiding runoff and ponding, irrigating at times when access is restricted, no drift of irrigation spray, no cross-connections with potable water supply lines and appropriate signage noticing the use of reclaimed wastewater on the golf course. The wastewater treatment plant disinfects effluent with UV radiation.

The city of Hays discharges to Chetolah Creek which enters Big Creek south of town. The wastewater treatment plant chlorinates its effluent to disinfect the wastewater and has

the same permit limits and conditions as Ellis, except it monitors twice monthly. Effluent can be diverted to irrigate golf courses and ball fields.

Table 3. NPDES facilities along Big Creek

Facility	NPDES#	KS Permit #	Type	Rec Stream	Design Q (MGD)	Permit Expires
City of Hays WWTP	KS0036684	M-SH16-OO02	Activated Sludge	Chetolah Creek	2.8	2/28/2014
City of Ellis WWTP	KS0094145	M-SH06-OO02	Aeromod Activated Sludge	Big Creek	0.3	3/31/2014
City of Wakeeney WWTF	KS0099309	M-SH38-OO02	3-Cell Lagoon	Unnamed Trib to Big Creek	0.25	12/31/2014
Ellis County Concrete	KSG110186	I-SH16-PR02	Ready Mix Plant with retention basin	Unnamed Trib to Big Creek	0.0	9/30/2012
APAC-KS-Shears (Hays Plant #601)	KSG110018	I-SH16-PR01	Ready Mix Plant with retention basin	Big Creek	0.0	9/30/2012
City of Gorham*	~~KSJ000327~~ KS0096610	~~M-SH10-NO01~~ M-SH10-OO01	~~Non-Q;~~ 3-Cell Lagoon	Unnamed Trib to Walker Creek	~~0.0~~*; 0.0478	~~7/31/2010~~ 12/31/2014
City of Victoria	KSJ000118	M-SH37-NO01	Non-Overflowing	NA	0.0	5/31/2010
Munjor Improvement District	KSJ000316	M-SH50-NO01	Non-Overflowing	NA	0.0	2/28/2015
APAC-KS-Shears (Hays Plant #921)	KSJ000116	I-SH16-NP05	Non-Overflowing	NA	0.0	1/31/2010
KDOT – Trego Co Rest Area	KSJ000311	M-SH38-NR02	Non-Overflowing	NA	0.0	3/31/2015
KDOT – Gove Co Rest Area	KSJ000331	M-SH12-NR02	Non-Overflowing	NA	0.0	1/31/2015
City of Grinnell	KSJ000332	M-SH14-NO01	Non-Overflowing	NA	0.0	1/31/2015
City of Grainfield	KSJ000329	M-SH12-NO01	Non-Overflowing	NA	0.0	1/31/2015
USD#292 Grainfield-Wheatland School	KSJ000330	M-SH12-NO02	Non-Overflowing	NA	0.0	2/28/2015

* Gorham converting to discharging 3-Cell Lagoon in late 2010

According to Discharge Monitoring Records submitted by the cities for their wastewater, E coli levels are generally below the permit limits **(Figure 20).** Infrequent exceedances of the permit limits were seen at Hays and Ellis in 2009. The higher bacteria levels from Hays in June and July were associated with wet weather and likely indicated some stormwater inflow/infiltration into the sanitary sewer system that diminished the effectiveness of the chlorination process. The samples bracketing the high bacteria samples were well below permit limits. Dry weather was indicated at Ellis in September of 2009 so the slight elevation in bacteria in the wastewater might reflect a minor operational issue that was subsequently corrected. The analysis of the wastewater data indicates effluent is not responsible for the high bacteria seen in Big Creek.

Hays also has a MS4 NPDES stormwater permit, (M-SH16-SN01; KSR044008) currently in renewal (Expired September 30, 2009). The permit follows a general permit format, requiring the six minimum controls to be implemented throughout the corporate limits of Hays. Part III of the permit lists required best management practices to attenuate specific pollutants loading to specific waterbodies, with a minimum of one BMP for each listed parameter to be implemented within two years of permit renewal.

After this TMDL is approved, the next stormwater permit will contain the requirement to direct best management practices to abate bacteria somewhere within the jurisdiction of Hays. WRAPS data indicates that small drainages, such as Chetolah and Lincoln Draws, within Hays can see extremely high bacteria levels during storm events. Unlike wastewater, stormwater from Hays is likely causing some of the elevated bacteria seen on the lower reaches of Big Creek during wet weather.

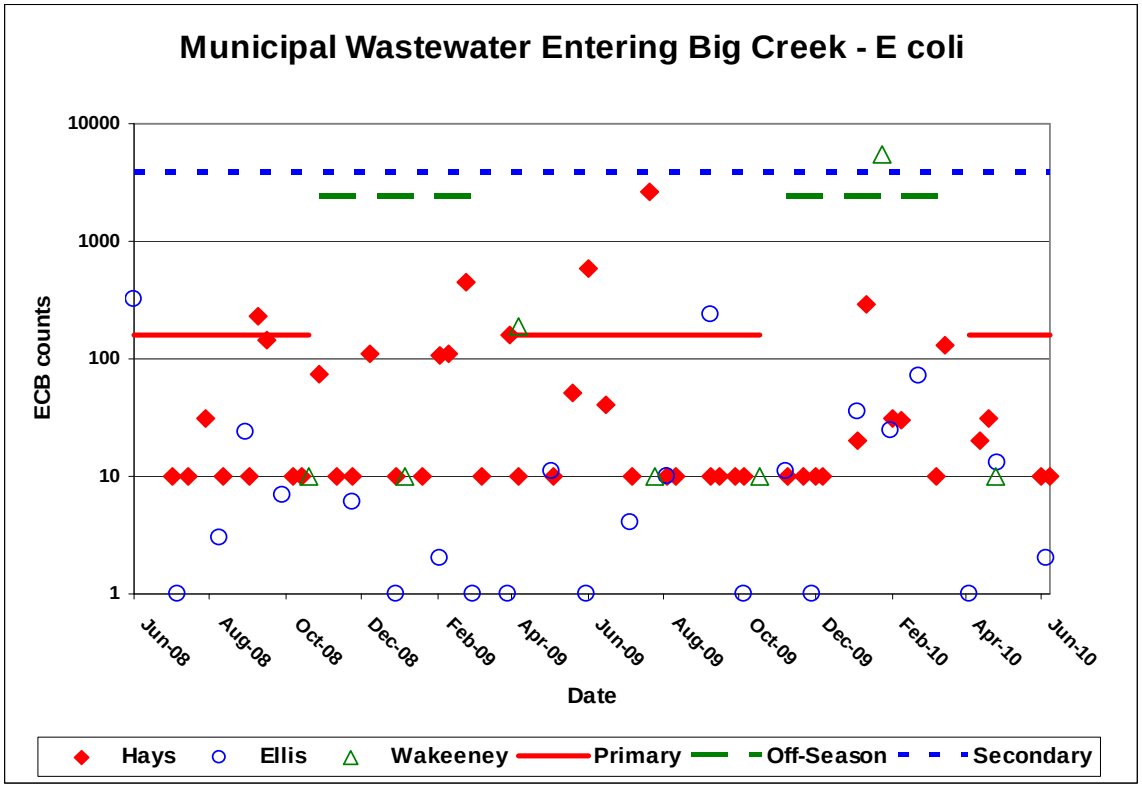

Figure 20. Wastewater E coli at Wakeeney, Ellis and Hays

Land Use: Cropland is the predominant land use within Big Creek Subbasin, comprising 62% of the acreage. Grassland is the more likely source of bacteria during runoff events because of grazing possibilities. **Figure 21** indicates that cropland is interspersed with grasslands throughout the drainage, but dominates the land use in Gove County, where ground water irrigation from the High Plains Aquifer supports row crop production, along Ogallah Creek and in the eastern half of Ellis County. Grassland tends to be located on the southern portion of the watershed and in headwater areas of some of the tributaries. It also seems to be the predominant land cover in areas of the steepest slopes (**Figure 22**).

Table 4 summarizes the proportion of grassland in each of the HUC 12s (**Appendix C**) comprising the Big Creek drainage. The greatest percentage of acres in grass occurs in the drainage lying between Ellis and Hays. There is a marked drop-off in acres of grass along Big Creek below Hays to the confluence with the Smoky Hill River. The percentage of grass within a 100 foot riparian buffer along the streams in the drainage is more variable from west to east, but is notably dominant along the tributaries. The riparian buffer makes up a very small proportion of the land area within each HUC 12.

Table 4. Grassland Acres in Big Creek Drainage

HUC 12	Grass Acres	Grass%	Riparian Grass Acres	Riparian % Grass	%HUC as Riparian
0101	6,892.5	20.1%	884.5	79.9%	12.8%
0102	6,071.9	17.9%	240.2	75.4%	4.0%
0103	6,215.1	16.4%	110.8	18.3%	1.8%
0104	9,730.7	32.5%	316.9	36.0%	3.3%
0201	10,815.4	36.9%	69.8	16.7%	0.6%
0202	10,154.0	37.1%	160.3	46.0%	1.6%
0203	9,227.5	28.5%	616.0	56.0%	6.7%
0204	12,358.6	43.4%	239.7	41.7%	1.9%
0301	17,686.1	46.0%	220.2	42.2%	1.2%
0302	16,820.3	53.2%	120.5	47.3%	0.7%
0303	15,544.9	55.2%	138.3	33.5%	0.9%
0304	9,639.1	32.7%	260.2	38.4%	2.7%
0305	10,600.1	28.3%	452.1	59.7%	4.3%
0401	14,037.4	43.5%	211.5	32.1%	1.5%
0402	9,530.1	40.0%	294.5	58.6%	3.1%
0403	5,844.4	30.5%	365.2	61.7%	6.2%
0404	11,457.2	40.4%	814.9	75.7%	7.1%
0405	10,694.8	36.6%	240.6	32.0%	2.2%

Contributing Runoff: Soil permeability values across the watershed, based on NRCS STATSGO database, indicate the average soil permeability of the watershed is less than 1.2”/hour, which contributes to runoff during low rainfall intensity events. Whereas over 95% of the watershed would contribute runoff under rainfall intensities of 1.5 inches per hour, that proportion drops to 50% at 1.14”/hr, 21% at 0.9”/hr and 6% at 0.5”/hr.(Juracek,

1999,2000). Soil-permeability probably dictates the production of runoff along Big Creek. Relatively small slopes **(Figure 22)** throughout the watershed would allow for landscape saturation provided there was enough rainfall to overcome the strong evapo-transpiration processes present along the warm, windy plains. These factors require sufficient rain over a finite amount of time to generate runoff and storm flows to carry bacteria and other non-point source pollutants.

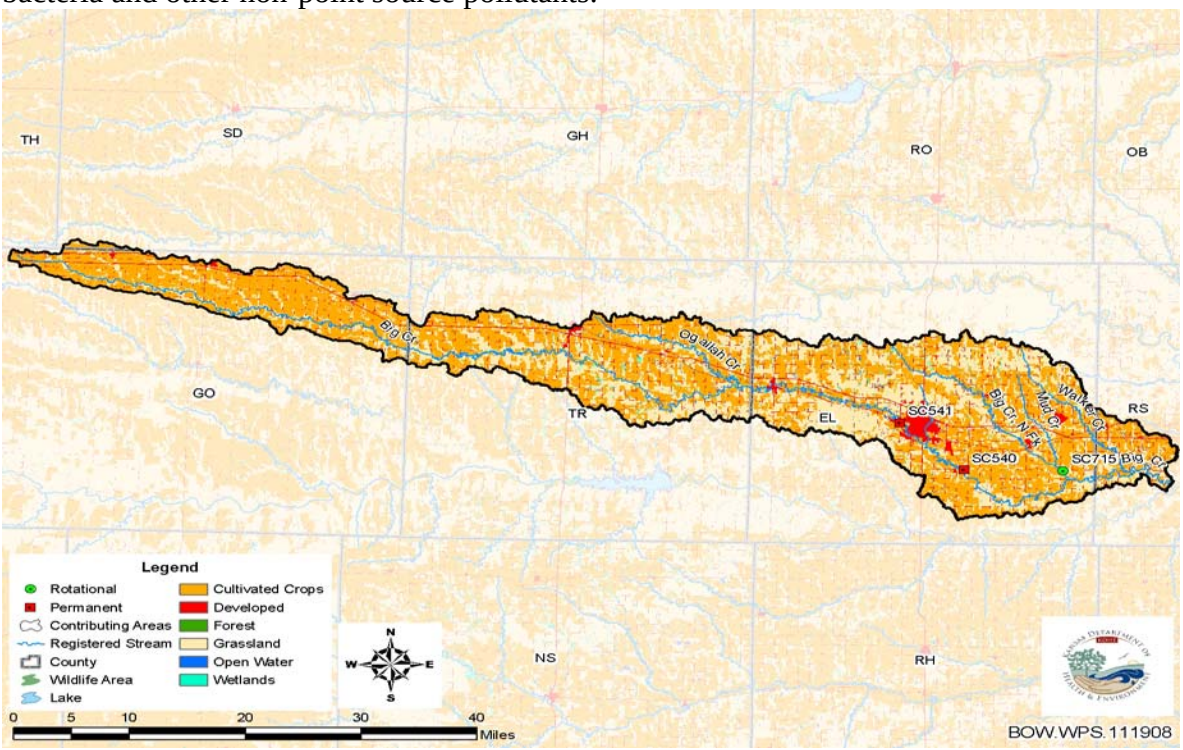

Figure 21. General Land Use in Big Creek Watershed (from 2001 NLCD)

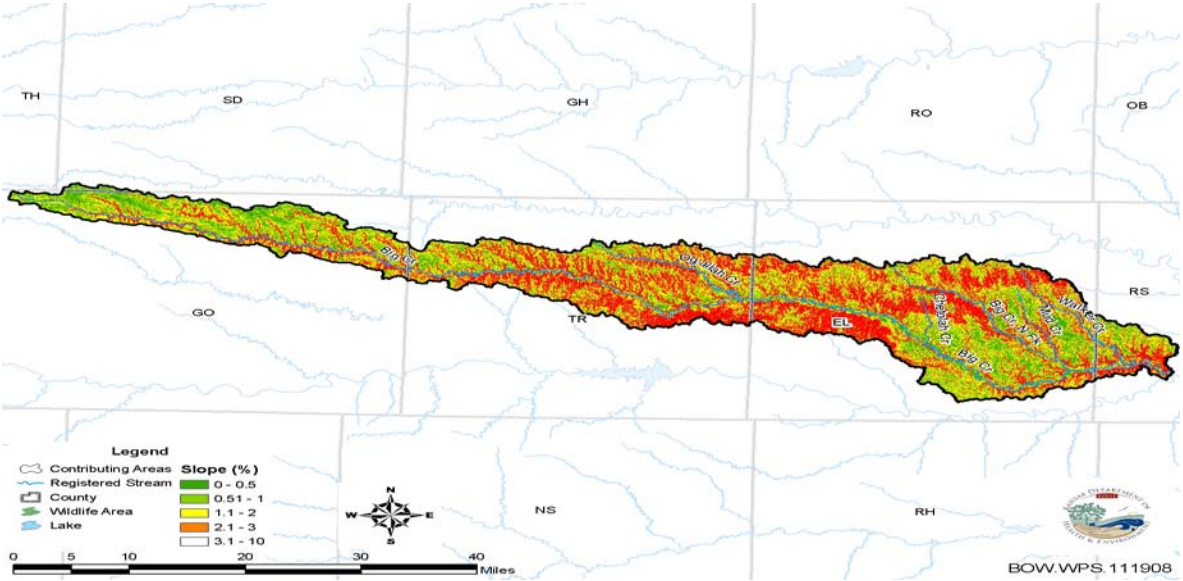

Figure 22. Land slope Across the Big Creek Watershed

Livestock and Waste Management Systems: There are 44 certified, permitted or registered animal feeding operations (AFOs) within the Big Creek Subbasin covered by this TMDL (see **Appendix D**). All of these livestock facilities have waste management systems designed to minimize runoff entering their operations and detain runoff emanating from their facilities. These facilities are designed to retain a 25-year, 24-hour rainfall/runoff event as well as an anticipated two weeks of normal wastewater from their operations. Typically, this rainfall event coincides with streamflow that occurs less than 1-5% of the time.

Though the total potential number of animals is approximately 47,600 animal units in the watershed, the actual number of animals at the feedlot operations is typically less than the allowable permitted number **(Table 5).** Most of the facilities handle cattle, with one facility in Ellis County exceeding the Federal threshold (1000 AU), requiring a NPDES permit (KS0037630; A-SHEL-CO02; 30,000 animal units of cattle, permit expiring in 3/15/2014). Cattle comprise 93% of the animal units under KDHE review and dairy represents another 4.4%. Swine and Sheep make up the balance and there is a game bird operation (exotic) that is not counted toward Federal Animal Units.

Based on Kansas Agricultural Statistics, most cattle are located in Gove and Ellis Counties as are the cattle in confined feeding operations **(Tables 5 & 6).** There are livestock present in Russell County but no regulated facilities in the Big Creek drainage portion of the county **(Figure 23).** Specific HUC-12s are identified in **Appendix C**.

Table 5. Animal Feeding Operations in the Big Creek Subbasin

County	HUC 12	Beef	Dairy	Swine	Sheep	Game Birds
Gove	**0101**	2310				
	0103	5290	1241		999.9	
Trego	**0201**	1052		171.2		
	0203	943	140	5.6		
	0204	800				
Ellis	**0302**	450	56			
	0303	31099	323			
	0304	150				
	0305		150			
	0401	1233				
	0402		84			
	0403		105			5000*
	0404	700				
	0405	300				
Total	**Animal Units**	**44327**	**2099**	**176.8**	**999.9**	**5000***

*** Exotic animal units not counted toward Federal permit thresholds**

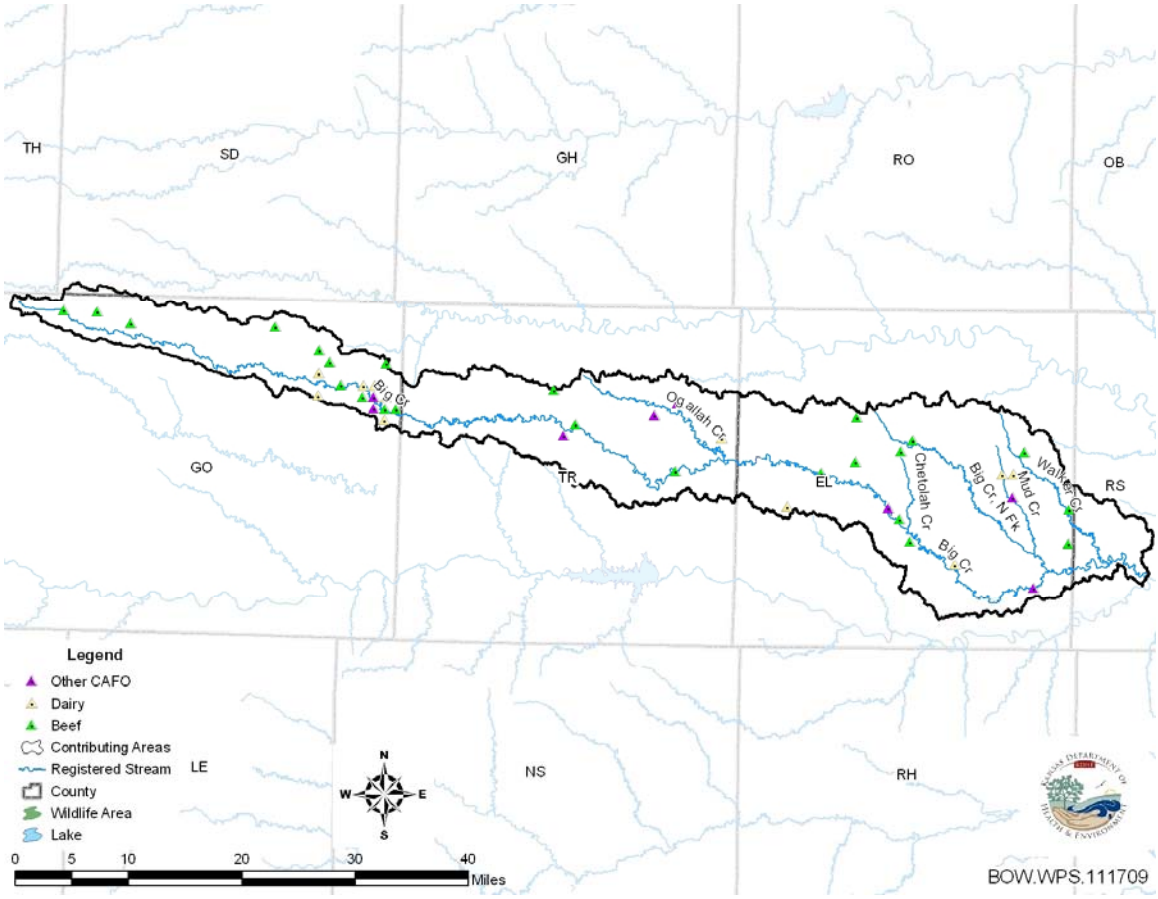

Figure 23. Animal Feeding Operations in Big Creek Watershed

Population Density: **Table 6** summarizes the populations for the four counties within the Big Creek Sub-Basin. The population trends for all of these counties, except Ellis (+ 1.1%) indicate the population bases are declining (– 9.9% to – 16.9%). The population density is greatest in Ellis County (30.6 people/sq.mi.), because of Hays; and least in Gove County (2.9 people/sq.mi.). The population residing in cities and towns in each county ranges from 56-58% in Gove and Trego counties to 69-84% in Russell and Ellis counties. Farms are smaller and more numerous in Ellis County than Gove County. The percentage of farmland in each county ranges from 76% in Trego County to 91% in Ellis County.

Table 6. **Selected Big Creek County information**.

County	2008 Population*	2000 Census Population	County Size Sq.Miles	2007 # of Farms**	2007 Farm Acreage	2009 Cattle Head
Ellis	27,801	27,507	900	687	526,202	52,800
Russell	6,641	7,370	885	522	442,550	30,900
Trego	2,882	3,319	888	380	429,588	30,800
Gove	2,548	3,068	1,071	413	593,622	76,000

* - U.S. Census Bureau Estimates ** 2007 Ag Census & Kansas Agricultural Statistics

On-Site Waste Systems: Based on the 1990 census data, about 13% of the households in Ellis County, 39% of the households in Trego County, 37% of the households in Gove County and 19% of the households in Russell County utilize septic or other on-site systems. Because of their small flows and loads, failing on-site septic systems would be a minor source of bacteria loadings within the watershed and would not significantly contribute to the impairment along lower reaches of Big Creek.

Background Levels: 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.

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

This TMDL will be established to meet the primary recreation season geometric mean of bacteria counts for Big Creek in Ellis and Russell Counties. For Segment 5, as monitored by SC541 and WRAPS stations #5 and #9, the geometric mean of five samples taken within 30 days should be below 262 counts during April through October. For Segment 3 as monitored by SC540 and WRAPS stations #6, 7 and 13, and for Segment 1 as monitored by WRAPS stations at Walker, Blundon and Balta Roads, the geometric mean needs to be below 427 counts. Despite the secondary recreation designation for Segment 3, that reach affects the recreation potential of downstream Segment 1 and will be held to the Primary "C" standard.

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 recreation season such that a majority will be below the nominal value of the criterion. **Figure 24** displays the distribution of KDHE ECB samples taken during the primary recreation months since 2003 over flow conditions. Excessively high flows have not been encountered in KDHE sampling, so the current condition is defined by lower flows. While the hydraulic geometry of Big Creek limits favorable conditions to support primary recreation to higher flows occurring 5 – 40% of the time, impounded and pooled areas provide opportunities for primary recreation during lower flows and should be devoid of excessive bacteria. Station 541 above Hays shows consistently low bacteria levels during the lower flow conditions, whereas the lower reaches monitored by Station 540 have episodic digressions.

It is apparent that different mechanisms contribute bacteria during baseflow and runoff conditions. Generally, point sources will be responsible for maintaining the potential of Big Creek to support primary contact recreation during lower flows. Stormwater from urban and rural areas will be responsible with maintaining adequate bacteria levels in the creek during higher flows that may be more amenable to support primary recreation.

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 through facilities under NPDES permits will either be disinfected at the two mechanical plants or with the two lagoon systems, have sufficient retention time prior discharge to ensure bacteria die-off.

The Wasteload Allocations will reflect the applicable permit limits of colonies or counts) of bacteria per 100 ml. For Hays and Ellis, those limits are 160 counts between April and October and 2358 counts during November through March. Hays samples twice monthly and Ellis collects a monthly sample. Wakeeney has a year round permit limit of 3843 counts and monitors quarterly, consistent with the secondary "b" designation for the upper reaches of Big Creek. Gorham will monitor effluent from its upgraded lagoons quarterly, but though no limits are in place, they likely would be similar to Wakeeney to reflect the secondary recreation support of Walker Creek (3843 counts).

Figure 20 indicates little causal relationship between the effluent content of the three currently discharging facilities and the impaired status of Big Creek. Since July 2008 through June 2010, Hays has geometric means of 25 and 30 counts for the primary and secondary seasons, respectively, with three of 47 samples exceeding the permit limit. Ellis has geometric means of 6 and 6 counts, with 2 of 25 samples exceeding permit limits. Wakeeney has geometric means of 18 and 232 counts for the two recreation periods with 1 of 7 samples exceeding the permit limit. Of the six samples greater than the permit limits, one, zero and zero of the samples were greater than the criterion value for the Big Creek reach immediately downstream of Wakeeney, Ellis and Hays, respectively. The individual Wasteload Allocations for each of the four facilities are enumerated in **Appendix E**.

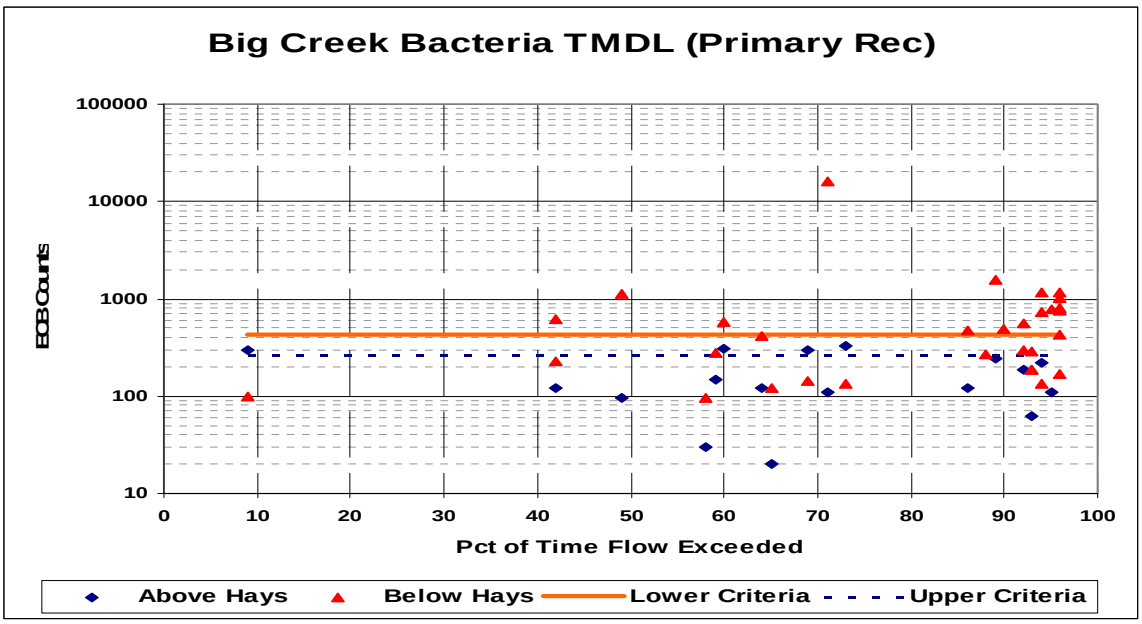

Figure 24. Distribution of E coli values from KDHE Sampling over Flow Conditions

Phase II NPDES stormwater permits issued to the Hays MS4 will reference the need to apply specific Best Management Practices to attenuate the discharge of bacteria whenever urban stormwater drains to Big Creek, either directly or through Lincoln and Chetolah Draws. While no specific numeric limits will be attached to this stormwater permit, a WLA is assigned to this source. The WLA is proportional to the runoff-driven load arising from the developed area in Hays covered by the MS4 permit. In the case of Big Creek, low flows are chiefly influenced by nearby non-point sources in and around the stream, while no runoff is occurring.

As wet weather develops, the potential for runoff in the watershed increases, chiefly from developed areas within HUC's 102600070303 and 0304 encompassing Hays. In this situation, 11% of the area, and thereby 11% of the runoff load, is attributed to developed land during these normal flow conditions. As precipitation increases, flows from western Ellis County (HUC 12's 0302 and 0301) will appear at Hays along with the locally generated runoff. In this situation, developed area in Hays comprises 6-7% of the expanded contributing area and its MS4 WLA is adjusted accordingly. The balance of load, after accounting for the wastewater WLA, is assigned as load allocations to non-point sources. The calculated allocations are provided in **Appendix E**.

There will be Wasteload Allocations of zero assigned to the concrete batch plants, the non-discharging wastewater facilities and the confined animal feeding operations because all of these facilities should have no discharge to Big Creek.

Nonpoint Source: The Load Allocation (LA) assigns responsibility for nonpoint source contributors for the bacteria input into Big Creek from rural settings. The Load Allocations for Big Creek in **Appendix E** represent the balance of load capacity remaining after the wastewater and stormwater WLA's are accounted. At low flow, any non-point sources appear to be in proximity to Big Creek (**Figure 24**). As runoff develops, contributions from the surrounding area increase to the creek. For the intention of implementation, Load Allocations would be achieved through Best Management Practices directed at non-point activities in Ellis County. Progress will be determined by reduction in the ECB index profiles developed by the WRAPS for Stations 9, 7 and 13 (**Figure 18**). These profiles are particularly relevant since they were based on E coli concentrations occurring chiefly during and after storm events in 2008 – 2009. As the profiles decline, intensive sampling during the primary contact recreation season should be done to assess whether the water quality standards are now being achieved.

Defined Margin of Safety: The Margin of Safety provides some hedge against the uncertainty in bacteria loading into Big Creek, predominantly from wet weather sources in the watershed. This TMDL uses an implicit margin of safety, relying on conservative assumptions tied to assessing attainment to the primary recreation Class B and C criteria (262 and 427 colonies/100 ml). The wasteloads from Hays, Ellis and Wakeeney are established by existing permit limits that are below the applicable criterion, and can be easily met through disinfection and long term retention of wastewater. Additionally, the wasteloads of Ellis and Wakeeney and Gorham are established even though there is strong evidence those wasteloads will not transport down Big Creek as evidenced by the

typical low bacteria conditions monitored at SC541 at Hays. Finally, even though the majority of Big Creek will not hydraulically support primary recreation (limited depth) except under runoff conditions, the primary criteria will be applied as endpoints for this TMDL at any flow condition throughout April to October.

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

Priority HUC12s: This TMDL will initially concentrate on conditions on Big Creek in the vicinity of Hays between SC541 and SC540. As improved conditions are noted at the two KDHE sites, implementation of the TMDL will expand to the western edge of Ellis county and into Russell County. Wet weather is the principal driver of the bacteria impairment so implementation will involve urban stormwater management and non-point source abatement along the lower Big Creek. The HUC 12s surrounding Hays (102600070303 & 04; **Appendix C**) have the largest percentage of developed land within them among the 18 sub watershed comprising the Big Creek watershed. Contributions in those two HUCs will be monitored by SC540 at Munjor.

Additionally, the HUC 12 below Munjor (10260070305) has a high percentage of grassland within its riparian corridor, with potential use by grazing livestock in the vicinity of the stream. The two western Ellis County HUC 12s (0301 and 0302) have the highest overall acreage of grassland in the county. Therefore, those three HUC 12s will be the priority areas for non-point source implementation. The lowest HUC 12 (0405) along Big Creek comprises rough ground, limiting access by livestock and recreation users. Furthermore, those sub watersheds to the west of Ellis County have meager hydrology delivering pollutant loads and will be relegated to a deferred status for implementation actions.

5. IMPLEMENTATION

Desired Implementation Activities

1. Facilitate urban stormwater management in Hays to abate pollutant loads.
2. Maintain disinfection operations under state and federal permits, inspect permitted facilities, continue monitoring requirements and evaluate compliance with permit limits.
3. Improve riparian conditions along stream systems by limiting overuse from grazing livestock along the stream.
4. Provide alternative water supplies for livestock to limit their use of streams as water sources.
5. Ensure land applied manure is being properly managed and is not susceptible to runoff into nearby streams.
6. Install pasture management practices, including proper stock density to reduce soil erosion and storm runoff.

7. 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 2014 and operation of disinfection techniques.
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.
g. Establish housekeeping practices among urban homeowners to manage pet waste, through the Hays stormwater management program.
h. Establish Best Management Practices for stormwater and pollutant reduction along upper reaches of Lincoln Draw and Chetolah Creek in Hays.

Nonpoint Source Pollution Technical Assistance – KDHE

a. Support Section 319 demonstration projects for reduction of bacteria loading from agricultural lands though livestock management.
b. Provide technical assistance on practices geared to the establishment of vegetative buffer strips.
c. 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.
d. Support Watershed Restoration and Protection Strategy (WRAPS) efforts for the Big Creek – Middle Smoky Hill Sub-basins and incorporate long term objectives of this TMDL into their 9-element watershed plan

Water Resource Cost Share and Nonpoint Source Pollution Control Program – SCC

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 within 100 feet of Big Creek or its tributaries.

Riparian Protection Program – SCC

a. Establish or reestablish natural riparian systems, including vegetative filter strips and stream bank vegetation.
b. Develop riparian restoration projects along targeted stream segments, below Hays.
c. Promote wetland construction to reduce runoff and assimilate loadings within Hays.

Buffer Initiative Program – SCC

a. Install grass buffer strips near Big Creek and tributary streams.
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.
f. Promote and utilize Big Creek – Middle Smoky Hill WRAPS efforts at pollution prevention, runoff control and resource management.

Timeframe for Implementation: Urban stormwater and rural runoff management should commence in 2010 in Hays and the eastern reaches of Big Creek. Implementation of abatement practices should commence in the three priority HUC 12s in 2011. Implementation should continue through 2019.

Targeted Participants: The primary participants for implementation will be the City of Hays wastewater and stormwater programs, and agricultural and livestock operations immediately adjacent to the lower portions of Big Creek and tributaries within the priority sub watersheds. All will be encouraged to implement appropriate practices. Watershed coordinators and technical staff of the WRAPS, along with Conservation District personnel and county extension agents should assess possible sources adjacent to Big Creek below Hays over 2010 - 2011. Non-point source implementation activities should focus on those areas with the greatest potential to impact bacteria concentrations along Big Creek.

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. High density urban and residential development in proximity to streams and tributary areas to Big Creek.

Eventually, residents of Hays should be informed on waste management in conjunction with the Hays Stormwater Management Program to reduce loadings to Big Creek from urban runoff.

Milestone for 2014: Because bacteria daily loads are nonsensical, the preferred manner to track progress in implementing this TMDL is through alterations to the ECB index profiles for the two KDHE stations (**Figures 25 and 26**). 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 profiles approach the desired distribution indicated in the figures, intensive sampling during the primary recreation season can be done to ascertain whether the primary season geometric means are in compliance with the bacteria criterion.

In accordance with the TMDL development schedule for the State of Kansas, the year 2014 marks the next cycle of 303(d) activities in the Smoky Hill-Saline Basin. At that point in time, bacteria profiles from sites SC540 and SC541 should show decline. By this date, the City of Hays should be well underway in implementing the appropriate stormwater management to reduce bacteria profiles at sites influenced by urban runoff. Similar declines in rural bacteria profiles should be apparent, relative to those seen during wet periods of 2008 – 2009, at sites lying outside of Hays.

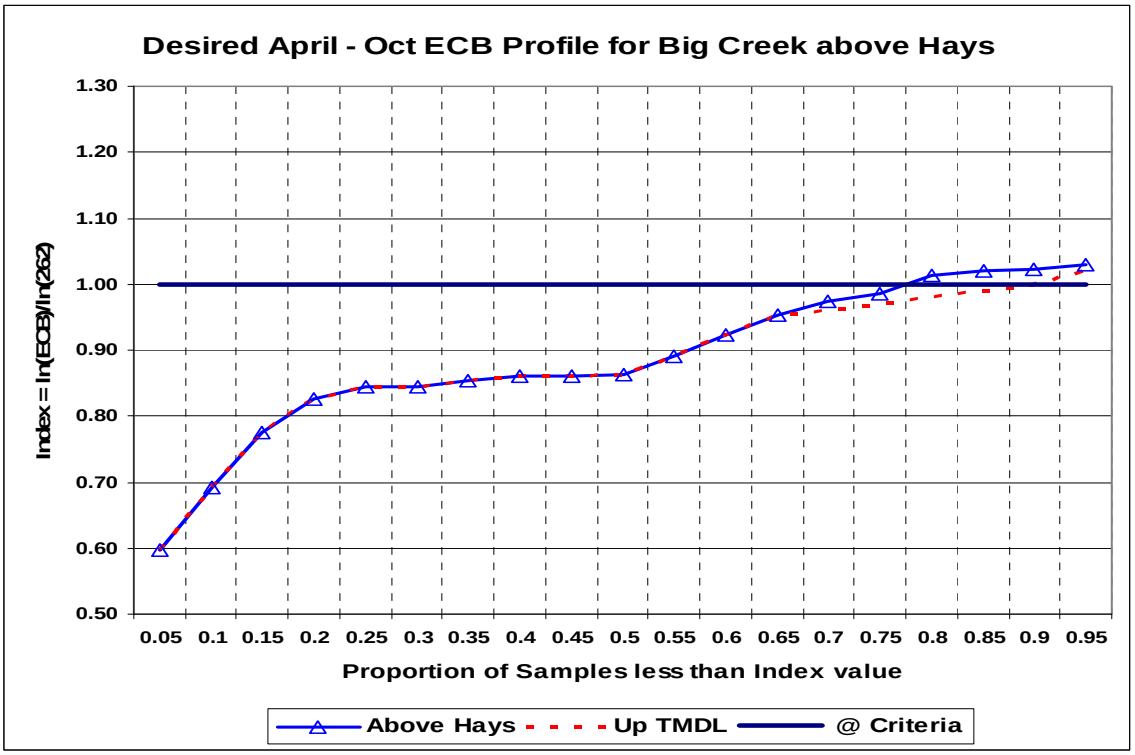

Figure 25. E coli Bacteria TMDL for Big Creek above Hays

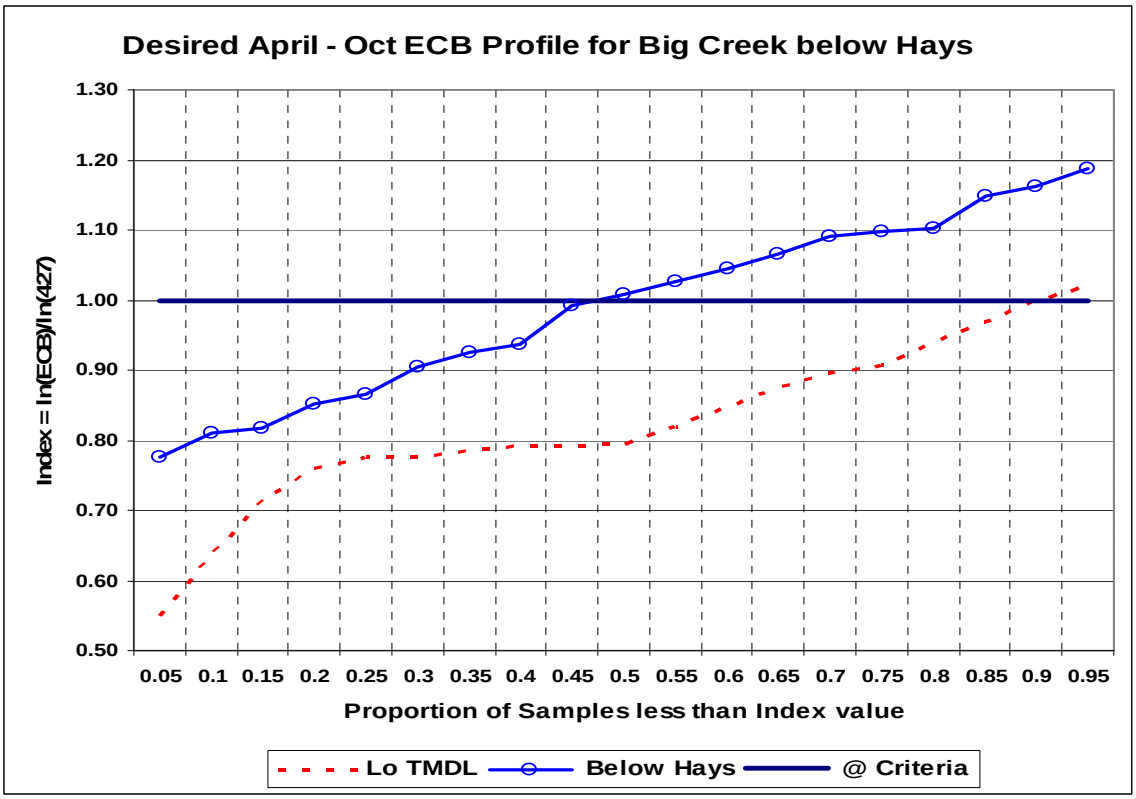

Figure 26. E coli Bacteria TMDL for Big Creek below Hays

Delivery Agents: The primary deliver agents for program participation will be KDHE, the Big Creek – Middle Smoky Hill WRAPS, the Hays Stormwater Management Program, Kansas State University Agricultural Experiment Station – Hays, State Extension Service, and the Ellis County Conservation District for programs of the State Conservation Commission.

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

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

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

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

4. K.A.R. 28-16-69 through 071 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas on a watershed basis.

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

6. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control 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 Smoky Hill-Saline River Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic area of the state for high priority in implementation.

Funding: The State Water Plan 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 watershed 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 located within a **High Priority** WRAPS area and should receive support for pollution abatement practices that lower the loading of bacteria and associated pollutants of sediment and nutrients to Big Creek and Kanopolis Lake.

Effectiveness: Use of retention and buffers that isolate streams from nearby uses and potential loadings has 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 has proven effective at reducing runoff associated with livestock facilities.

6. MONITORING

KDHE will continue to collect quarterly to bimonthly samples in every year at Stations SC540 and SC541 and by a new Station, SC752, near Russell. The stream will be evaluated for possible delisting in 2020. Stormwater monitoring should be continued by the Big Creek WRAPS and the City of Hays Stormwater Program. Periodic sampling should be made by the WRAPS at its stations in Ellis and Russell Counties. Monthly single samples should be drawn from Ellis City Lake and the impounded portion of Big Creek in Frontier Park in Hays during June, July and August since these areas present the greatest opportunity for primary recreation on Big Creek.

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 Smoky Hill-Saline Basin.

Public Hearing: A Public Hearing on this TMDL was held on February 10, 2010 in Hays to receive comments on this TMDL.

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 and again on March 3, 2010 in Hays.

Watershed Restoration and Protection Strategy Group: This TMDL has been reviewed in February, 2010 by the Big Creek – Middle Smoky Hill Subbasin WRAPS group. The data collected by the WRAPS were used in the development of this TMDL.

Milestone Evaluation: In 2014, evaluation will be made as the degree 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 2014 with consultation from local stakeholders and WRAPS teams.

Consideration for 303(d) Delisting: Big Creek will be evaluated for delisting under section 303(d), based on the monitoring data over 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 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 2010, which will emphasize implementation of WRAPS activities. At that time, incorporation of this TMDL will be made into the WRAPS. Recommendations of this TMDL will be considered in the Kansas Water Plan implementation decisions under the State Water Planning Process for Fiscal Years 2011 – 2019.

Revised August 25, 2010

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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 Locations, USGS Scientific Investigation Report 2004-5033.

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.

Appendix A. K.S.A. 82a-2001, et seq: Classified stream segments defined; other definitions. As used in this act:

(7) (A) "Recreational use" means:

(i) Primary contact recreational use is use of a classified stream segment for recreation during the period from April 1 through October 31 of each year, provided such classified stream segment is capable of supporting the recreational activities of swimming, skin diving, water skiing, wind surfing, kayaking or mussel harvesting where the body is intended to be immersed in surface water to the extent that some inadvertent ingestion of water is probable.

(a) Primary contact recreational use-Class A: Use of a classified stream segment for recreation during the period from April 1 through October 31 of each year, and the classified stream segment is a designated public swimming area. Water quality criterion for bacterial indicator organisms applied to Class A waters shall be set at an illness rate of eight or more per 1000 swimmers. The classified stream segment shall only be considered impaired for primary contact recreational use-Class A if the calculated geometric mean of at least five samples collected in separate 24-hour periods within a 30-day period exceeds the corresponding water quality criterion. The water quality criterion for primary contact recreational use-Class A waters during the period November 1 through March 31 of each year shall be equal to the criterion applied to secondary contact recreational use-Class A waters.

(b) Primary contact recreational use-Class B: Use of a classified stream segment for recreation, where moderate full body contact recreation is expected, during the period from April 1 through October 31 of each year, and the classified stream segment is by law or written permission of the landowner open to and accessible by the public. Water quality criterion for bacterial indicator organisms applied to Class B waters shall be set at an illness rate of 10 or more per 1000 swimmers. The classified stream segment shall only be considered impaired for primary contact recreational use-Class B if the calculated geometric mean of at least five samples collected in separate 24-hour periods within a 30-day period exceeds the corresponding water quality criterion. The water quality criterion for primary contact recreational use-Class B waters during the period November 1 through March 31 of each year shall be equal to the criterion applied to secondary contact recreational use-Class A waters.

(c) Primary contact recreational use-Class C: Use of a classified stream segment for recreation, where full body contact recreation is infrequent during the period from April 1 through October 31 of each year, and is not open to and accessible by the public under Kansas law and is capable of supporting the recreational activities of swimming, skin diving, water-skiing, wind surfing, boating, mussel harvesting, wading or fishing. Water quality criterion for bacterial indicator organisms applied to Class C waters shall be set at an illness rate of 12 or more per 1000 swimmers. The classified stream segment shall only be considered impaired for primary contact recreational use-Class C if the calculated geometric mean of at least five samples collected in separate 24-hour periods within a 30-day period exceeds the corresponding water quality criterion. The water quality criterion for primary contact recreational use-Class C waters during the period November 1 through March 31 of each year shall be equal to the criterion applied to secondary contact recreational use-Class B waters.

(ii) Secondary contact recreational use is use of a classified stream segment for recreation, provided such classified stream segment is capable of supporting the recreational activities of wading, fishing, canoeing, motor boating, rafting or other types of boating where the body is not intended to be immersed and where ingestion of surface water is not probable.

(a) Secondary contact recreational use-Class A: Use of a classified stream segment for recreation capable of supporting the recreational activities of wading or fishing and the classified stream segment is by law or written permission of the landowner open to and accessible by the public. Water quality criterion for bacterial indicator organisms applied to secondary contact recreational use-Class A waters shall be nine times the criterion applied to primary contact recreational use-Class B waters. The classified stream segment shall only be considered impaired for secondary contact recreational use-Class A if the calculated geometric mean of at least five samples collected in separate 24-hour periods within a 30-day period exceeds the corresponding water quality criterion.

(b) Secondary contact recreational use-Class B: Use of a classified stream segment for recreation capable of supporting the recreational activities of wading or fishing and the classified stream segment is not open to and accessible by the public under Kansas law. Water quality criterion for bacterial indicator organisms applied to secondary contact recreational use- Class B waters shall be nine times the criterion applied to primary contact recreational-Class C use waters. The classified stream segment shall only be considered impaired for secondary contact recreational use-Class B if the calculated geometric mean of at least five samples collected in separate 24-hour periods within a 30-day period exceeds the corresponding water quality criterion.

(B) If opposite sides of a classified stream segment would have different designated recreational uses due to differences in public access, the designated use of the entire classified stream segment may be the higher attainable use, notwithstanding that such designation does not grant the public access to both sides of such segment.

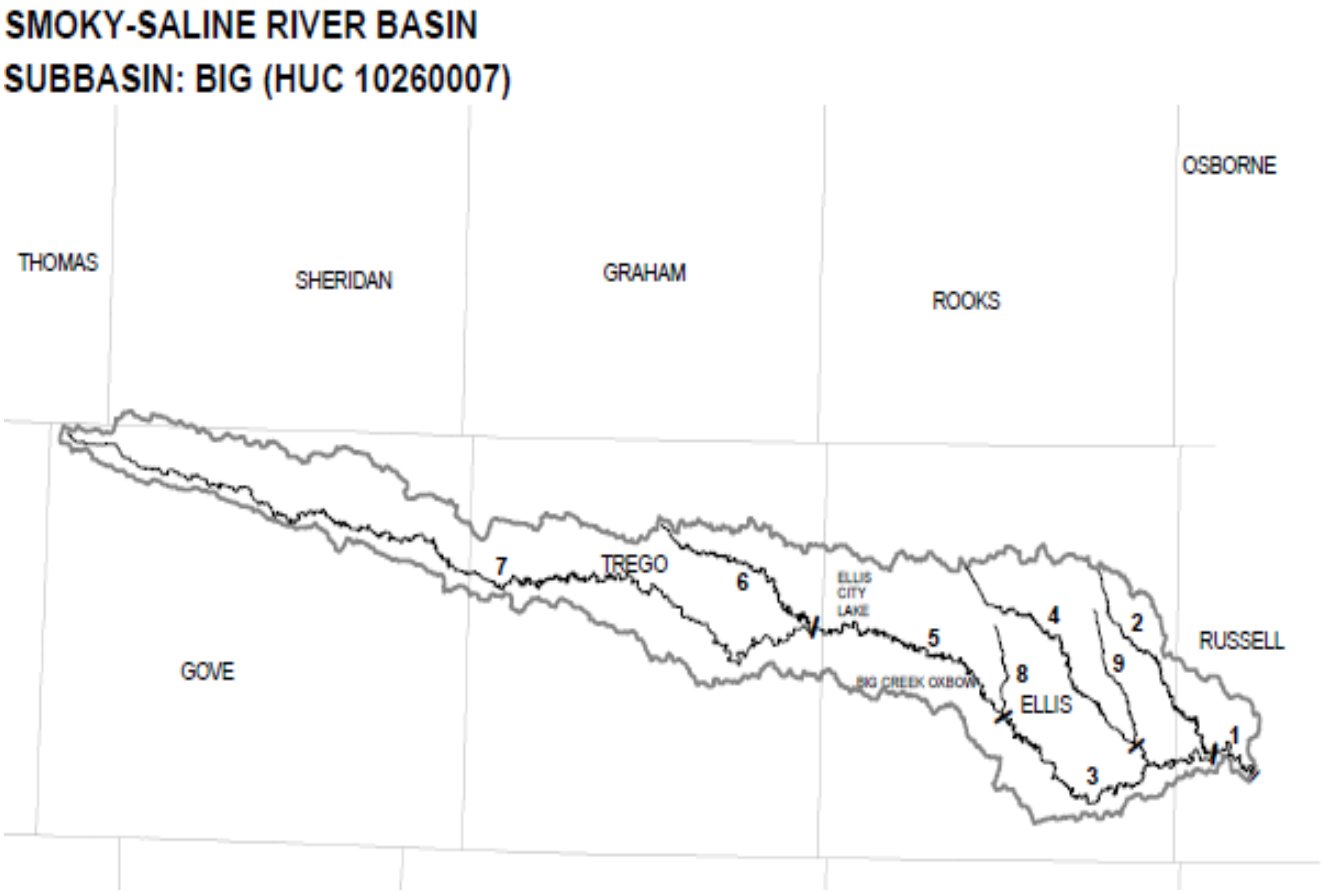
(C) Recreational use designations shall not apply to stream segments where the natural, ephemeral, intermittent or low flow conditions or water levels prevent recreational activities.

(d) "Ephemeral stream" means streams that flow only in response to precipitation and whose channel is at all times above the water table.

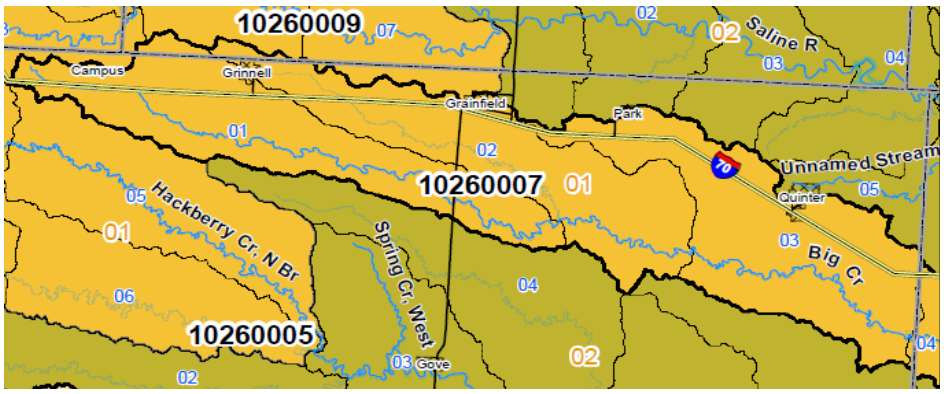
(e) "Secretary" means the secretary of health and environment.

History: L. 2001, ch. 100, § 1; L. 2003, ch. 105, § 1; May 1.

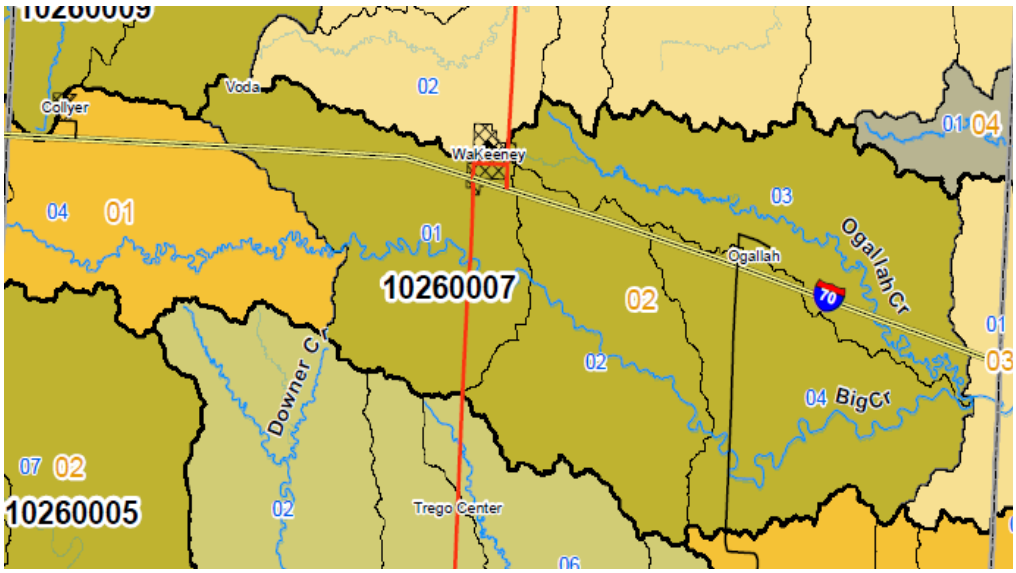
Appendix B. Classified Streams of the Big Creek Sub basin.



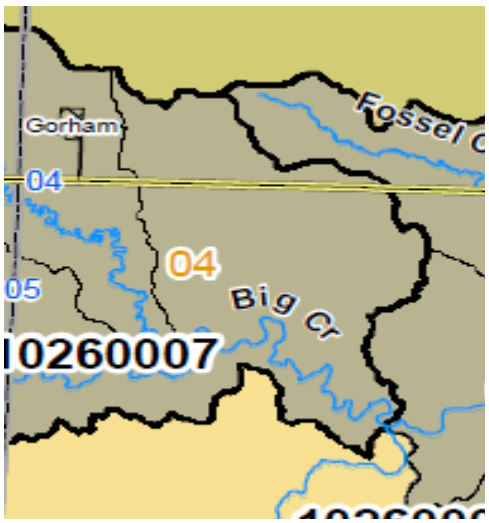
Appendix C: HUC 12 Subwatersheds of the Big Creek Watershed by County



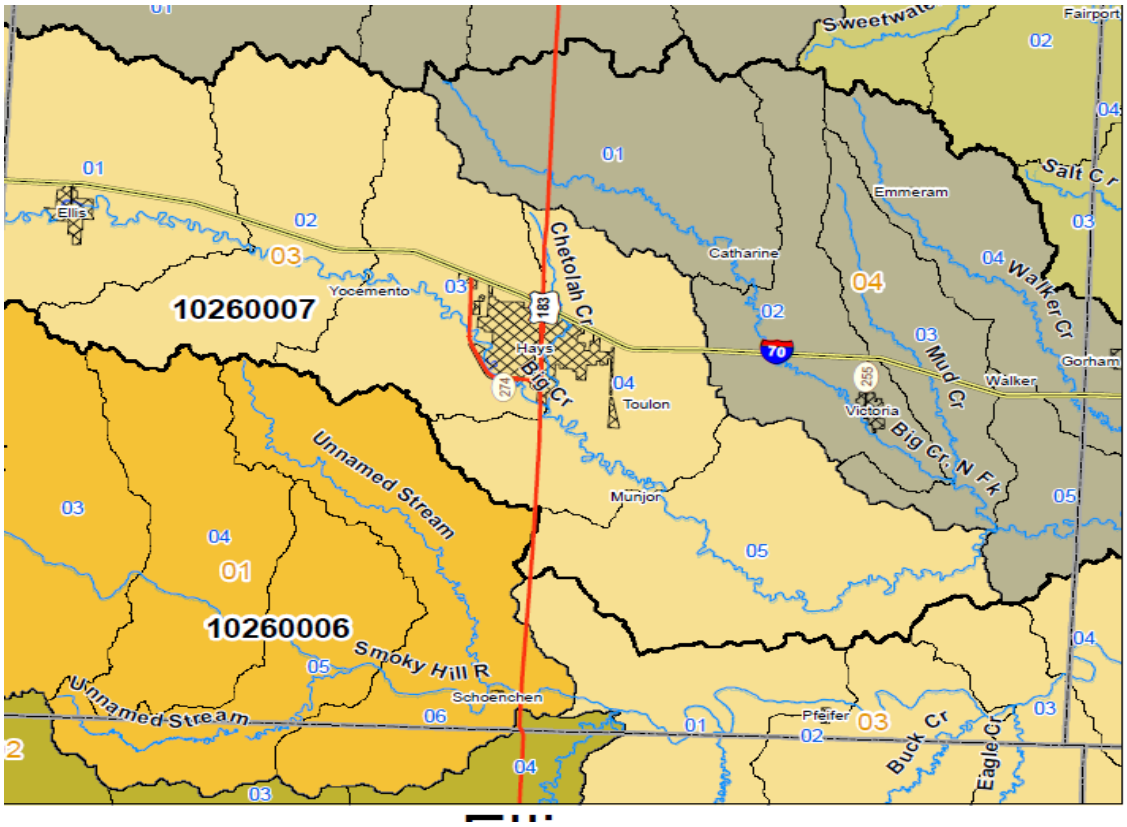
Gove County



Trego County



Russell County



Ellis County

Appendix D: Registered and Permitted Animal Feeding Operations in 10260007

County	HUC 10/12	KS Permit #	Permit Type	Fed AU	Type
Gove	***0101***	***A-SHGO-BO02***	***Permit***	***350***	***Beef***
		A-SHGO-BO18	Permit	980	Beef
		A-SHGO-BO15	Permit	590	Beef
	0103	***A-SHGO-BA02***	***Certificate***	***540***	***Beef***
		A-SHGO-BA03	Certificate	400	Beef
		A-SHGO-BA12	Certificate	600	Beef
		A-SHGO-BA08	Certificate	300	Beef
		A-SHGO-BO21	Permit	980	Beef
		A-SHGO-BO16	Permit	980	Beef
		A-SHGO-BO01	Permit	990	Beef
		A-SHGO-BO10	Permit	500	Beef
		A-SHGO-MA04	Certificate	63	Dairy
		A-SHGO-MA05	Certificate	112	Dairy
		A-SHGO-MA07	Certificate	42	Dairy
		A-SHGO-MA03	Certificate	168	Dairy
		A-SHGO-MO04	Permit	272	Dairy
		A-SHGO-MO03	Permit	482	Dairy
		A-SHGO-MO01	Permit Renewal	102	Dairy, Horses
		A-SHGO-LA01	Certificate	999.9	Sheep
Trego	***0201***	***A-SATR-BO02***	***Permit Renewal***	***252***	***Beef***
		A-SHTR-BO01	Permit Renewal	800	Beef
		A-SHTR-SO04	Permit	171.2	Swine
	0203	***A-SHTR-BO04***	***Permit***	***943***	***Beef, Swine***
		A-SHTR-MO05	Permit	140	Dairy
		822	Complaint	5.6	Swine
	0204	***A-SHTR-BO03***	***Permit Renewal***	***800***	***Beef***
Ellis	***0302***	***A-SHEL-BO06***	***Permit***	***450***	***Beef***
		A-SHEL-MA15	Certificate	56	Dairy
	0303	***A-SHEL-CO02***	***NPDES Permit****	***30000***	***Beef***
		A-SHEL-BO01	Permit	999	Beef
		A-SHEL-BA07	Registration	100	Beef
		A-SHEL-MO01	Permit	323	Dairy,Swine,Sheep
	0304	***A-SHEL-BO08***	***Permit***	***150***	***Beef***
	0305	***A-SHEL-MA16***	***Certificate***	***70***	***Dairy***
		A-SHEL-MO04	Permit	80	Dairy, Beef
	0401	***A-SHEL-BO07***	***Permit***	***473***	***Beef***
		A-SHEL-BO04	Permit	760	Beef
	0402	***A-SHEL-MA19***	***Certificate***	***84***	***Dairy***
	0403	***A-SHEL-MA05***	***Certificate***	***49***	***Dairy***
		A-SHEL-MO07	Permit	56	Dairy
		A-SHEL-EA01	Certificate	0**	Exotic (Game Birds)
	0404	***A-SHEL-BA05***	***Certificate***	***300***	***Beef***
		A-SHEL-BA06	Certificate	400	Beef
		A-SHEL-BO10	Permit Application	300	Beef

***KS0037630 **5000 Game Birds**

Appendix E. Wasteload Allocations for NPDES Wastewater and MS4 Stormwater and Load Allocations for NPS (Flows in cfs, Loads in Giga-counts/day)

E coli Bacteria Wasteload Allocations (Permit Limits reported as Monthly Geometric Means)

Facility	Design Q	Summer Limit	Summer WLA	Winter Limit	Winter WLA
Hays	2.8 MGD (4.33 cfs)	160 col/100ml	16.9 Gc/day	2358 col/100 ml	249.7 Gc/day
Ellis	0.3 MGD (0.46 cfs)	160 col/100 ml	1.8 Gc/day	2358 col/100 ml	26.5 Gc/day
Wakeeney	0.25 MGD (0.39 cfs)	3843 col/100 ml	36.6 Gc/day	3843 col/100 ml	36.6 Gc/day
Gorham	0.0478 MGD (0.07 cfs)	3843 col/100 ml	6.6 Gc/day	3843 col/100 ml	6.6 Gc/day
Total	3.40 MGD (5.25 cfs)		61.9 Gc/day		319.4 Gc/day

Big Creek Load Capacities, Wasteload Allocations and Load Allocations

Segment 5, monitored by SC541, potentially influenced by Wakeeney & Ellis
Big Creek from Trego County Line to Chetolah Creek; Criterion = 262

Pct	Flow	Wak / Ellis Design Q	Seg 5 LC	Seg 5 WLA	Seg 5 LA	Downstream Flow
90.00	1.00	0.85	11.85	11.85	0.00	1.85
75.00	2.70	0.85	22.74	22.74	0.00	3.55
50.00	11.00	0.85	75.91	38.40	37.51	11.85
25.00	23.00	0.85	152.79	38.40	114.39	23.85
10.00	37.00	0.85	242.48	38.40	204.08	37.85

Segment 3, monitored by SC540, influenced by Hays
Big Creek from Chetolah Creek to NF Big Creek; Criterion = 427

Pct	Incoming Flow	Hays Design Q	Seg 3 Added Watershed Q	Seg 3 Added LC	Seg 3 Added WLA	Seg 3 MS4 WLA	Seg 3 LA	Downstream Flow
90.00	1.85	4.33	0.26	47.92	16.90	0.00	31.02	6.44
75.00	3.55	4.33	0.70	52.54	16.90	3.92	31.72	8.58
50.00	11.85	4.33	2.86	75.07	16.90	4.07	54.10	19.04
25.00	23.85	4.33	5.98	107.64	16.90	5.44	85.30	34.16
10.00	37.85	4.33	9.62	145.65	16.90	7.72	121.02	51.80

Segment 1, monitored by new SC752, potentially influenced by Gorham
Big Creek from NF Big Creek to Mouth; Criterion = 427

Pct	Incoming Flow	Gorham Design Q	Seg 1 Added Watershed Q	Seg 1 Added LC	Seg 1 Added WLA	Seg 1 LA	Downstream Flow
90.00	6.44	0.07	0.00	0.73	0.73	0.00	6.51
75.00	8.58	0.07	1.43	15.65	6.60	9.05	10.08
50.00	19.04	0.07	5.82	61.51	6.60	54.91	24.93
25.00	34.16	0.07	12.17	127.81	6.60	121.21	46.40
10.00	51.80	0.07	23.31	244.10	6.60	237.50	75.18

Total Flows, Load Capacity and Allocations for Big Creek in Ellis & Russell Counties

Pct	Flow	Design Q	Watershed Q	Total LC	Total WLA	Total MS4	Total LA
90.00	6.51	5.25	1.26	60.50	29.48	0.00	31.02
75.00	10.08	5.25	4.83	90.93	46.24	3.92	40.77
50.00	24.93	5.25	19.68	212.49	61.90	4.07	146.52
25.00	46.40	5.25	41.15	388.24	61.90	5.44	320.90
10.00	75.18	5.25	69.93	632.23	61.90	7.72	562.60