SMOKY HILL-SALINE BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Big Creek
Water Quality Impairment: Total Suspended Solids

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 total suspended solids in the 2008-303(d) list for the Smoky Hill – Saline Basin. Station SC541, located above the Chetolah Creek confluence was not cited for suspended

solids, since its median concentration did not exceed the listing threshold (50 ppm); therefore, the impairment lies below Hays. Station SC715 on the North Fork Big Creek is not cited for total suspended solids since its median concentration of a small sample size from 1995, 1999 & 2003 was below the listing threshold.

Impaired Use: Expected Aquatic Life

Water Quality Criteria:
Suspended Solids: Suspended solids added to surface waters by artificial sources shall not interfere with the behavior, reproduction, physical habitat, or other factors related to the survival and propagation of aquatic or semiaquatic life or terrestrial wildlife. In the application of this provision, suspended solids associated with discharges of presedimentation sludge from water treatment facilities shall be deemed noninjurious to aquatic and semiaquatic life and terrestrial wildlife, if these discharges comply fully with the requirements of paragraphs (b)(6) and (8) and paragraph (c)(2)(D) of this regulation. (K.A.R. 28-16-28e(c)(2)(B)).

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Uses under 2008- 303(d): Suspended solids levels on Big Creek below Hays are sufficiently high, and those elevated conditions continue down the stream toward the confluence with the Smoky Hill River, increasing the probability of interfering with any aquatic life residing in the stream.

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 data from 1990-2009 **(Figure 1)**. A permanent sampling station, SC541, located on Big Creek at the U.S. 183 bypass bridge on the west edge of Hays has data from 1990-2009. A rotational sampling station, SC715, on the North Fork of Big Creek is located southwest of Walker and has data from 1995, 1999 and 2003. Visits to the station in 2006 yielded no samples because of lack of flow. Additionally, probabilistic monitoring sites on Big Creek at Ogallah, Ellis and Russell were sampled 2-4 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.

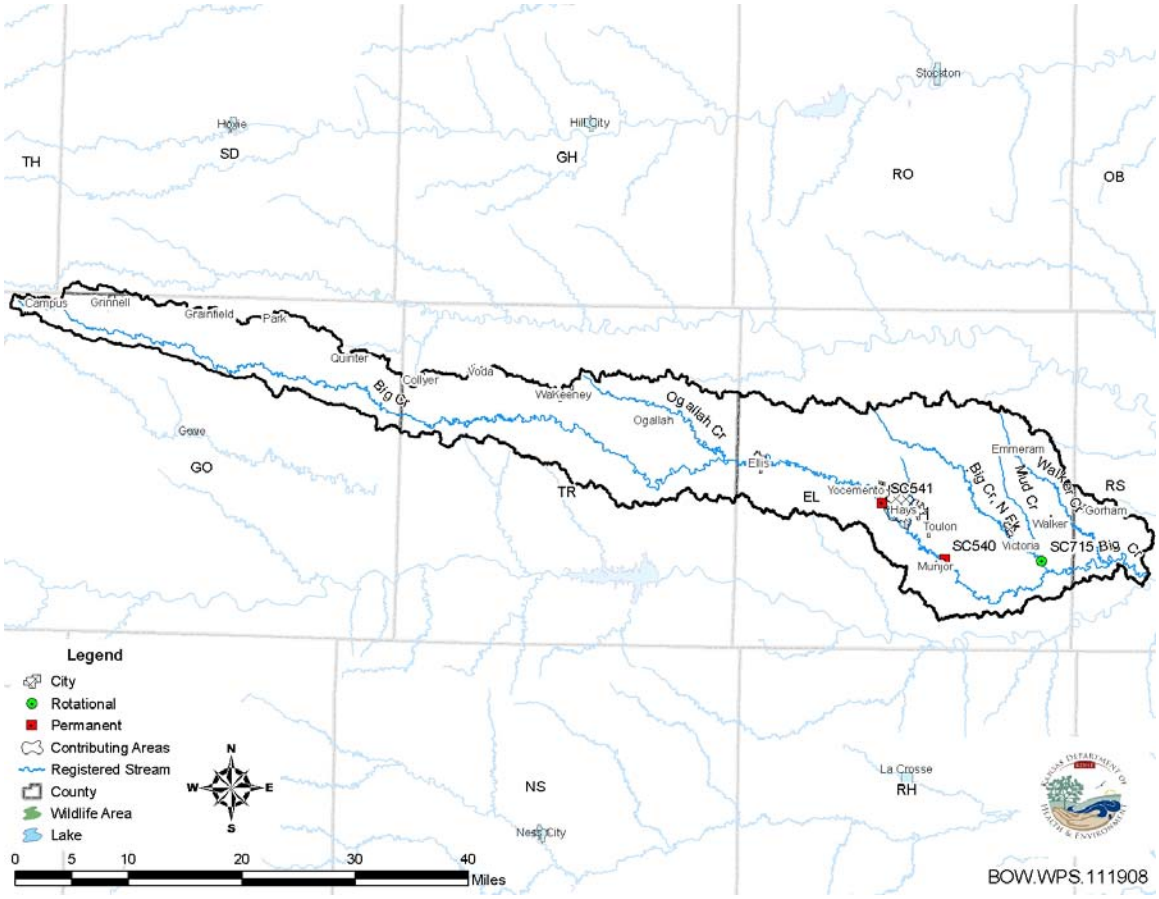

Figure 1. **Big Creek Subbasin with KDHE monitoring stations.**

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 0.43 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, 2004).

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

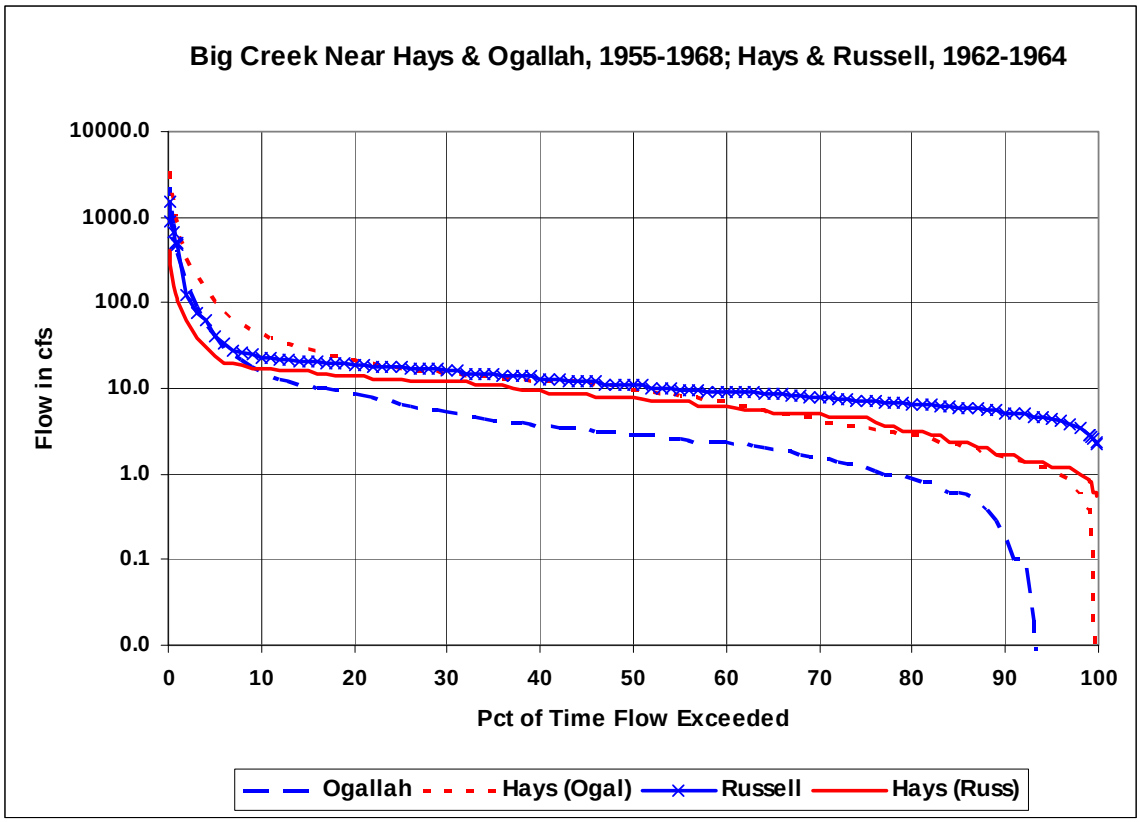

Figure 2. Flow Duration on Big Creek at Hays, Ogallah & Russell in Similar Years

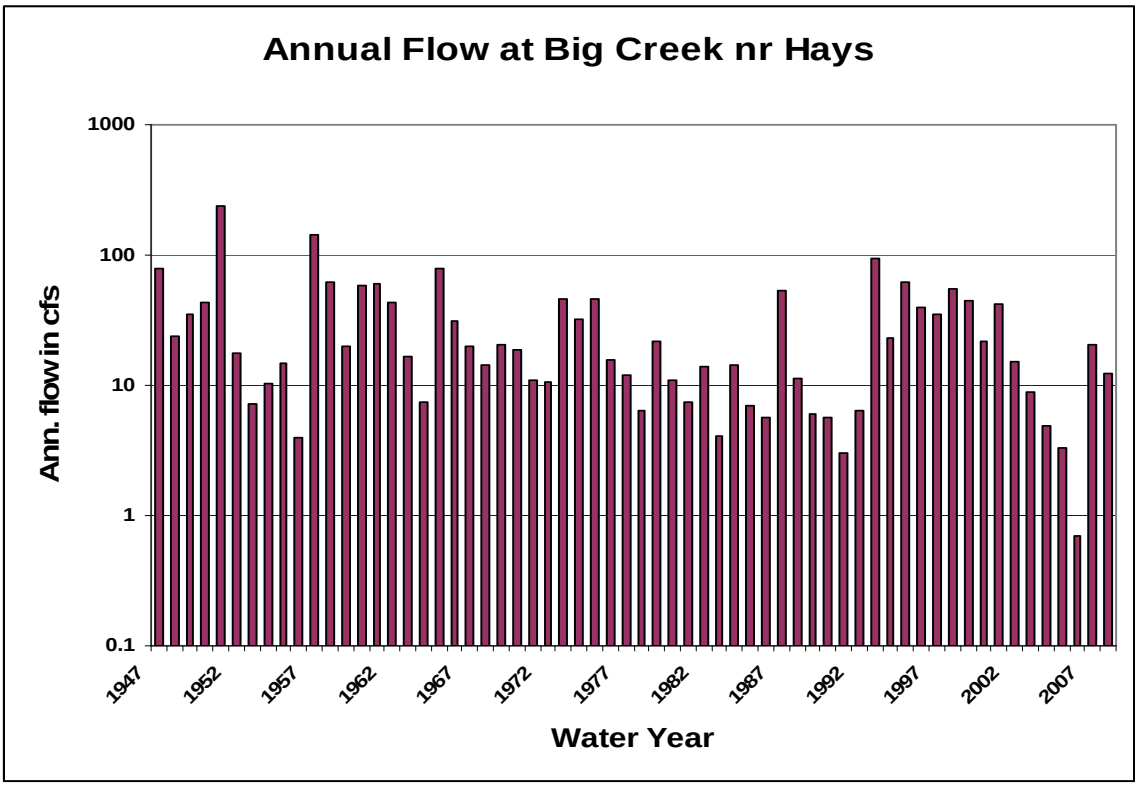

Figure 3. Average Annual Flow on Big Creek; 1947 - 2008

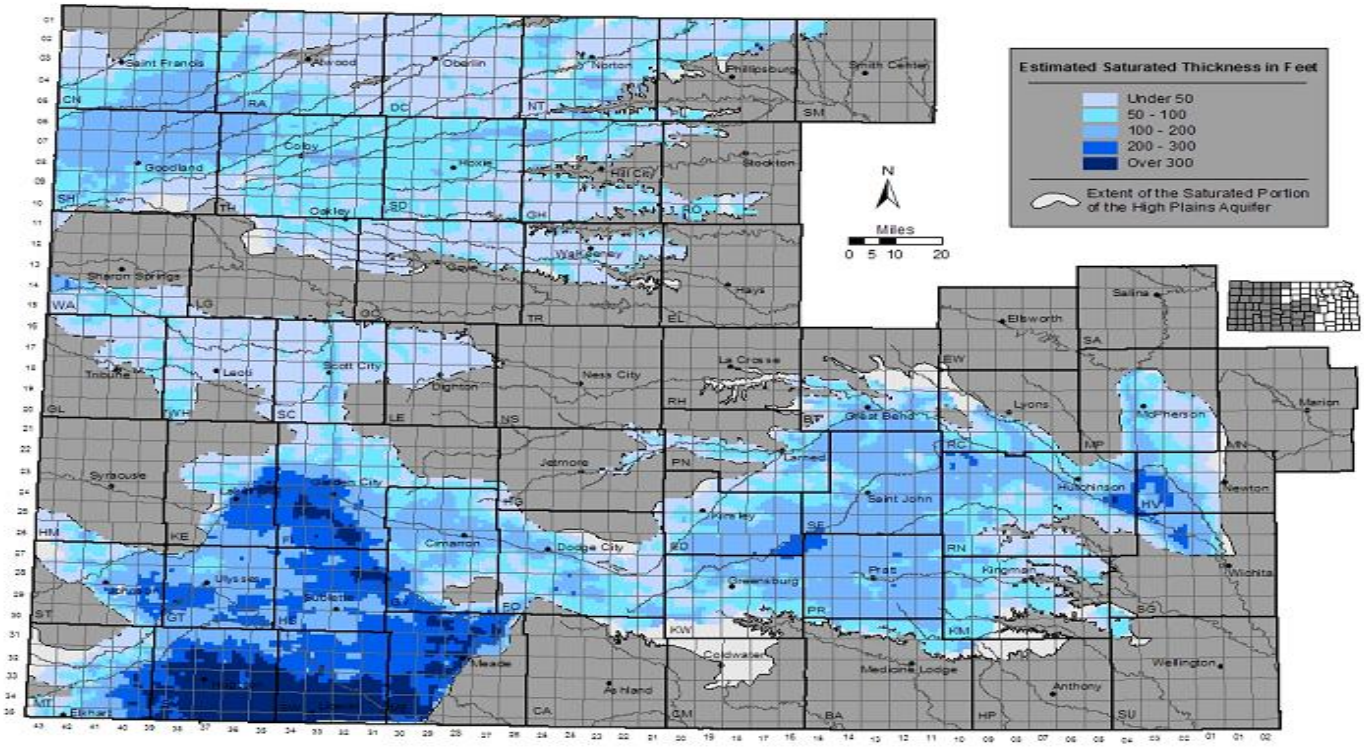

Figure 4. High Plains Aquifer Saturated Thickness

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. Since elevated suspended solids is seen at the Munjor site, but typically not above Hays during low flow, this TMDL will presume Ellis wastewater is not responsible for the high suspended solids seen in the downstream reach. Therefore, low flow conditions will be viewed as restricted to that portion of Big Creek in the vicinity of Yocemento in central Ellis County to its mouth southwest of Russell.

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).

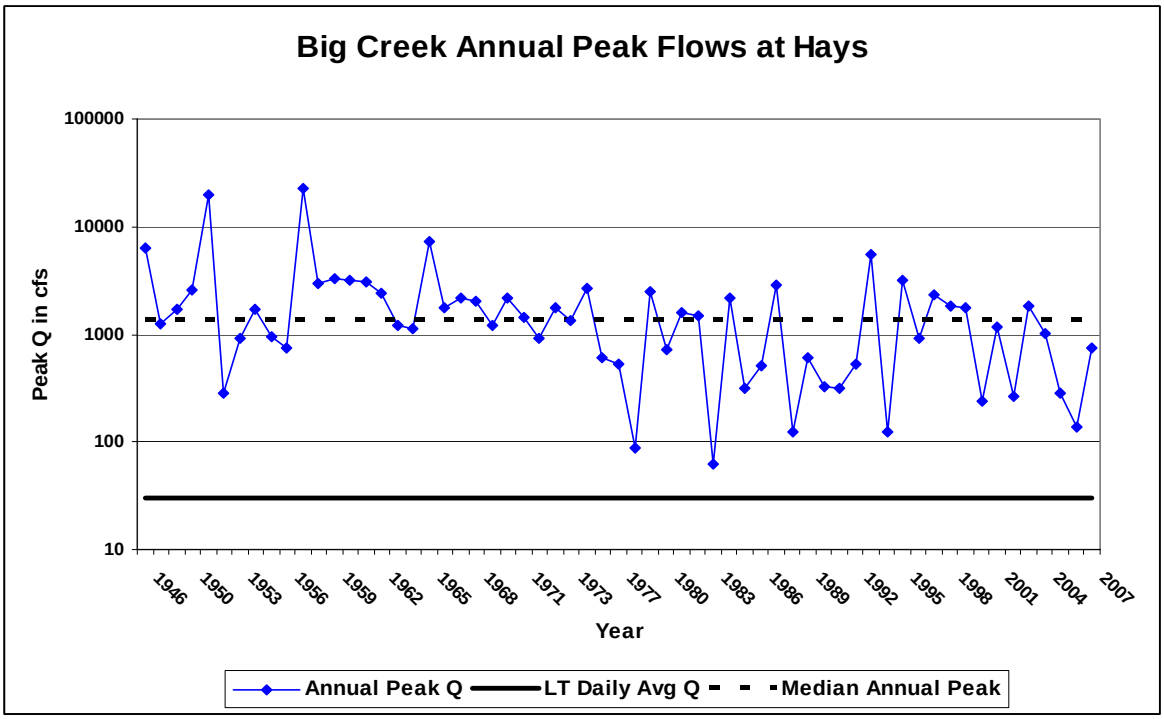

Figure 5. Annual peak flows on Big Creek at Hays

Flow duration data at the USGS gaging station at Hays indicate flows during the period of record for 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. Sampling covers most of the flow range seen on Big Creek, with the exception of the highest flows.

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 October were an order of magnitude less than the recent average flows over the sampling period of record **(Figure 7).**

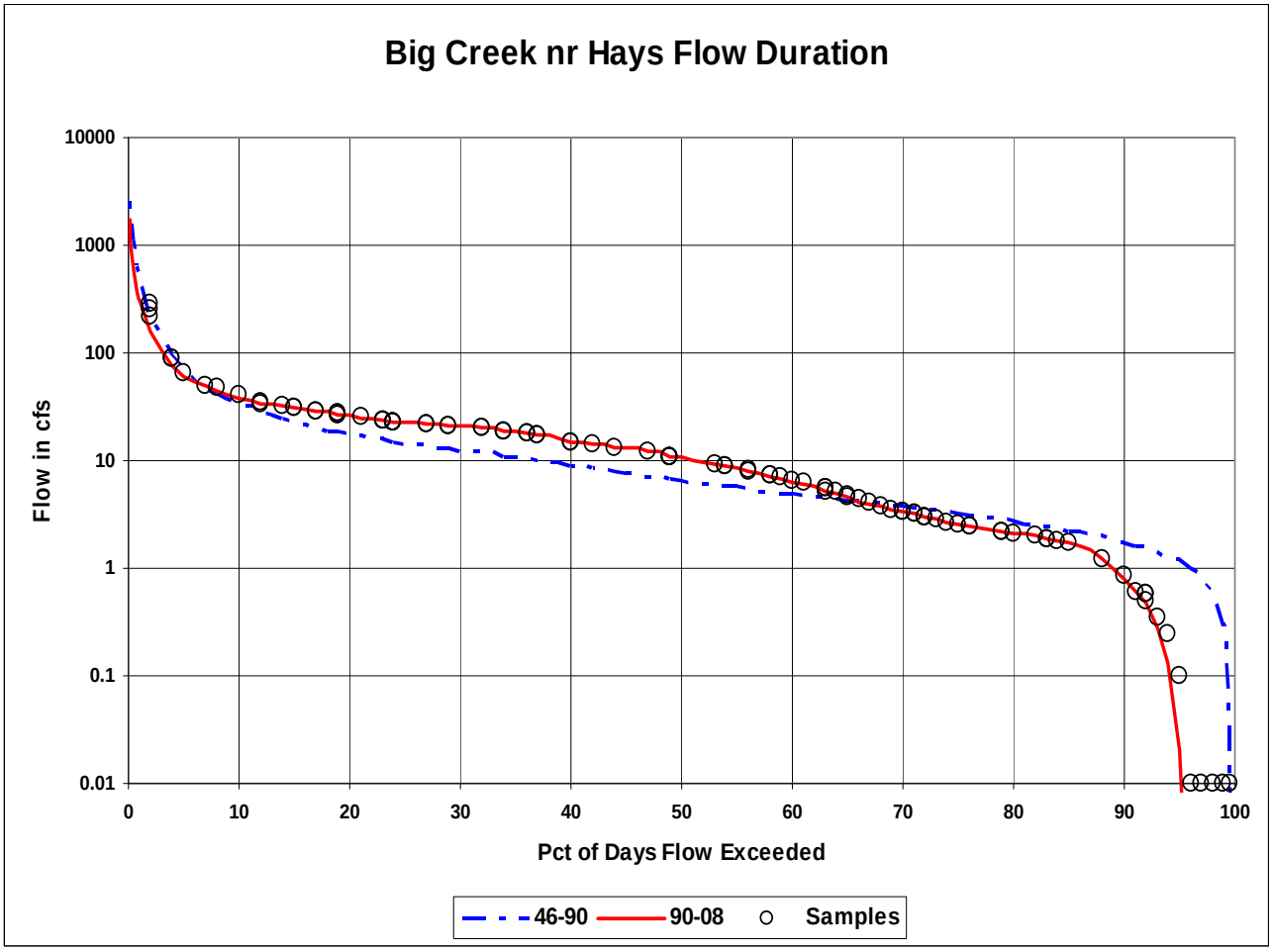

Figure 6. Big Creek Flow Duration Before and During KDHE Sampling

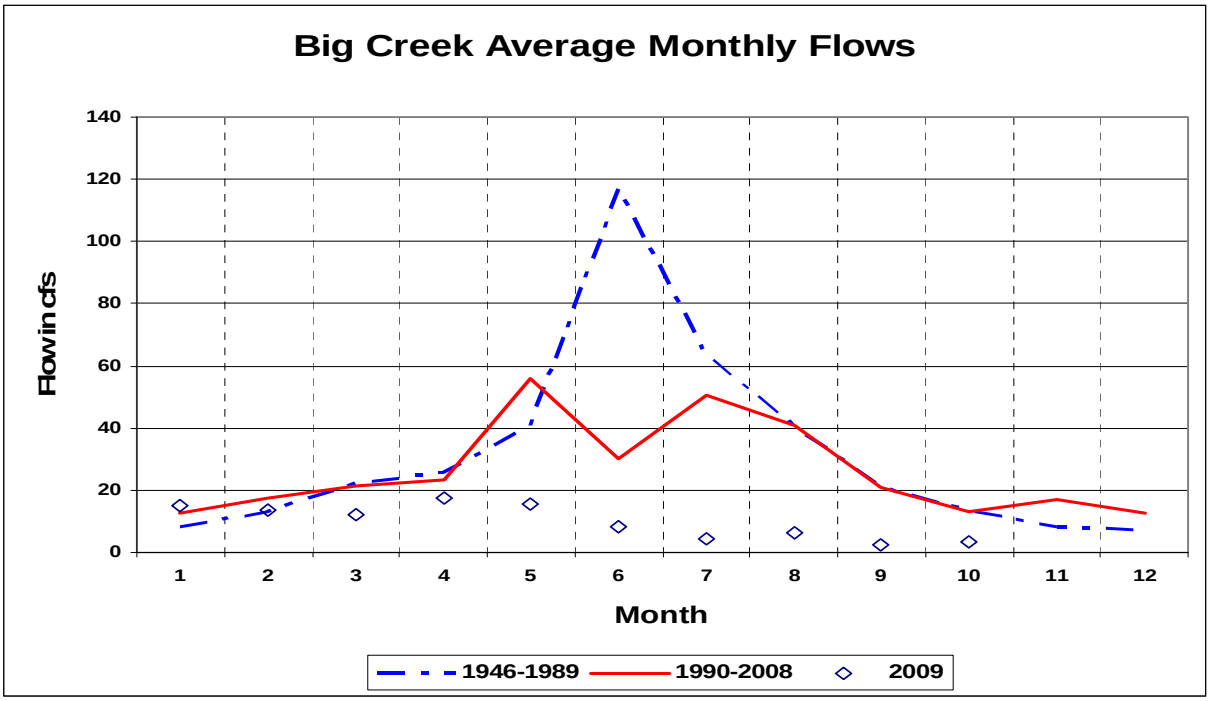

Figure 7. Average Monthly Streamflows on Big Creek Prior to and After 1990.

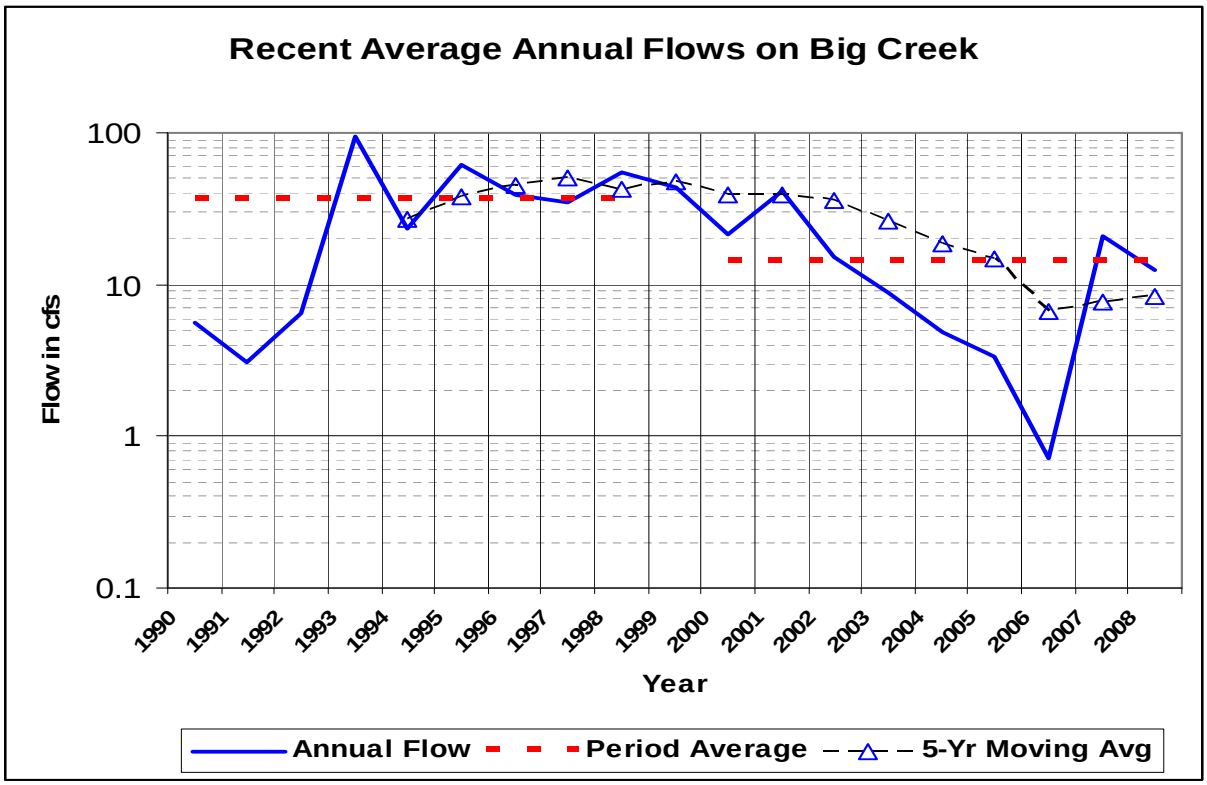

Figure 8. Average Annual Streamflows on Big Creek During KDHE Sampling Period

Because this TMDL will address TSS 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).

Suspended Solids (TSS) Concentrations: TSS concentrations are significantly higher at the Munjor site (SC540) than the upstream Hays site (SC541); **(Figure 9**). Overall TSS concentrations average 108 mg/l at the lower station and 56 mg/l at the upper station. Suspended solids concentrations reflect three separate conditions seen on Big Creek over 1990-2009. The first was a relatively dry period of 1990-1993 (median flow of 3.5 cfs), terminated by the large flows of summer, 1993. This was followed by a relatively wet period from 1994 – 2003 (median flow of 20 cfs), followed by a second dry period from 2004-2009 (median flow of 3.2 cfs). Upstream TSS concentrations averaged 54, 65, and 38 mg/l for the three respective periods, typical of a runoff dominated system, while average concentrations downstream of Hays were 167, 107 and 73 mg/l, perhaps reflective of more erosion control measures installed within Hays over time.

Because of the large variability in ambient suspended solids concentrations, median values are appropriate for determining long term condition. Listing on the 2008 Section 303(d) list for total suspended solids was determined by median concentrations exceeding 50 mg/l for any station. Median TSS concentrations on Big Creek below Hays over 1990-2009 were 72mg/l; the median for the upstream station was 43 mg/l.

Total suspended solids levels at Munjor are significantly higher than those at the upstream Hays station (**Figure 10**), but particularly at higher TSS (> 100 ppm) levels. The influence of increased urban hydrology, stormwater and disturbed sites is likely greater at and below Hays than in western Ellis County, as well as the watershed above Ellis.

Total suspended solids shows a strong seasonal pattern with low levels over November through February, followed by spring (March to June) rises to a summer (July and August)peak and then an autumn (September – October) recession (**Figure 11**). TSS concentrations appear to peak in July. Seasonal means above and below Hays are 19 and 24 mg/l, respectively, in winter; 49 and 100 mg/l in spring, 105 and 228 mg/l in summer and 65 and 85 mg/l in autumn. Median values, which are robust against high TSS values, are less distinct over September to February at the two sites (11 mg/l vs 19 mg/l) but remain divergent during spring and summer (53 mg/l vs. 113 mg/l). The notable increase in TSS values and difference between the two locations in the spring and summer is wholly a function of high flow conditions occurring during the March thru August period. Runoff occurs as a result of springtime frontal precipitation or summer convective precipitation.

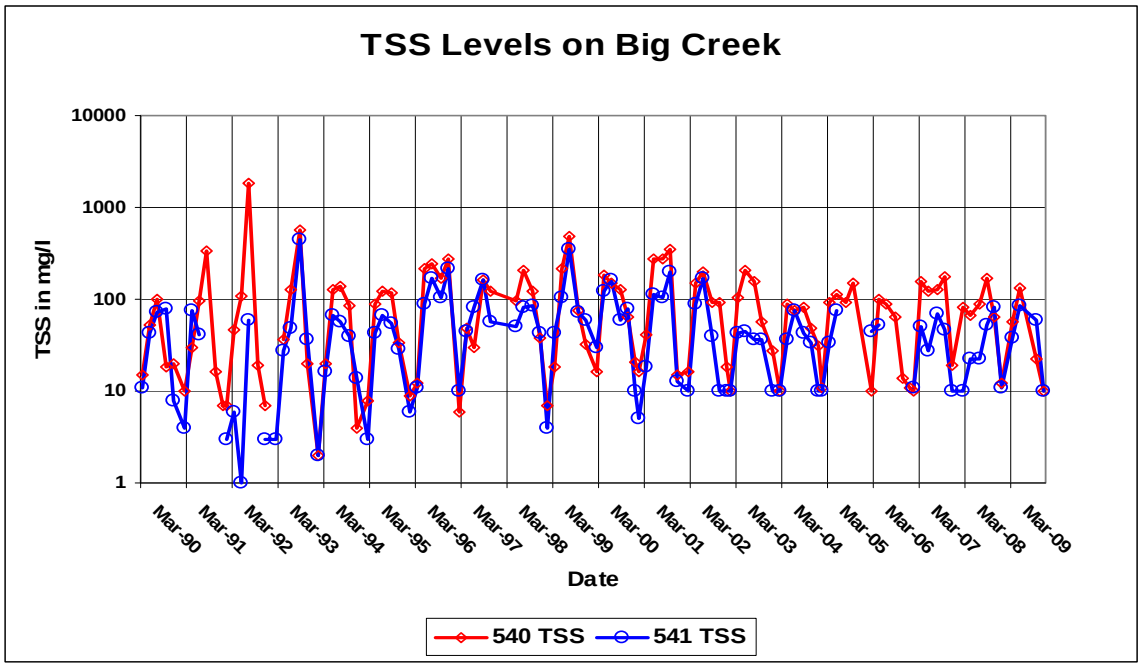

Figure 9. Total Suspended Solids Concentrations Above and Below Hays Since 1990

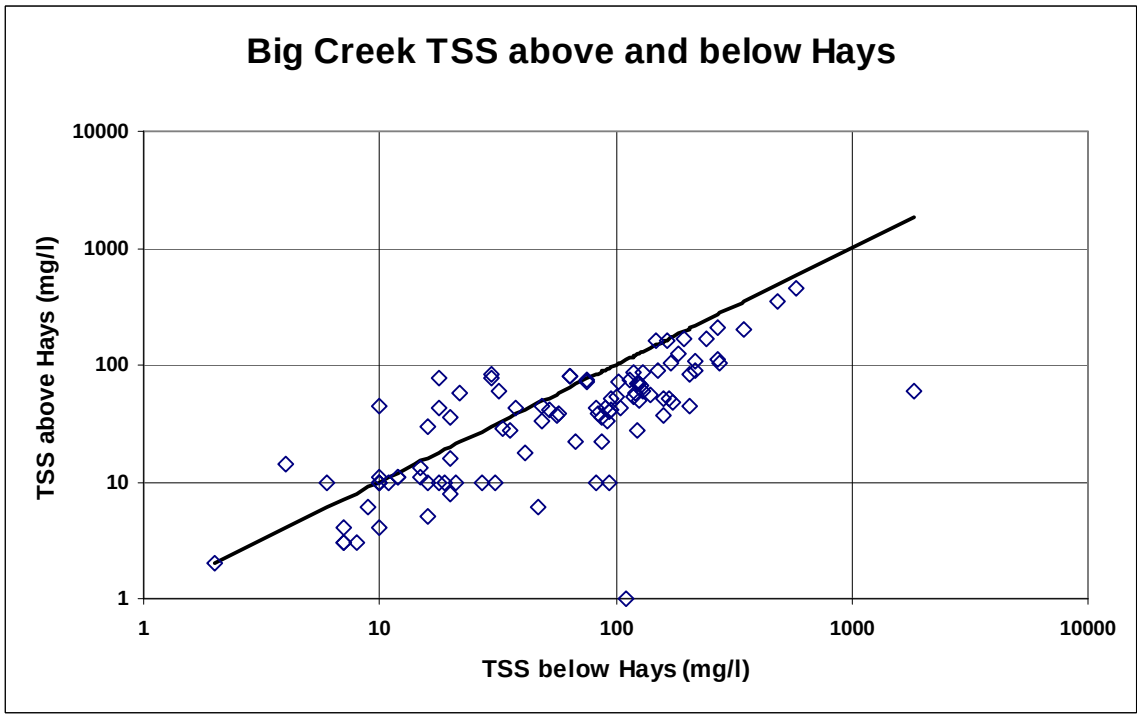

Figure 10. Concurrent Total Suspended Solids Samples on Big Creek Above & Below Hays

TSS levels at low flow are also influenced by the low TSS content of Hays wastewater. Although significantly different in the downstream direction (43 mg/l vs. 23 mg/l), most of that distinction occurs at lower flows that are on the falling limb of previous runoff events. Inter-reach differences in TSS levels at very low flows become less significant All NPDES discharging facilities are required to meet secondary treatment standards which includes low (~ 30 mg/l) TSS in their effluent.

Plotting TSS against flow shows the typical pattern of a fairly flat distribution around a mean value at low to moderate flows, followed by a rising trajectory with increased flow (**Figure 12**). Using flow duration to define flow condition, the pattern becomes more apparent (**Figure 13**). It would appear that the upward trend begins around the lower quartile (25%) flow value, which is around 20-25 cfs at the gaging station.

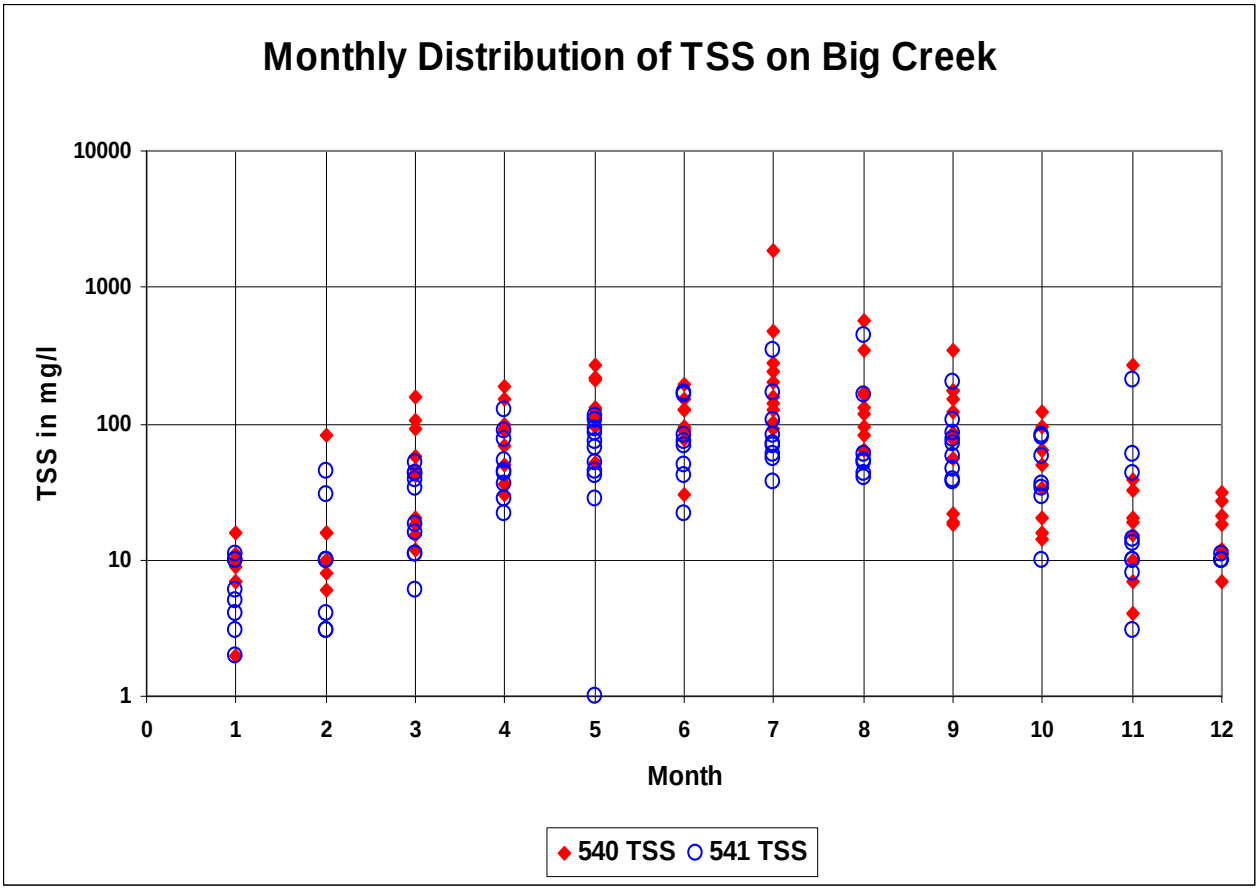

Figure 11. Monthly Distribution of Total Suspended solids on Big Creek

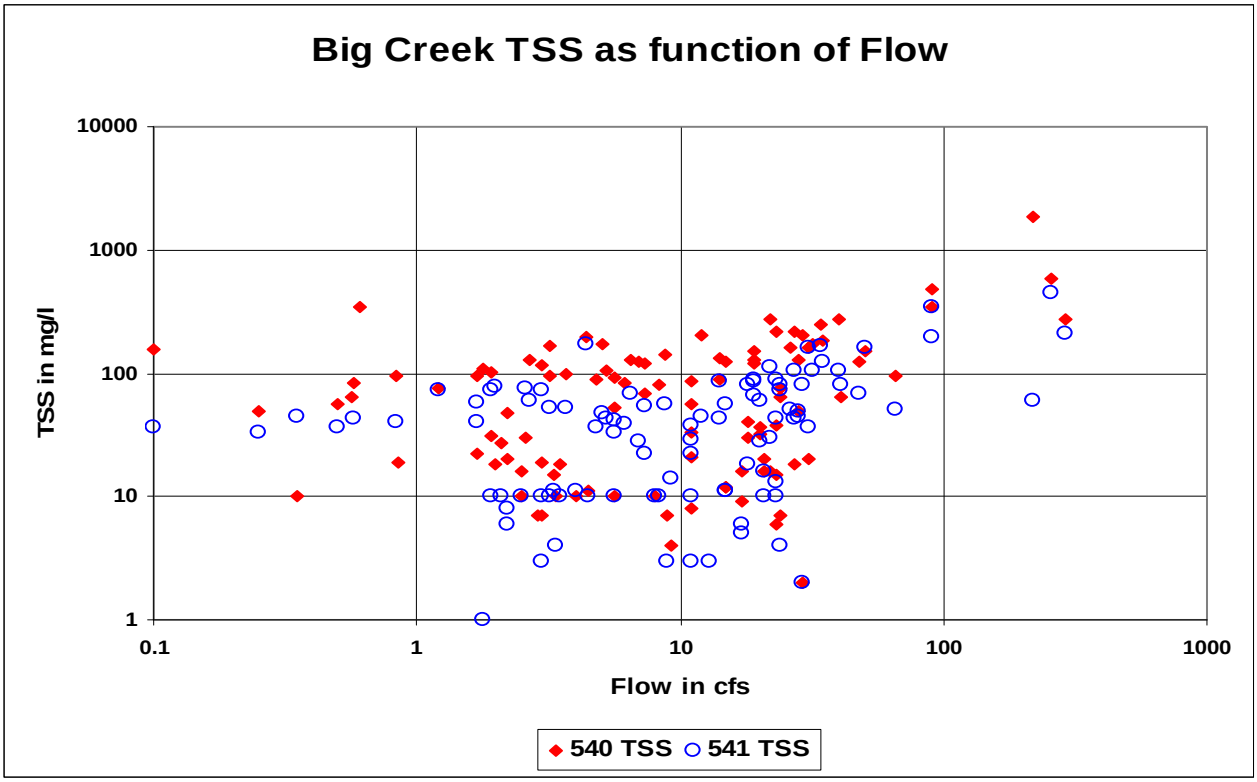

Figure 12. Total Suspended Solids on Big Creek as Flow Varies

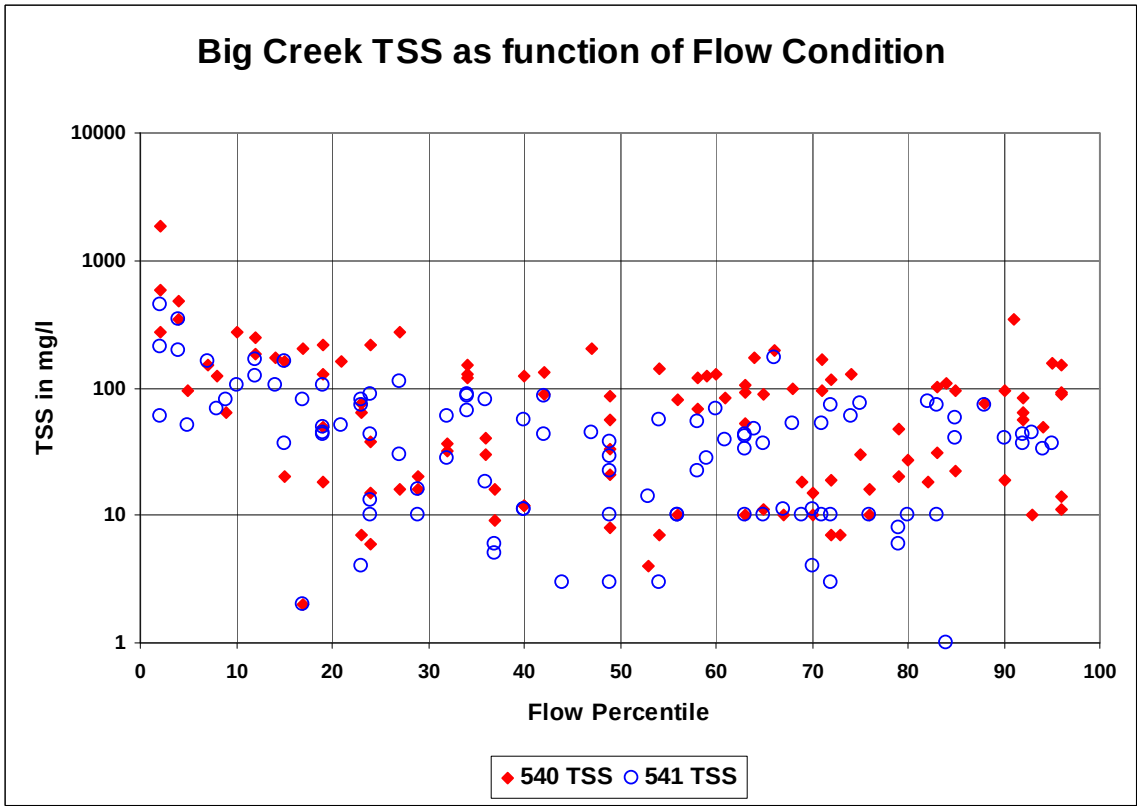

Figure 13. Big Creek TSS Levels in the Context of Flow Condition

Therefore, there are two mechanisms in place dictating total suspended solids concentrations in the lower reaches of Big Creek. The first factor is activities in proximity to the stream channel that predominate the low flow condition. This factor is a combination of point source and non-point source loadings and activities that potentially dislodge solids within the stream channel. The second mechanism is the erosion and transport of solids during wet weather from the watershed as a whole. Although bank sloughing and channel instability can contribute to this, Big Creek tends to be a flat stream with modest bank height. Overland runoff loads are likely contributors to the rising trajectory of TSS concentrations at higher flows.

Concurrent sampling through the stream probabilistic network during 2008-2009 indicated mixed relationships. Upstream suspended solids levels at Ogallah and Yocemento will surpass those at the Munjor site downstream of Hays **(Figure 14**) during the non-runoff seasons. TSS at Munjor is typically highest along Big Creek during prime runoff months in 2008 and 2009. There is little distinction between the upstream stations and Site 541 or Site 540 and the Russell station in this limited dataset. Finally, during winter months (November, 2009), there is no difference among stations.

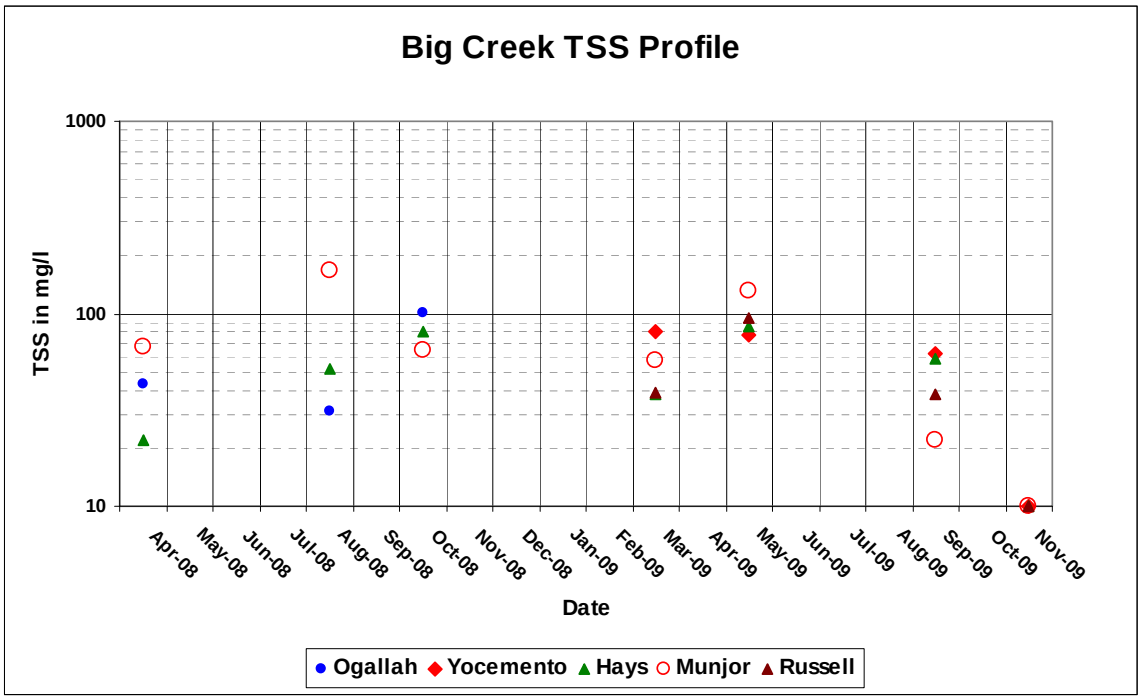

Figure 14. Probabilistic Stream Monitoring of TSS on Big Creek in 2008-09

The Big Creek – Middle Smoky Hill River Watershed Restoration and Protection Strategy Group (WRAPS) have collected water quality data since 2007 along numerous locations of Big Creek **(Figure 15**), including total suspended solids. A TSS profile along Big Creek over time shows variability and overlap among the stations, but the creek above Hays (110th Street, 150th Street, Highway 183 (#5) and 220th Street (#9) are consistently among the lowest values **(Figure 16)**. However, that relation will dissolve during the higher flow months when episodes of high TSS will be seen immediately above Hays (Stations #5 & 9). Conversely the stations below the confluence of Chetolah Creek (#6 & #7), which drains most of Hays is persistently high during the wet season. Similar high values are seen downstream of Hays at Station #13 and the sites on Walker, Blundon and Balta roads. 2008 shows a tendency of all stations to have high TSS, particularly during the wet season of that wet year. The drier condition of 2009 lowers the magnitude of TSS seen on Big Creek as well as the frequency of high TSS occurring at the various stations along the creek.

Plotting concurrent sampling relative to the Big Creek station immediately below the Hays outfall (Chetolah Creek) reveals there is some increase in downstream TSS at lower concentrations at the upstream stations (**Figure 17**). That relationship approaches unity once TSS levels rise above 20 mg/l and TSS levels become indistinct among stations over 50 mg/l. Conversely, there tends to be an increase in TSS between Hays and Munjor (**Figure 18**) at TSS levels below 100 mg/l. The TSS condition persists between Stations #7 and #13. Unlike some of the other impairments on Big Creek, higher TSS levels are seen downstream of Hays regardless of sampling timing. Once TSS levels rise over 100 mg/l, indicative of large runoff, the conditions at the stations begin to merge.

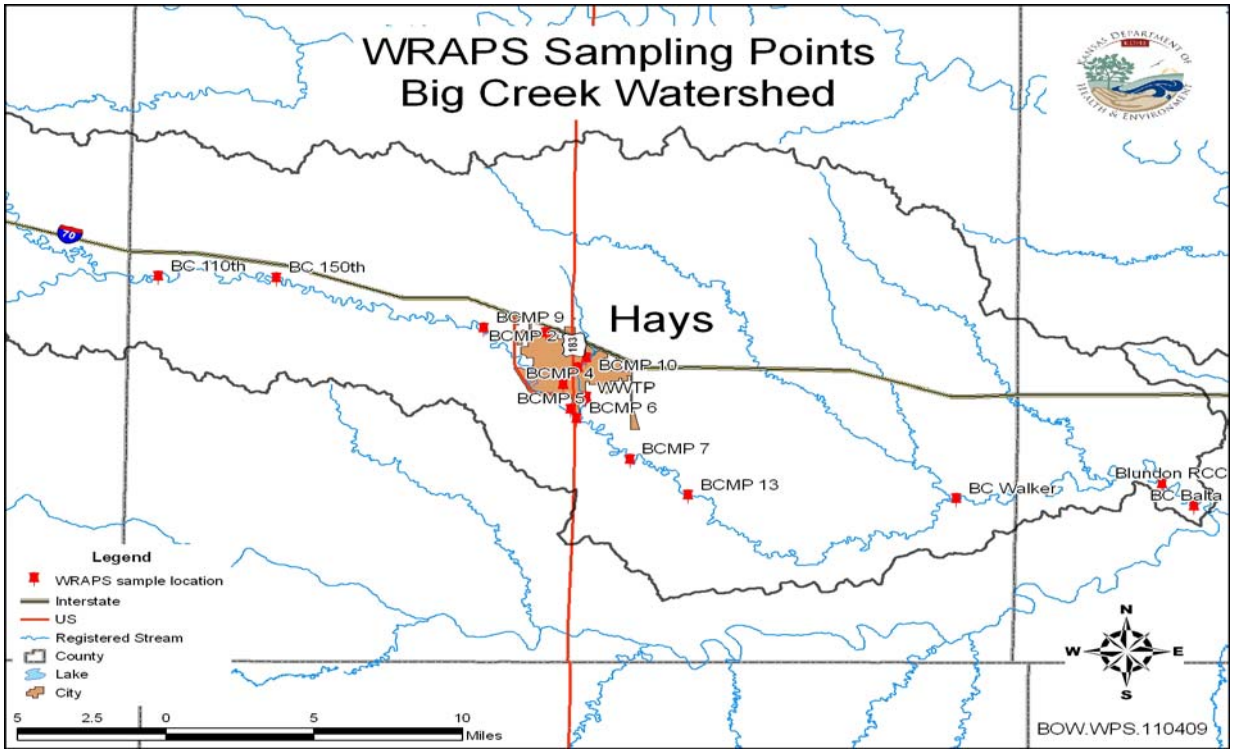

Figure 15. Locations of WRAPS Sampling Sites along Big Creek

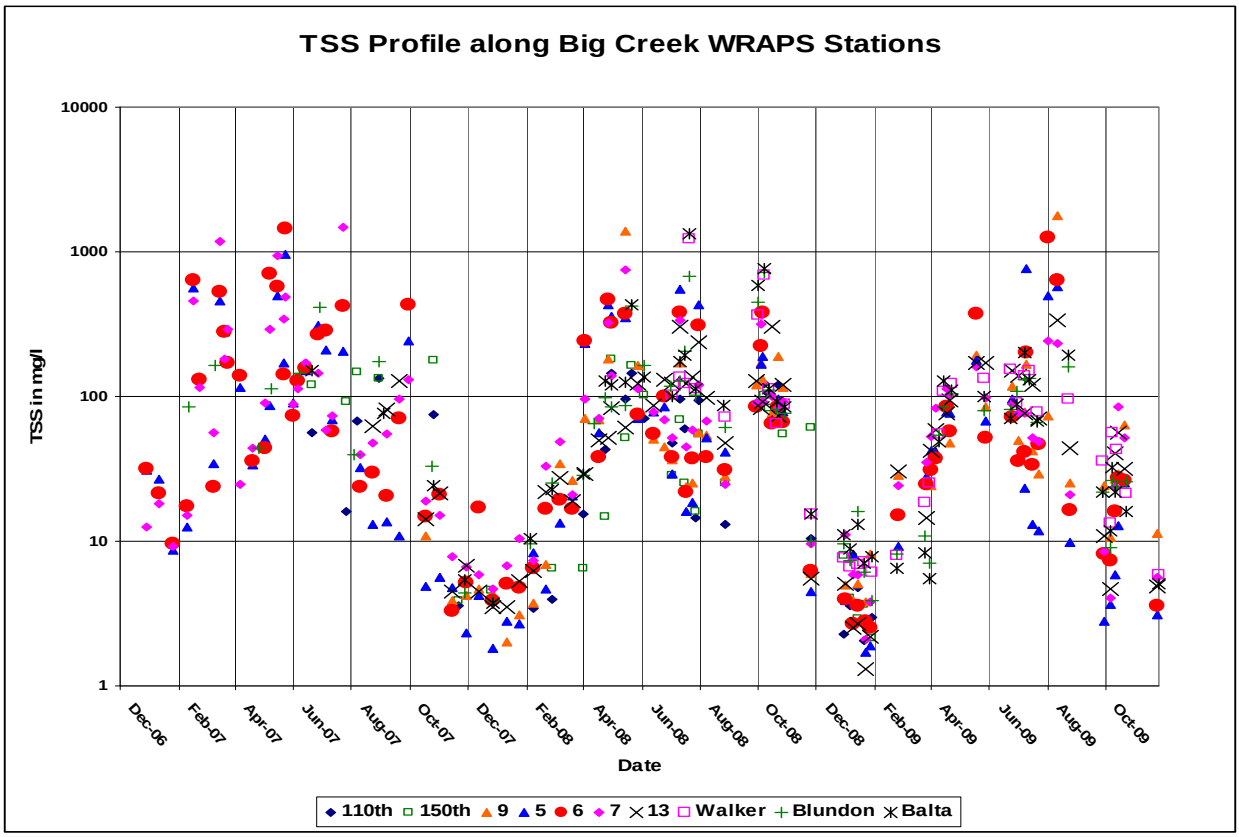

Figure 16. Profile of TSS along Big Creek at WRAPS Sampling Stations

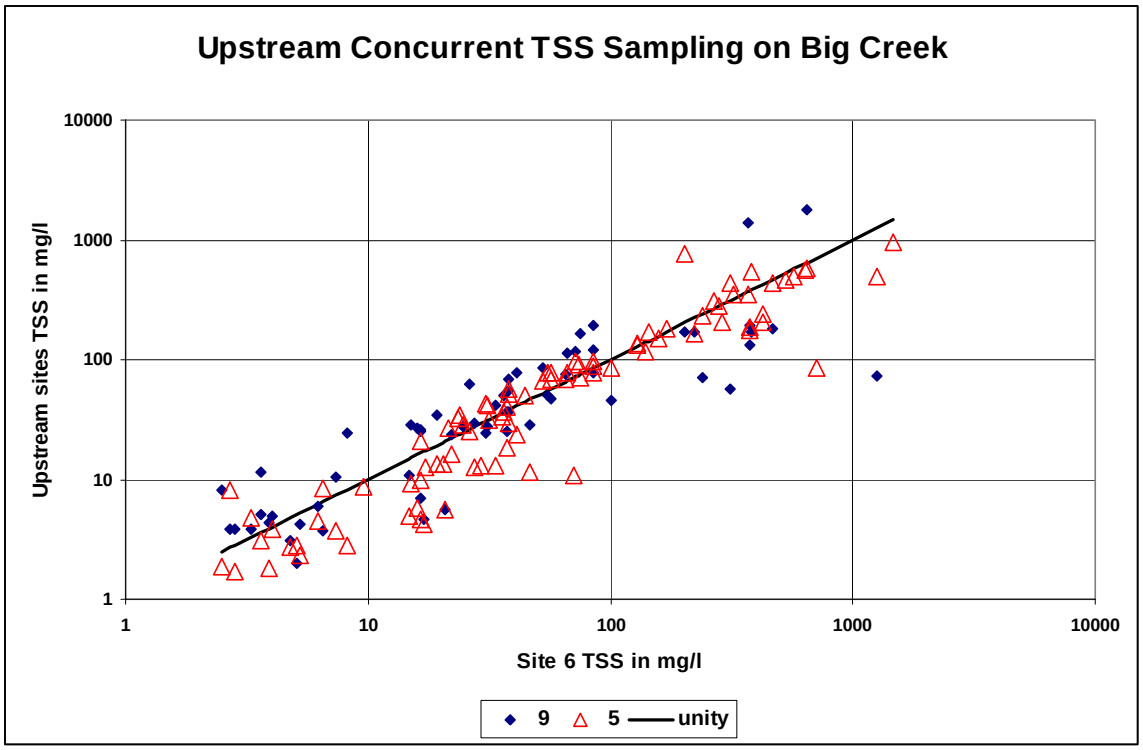

Figure 17. Concurrent Sampling on Big Creek at and above Hays

The profile of average TSS concentrations over the past two years shows some variability but also a general rise in the downstream direction of Big Creek (**Figure 19**). Because of disparate sampling times, these averages may not reflect consistent hydrologic conditions along Big Creek.

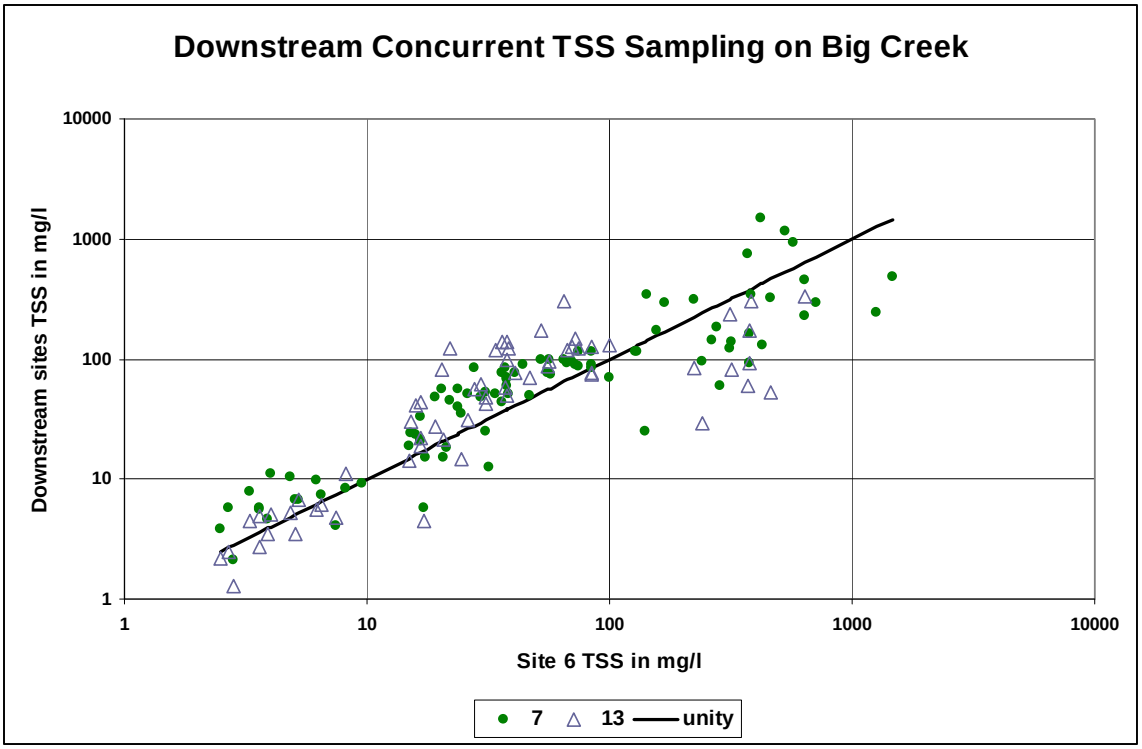

Figure 18. Concurrent Sampling on Big Creek at and below Hays

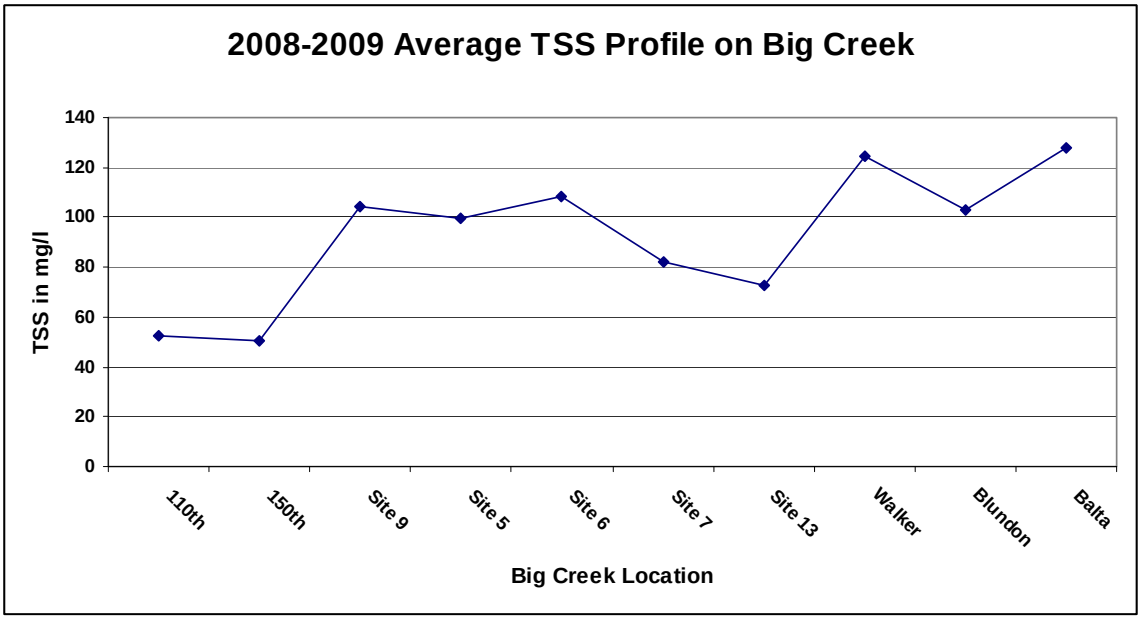

Figure 19. Profile of Average TSS Concentrations along Big Creek

Desired Endpoint: The ultimate endpoint of this TMDL will be to achieve the Kansas Water Quality Standards by eliminating any of the impacts to aquatic life associated with excessive suspended solids as described in the narrative criteria pertaining to solids. There are no existing numeric sediment criteria currently in Kansas. However, the listing methodology for TSS in the 2008 and 2010 Section 303(d) lists showed some relationship between robust macroinvertebrate communities, as indicated by good MBI scores and median TSS values for streams where both biological and chemical sampling occurred. The breakpoint between good biotic quality and indications of impairment was in the vicinity of 50 mg/l. That endpoint will serve as the initial goal of this TMDL pending more complete analysis of the relationships between total suspended solids, sediment, channel condition and stream biota.

As a further hedge in achieving desirable sediment or suspended solids conditions on Big Creek, the future endpoint will be to align the median concentrations at the downstream station with that of the upstream station (43 mg/l). Since this falls below the original threshold for listing waters for TSS, subsequent assessment of the biological integrity should be made on Big Creek once median TSS values at the Station SC540 fall within the range of 43 – 50 mg/l. **Figure 20** displays the current and desired TSS conditions on Big Creek. Because of the wide variability in TSS values seen on Big Creek, a logarithmic scale is necessary to properly view the relationship. The current condition is denoted by the 1.857 line. The initial goal of 50 mg/l is represented by the 1.70 line and the desired goal of the upstream median of 43 mg/l is shown as the 1.633 line.

Upon the attainment of the initial endpoint, an assessment of stream conditions will be done to corroborate the reduction of the nuisance conditions expressed in the narrative criteria. Adjustments to the follow-up endpoint linked to the resulting stream conditions may be made after that assessment. At such time that stream conditions mirror those expressed by the narrative criteria, the resulting ambient TSS concentrations will be adopted as numeric criteria. Achievement of these endpoints indicates any loads of suspended solids 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.

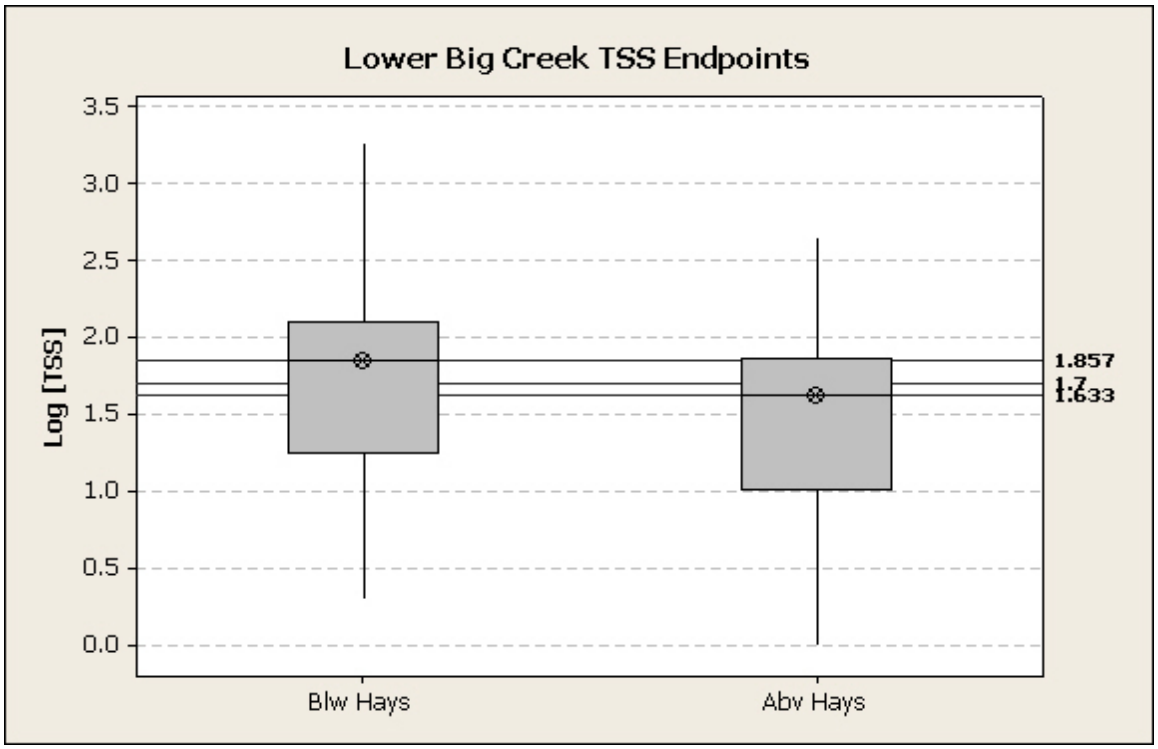

Figure 20. TSS Endpoints for Big Creek

3. SOURCE INVENTORY AND ASSESSMENT

Point Sources: There will be six NPDES permitted facilities potentially discharging to Big Creek above Station SC540 **(Table 2)**. 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 has TSS limits of 120 mg/l as a weekly average and 80 mg/l as a monthly average. They monitor for TSS on a quarterly basis. In the brief time, the lagoon system has been on-line, it has performed very well in producing low TSS effluent. In five

quarters over 2008 – 2009, the average TSS was 37 mg/l. Regardless, the pervasive dry conditions in Trego County limit the transport of any effluent discharge from Wakeeney's outfall down Big Creek, except under runoff conditions, which in turn would dwarf the wasteload contribution.

Similarly, Gorham's three-cell lagoon system will be upgraded to discharge by August 2010. Wastewater will flow, up to 0.0478 MGD, down an unnamed tributary to Walker Creek and then, lower Big Creek. Effluent can be used to irrigate adjacent cropland, and as a lagoon system, Gorham will have the typical 80/120 mg/l limits for TSS with quarterly monitoring.

The City of Ellis Wastewater Treatment Plant discharges to Big Creek and is required to maintain weekly and monthly TSS averages of 45 and 30 mg/l. Ellis monitors TSS on a monthly basis and the average over 2004 – 2009 was 7 mg/l. With an average discharge of 0.218 MGD, the average total suspended solid load is 17.5# per day from Ellis' wastewater treatment. Ellis can reuse its effluent to irrigate its municipal golf course.

The city of Hays discharges to Chetolah Creek which enters Big Creek south of town. The wastewater treatment plant underwent an upgrade in 1993, and reduces TSS as part of its secondary treatment process. Like Ellis, Hays has a weekly average permit limit of 45 mg/l and a monthly average limit of 30 mg/l. Hays does monitor TSS in its effluent twice monthly and has averaged 6 mg/l over 2004 – 2009. Like Ellis, effluent can be diverted to irrigate several golf courses and ball fields. Hays averaged 1.9 MGD in discharge over 2003 – 2009 and a TSS wasteload of 140 # per day.

The records from the effluent data indicate that wastewater from the municipalities are not the underlying cause for elevated total suspended solids on Big Creek. Based on WRAPS data, the relative impact of Hays wastewater can be examined by comparing TSS concentrations on Big Creek above and below Chetolah Creek (**Figure 21).** Below 20 cfs, there is typically little difference in TSS levels between the two monitoring sites. There is likely to be higher TSS at the upstream station than that seen concurrently at the lower station. Once flows (at the gage located above Hays, indicative of mounting runoff conditions) increase past 20 cfs, increases in TSS from intervening areas within Hays can be noted. However, these increases are attributed to stormwater, not wastewater.

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. In the case of this TMDL, suspended solids increase at higher flows on the lower reaches of Big Creek receiving urban stormwater during wet weather, while rural runoff increases the sediment levels from the remainder of the watershed.

Table 2. 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

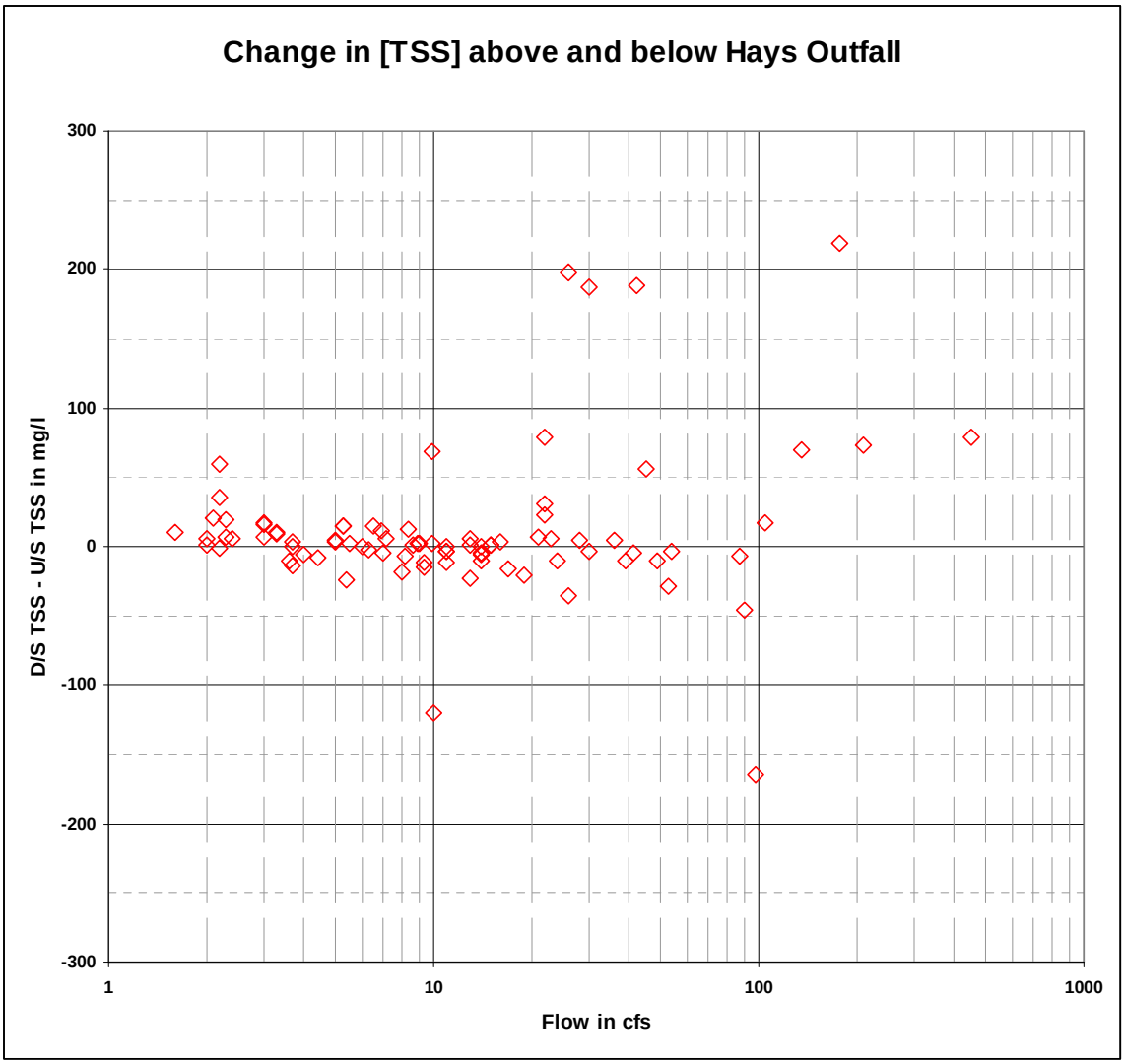

Figure 21. Difference between upstream and downstream TSS concentrations at Hays.

Land Use: Cropland is the predominant land use within Big Creek Subbasin, comprising 62% of the acreage. **Figure 22** 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. Cropland tends to be concentrated on the uplands where flatter slopes support expansive cultivation **(Figure 23).** As Big Creek enters Russell County, it courses through a series of breaks that do not lend themselves to extensive agriculture. Row crop production in the vicinity of Big Creek can contribute suspended solids to the surface water via overland flow. Sediment and suspended solids increase with runoff from the rural portions of the watershed.

Table 3 summarizes the most recent crop year plantings for the four counties in the Big Creek drainage. Wheat is the predominant crop over the winter and spring and sorghum dominates the summer – fall period. Corn is prevalent in Gove and Trego counties where irrigation from the High Plains Aquifer is an option. Soybeans have a small niche within

all four counties. The acres of corn for silage in Gove County are unusually high likely because of salvaging after the 2006 drought, typical silage averages 4400 acres.

Table 3. Planted Crop Acres in Big Creek Drainage

	Big Creek Counties			
Year & Crop	**Ellis**	**Russell**	**Trego**	**Gove**
2009 Wheat	113,000 ac	77,000 ac	89,000 ac	104,000 ac
2008-9 Corn	4500 ac	----------	15,500 ac	74,500 ac
2009 Sorghum	51,000 ac	51,000 ac	61,000 ac	48,000 ac
2006-8 Soybeans	1800 ac	2500 ac	900 ac	2200 ac
2006 Corn Silage*	----------	----------	2100 ac	19200 ac
2007 Sorghum Silage*	3300 ac	----------	600 ac	1400 ac

- *Silage represents acres harvested or salvaged for fermentation

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 (Juracek, 2000). 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 24)** 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.

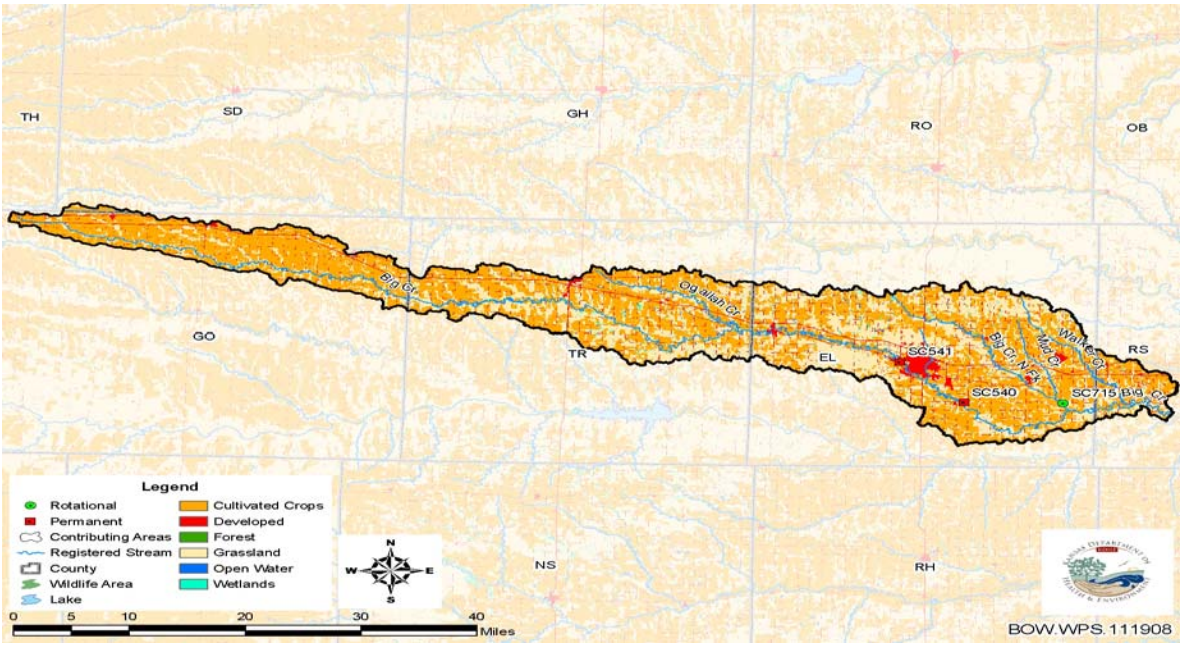

Figure 22. General Land Use in Big Creek Watershed (from 2001 NLCD)

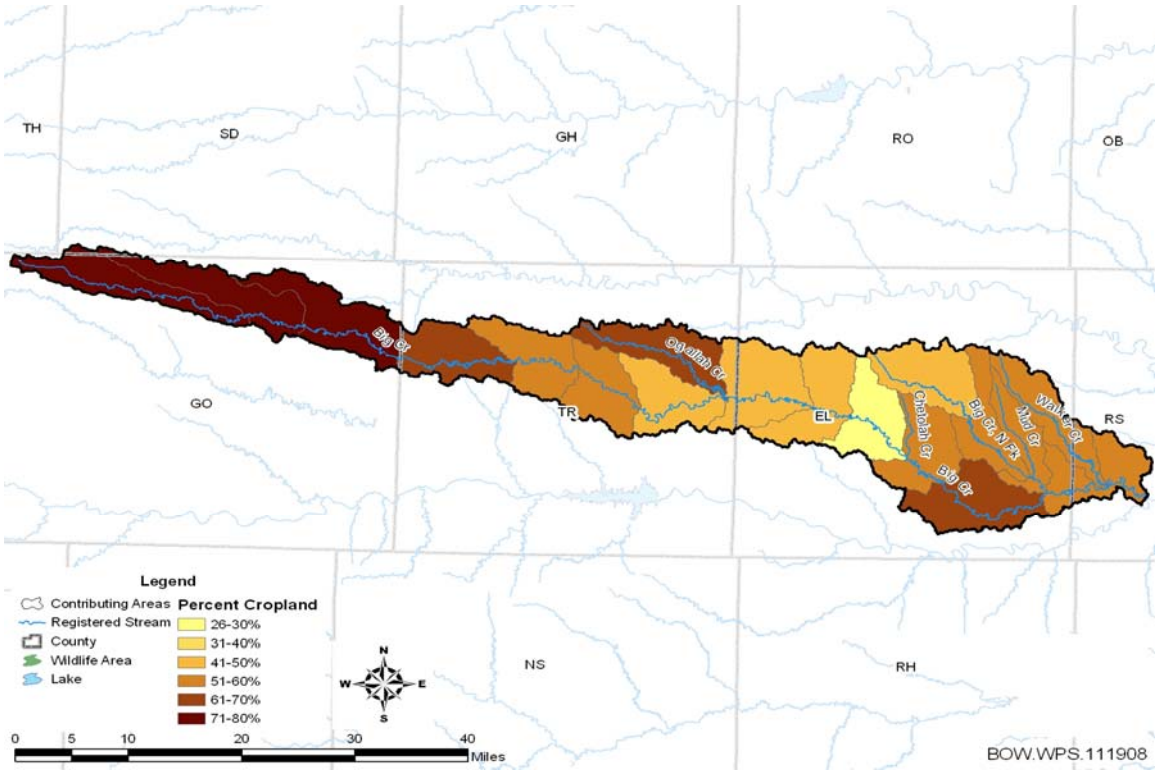

Figure 23. Cropland Distribution Across Big Creek Watershed

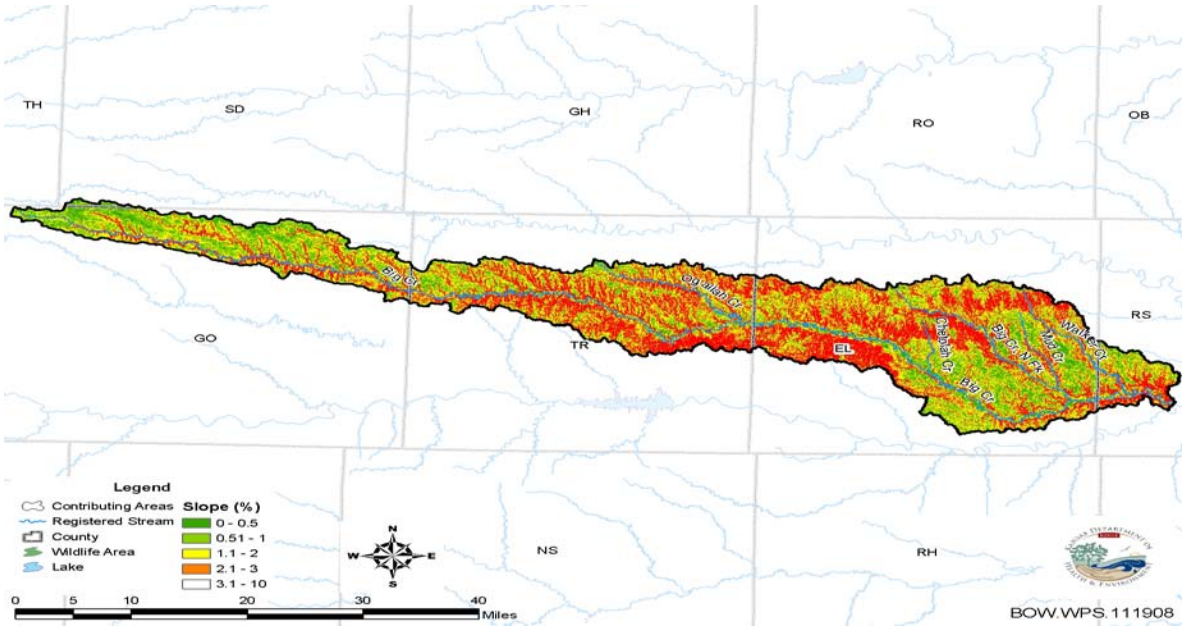

Figure 24. Land slope Across the Big Creek Watershed

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 A). 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 4).** 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 4 & 5).** There are livestock present in Russell County but no regulated facilities in the Big Creek drainage portion of the county **(Figure 25).** Individual HUC-12s are identified in **Appendix C**.

Table 4. 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**

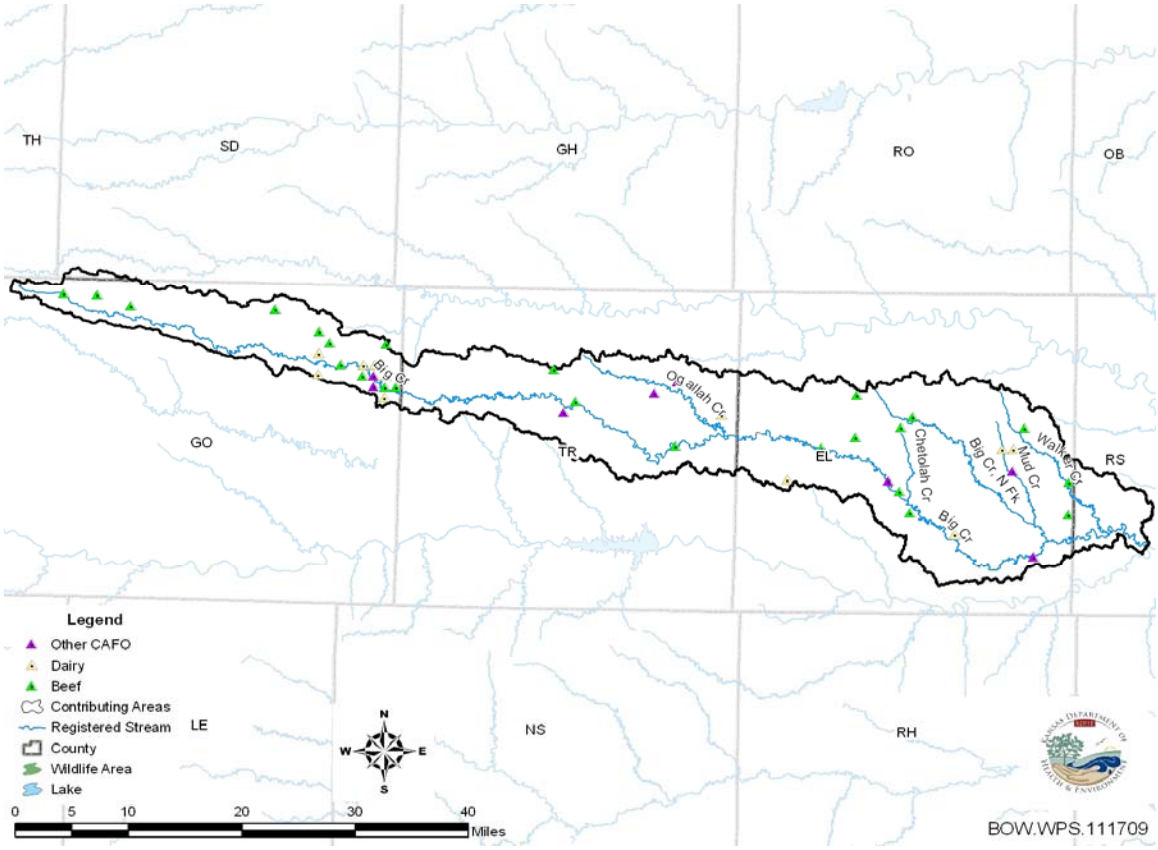

Figure 25. Animal Feeding Operations in Big Creek Watershed

Population Density: **Table 5** 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. Developed land and roads comprise 6.7% of the Big Creek drainage across the four counties.

Table 5. **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 sediment loadings within the watershed and would not contribute to the suspended solids impairment along lower reaches of Big Creek.

Background Levels: Sediment and suspended solids are part of the landscape, in the soil profile as well as within the stream channels. There will always be extreme precipitation events that generate erosion from the land surface and transport solids into the stream channel as part of the aggregation/degradation process of fluvial geomorphology.

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

This TMDL will be established to meet the endpoint of reducing existing median concentrations of total suspended solids on the lower reaches of Big Creek to the median TSS seen at the upstream station (43 mg/l). The stream segments in the sub basin are displayed in **Appendix B**. Initially, TSS values should be reduced on lower Big Creek to a level below 50 mg/l, which would be the first indication of favorable conditions for supporting aquatic life on Big Creek. The endpoints will be assessed by subsequent stream reconnaissance for biological status in the creek.

Point Sources: Even though the TSS impairment on Big Creek is not attributable to the wasteloads associated with the wastewater treatment facilities for the cities of Wakeeney, Gorham, Ellis or Hays, Wasteload Allocations (WLA) will be established for those facilities, using their existing permit limits and design flows. Even though the suspended solids loads from Gorham, Wakeeney or Ellis are not expected to traverse downstream and arrive at the critical reaches of Big Creek, this TMDL will assign a wasteload allocation to those facilities to manage any local effects below their respective outfalls (**Table 6**).

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.

Table 6. Total Suspended Solids Wasteload Allocations for Big Creek Dischargers

Facility	Design Q	Expected [TSS]	TSS WLA
Hays	2.8 MGD (4.33 cfs)	30 mg/l	702 #/d
Ellis	0.3 MGD (0.46 cfs)	30 mg/l	75 #/d
Wakeeney	0.25 MGD (0.39 cfs)	80 mg/l	168 #/d
Gorham	0.0478 MGD (0.07 cfs)	80 mg/l	30 #/d
Total WW WLA	3.40 MGD (5.25 cfs)	34 mg/l	975 #/d

The Wasteload Allocation for Hays MS4 stormwater is provided by proportioning the remaining load capacity, after accounting for the NPDES WLA, between MS4 and NPS loads (**Table 7**). This was done by assuming load contributions would arise from the two

HUC 12s surrounding Hays. Thus the MS4 WLA was based on the proportion of developed land in HUCs 102600070303 & 04 ~ 11% (6200 acres out of 57,650 acres) during low to normal flow conditions (flows exceeded more than 40% of the time). Under wet conditions (flow exceeded 1 – 40% of the time), load contributions are assumed to arise from western Ellis County as well and the developed land WLA proportion dwindles to 6% (7900 acres (including Ellis) divided by 127,730 acres in HUC 12's 01, 02, 03 & 04). The calculated allocations are provided in **Appendix D**.

Nonpoint Source: The load allocation for non-point sources is the remaining load capacity after Wasteload Allocations for NPDES wastewater and MS4 stormwater have been accounted **(Appendix D).** Non-point sources are assumed to be minimal at times that Big Creek is composed strictly of Hays wastewater. The load allocation grows proportionately as normal conditions occur, comprising 89% of non-wastewater load during normal flow conditions and generally restricted to central and eastern Ellis County. The allocation and contributing areas grows as wet weather ensues. At least 94% of the runoff driven loads are non-point source in nature and emanate throughout Ellis County up to the Trego County line. Sources in Trego and Gove counties are assumed to arrive at Hays only under prolonged wet conditions, exceeded less than 1 % of the time. Under the wettest conditions, it was felt it was infeasible to achieve the long term median with pervasive runoff, therefore, the desired TSS level was set at the median of TSS seen under those conditions at the upstream site SC541.

Defined Margin of Safety: The Margin of Safety provides some hedge against the uncertainty in suspended solids loading into Big Creek. This TMDL uses an implicit margin of safety, relying on conservative assumptions to be assured that future load and wasteload allocations will not cause further excursions from the suspended solids criteria. First, wasteload allocations are set based on current permit limits which do not cause the impairments by TSS seen in the lower reaches of Big Creek, since current wasteload either do not reach the station where the impairment was noted or actual treatment produces TSS levels in wastewater far below permit limits. Second, although the target median is 50 mg/l, the endpoint for this TMDL is 43 mg/l, reflective of the conditions above Hays; this should ensure good conditions on the lower reaches for the biology.

State Water Plan Implementation Priority: Due to the coincidence of high suspended solids in the lower portions of Big Creek below Hays, the presence of fish but no mussels in the lower reaches, whereas there is evidence of mussels in Big Creek above Hays, the need to direct stormwater management in Hays toward pollutant load control on either side of Hays and continued protection of existing storage in Kanopolis Lake from siltation, this TMDL will be **High Priority** for implementation.

Priority HUC12s: Priority HUC12s within the watershed can be identified based on the land use seen among the sub watersheds and within 100 foot buffers along the streams in the watershed. Because the hydrology of the watershed is meager to the west of Hays, and the current median TSS concentration is within the realm of acceptable limits, those sub watersheds will be relegated to future implementation. 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. Additionally, HUC 102600070305 with the highest proportion of cropland in its sub watershed (66%) would be targeted as high priority for non-point source abatement along the lower portions of Big Creek. These three HUC 12s will be the initial priority for implementation. As progress is made on these priority areas, the two upstream HUC 12s (01 & 02) should receive attention to abate non-point source loadings.

5. IMPLEMENTATION

The excess TSS loads on Big Creek are closely associated with areas impacted by urban or agricultural activity. The largest TSS loads typically occur during spring and summer runoff. The TSS loads are smallest in the winter months because of the low streamflow. There is a good potential that best management practices will control TSS loads and improve water quality. Some of the recommended practices are as follows.

Desired Implementation Activities

1. Implement and maintain conservation farming, including conservation tilling, contour farming and no-till farming to reduce runoff and suspended solids loads from Big Creek and its tributaries.
2. Improve riparian conditions along stream systems by installing grass and/or forest buffer strips to trap suspended solids, and reducing livestock activities within riparian areas to reduce stream bank erosion.
3. Install pasture management practice, including proper stock density, to reduce soil erosion and storm runoff.
4. Minimize road and bridge construction impacts on streams.
5. Maintain permit limits for TSS in federal and state permits, inspect permitted facilities and monitor wastewater discharges to assure compliance.
6. Incorporate this TMDL into the Big Creek – Middle Smoky Hill River WRAPS program.
7. Establish urban and construction stormwater management practices to abate sediment loading in Hays.

Implementation Programs Guidance

NPDES - Municipal Program – KDHE

a. Monitor effluent from wastewater treatment plants to determine their total suspended solids contributions.
b. Ensure proper monitoring, permitting, and operations of municipal wastewater systems to reduce total suspended solids discharges.
c. Incorporate sediment control in Hays MS4 NPDES stormwater permit.

Nonpoint Source Pollution Technical Assistance - KDHE

a. Support Section 319 demonstration projects for reduction from livestock operations,

b. Provide technical assistance on practices geared to establishment of vegetative buffer strips,

c. Provide technical assistance on sediment and pasture management in vicinity of streams,

d. Support Watershed Restoration and Protection Strategy (WRAPS) implementation efforts for the Big Creek – Middle Smoky Hill River Watershed.

e. Incorporate the provisions of this TMDL into any Big Creek – Middle Smoky Hill River WRAPS documents, especially the 9-element watershed plan.

Water Resource Cost Share Nonpoint Source Pollution Control Program - SCC

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

Riparian Protection Program - SCC

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

Buffer Initiative Program - SCC

a. Install grass buffer strips near streams,

b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance - Kansas State University

a. Educate agricultural producers on riparian and sediment management techniques,

b. Provide technical assistance on sediment management,

c. Continue Section 319 demonstration projects on sediment management,

d. Support outreach efforts by Big Creek – Middle Smoky Hill River WRAPS.

Time Frame for Implementation: Pollutant reduction practices should be installed within the top priority subwatersheds at and below Hays before 2014, with follow-up implementation, including other subwatersheds over 2015 – 2019.

Targeted Participants: Primary participants for implementation will likely be the City of Hays stormwater management program and agricultural producers operating along the lower reaches of Big Creek and tributaries within the drainage of priority subwatersheds. Implementation activities should target those areas with greatest potential to impact the river's TSS levels:

1. Total rowcrop acreage and gully locations
2. Conservation compliance on highly erodible areas

3. Acreage of poor rangeland or overstocked pasture
4. Livestock use of riparian areas and condition of riparian areas
5. Unvegetated or graded roadside ditches
6. Construction projects without erosion control techniques
7. Uncontrolled entry points for urban runoff
8. Impervious area generating increased runoff

Some inventory of local needs should be conducted in 2010 to identify such activities. Such an inventory would be done by local program managers with appropriate assistance by commodity representatives and state program staff in order to direct state assistance programs to the principal activities influencing the quality of the stream and its tributaries in the watershed during the implementation period of this TMDL.

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: 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, suspended solids data from site SC540 should show indications of declining concentrations relative to the pre-2010 data, particularly at normal conditions. By this date, the City of Hays should be well underway in implementing the appropriate landscape treatment to decrease urban runoff loadings.

Delivery Agents: The primary deliver agents for program participation will be KDHE, the Big Creek – Middle Smoky Hill WRAPS, 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 sediment and nutrients to Kanopolis Lake.

Effectiveness: Implementation of erosion control and land treatment practices has long been shown to reduce sediment and suspended solids loadings to surface waters.

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. Based on the sampling data, the priority status of the 303(d) listing will be evaluated in 2014. If the impairment status of Big Creek changes, the desired endpoints under this TMDL may be refined to reflect necessary reductions in total suspended solids. The stream will be evaluated for

possible delisting in 2020. Subsequent stream evaluation will be done at that time to assure that the conditions described by the narrative suspended solids criteria are attained.

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 2010-2019.

Revised August 25, 2010

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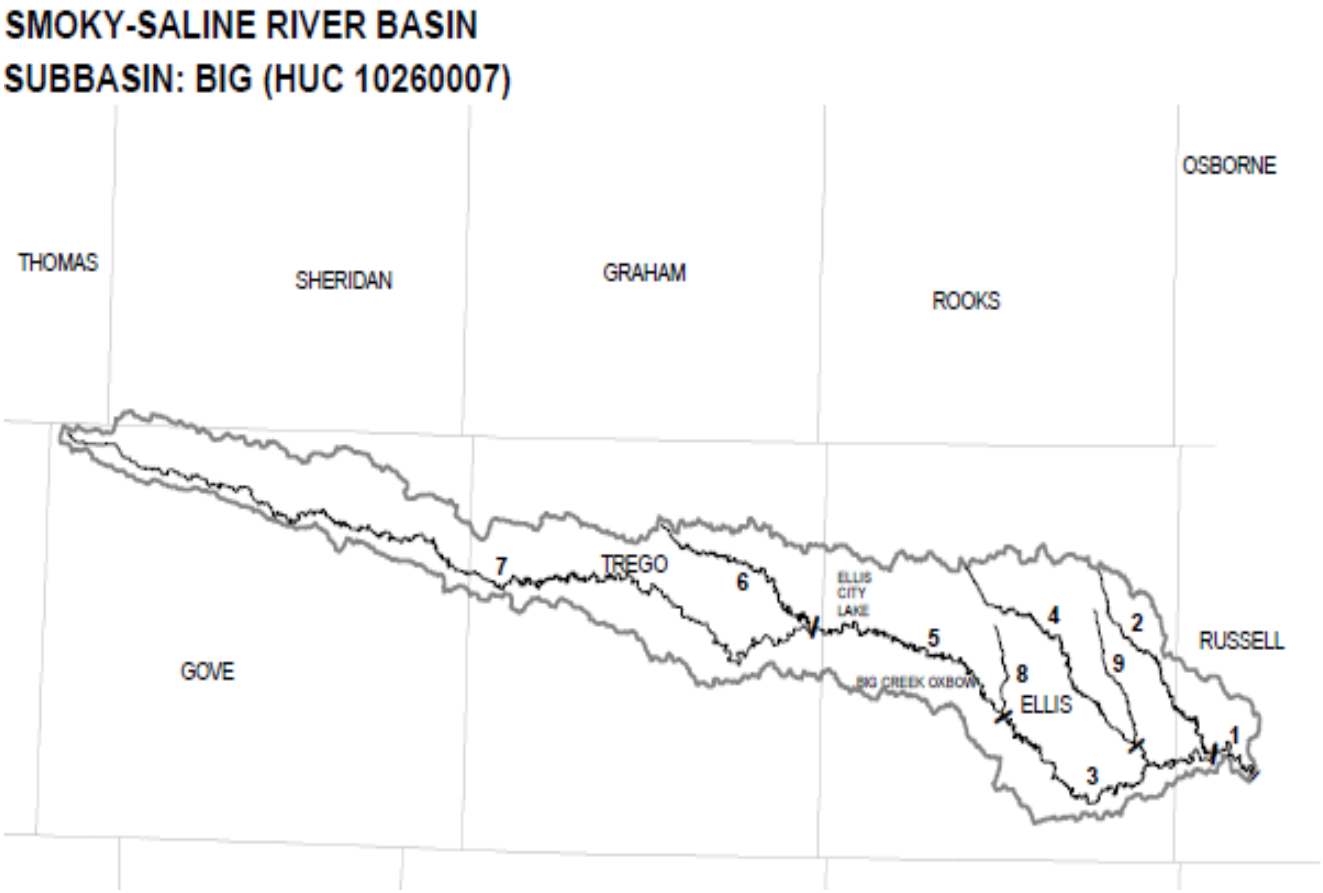
Appendix A: Registered and Permitted Animal Feeding Operations in 10260007

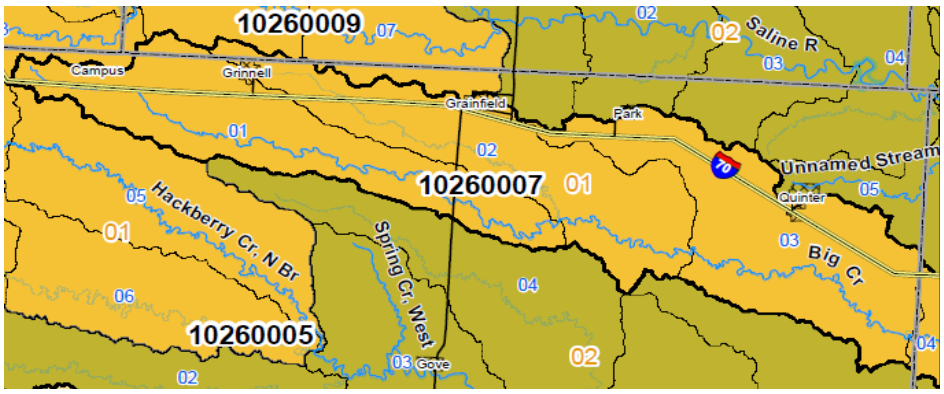
County	HUC 10/12	KS Permit #	Permit Type	Fed AU	Type
Gove	***0101***	***A-SHGO-BO02***	***Permit***	***350***	***Beef***
		A-SHGO-BO18	Permit	980	Beef
		A-SHGO-BO15	Permit	590	Beef
	0103	***A-SHGO-BA02***	***Certificate***	***540***	***Beef***
		A-SHGO-BA03	Certificate	400	Beef
		A-SHGO-BA12	Certificate	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**

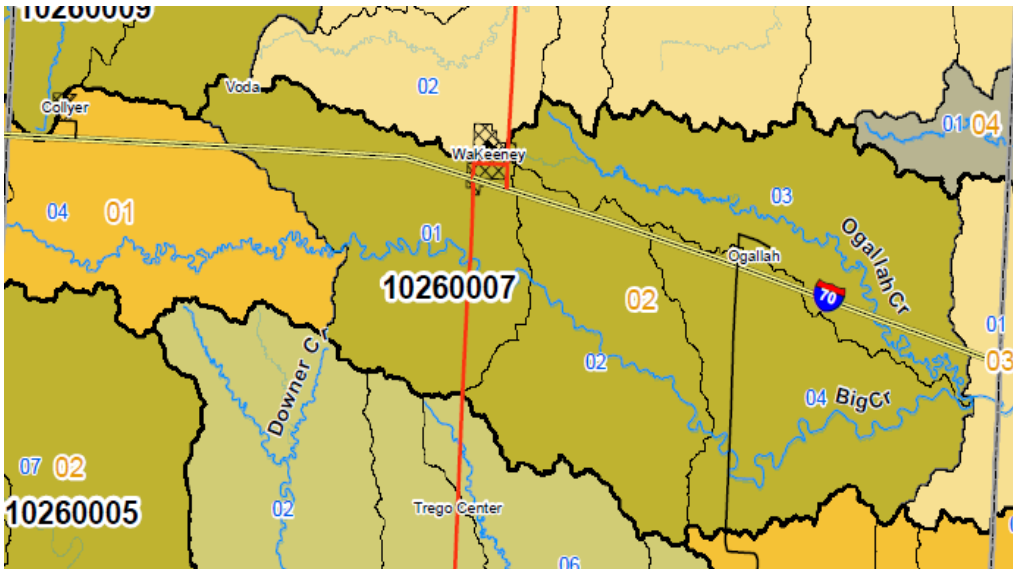
Appendix B. Classified Streams of the Big Creek Sub basin.



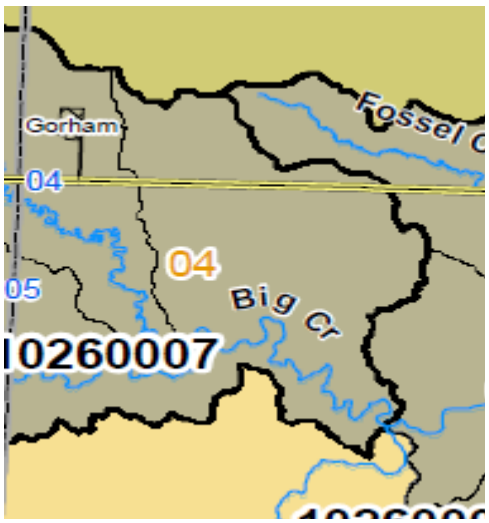
Appendix C: HUC 12 Subwatersheds of the Big Creek Watershed by County



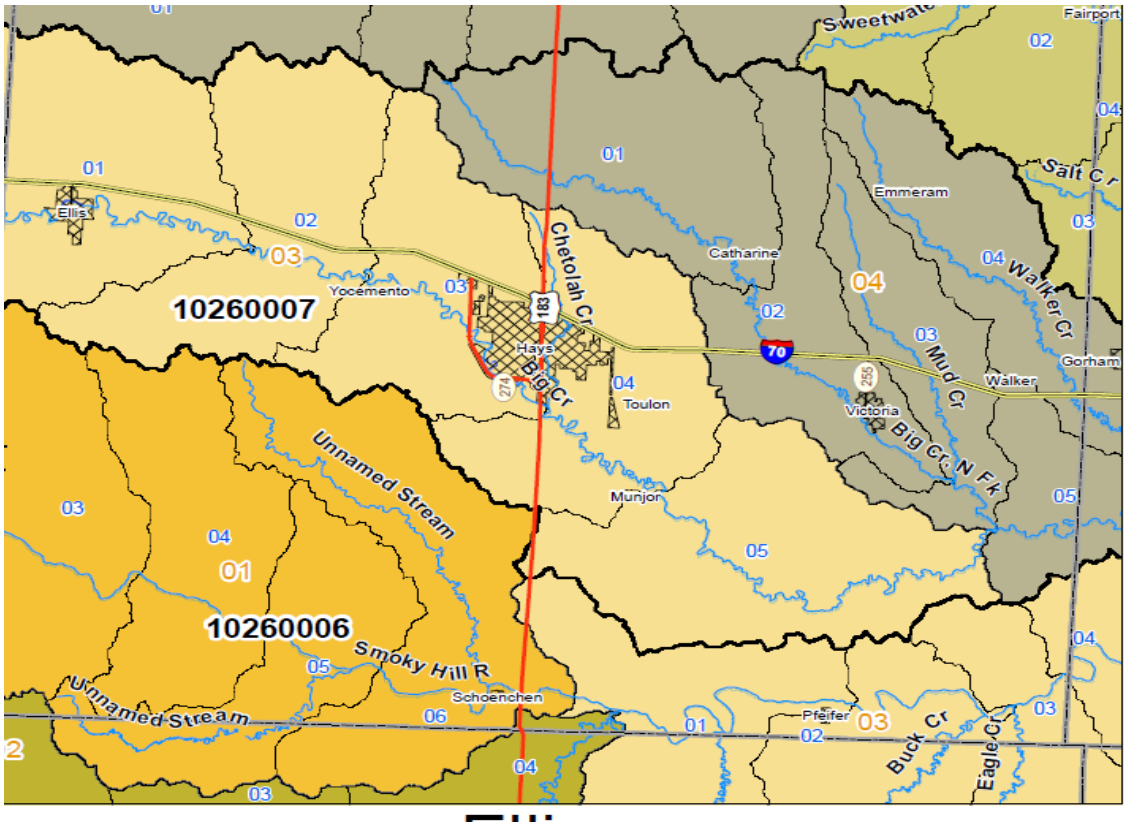
Gove County



Trego County



Russell County



Ellis County

Appendix D. TSS Load Capacities, Wasteload Allocations for NPDES Wastewater and MS4 Stormwater and Load Allocations for NPS (Criterion in mg/l, Flows in cfs, Loads in pounds/day)

Segment 5, monitored by SC541, potentially influenced by Wakeeney & Ellis
Big Creek from Trego County Line to Chetolah Creek; Criterion = 43 mg/l

Pct	Flow	Wak / Ellis Design Q	Seg 5 LC	Seg 5 WLA	Seg 5 LA	Downstream Flow
90.00	1.00	0.85	429.57	243.00	186.57	1.85
75.00	2.70	0.85	824.31	243.00	581.31	3.55
50.00	11.00	0.85	2751.57	243.00	2508.57	11.85
25.00	23.00	0.85	5537.97	243.00	5294.97	23.85
10.00	37.00	0.85	8788.77	243.00	8545.77	37.85

Segment 3, monitored by SC540, influenced by Hays
Big Creek from Chetolah Creek to NF Big Creek; Criterion = 43 mg/l

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	1065.80	701.50	0.00	364.30	6.44
75.00	3.55	4.33	0.70	1168.43	701.50	51.36	415.57	8.58
50.00	11.85	4.33	2.86	1669.52	701.50	67.76	900.26	19.04
25.00	23.85	4.33	5.98	2393.98	701.50	101.55	1590.93	34.16
10.00	37.85	4.33	9.62	3239.19	701.50	152.26	2385.43	51.80

Segment 1, monitored by new SC752, potentially influenced by Gorham
Big Creek from NF Big Creek to Mouth; Criterion = 43 mg/l

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	16.25	16.25	0.00	6.51
75.00	8.58	0.07	1.43	348.03	30.20	317.83	10.08
50.00	19.04	0.07	5.82	1367.94	30.20	1337.74	24.93
25.00	34.16	0.07	12.17	2842.50	30.20	2812.30	46.40
10.00	51.80	0.07	23.31	5428.84	30.20	5398.64	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	1511.62	960.75	0.00	550.87
75.00	10.08	5.25	4.83	2340.77	974.70	51.36	1314.71
50.00	24.93	5.25	19.68	5789.02	974.70	67.76	4746.56
25.00	46.40	5.25	41.15	10774.45	974.70	101.55	9698.20
10.00	75.18	5.25	69.93	17456.80	974.70	152.26	16329.83