NEOSHO BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody / Assessment Unit: Short Creek and Shoal Creek in the Spring River Watershed
Water Quality Impairment: Total Phosphorus

1.0 INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Spring

Counties: Cherokee

HUC8: 11070207 **HUC10(12):** 08(06) & 09(04)

Ecoregion: Ozark Highlands, Springfield Plateau (39a)

Drainage Area: Shoal Creek = approximately 10.1 square miles in Kansas
Short Creek = approximately 5.94 square miles in Kansas

Water Quality Limited Segments Covered Under this TMDL:

Station	*Main Stem Segment*	*Tributary*
Station SC570	Short Creek (881)	
Station SC212	Shoal Creek (2)	Unnamed Stream (886)

2008, 2010, 2012 & 2014 303(d) Listings: Kansas Stream segments monitored by stations SC212 on Short Creek and SC570 on Shoal Creek, are cited as impaired by Total Phosphorus (TP) for the Neosho Basin.

Impaired Use: Special Aquatic Life, Expected Aquatic Life, Contact Recreation and Domestic Water Supply.

Water Quality Criteria:
Nutrients – Narratives: The introduction of plant nutrient into surface waters designated for domestic water supply use shall be controlled to prevent interference with the production of drinking water (K.A.R. 28-16-28e(c)(3)(D)).

The introduction of plant nutrients into streams, lakes, or wetlands from artificial sources shall be controlled to prevent the accelerated succession or replacement of aquatic biota or the production of undesirable quantities or kinds of aquatic life (K.A.R. 28-16-28e(c)(2)(A)).

The introduction of plant nutrients into surface waters designated for primary or secondary contact recreational use shall be controlled to prevent the development of objectionable concentrations of algae or algal by-products or nuisance growths of submersed, floating, or emergent aquatic vegetation (K.A.R. 28-26-28e(c)(7)(A)).

Designated Uses: Special Aquatic Life Use (segments 2 & 886); Expected Aquatic Life (881,); Primary Contact Recreation B (segment 2); Secondary Contact Recreation b (segments 881 & 886); Domestic Water Supply (segments 2, 881 & 886); Food Procurement (segments 2, 881, and 886); Groundwater Recharge (segment 2, 881 & 886); Industrial Water Supply Use (segments 2, 881 & 886); Irrigation Use (segments 2, 881 & 886); Livestock Watering Use (segments 2, 881 & 886). Empire Lake is designated for Expected Aquatic Life Use; Primary Contact Recreation B; Domestic Water Supply; Food Procurement; Groundwater Recharge; Industrial Water Supply; Irrigation Use; Livestock Watering Use;

2. CURRENT WATER QUALITY CONDITIONS AND DESIRED ENDPOINT

Level of Support for Designated Uses under 2014-303(d): Phosphorus levels on Shoal Creek and Short Creek are consistently high. Excessive nutrients are not being controlled and are thus impairing aquatic life, domestic water supply, and contact recreation.

Stream Monitoring Sites and Period of Record: Station SC570: KDHE rotational Station SC570 on Short Creek is sampled bimonthly or quarterly during the sampling years of: 1990, 1994, 1998, 2002, 2006, 2010, and 2014.

Station SC212: KDHE permanent monitoring station SC212 on Shoal Creek near Galena is sampled bimonthly or quarterly during the period of record from 1990-2014.

Station SC213: KDHE permanent monitoring station SC213 on Spring R near Baxter Springs is sampled bimonthly or quarterly during the period of record from 1990-2014.

Station SC210: KDHE rotational station SC210 on Center Creek near Smithfield, MO is sampled bimonthly or quarterly during the sampling years of: 1990, 1994, 1998, 2002, 2006, 2010, and 2014.

Station SC211: KDHE rotational station SC211 on Turkey Cr near Joplin, MO is sampled bimonthly or quarterly during the sampling years of: 1990, 1994, 1998, 2002, 2006, 2010, and 2014.

Station 569: KDHE rotational station SC569 on Shawnee Creek near Crestline is sampled bimonthly or quarterly during the sampling years of: 1990, 1994, 1998, 2002, 2006, 2010, and 2014.

Station SC746: KDHE rotational station SC746 on Willow Creek near Baxter Springs is sampled bimonthly or quarterly during the sampling years of: 2006, 2010, and 2014.

Station SC747: KDHE rotational station SC747 on Brush Cr near Riverton is sampled bimonthly or quarterly during the sampling years of: 2006, 2010, and 2014.

Figure 1a. Base Map of Kansas TMDL watershed and surrounding Spring River watershed.

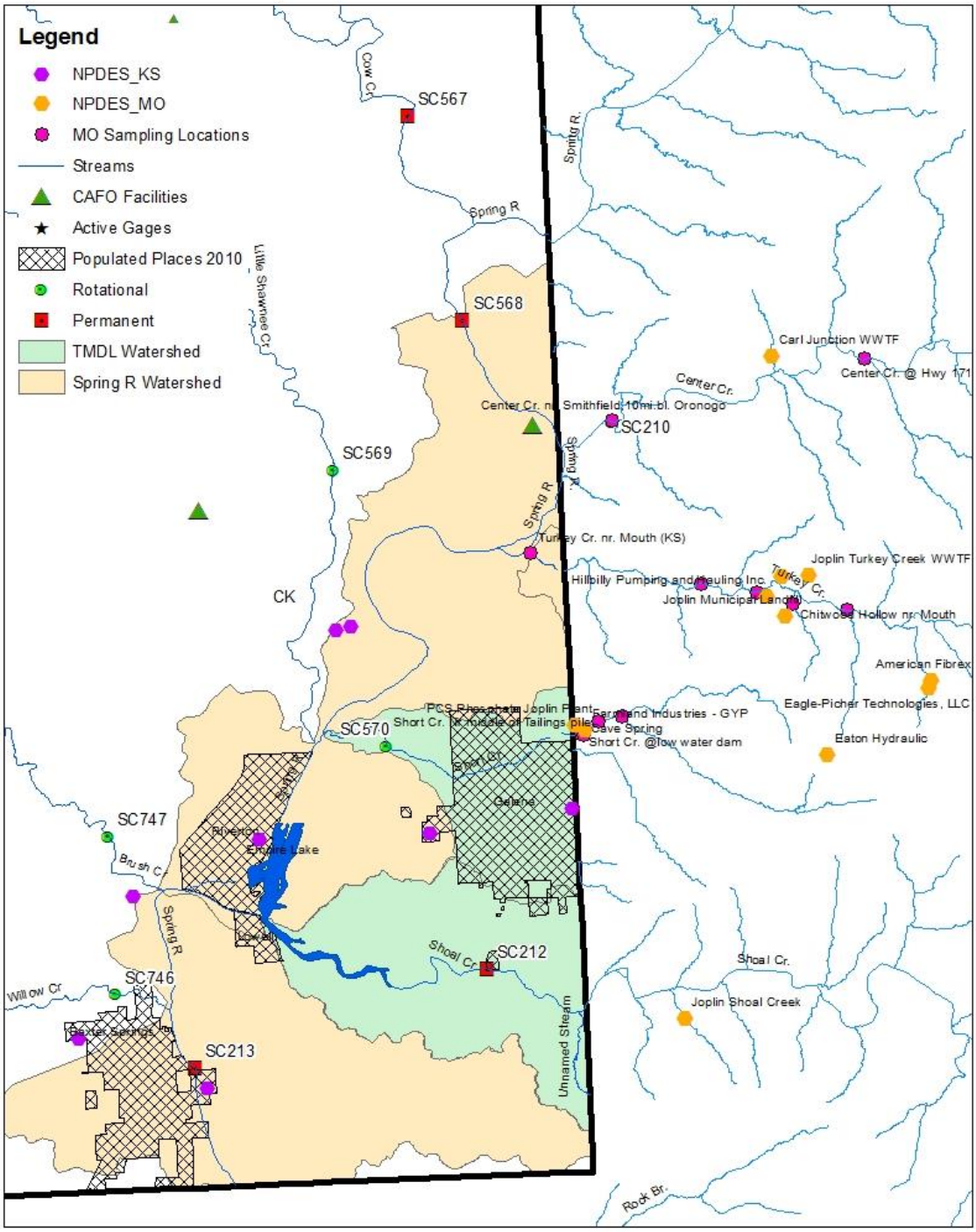
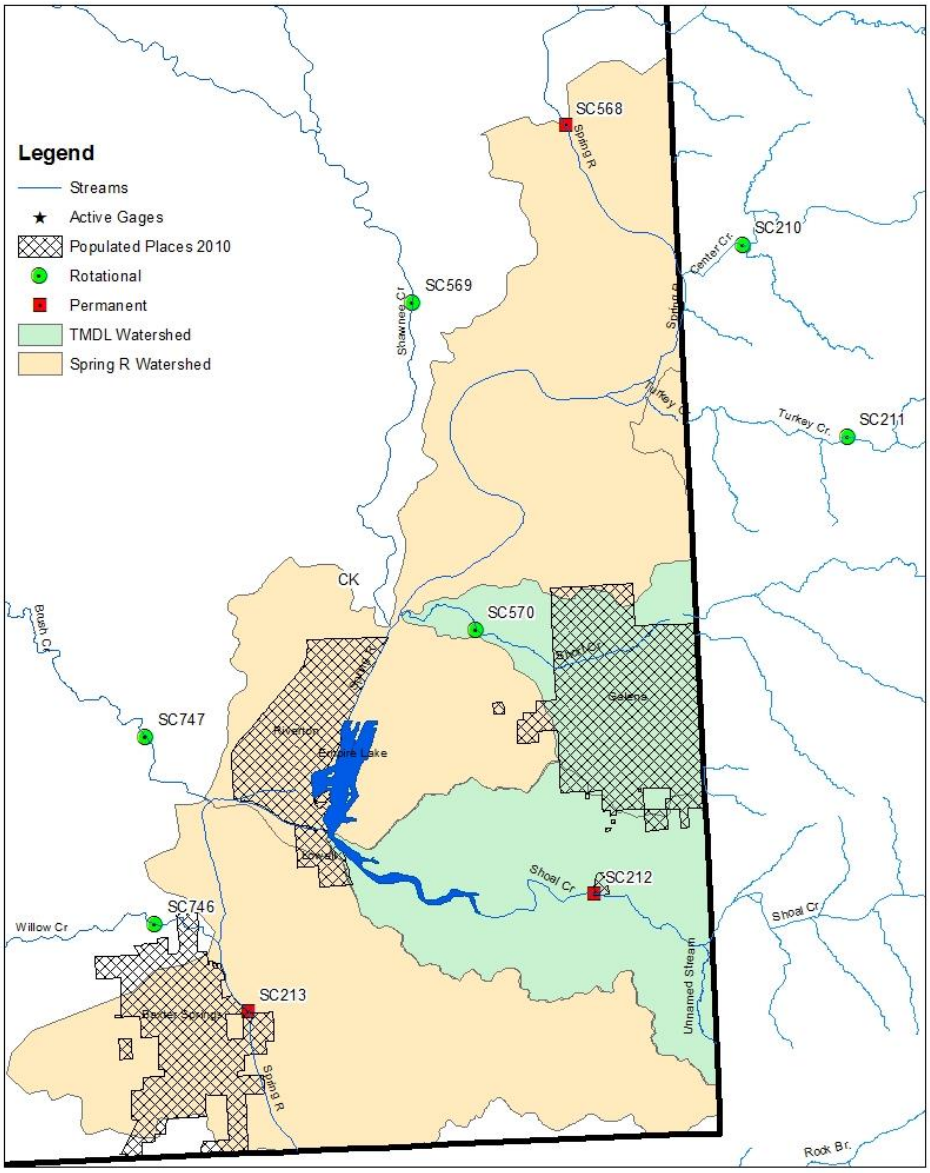


Figure 1b. Watershed Basemap detailing KDHE sampling station locations.



Hydrology: Table 1 indicates the estimated flows at selected exceedance percentages as provided in the USGS Scientific Investigations Report 2004-5033 (Perry, 2004 revision 1.1). Long term flow conditions were estimated by utilizing a watershed ratio calculation with the USGS gage 0718800 on Spring River and are displayed in Table 2. Empire Lake is downstream of the Short Creek and is fed directly by Shoal Creek as seen in Figures 1a and 1b. Empire Lake is where Shoal Creek and Spring River meet, water discharges over the Empire Dam Falls. Empire Lake was created to provide source water storage and to serve as a cooling lake for the Riverton Power station.

Table 1. Estimated flow values from USGS Scientific Investigations Report 2004-5033 (Perry, 2004 revision 1.1)

Stream	Drainage Area (Sq. Miles)	Mean Flow (cfs)	Percent Flow Exceedance (cfs)				
			90%	75%	50%	25%	10%
Spring R at Baxter Springs	2516	2060	195	347	785	1810	4080
Willow Creek	27	23.7	0.01	0.45	3.01	10.5	29.5
Brush Creek	53.5	51.4	0.34	2.32	9.13	28.7	75.5
Shoal Creek	578	454	89.1	133	246	473	937
Shawnee Creek	66.6	56.6	0.17	1.86	8.01	27.4	77.3
Short Creek	13.5	17.2	0.16	1.26	4.32	11.6	26.5
Turkey Creek	75	74.5	0.49	3.04	12.7	41.6	112
Center Creek*	260	230	25	45	99	220	450

*Value not from USGS report, this value was estimated based off of the Spring River Metals TMDL (KDHE, 2005).

Table 2. Long Term Flow Conditions as calculated for USGS gage 0718800 on the Spring River.

Stream	Mean Flow (cfs)	Pecent of Flow Exceedance (cfs)				
		90%	75%	50%	25%	10%
Shoal Creek	572.5	54.9	96.5	216.6	505.4	1180.8
Short Creek	13.4	1.28	2.25	5.06	11.8	27.6
Spring R near Quapaw, Ok	2492	239	420	943	2200	5140

Flow duration curves derived from the watershed ratio calculation covering the period of record from 1990-2014 are illustrated for Shoal Creek at SC212, Short Creek at SC570, and Spring River at SC213 in Figure 2. Annual flow averages for Shoal Creek are detailed in Figure 3. Extremely dry years within the watershed were observed in 1991, 1996, 1997, 2000, 2003, and 2006. Based on annual flow averages, the wetter years include 1990, 1992, 1994, 1995, 1999, 2007, 2008, 2009 and 2013. Monthly flow averages and medians are detailed in Figure 4 for Shoal Creek. Higher flows within the watershed are observed in the months of March, April, May, and June whereas the months with the lower median flows consists of August, September, October, and November. The flow conditions for each sampling year correspond to the other stations within the watershed since the long term flow conditions were based on the area ratio for each subwatershed.

Figure 2. Flow Duration Curve for Shoal Creek, Short Creek and the Spring River.

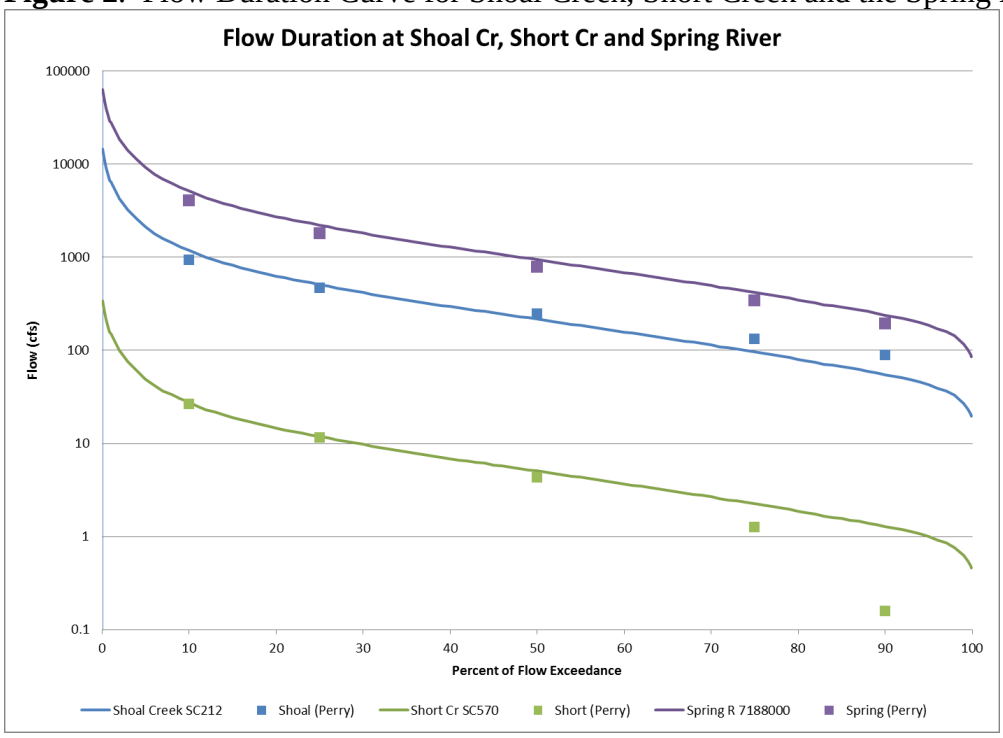


Figure 3. Estimated Annual Flow Averages at SC212 on Shoal Creek.

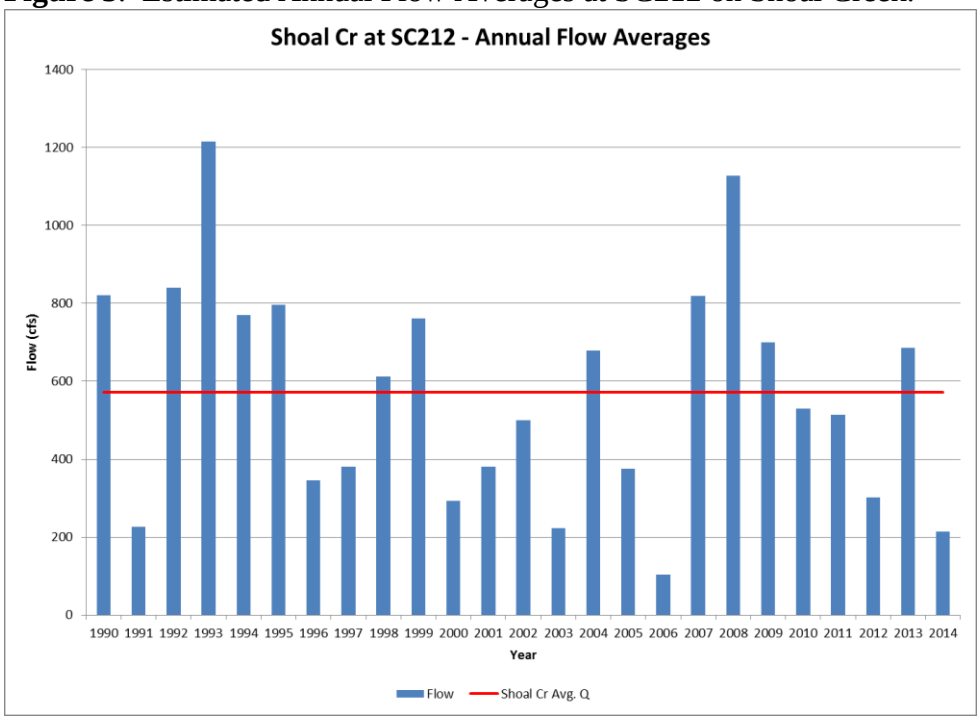
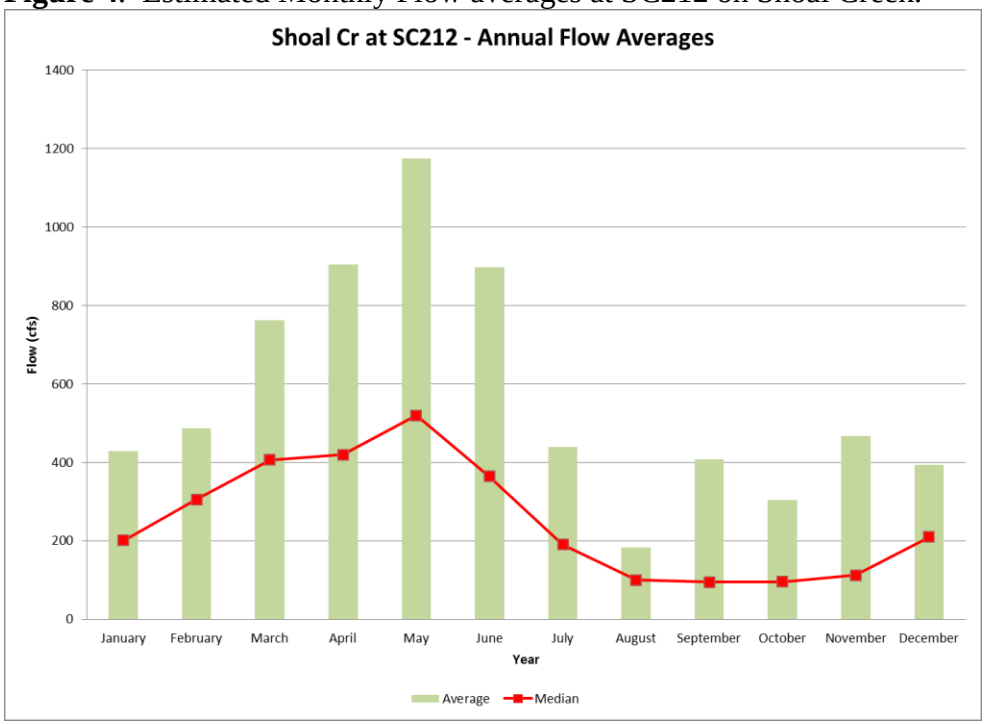


Figure 4. Estimated Monthly Flow averages at SC212 on Shoal Creek.



Assessment Season: Seasonal variability has been accounted for in this TMDL. A three season approach was utilized to include: the Spring season consisting of the months of April, May, and June; the Summer-Fall season consisting of the months of July, August, September, and October, and the Winter season that includes January, February, March, November, and December.

Phosphorus Concentrations on SC212 Shoal Creek: The overall Total Phosphorus (TP) concentration average is 0.275 mg/L at SC212, with a median concentration of 0.247 mg/L. Seasonal TP averages range from a low of 0.251 mg/L in the Spring season to a high of 0.308 mg/L in the Summer-Fall season. Seasonal median concentrations range from a low of 0.214 mg/L in the Winter, to 0.240 mg/L in the Spring, to a high of 0.291 mg/L in the Summer-Fall. Seasonal TP concentrations are further detailed in Figure 5.

Phosphorus concentration averages based on the three defined flow conditions are the highest during the low (75-99% flow exceedance) and normal (25-74% flow exceedance) flow conditions with respective averages of 0.399 mg/L and 0.228 mg/L in Shoal Creek. The TP average is the lowest during the high flow condition (0-24% flow exceedance) with a concentration of 0.218 mg/L. TP concentrations based on flow condition are detailed in Figure 6.

Seasonal TP concentrations based on the flow conditions are further detailed in Table 3 and Figure 7. The highest average TP concentrations are observed during the low flow condition during the spring season and the lowest average TP concentrations are observed during the winter high flow condition. The higher TP concentrations during the low flow condition are indicative of wastewater loading, which in this case is primarily a result of TP loading from the larger facilities in Missouri, including the City of Joplin's wastewater treatment plant, Monett WWTF, and Neosho-Shoal Creek WWTF.

Figure 5. Seasonal TP Concentrations at SC212.

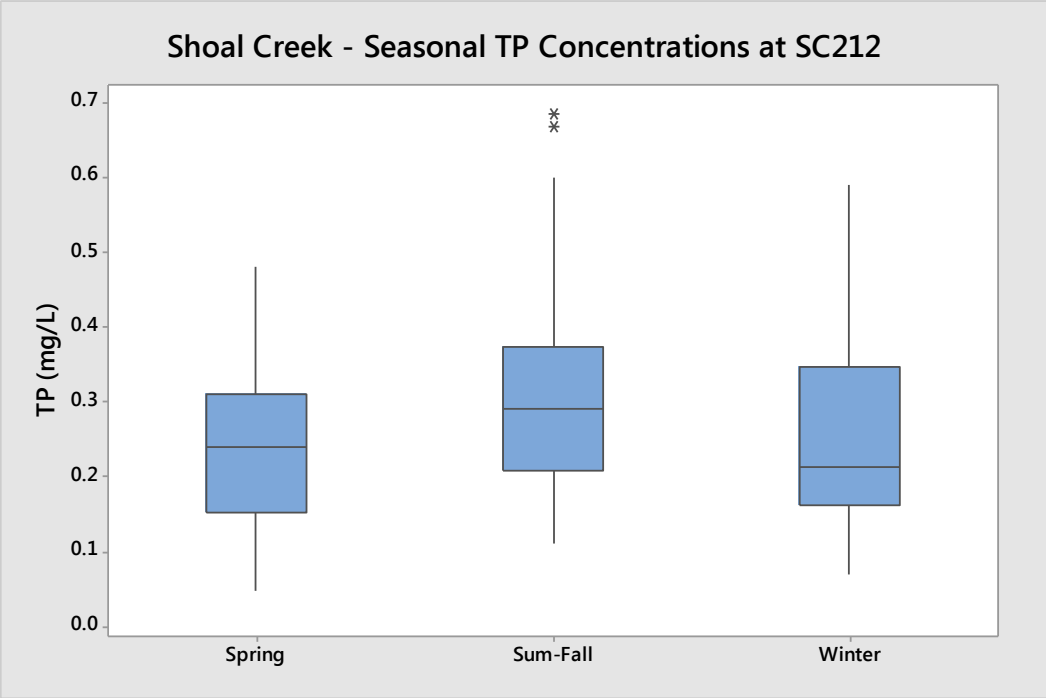


Figure 6. TP Concentrations relative to flow condition.

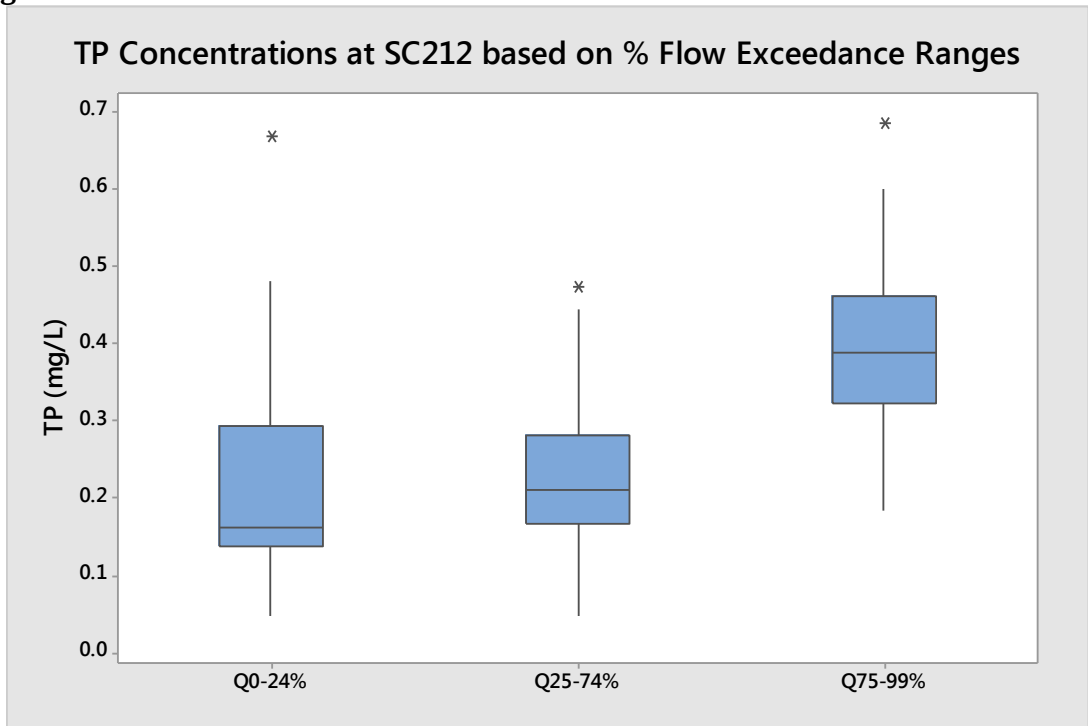


Figure 7. Seasonal average and median TP concentrations based on flow conditions.

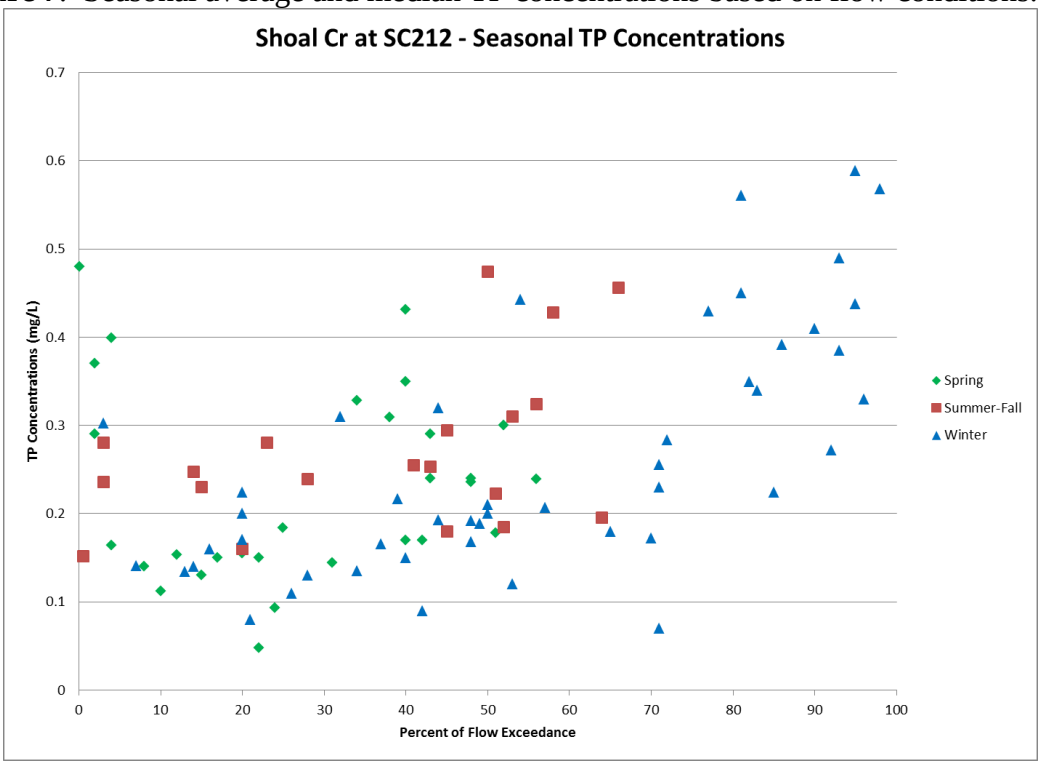


Table 3. Seasonal average and median TP concentrations based on flow conditions on Shoal Creek at SC212.

Season / Flow Condition	TP (mg/L) Low Q (75-99% flow exceedance)	TP (mg/L) Normal Q (25-74% flow exceedance)	TP (mg/L) High Q (0-24% flow exceedance)	TP (mg/L) Average	TP Season Median (mg/L)
Spring	0.446	0.266	0.202	0.251	0.240
Summer-Fall	0.383	0.229	0.307	0.308	0.291
Winter	0.415	0.198	0.173	0.261	0.214
Flow Condition Average (mg/L)	0.399	0.228	0.218	0.275	
Flow Condition Median (mg/L)	0.387	0.22	0.162		0.247

Phosphorus Concentrations at SC570 on Short Creek: The overall Total Phosphorus (TP) concentration average is 0.485 mg/L at SC570, with a median concentration of 0.322 mg/L. Seasonal TP averages range from a low of 0.401 mg/L in the Spring season to a high of 0.648 mg/L in the Winter season. Seasonal median concentrations range from a low of 0.271 mg/L in the Summer-Fall, to 0.322 mg/L in the Spring, to a high of 0.369 mg/L in the Winter. Seasonal TP concentrations are further detailed in Figure 8.

Phosphorus concentration averages based on the three defined flow conditions are the highest during the normal (25-74% flow exceedance) and high (0-24% flow exceedance) flow conditions with respective averages of 0.637 mg/L and 0.557 mg/L in Short Creek. The TP average is the lowest during the low flow condition (75-99% flow exceedance) with a concentration of 0.175 mg/L. TP concentrations based on flow condition are detailed in Figure 9.

Seasonal TP concentrations based on the flow conditions are further detailed in Table 4 and Figure 10. The highest average TP concentrations are observed during the normal flow condition during the winter season and the lowest average TP concentrations are observed during the winter low flow condition. In Short Creek, TP concentrations are generally lower during the low flow condition and higher during the normal and high flow condition as seen in Figures 9 and 10.

Figure 8. Seasonal TP Concentrations at SC570.

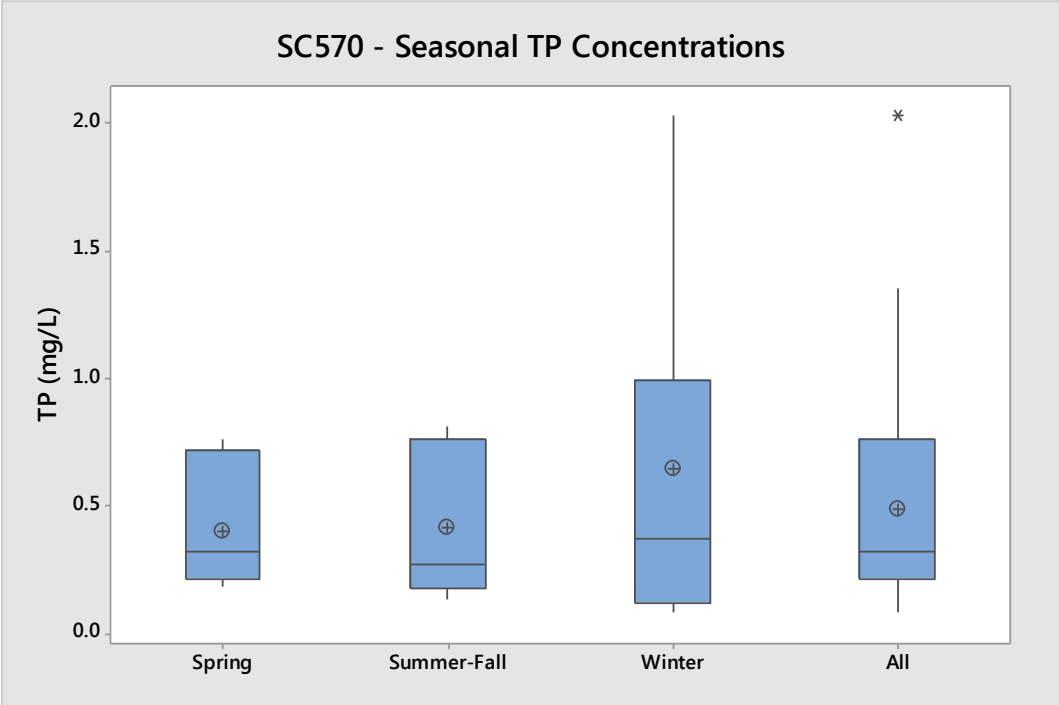


Figure 9. TP Concentrations relative to flow conditions.

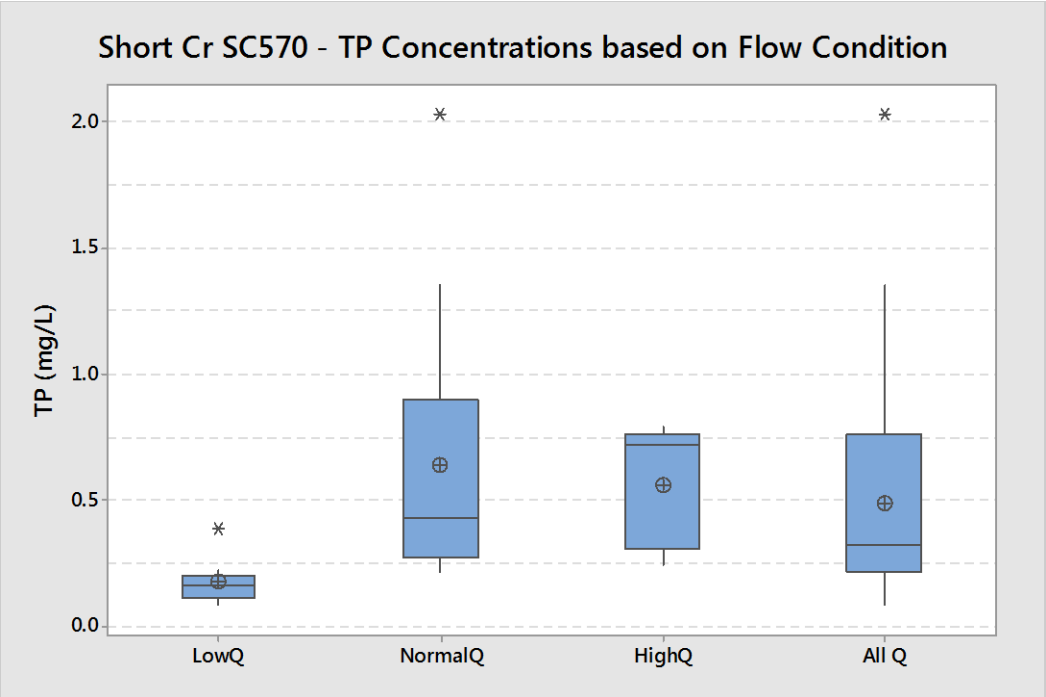


Figure 10. Seasonal TP Concentrations on Cow Creek at SC570 relative to the percent of flow exceedance.

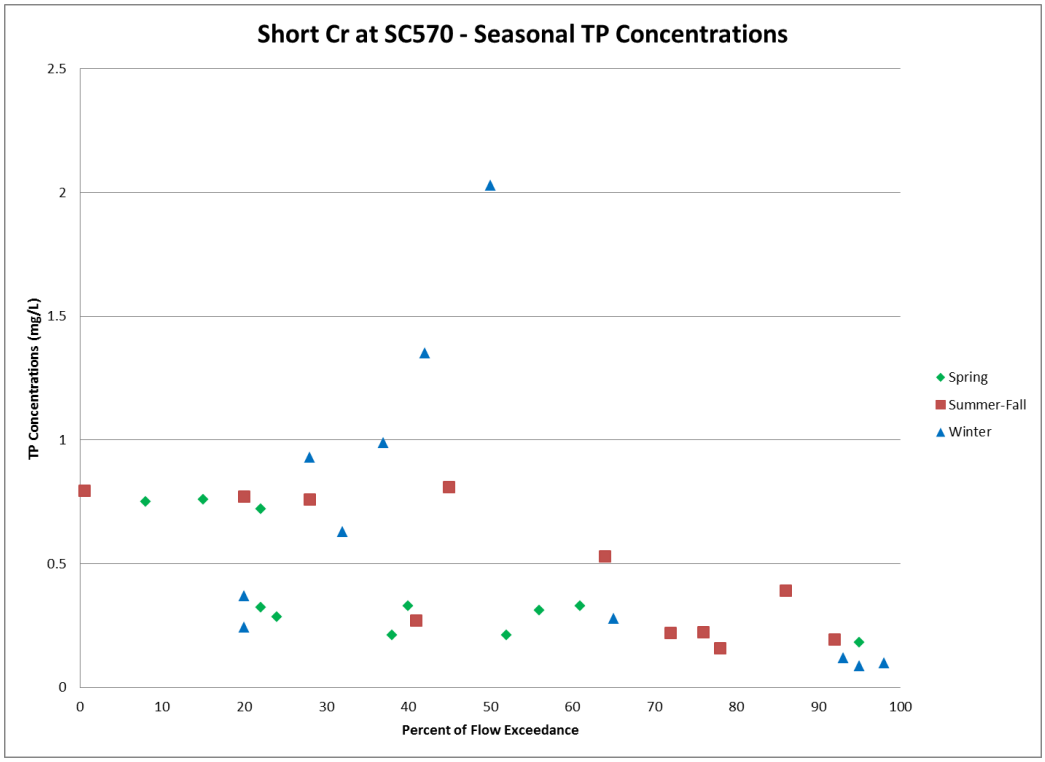


Table 4. Seasonal average and median TP concentrations based on flow conditions on Short Cr at SC570.

Season / Flow Condition	TP (mg/L) Low Q (75-99% flow exceedance)	TP (mg/L) Normal Q (25-74% flow exceedance)	TP (mg/L) High Q (0-24% flow exceedance)	TP (mg/L) Average	TP Season Median (mg/L)
Spring	0.182	0.279	0.638	0.401	0.322
Summer-Fall	0.211	0.518	0.782	0.417	0.271
Winter	0.101	1.035	0.307	0.648	0.369
Flow Condition Average (mg/L)	0.175	0.637	0.557	0.485	
Flow Condition Median (mg/L)	0.164	0.430	0.720		0.322

Phosphorus Concentrations at SC213 on the Spring River near Baxter Springs: The overall TP concentration average at SC213 on the Spring River near Baxter Springs is 0.199 mg/L, with a median concentration of 0.181 mg/L. There is minimal seasonal variability of the TP concentrations at SC213, where seasonal TP concentrations range

from a low of 0.184 mg/L in the winter season to a high of 0.209 mg/L in the spring season. Seasonal median concentrations range from a low of 0.165 mg/L in the winter, to 0.186 mg/L in the summer-fall, to a high of 0.199 mg/L in the spring. Seasonal TP concentrations are further detailed in Figure 11.

Phosphorus concentration averages at SC213 based on the three defined flow conditions are the highest during the high flow (0-24% flow exceedance) and low flow (75-99% flow exceedance) conditions with respective averages of 0.247 mg/L and 0.224 mg/L. The TP average is the lowest during the normal flow condition (25-74% flow exceedance) with a concentration of 0.160 mg/L. TP concentrations based on flow condition are detailed in Figure 12.

Seasonal TP concentrations based on the flow conditions are further detailed in Table 5 and Figure 13. The highest average TP concentrations are observed during the high flow condition during the summer-fall season and the lowest during the normal flow condition of the winter.

Figure 11. Seasonal TP Concentrations at SC213 on the Spring River.

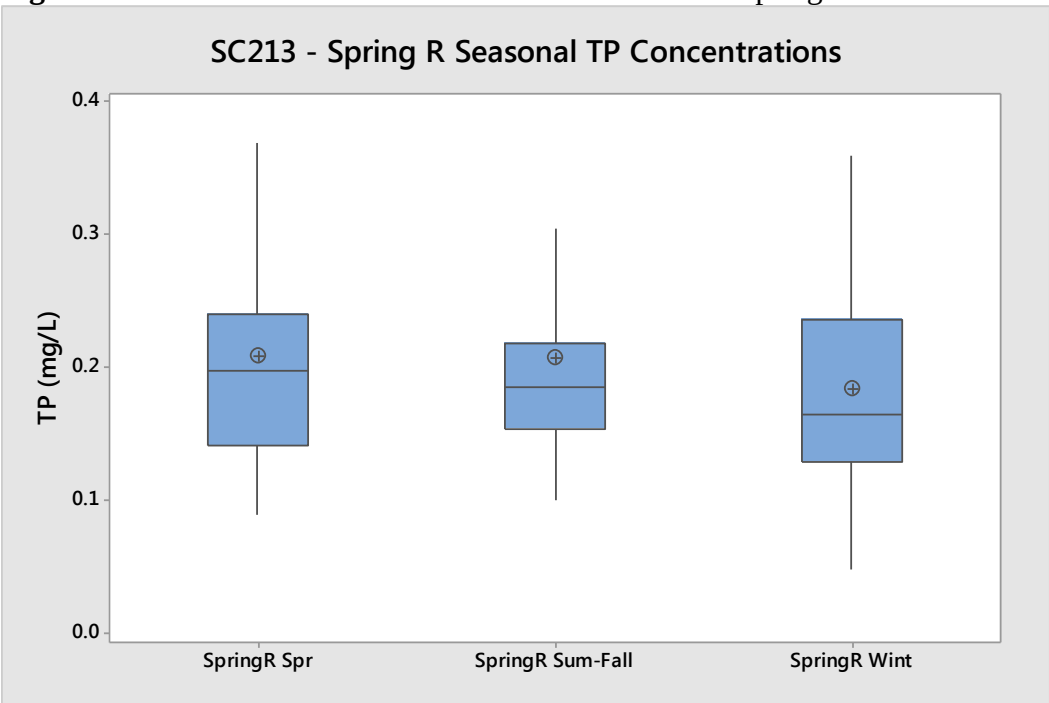


Figure 12. TP Concentrations relative to Flow at SC213 on Spring River.

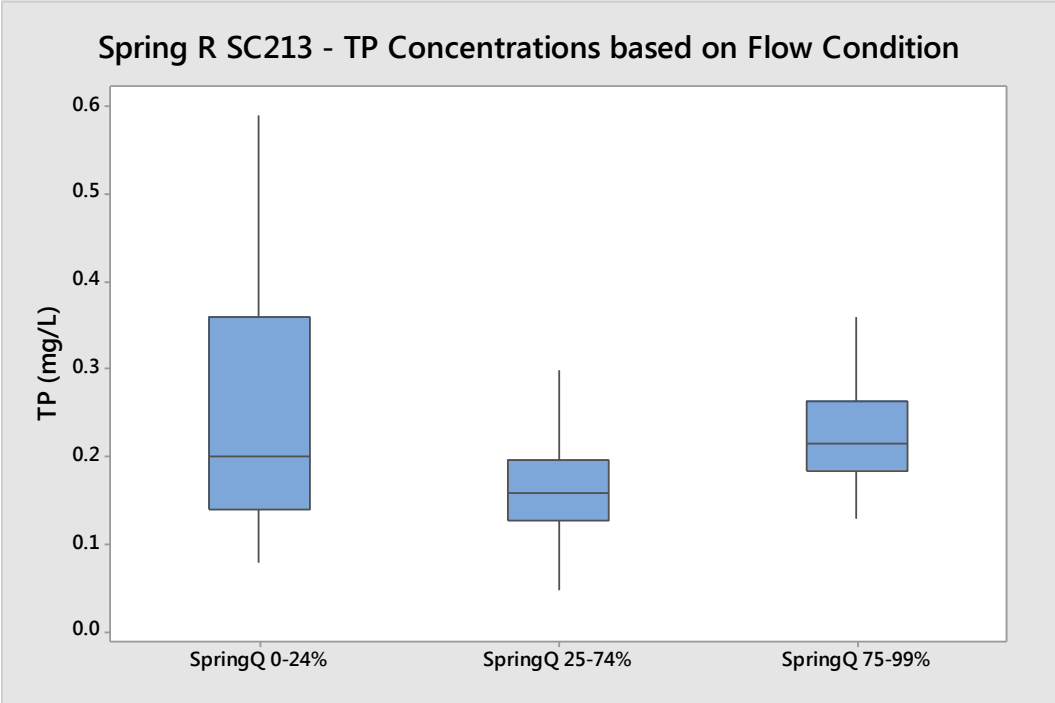


Figure 13. Seasonal TP Concentrations on Spring River at SC213 relative to the percent of flow exceedance.

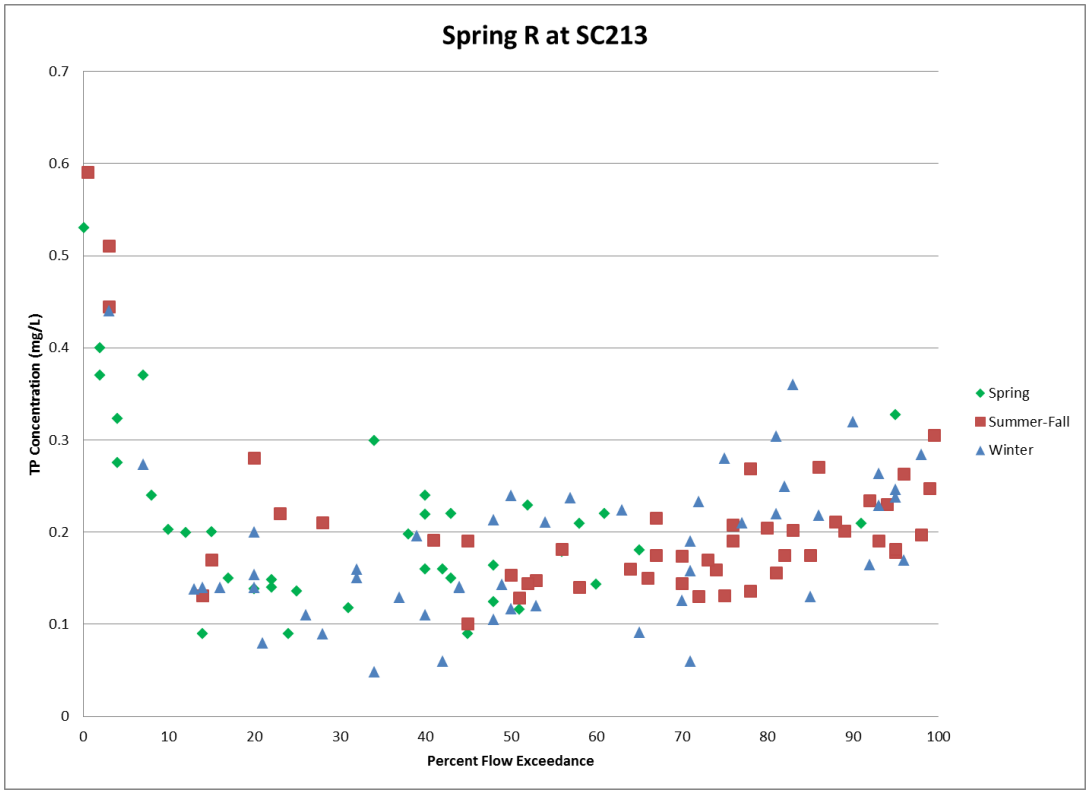


Table 5. Seasonal average and median TP concentrations based on flow conditions at SC213 on Spring River.

Season / Flow Condition	TP (mg/L) Low Q (75-99% flow exceedance)	TP (mg/L) Normal Q (25-74% flow exceedance)	TP (mg/L) High Q (0-24% flow exceedance)	TP (mg/L) Average	TP Season Median (mg/L)
Spring	0.268	0.177	0.242	0.209	0.199
Summer-Fall	0.207	0.161	0.335	0.207	0.186
Winter	0.243	0.146	0.190	0.184	0.165
Flow Condition Average (mg/L)	0.224	0.160	0.247	0.199	
Flow Condition Median (mg/L)	0.215	0.158	0.200		0.181

Watershed TP concentrations: Average and median TP concentrations within the Spring River watershed are further detailed in Table 6. TP concentrations on Center Creek in Missouri at KDHE sampling station SC210 average 0.141 mg/L. The highest TP concentrations in the watershed are observed in Missouri at KDHE sampling station SC211 on Turkey Creek, where the TP concentration average is 0.97 mg/L. The lowest TP concentrations in the watershed are associated with the Spring River tributaries of Willow Creek and Brush Creek, where TP concentrations average 0.079 mg/L and 0.070 mg/L respectively.

Table 6. Average and median TP concentrations for the Spring River watershed sampling stations.

Station	Stream	TP Average (mg/L)	TP Median (mg/L)
SC210	Center Cr	0.141	0.12
SC211	Turkey Cr	0.97	0.77
SC569	Shawnee Cr	0.131	0.113
SC570	Short C	0.485	0.322
SC212	Shoal Cr	0.275	0.247
SC747	Willow Cr	0.079	0.069
SC746	Brush Cr	0.07	0.057
SC213	Spring R	0.199	0.181

Since there is large variability in ambient phosphorus concentrations, median values are appropriate for determining long-term conditions. Listing on the 303(d) lists for TP was determined by median concentrations exceeding 0.201 mg/L for KDHE stream monitoring stations.

Phosphorus is typically linked to sediment or total suspended solids (TSS) because of the propensity of those solids to adsorb phosphorus. As seen in Figure 14, when TSS levels on Shoal Creek are low there is a poor correlation with phosphorus. This notable lack of relation between the two is typically indicative of the dominant influence of wastewater with the elevated phosphorus and low TSS content within Shoal Creek. When runoff causes high TSS concentrations, phosphorus typically rises as well. As seen in Figure 15, TSS levels on Short Creek are very low and poorly correlate with phosphorus concentrations. This notable lack of a relation between the two is not definitive since the TSS concentrations within Short Creek are so low. The TP and TSS relationship at SC213 is observed in Figure 16, which indicates there is linkage between the two for the samples with TSS concentrations higher than 50 mg/L. This relationship displays the nonpoint source influence on water quality during runoff conditions, where TP and TSS concentrations rise as flows increase within Spring River.

Figure 14. Relationship between TP and TSS at SC212 on Shoal Creek.

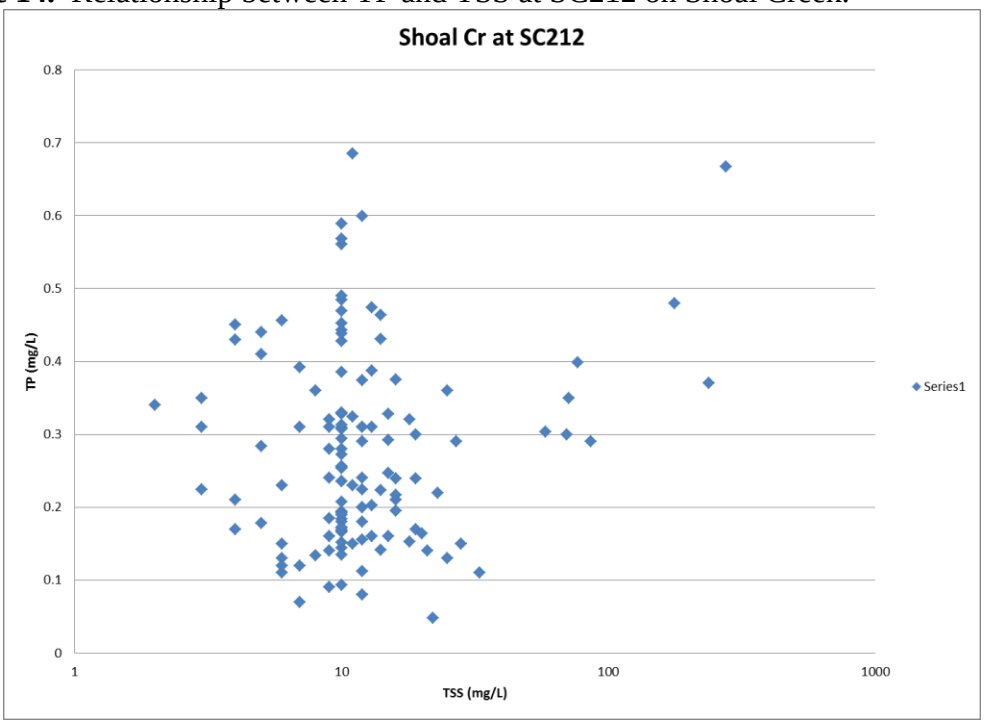


Figure 15. Relationship between TP and TSS at SC570 on Short Creek.

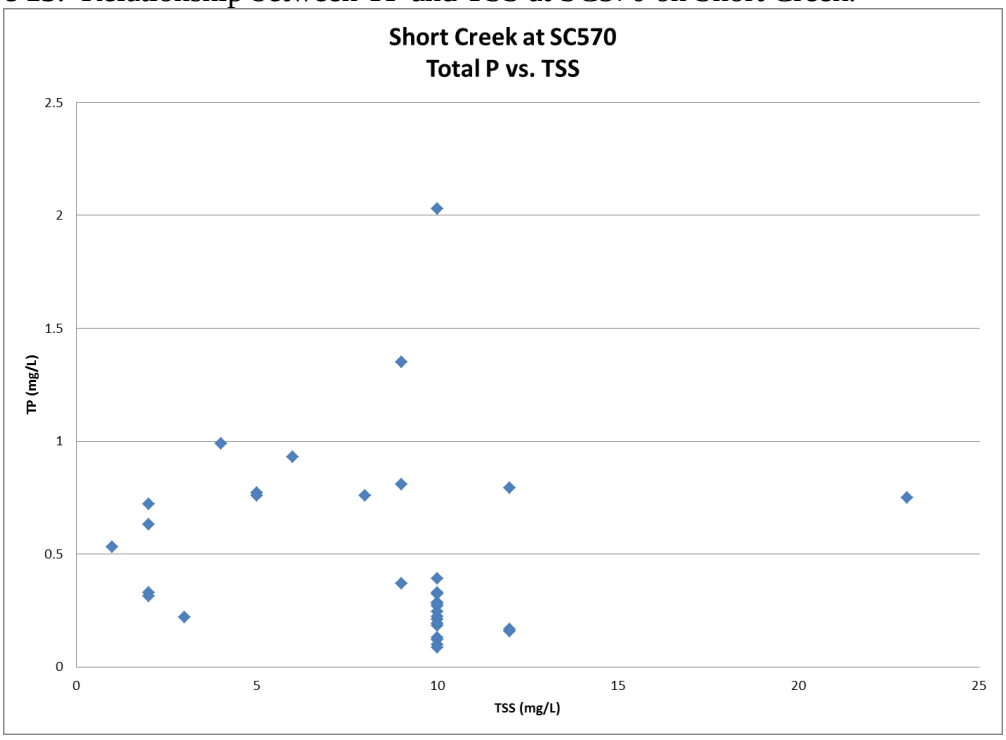
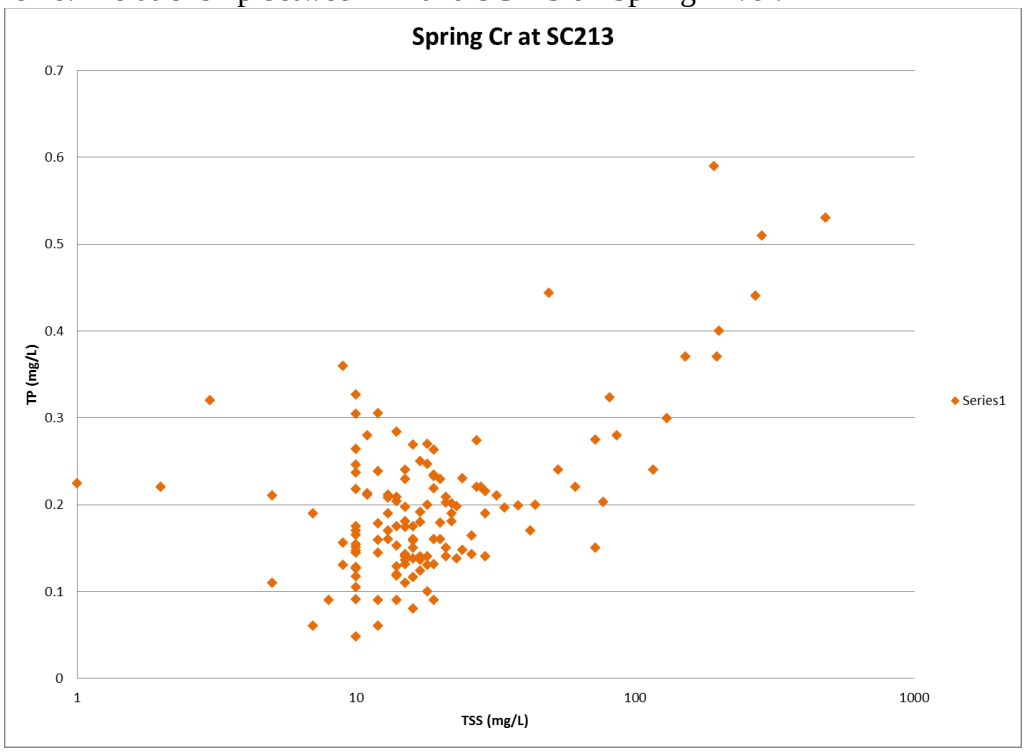


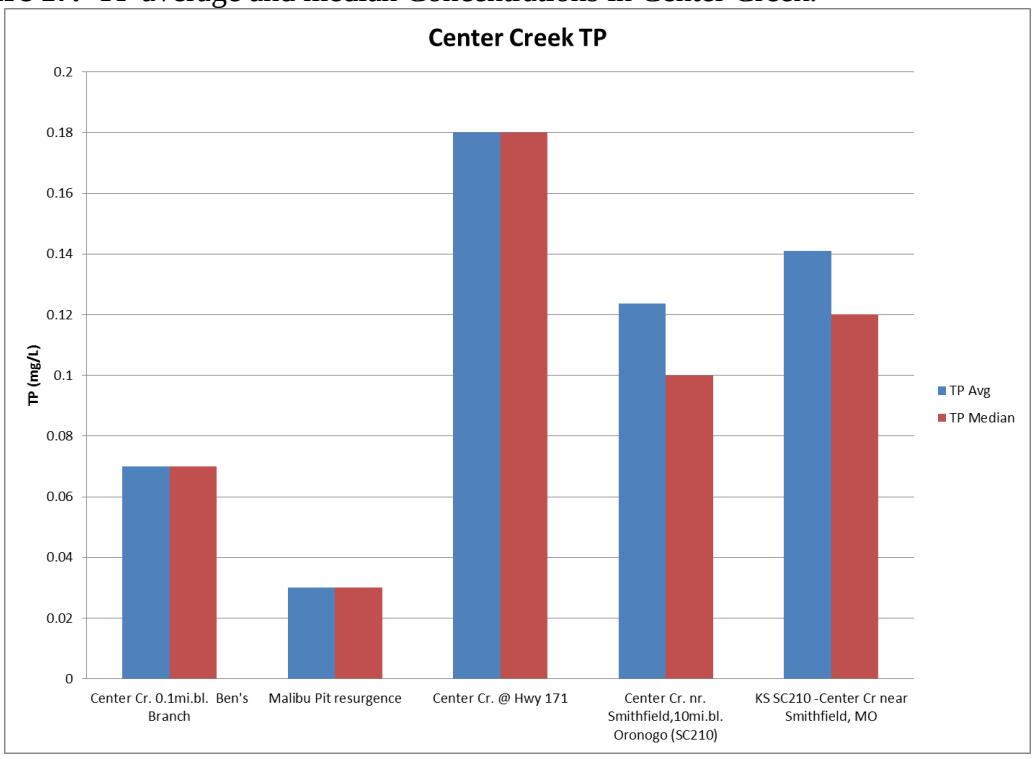
Figure 16. Relationship between TP and SC213 on Spring River.



There are three mechanisms in place dictating phosphorus concentrations in Shoal Creek and Short Creek that influence concentrations in the Spring River. The first factor is the effect of loads derived from portions of the watershed in Missouri, which includes significant point source loading from the Joplin wastewater treatment plant. The second function is nonpoint sources in proximity to the Shoal Creek and Short Creek that contribute direct loadings. The final function is wet weather sources that dominate loading during runoff events, which includes the wet weather stormwater from Galena and Joplin and runoff from nonpoint sources in the aftermath of rainfall.

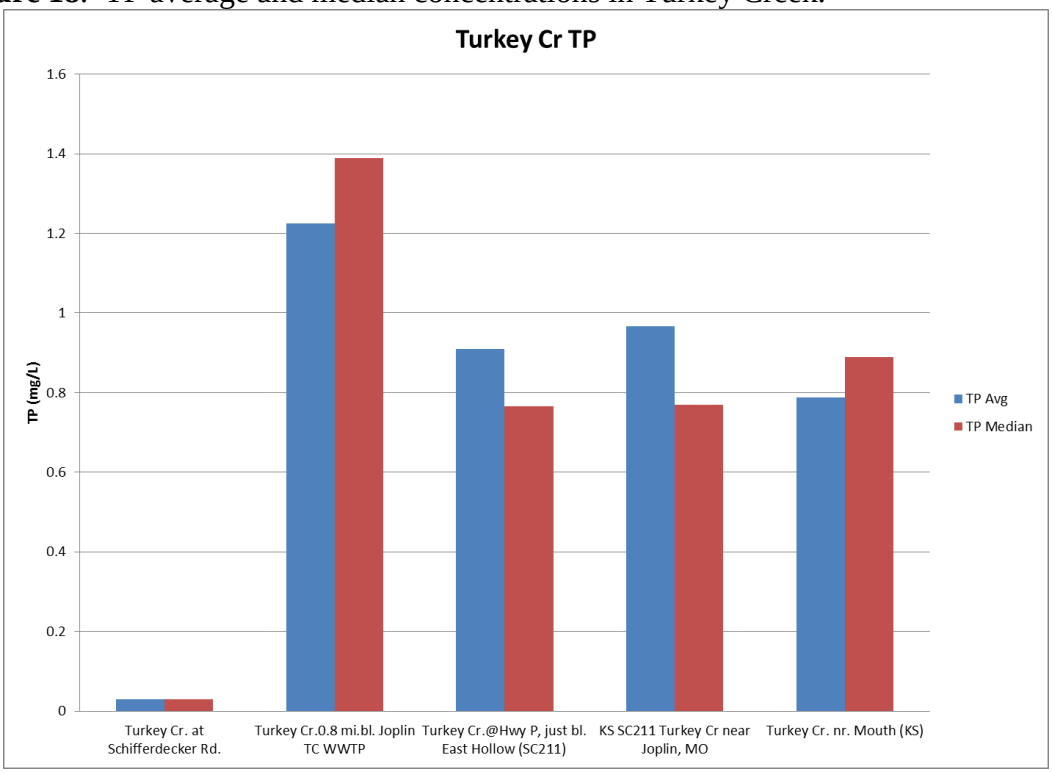
Total Phosphorus Concentrations in Missouri: The Missouri Department of Natural Resources provided stream chemistry data for sampling locations along Center Creek, Turkey Creek, Short Creek and Shoal Creek within Missouri. There were five sampling locations along Center Creek that indicate TP concentrations increase in Center Creek at the sampling location at Highway 171. Figure 17 details concentrations in Center Creek from upstream to downstream, with the Center Cr near Smithfield being the furthest downstream station, which is also the same sampling location as KDHE SC210. The three sampling sites located above the Smithfield/ SC210 location were only sampled once. Missouri sampled the Smithfield site 137 times, and TP concentrations are similar to those seen from the KDHE samples at this location. TP concentrations increase due to point source facilities along Center Creek, which include the Center Creek WWTF and the Carl Junction WWTF.

Figure 17. TP average and median Concentrations in Center Creek.



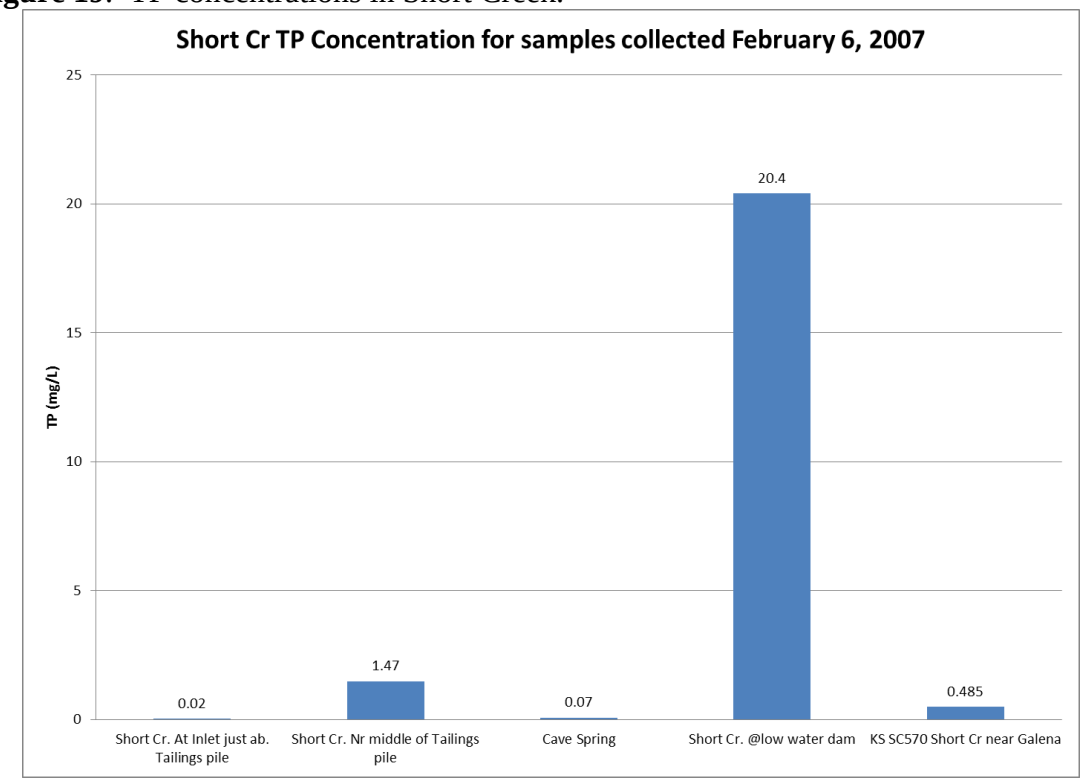
A profile of the TP concentrations in Turkey Creek within Missouri is detailed in Figure 18. TP concentrations above the Joplin Turkey Creek WWTF are low, with an average and median TP concentration of 0.03 mg/L for eight samples collected at Schifferdecker Road. Below the Joplin Turkey Creek WWTF, TP concentrations average 1.22 mg/L. Missouri collected 136 samples at Hwy P, just below East Hollow, which is also located at the same location as KDHE station SC211. TP concentration averages and medians are very similar for samples collected by Kansas and Missouri at this location. Additionally, Missouri collected seven samples near the mouth of the Spring River in Kansas, where TP concentrations averaged 0.787 mg/L at this location. TP concentrations and loads in Turkey Creek are attributed to the Joplin Turkey Creek WWTF.

Figure 18. TP average and median concentrations in Turkey Creek.



Short Creek was sampled at three locations in Missouri just one time. A cave spring that drains to Short Creek was also sampled one time. The TP concentrations in Short Creek during this sampling event increase as Short Creek approaches the Kansas Stateline. The sample collected at the low water dam had an extremely high TP concentration of 20.4 mg/L. It is unknown if the sampling event in 2007 was instigated by a spill or discharge investigation. The sampling results for these sites on Short Creek are detailed in Figure 19. There are two NPDES facilities in Missouri along Short Creek that may contribute to the TP loadings, the Farmland Industries facility discharges to Short Creek and the PCS Phosphate Joplin Plant discharges to a tributary of Short Creek near the Kansas Stateline.

Figure 19. TP concentrations in Short Creek.



Shoal Creek was sampled at three locations in Missouri. The furthest upstream sampling site was sampled three times on Shoal Creek at Ritchey, where TP concentrations averaged 0.53 mg/L. The sampling site near Grandby at Old Highway E was sampled one time, with a TP concentration of 0.19 mg/L. Shoal Creek at Highway 86 was sampled 69 times, with an average TP concentration of 0.164 mg/L. The Joplin Shoal Creek facility is below this sampling site and contributes to higher TP concentrations at KDHE site SC212. Concentrations in Shoal Creek are detailed in Figure 20.

A complete summary of the TP sampling data for locations within Missouri is detailed in Table 7.

Figure 20. Average and median TP concentrations in Shoal Creek.

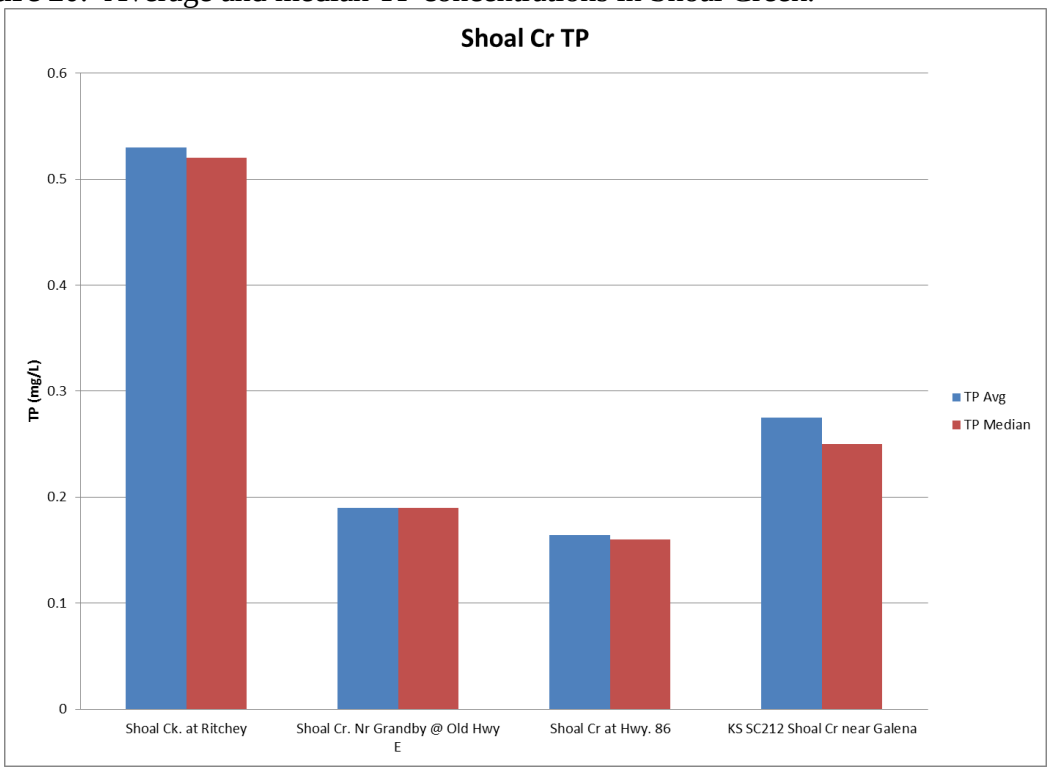


Table 7. Summary of sampling TP data from sampling locations in Missouri.

Sampling Locations in Missouri	Number of Samples	TP Average (mg/L)	TP Median (mg/L)
Shoal Creek			
Shoal Ck. at Ritchey	3	0.53	0.52
Shoal Cr. Nr Grandby @ Old Hwy E	1	0.19	0.19
Shoal Cr at Hwy. 86	69	0.164	0.16
Short Creek			
Short Cr. At Inlet just ab. Tailings pile	1	0.02	0.02
Short Cr. Nr middle of Tailings pile	1	1.47	1.47
Cave Spring	1	0.07	0.07
Short Cr. @low water dam	1	20.4	20.4
Joplin Creek			
Joplin Cr. US of Geneva Ave.	2	0.021	0.021
Joplin Cr. DS of Geneva Ave.	2	0.012	0.012
Joplin Cr. 0.1 mi DS of 15th St.	2	0.012	0.012
Joplin Cr. 0.2 mi US of Campbell Parkway	2	0.016	0.016
Joplin Cr. 0.1 mi DS of Hwy 66	2	ND	ND
Turkey Creek			
Turkey Cr. at Schifferdecker Rd.	8	0.03	0.03
Turkey Cr.0.8 mi.bl. Joplin TC WWTP	7	1.23	1.39
Turkey Cr.@Hwy P, just bl. East Hollow (SC211)	136	0.91	0.765
KS SC211 Turkey Cr near Joplin, MO	33	0.967	0.77
Turkey Cr. nr. Mouth (KS)	7	0.787	0.89
Center Creek			
Center Cr. 0.1mi.bl. Ben's Branch	1	0.07	0.07
Malibu Pit resurgence	1	0.03	0.03
Center Cr. @ Hwy 171	1	0.18	0.18
Center Cr. nr. Smithfield,10mi.bl. Oronogo (SC210)	137	0.124	0.1
KS SC210 -Center Cr near Smithfield, MO	35	0.141	0.12

Relationship between Phosphorus and Biological Indicators: The narrative criteria of the Kansas Water Quality Standards are based on indications of the prevailing biological community. Excessive primary productivity may be indicated by extreme swings in dissolved oxygen or pH as the chemical reactions of photosynthesis and respiration alter the ambient levels of oxygen or acid-base balance of a stream. The relationship between pH and stream temperature is illustrated in Figures 21, 22, and 23 for Short Creek, Shoal Creek, and Spring River. Higher pH values tend to occur during higher photosynthesis periods. Levels of pH exceeded the criterion of 8.5 at SC212 on Shoal Creek during two

sampling events. Otherwise, pH is steady at all temperatures above 8 degrees Celsius. The average pH at SC212 is 7.94, which is within the range of pH criteria for Kansas waters. Levels of pH exceeded the criterion of 8.5 at SC570 on Short Creek during one sampling event and there is a slight rise in pH with elevated temperature that are likely attributed to greater primary productivity during this condition. The average pH at SC570 is 7.25, which is within the range of the pH criteria for Kansas waters. On the Spring River at SC213, pH exceeded the criterion six times and averaged 7.87.

Figure 21. Relationship between pH and temperature in Shoal Creek.

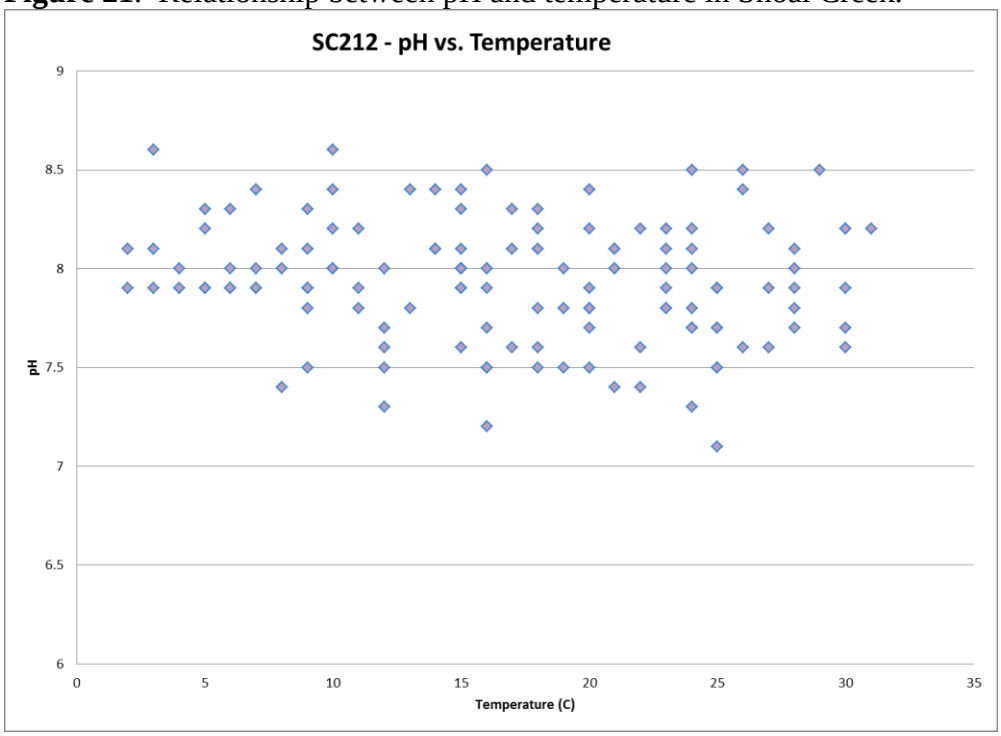


Figure 22. Relationship between pH and stream temperature in Short Creek.

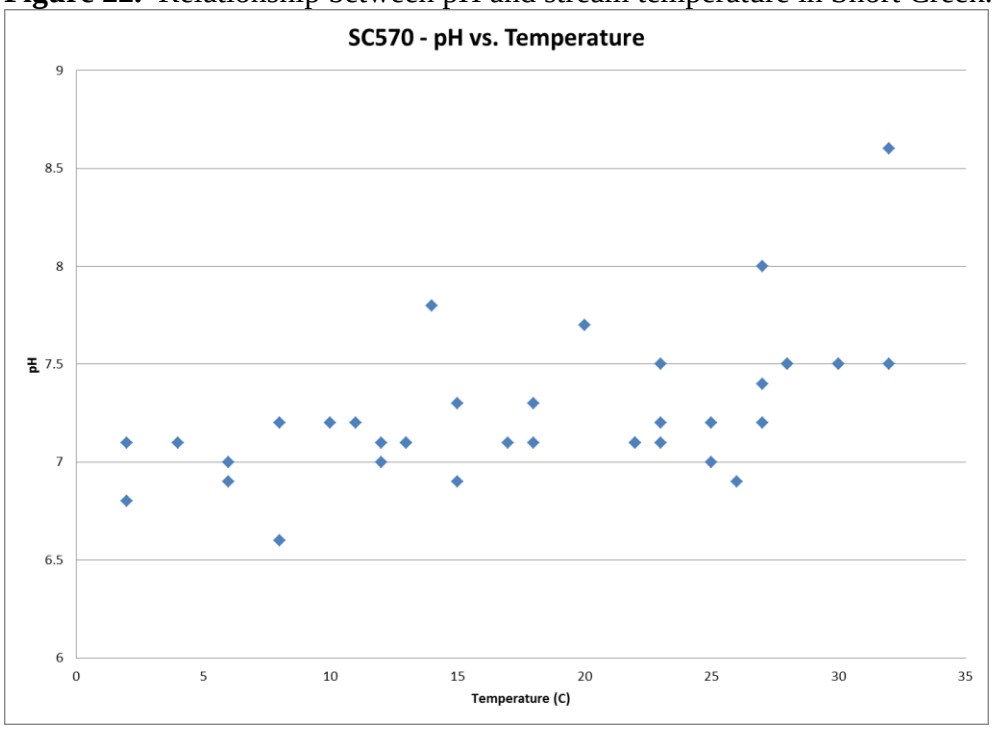
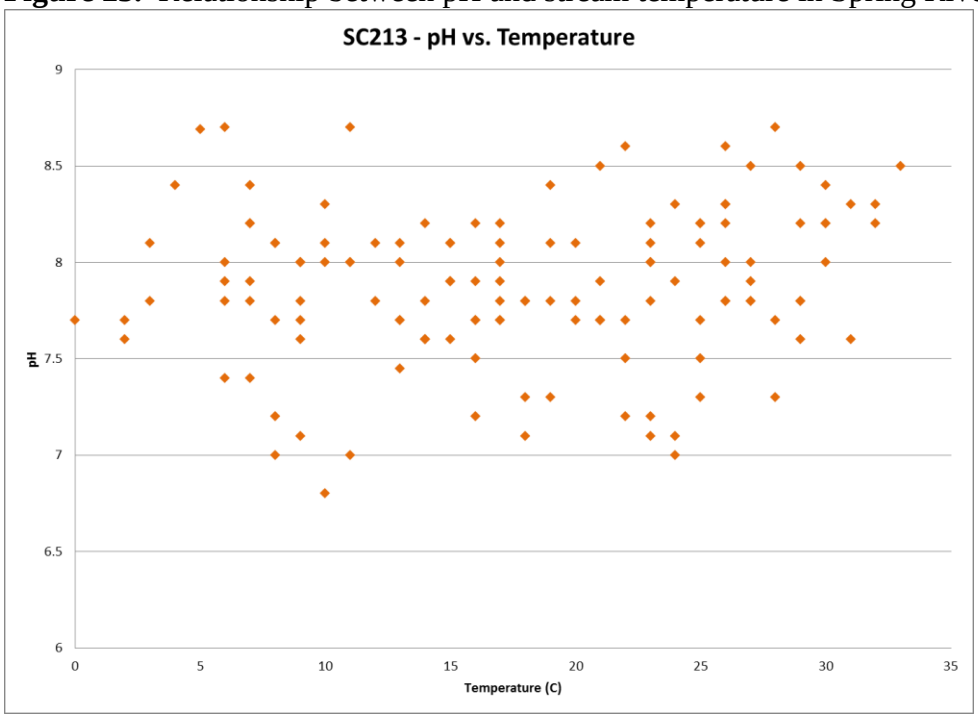


Figure 23. Relationship between pH and stream temperature in Spring River.



In Short Creek, Shoal Creek, and the Spring River dissolved oxygen (DO) tends to swing inversely to the ambient temperature of the stream as seen in Figures 24, 25 and 26, which also shows the monthly average DO concentrations and temperature for each sampling location. Monthly average DO concentrations do not go below 5 mg/L at any of the three sampling locations.

Figure 24. Relationship between pH and temperature in Shoal Creek.

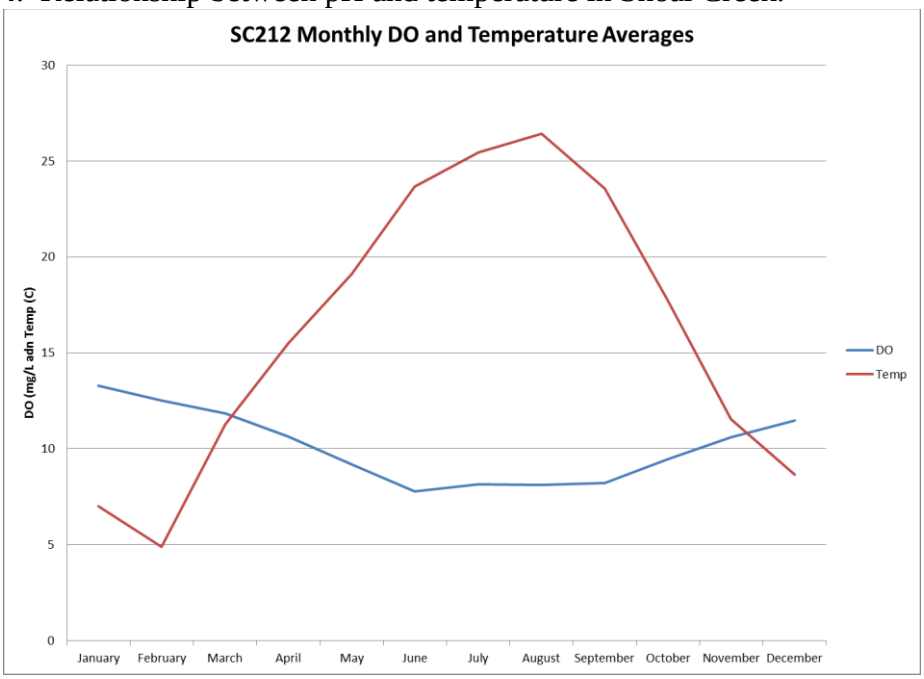


Figure 25. Relationship between pH and temperature in Short Creek.

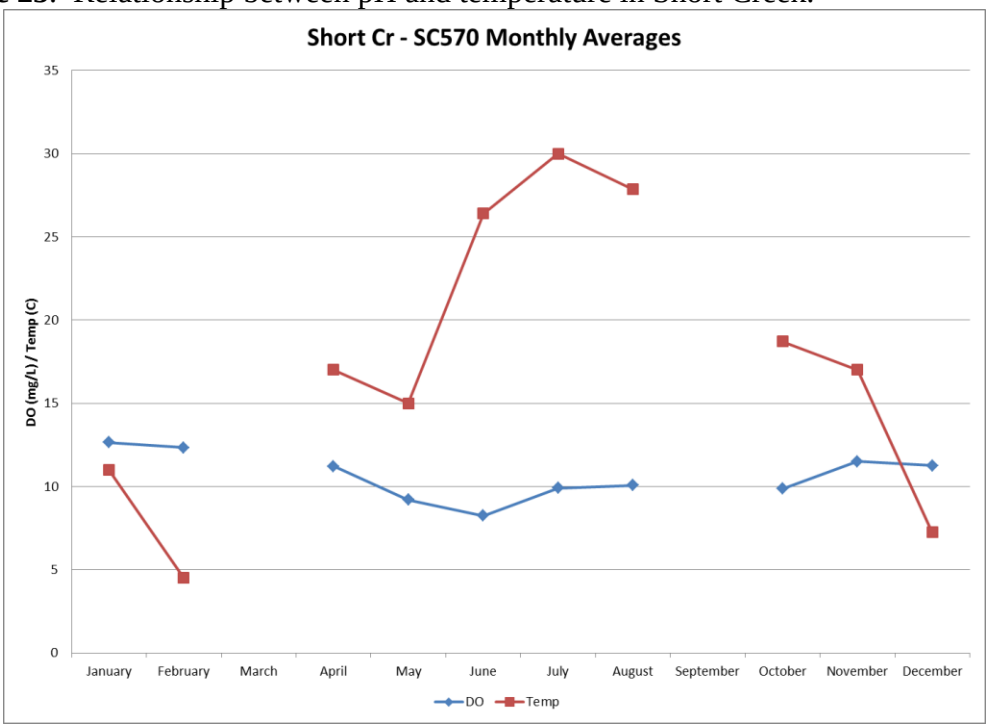
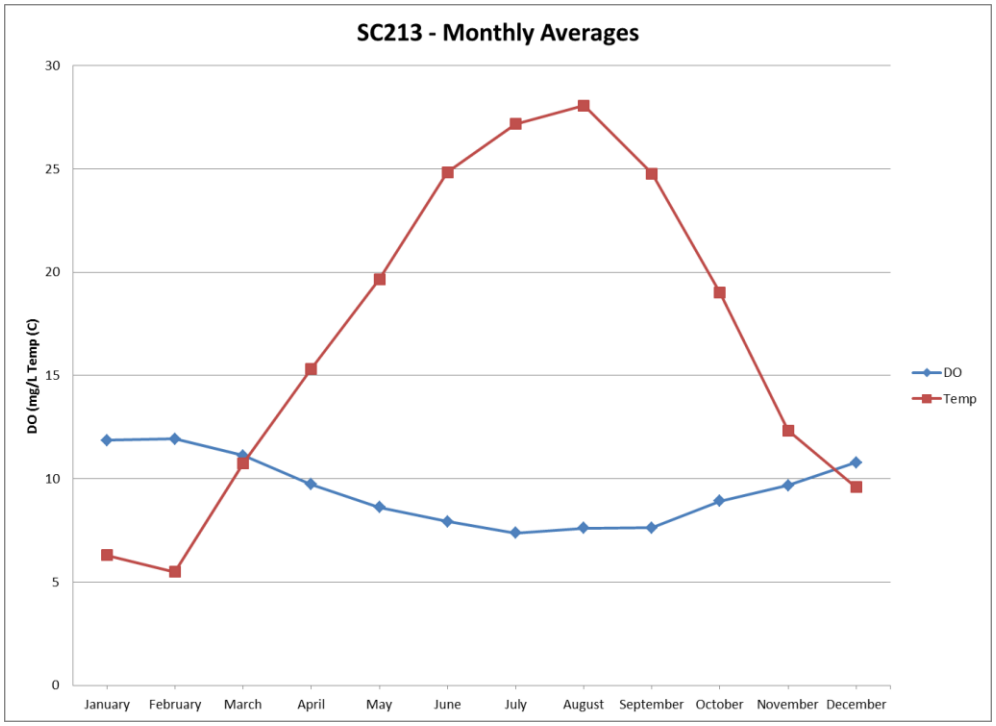


Figure 26. Relationship between temperature and DO in Spring River at SC213.



Water Quality Mass Balance: Water quality and loads from Short and Shoal Creek influence the water quality observed at SC213 on Spring River near Baxter Springs. Table 8 details a mass balance scenario for TP loads utilizing the current median concentrations at median flow conditions within the watershed. TP loads originating from the Shoal Creek and Short Creek account for about 43% and 1% of the load reaching SC213 respectively.

Table 8. Mass Balance scenario for loads reaching SC213 on the Spring River.

Stream	Station	50% Flow Exceedance (cfs)	Median TP Concentration (mg/L)	Current Load (lbs/day)	% of Load at SC213
Spring R near Crestline	SC568	372	0.133	267.17	34.82
Center Creek	SC210	99	0.12	64.15	8.36
Turkey Creek	SC211	12.7	0.77	52.81	6.88
Short Creek	SC570	4.32	0.322	7.51	0.98
Shawnee Creek	SC569	8.01	0.113	4.89	0.64
Shoal Creek	SC212	246	0.247	328.11	42.76
Brush Creek	SC746	9.13	0.057	2.81	0.37
Willow Creek	SC747	3.01	0.061	0.99	0.13
Spring River supplemental	NA	30.83	0.233	38.81	5.06
Spring R at Baxter Springs	SC213	785	0.181	767.26	100.00

EPA's guidance on nutrient criteria for streams (2000) indicated trophic issues in streams with over 8-15 µg/L sestonic chlorophyll. From EPA's work on ambient water quality criteria pertaining to nutrients, median values for summer chlorophyll *a* in the Central Irregular Plains Level III ecoregion 40 for three analytical techniques (fluorometric, spectrophotometric, trichromatic) to be 12.4, 11.8, and 13.5 µg/L, respectively. The three corresponding lower quartile (25%) values are 4.6, 6.8, and 8.5 µg/L. Current EPA philosophy is predicated on the lowest quartile of stream total phosphorus within an ecoregion as indicative of minimum impact conditions (in absence of reference streams). This generalization is not tied to specific biological conditions, but represents water quality protection policy guiding EPA's administration of clean water programs.

KDHE has not sampled sestonic chorophyll at SC213 or SC570. KDHE sampled sestonic chlorophyll at SC212 six times during 2003. The highest chlorophyll concentration during this sampling year was 6.6 µg/L.

Figure 27a displays the relationship between the median phosphorus values and ALUS Index scores within the Neosho Basin. Figure 27b displays the relationship between the median phosphorus values and ALUS Index scores within ecoregions 39a, 40c, and 40d, which are the ecoregions that the lower Neosho Basin is within. High ALUS Index scores are indicative of high quality biological communities. Kansas protocol is to delineate the boundaries between full and partial aquatic life support and between partial support and non-support as ALUS Index scores of 14 and 6, respectively. Based on Figures 27a, conditions of partial support have a range of phosphorus concentrations from 0.015 mg/L to 0.250 mg/L in the Neosho Basin.

Figure 27. ALUS Index scores and the median total phosphorus levels for stations in the Neosho basin. Compiled values indicate compilation of all stations in that Basin.

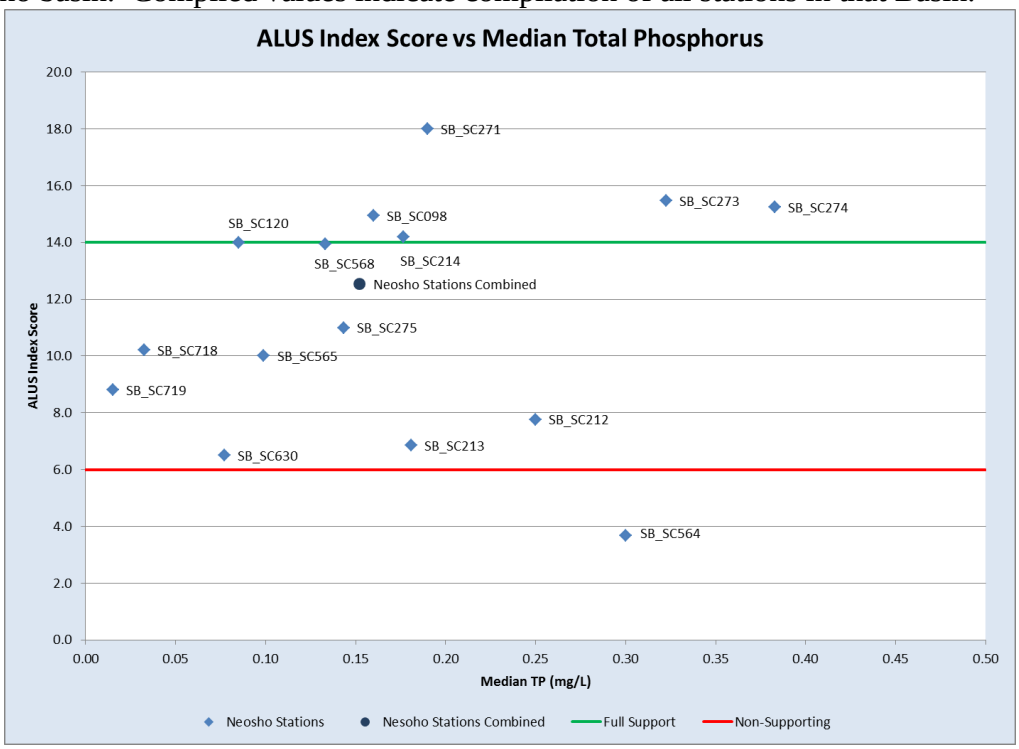
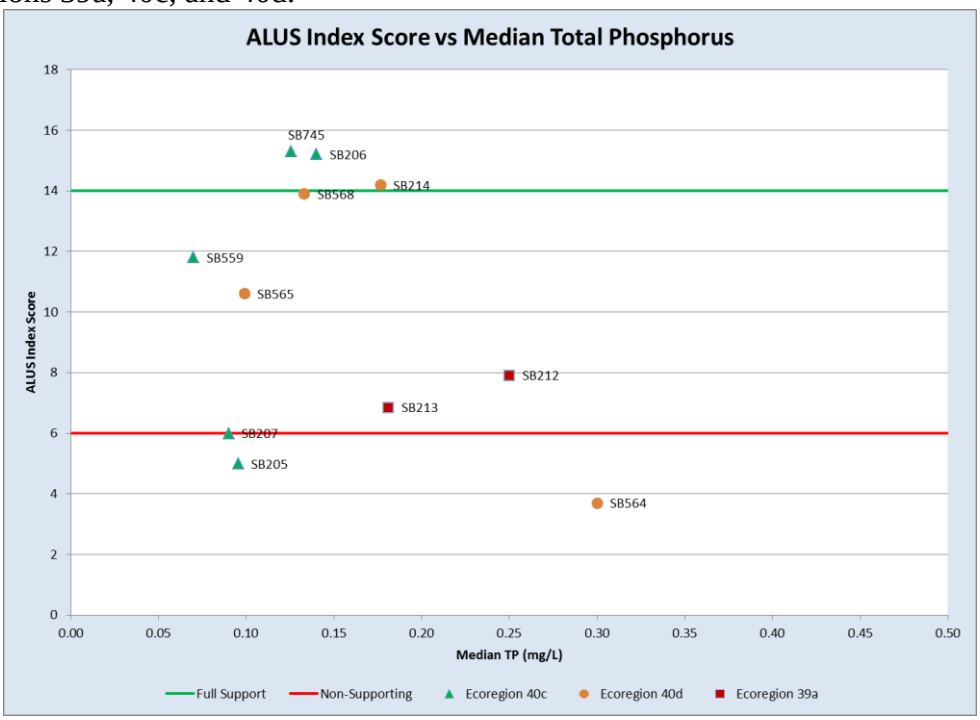


Figure 27b. ALUS Index scores and the median total phosphorus levels for stations in ecoregions 39a, 40c, and 40d.



Desired Endpoint: The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards by eliminating the impacts to aquatic life, domestic water supply or recreation associated with excessive phosphorus and objectionable amounts of algae as described in the narrative criteria pertaining to nutrients. There are no existing numeric phosphorus criteria currently in Kansas.

The original listing for phosphorus at SC212 and SC570 came about because of median values that were greater than 0.201 mg/L, per the KDHE 303(d) listing methodology. The current EPA suggested stream TP concentration benchmarks for aggregate ecoregion IX streams is 0.0366 mg/L. A similar EPA benchmark for Level III ecoregion 40 streams based on the 25th percentile of data for 146 streams sampled is 0.0925 mg/L (EPA, 2000).

Comparable analysis for data collected from 1990-2014 and restricted to the Kansas stations in ecoregion 40d (Central Irregular Plains, Cherokee Plains) from eight stations with the lowest TP concentration average, indicates the average concentration of the pooled data set is about 0.140 mg/L, which has a respective median concentration of 0.110 mg/L. The KDHE sampling stations located in Kansas ecoregion 40d are detailed in Table 9.

Table 9. Kansas Ecoregion 40d Stations with the lowest TP concentration average.

Ecoregion 40d Station	Average	Median
SC110	0.052	0.036
SC746	0.070	0.057
SC747	0.079	0.069
SC605	0.118	0.080
SC569	0.131	0.113
SC565	0.143	0.100
SC209	0.147	0.150
SC568	0.171	0.135

The Aquatic Life Use Support Indices (ALUS Index) and sestonic chlorophyll concentrations will serve to establish if the biological community in Short Creek and Shoal Creek reflects recovery, renewed diversity and minimal disruption by the impacts described in the narrative criteria for nutrients on aquatic life, recreation, and domestic water supply. The ALUS Index, as described in the 2014 303(d) Methodology consists of five categorizations of biotic condition that, once measured, are assigned a score (Table 10). Scores are then tallied and a support category is assigned according to Table 11. The index was designed to assess the response of macroinvertebrate communities to

a wide variety of stressors including various toxics, low dissolved oxygen and sedimentation. The ALUS Index is composed of the following five metrics:

1. Macroinertebrate Biotic Index (MBI): A statistical measure that evaluates the effects of nutrient and oxygen demanding substance on macroinvertebrates based on the relative abundance of certain indicator taxa (orders and families).
2. Ephermeroptera, Plecoptera, and Trichoptera (EPT) abundance as a percentage of the total abundance of macroinvertebrates.
3. Kansas Biotic Index for Nutrients (KBI-N): Mathematically equivalent to the MBI, however the tolerance values are species specific and restricted to aquatic insect orders.
4. EPT Percent of Count (EPT% CNT) – The percentage of organisms in a sample consisting of individuals belonging to the EPT orders.
5. Shannon's Evenness (SHN EVN) – A measure of diversity that describes how evenly distributed the numbers of individuals are among the taxa in a sample.

Once measured, the metrics detailed above are then assigned a score according to Table 10 and the scores are tallied and a support category assigned according to Table 11.

Table 10. ALUS Index metrics with scoring ranges.

MBI	KBI-N	EPT	EPT % CNT	SHN EVN	Score
<= 4.18	<= 2.52	>= 16	>= 65	>= 0.849	4
4.19-4.38	2.53-2.64	14-15	56-64	0.826-0.848	3
4.39-4.57	2.65-2.75	12-13	48-55	0.802-0.825	2
4.58-4.88	2.76-2.87	10-11	38-47	0.767-0.801	1
>= 4.89	>= 2.88	< = 9	<= 37	<= 0.766	0

Table 11. ALUS Index score range, interpretation of biotic condition, and supporting, partial and no supporting categories.

ALUS Index Score	Biotic Condition	Support Category
17-20	Very Good	Supporting
14-16	Good	
7-13	Fair	Partially Supporting
4-6	Poor	Non-supporting
1-3	Very Poor	

Therefore, the numeric endpoints for this TMDL indicating attainment of water quality standards in the TMDL watershed will be:

1. An ALUS Index score greater than or equal to 14.
2. Sestonic chlorophyll: The concentration of planktonic algae floating in the water column of the stream. EPA (2000) sestonic chlorophyll levels over 8-15 µg/L are problematic. A target value of <5 µg/L will be sought for SC212 and SC570.

The endpoints have to initially be maintained over three consecutive years to constitute full support of the designated uses of the Shoal Creek at SC212 and Short Creek at SC570. After standards are attained, simultaneous digression of these endpoints more than once every three years, on average, constitutes a resumption of impaired conditions.

The endpoints will be evaluated periodically as phosphorus levels decline over time. This TMDL looks to establish management milestones for phosphorus concentrations that would be the cue to examine the biological conditions of the streams. This TMDL established two milestones to achieve the ultimate endpoint of this TMDL. The first milestone will be a reduction of the median TP concentration at SC212 and SC570 to 0.140 mg/L, based on the approximate average TP values of the pooled data from the sampling stations within ecoregion 40d that have the lowest TP concentration average. The second milestone will be a reduction of the TP median at SC212 and SC570 to 0.110 mg/L, reaching the median of the pooled data from the sampling stations within ecoregion 40d that have the lowest TP concentration average. The resulting reductions on Short Creek and Shoal Creek will improve the TP concentrations in the Spring River at Baxter Springs with an estimated TP concentration reduction of greater than 20%. Table 12 details the reduction of the current TP median concentration at SC212 and SC570 to reach these milestones.

Table 12. TP concentration reductions necessary to meet TMDL endpoints.

	Current TP Median (mg/L)	Stage I TMDL (mg/Ll)	Stage I Concentration Reduction	Stage II TMDL (mg/L)	Stage II Concentration Reduction
SC212 Shoal Cr	0.247	0.140	43.3%	0.110	55.5%
SC570 Short Cr	0.322	0.140	56.5%	0.110	65.8%

Presuming the first stage of reducing phosphorus levels in the TMDL watershed improves water quality but does not attain the biological indictors, a second stage of implementation will commence. In time, median phosphorus concentrations should approach the median value (0.110 mg/L) of the TP data for the eight stations within ecoregion 40d that have the lowest TP concentration average, encompassing all flow conditions.

The resulting TP concentrations at SC213 on Spring River near Baxter Springs will net in an approximate 20% TP concentration and load reduction during Stage I from the current condition during median flows as determined from the mass balance scenario in Table 13. The reduction ensures nutrients in the Spring River watershed are adequately supporting all designated uses as waters leave the state towards Oklahoma. Additionally all designated uses in Empire Lake will continue to be supported and protected with the achievement of this TMDL

Achievement of the biological endpoints indicate any loads of phosphorus 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. The biological endpoints have to initially be maintained over three consecutive years to constitute full support. Additionally, biological monitoring on Spring River at SC213 should result in ALUS scores over 14 for a majority samples taken in a ten-year period.

Table 13. Mass Balance Scenario with Phase I TMDL achievement.

Stream	Station	50% Flow Exceedance (cfs)	Median TP Concentration (mg/L)	Stage I Load (lbs/day)	% of Load at SC213
Spring R near Crestline	SC568	372	0.133	267.17	43.64
Center Creek	SC210	99	0.12	64.15	10.48
Turkey Creek	SC211	12.7	0.77	52.81	8.63
Short Creek	SC570	4.32	0.14	3.27	0.53
Shawnee Creek	SC569	8.01	0.113	4.89	0.80
Shoal Creek	SC212	246	0.14	185.98	30.38
Brush Creek	SC746	9.13	0.057	2.81	0.46
Willow Creek	SC747	3.01	0.061	0.99	0.16
Spring River supplemental	NA	30.83	0.181	30.13	4.92
Spring R at Baxter Springs	SC213	785	0.144	612.19	100.00

3. SOURCE INVENTORY AND ASSESSMENT

Point Sources Kansas: There are no NPDES facilities within the Shoal Creek watershed in Kansas. There is one permitted NPDES facility in the Kansas portion of the Short Creek watershed. This facility is a permanent ready-mix concrete batch plant (O'Brien Ready Mix), which generates water from washing trucks that is collected in a three cell concrete basin. There is no potential for this facility to contribute to the nutrient impairment based on their operations and due to the fact that there have been no reported discharges from this facility. There are four NPDES permitted facilities that discharge in the Spring River above SC213. The City of Galena and the Cherokee County S.D #1 facilities operate lagoon systems that discharge TP loads to the Spring River. The City of Galena currently monitors TP concentrations in their effluent, with an average TP concentration of 1.9 mg/L. The Cherokee County S.D. #1 does not currently monitor TP. The two industrial facilities, Jayhawk Fine Chemical Corporation and Empire District Electric Riverton Plant, do not monitor TP in their effluent and have no potential to contribute to the TP loads in the Spring River based on their current operations. The Kansas NPDES facilities in the watershed are detailed in Table 14.

Table 14. NPDES facilities in the Spring River watershed.

PERM_NO	FAC_NAME	FAC_CITY	NPDES_NO	RECV_STRM	Dowstream Sampling Station	Design Flow	Permit Expires
I-NE28-PO07	JAYHAWK FINE CHEMICAL CORP.	GALENA	KS0092568	SPRING RIVER VIA LAKE OXBOW	SC213	0.072	11/30/2018
I-NE28-PR02	O'BRIEN READY MIX - GALENA PLANT	GALENA	KSG110201	SPRING RIVER VIA SHORT CREEK V UNN TRIB	SC570	0.00	9/30/2017
I-NE73-BO01	EMPIRE DISTRICT ELECTRIC-RIVERTON PLT	RIVERTON	KS0079812	NEOSHO RIVER VIA SPRING RIVER	SC213	97.72	12/31/2018
M-NE28-OO01	GALENA, CITY OF	GALENA	KS0048135	SPRING RIVER VIA UNNAMED TRIBUTARY	SC213	0.42	12/31/2018
M-NE73-OO02	CHEROKEE CO. S.D. #1	RIVERTON	KS0091057	SPRING RIVER	SC213	0.22	3/31/2018

Point Sources Missouri: Kansas has no authority to set wasteload allocations in the State of Missouri and therefore did not assess wastewater monitoring data associated with the Missouri NPDES facilities. A general assessment of point source facilities in Missouri is detailed in Table 15a and 15b. The facilities that discharge nutrients contribute to TP loading to the streams entering Kansas. Based on the design flows of these facilities and the resulting water quality observed downstream of these plants, TP loading is attributable to the Joplin Shoal Creek plant, the Joplin Turkey Creek WWTF, Monett WWTF, Neosho-Shoal Creek WWTF and the Center Creek WWTF. According to the Missouri Department of Natural Resources, there is a Tyson Foods poultry slaughtering and processing plant in the Shoal Creek watershed that discharges the first 88,000 gallons per day of stormwater to the Monett WWTF. These facilities influence TP loads and concentrations in Shoal Creek, Turkey Creek, Center Creek and the Spring River. The PCS Phosphate Joplin Plant and the Farmland Industries facility discharge to Short Creek, and likely contribute TP loads during discharging events contributing to the impairment of Short Creek. The Hillbilly Pumping and Hauling facility has two permits dealing with food wastes and biosolids, stormwater runoff from this facility may contribute to the TP loading of Short Creek.

Table 15a. NPDES Facilities in Missouri.

Facility	Permit #	Type	Reciving Stream	Design Flow
Eagle-Picher Technologies, LLC	MO0002348	Storm Water	Trib Lone Elm Creek	3.500
Eaton Hydraulic	MO0002411	Mechanical Plant	Tributary to Turkey Creek	0.600
Joplin Shoal Creek	MO0023256	Mechanical Plant	Shoal Cr.	6.500
Carl Junction WWTF	MO0025186	Land Application	Unnamed Tributary to Center Cr.	1.270
Center Creek WWTF	MO0040185	Mechanical Plant	Unnamed tributary to Center Creek	4.800
Farmland Industries - GYP	MO0053627	No Discharge	Short Creek	1.000
TAMKO Building Products Inc. WWTF	MO0093998	Storm Water	Tributary to Turkey Cr.	0.000
American Fibrex	MO0102253	Storm Water	Lone Elm Hollow	0.000
Joplin Turkey Creek WWTF	MO0103349	Mechanical Plant	Turkey Cr.	15.000
Joplin Municipal Landfill	MO0108731	Storm Water	TRIB CHITWOOD HOLLOW	0.000
Southern Star Central Gas Pipeline, Inc	MO0108766	Storm Water	UN TRIB THURMAN CR	0.012
PCS Phosphate Joplin Plant	MO0128155	Lagoon	tributary to Short Creek	0.042
Hillbilly Pumping and Hauling, Inc.	MOG821008	Land Application	Tributary to Short Creek	0.000
Hillbilly Pumping and Hauling Inc.	MOG822182	Storm Water	Unnamed Tributary to Short Creek	0.000

Table 15b. Domestic Discharging WWTF in Missouri portion of the watershed (MO DNR).

Facility Name	Permit No.	Facility Type	Design Flow (MGD)
Monett WWTF	MO-0021440	Major municipal	6
Diamond WWTF	MO-0042013	Minor municipal	No discharge
City of Purdy WWTF	MO-0043222	Minor 92-500	No discharge
Pierce City WWTF	MO-0099155	Minor 92-500	0.2
Neosho-Shoal Creek WWTF	MO-0104906	Major municipal	3
Granby WWTF	MO-0107581	Minor 92-500	0.22
John Sim LLC WWTF	MO-0110299	Minor non-municipal	0.01
Park Place MHP – Joplin WWTF	MO-0116491	Minor non-municipal	0.0078
Highway 60 RV Park WWTF	MO-0120561	Minor non-municipal	0.0033
Camp Barnabas WWTF	MO-0125164	Minor non-municipal	0.012
Butterfield WWTF	MO-0126292	Minor municipal	0.0604
Monett Municipal Airport WWTF	MO-0132284	Minor state facility	0.0011
Shoal Creek RV Campground WWTF	MO-0134287	Minor non-municipal	0.0125
Raines MHP WWTF*	MO-0131695	Minor non-municipal	0.0054
Timberlost Mobile Home Park*	MOG823002	Wastewater-land application	0.007899

Livestock Waste Management: There are no certified or permitted confined animal feeding operations in the Shoal Creek or Short Creek watersheds in Kansas. According to the 2007 Agriculture Census, there are 730 farms with 290,000 acres of farmland in Cherokee County. Additionally, there are 32,000 head of cattle in Cherokee County according to the 2012 Kansas Farm Facts.

Population Density: According to the 2010 Census Block information, the Shoal creek watershed in Kansas has 929 people, with a population density of 92 people/square mile. The Short Creek watershed has 3,129 people, with a population density of about 527 people/square mile in Kansas. There are approximately 3,085 people residing within the city limits of Galena, which has a city boundary that is primarily all within the Short Creek watershed. Population changes from the 2000 to 2010 census show that the population of Galena has decreased 6.15%, going from 3,287 to 3,085 people over the ten year period.

On-Site Waste Systems: The Spreadsheet Tool for Estimating Pollutant Load (STEPL) was utilized to identify the number of septic systems within the HUC12 that contains the Shoal Creek and Short Creek watersheds in Kansas. According to STEPL, there were 59 septic systems within the HUC12 encompassing the Shoal Creek watershed and 206 septic systems within the HUC12 encompassing the Short Creek watershed. STEPL estimates the failure rate of 0.93% for these systems. Failing on-site septic systems do not likely contribute to the total phosphorus impairment within the TMDL watershed containing Short Creek and Shoal Creek.

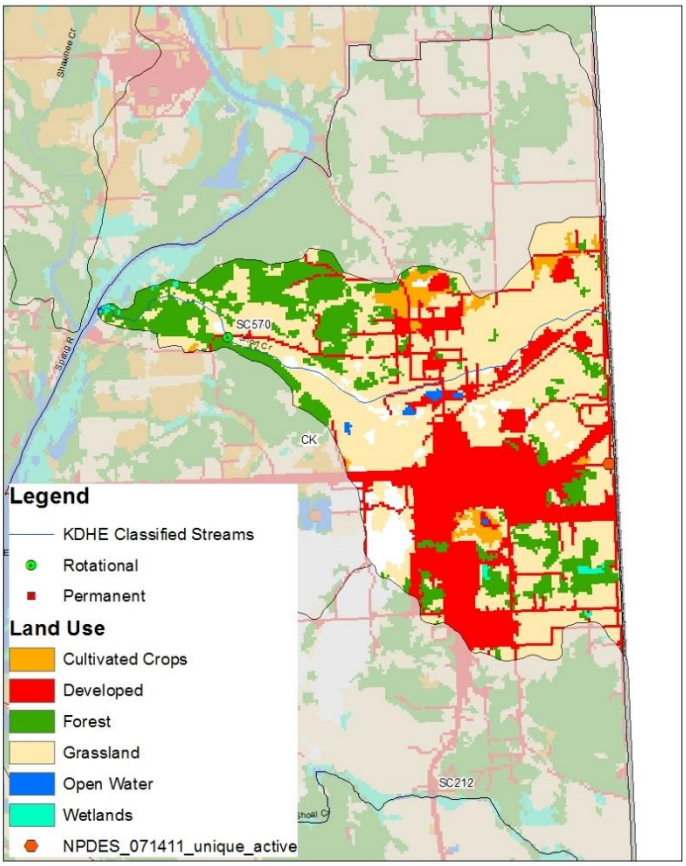
Land Use: Land use within the Short Creek watershed in Kansas is dominated by grassland (46.47%) according to the 2001 National Land Cover Data (NLCD). Developed areas and forest comprise about 28.36% and 17.38% of the watershed respectively. The land use percentages and acres within the watershed are in Table 16

and are further illustrated in the land use map (Figure 28). Runoff from the cropland and developed areas could contribute significant sources of total phosphorus loading.

Table 16. Landuse acres and percentages in the Short Creek Watershed.

Land Use	Acres	Percent
Grassland	1771.63	46.47
Developed	1081.3	28.36
Forest	662.75	17.38
Barren	155.46	4.08
Cropland	113.65	2.98
Wetland	14.23	0.37
Open Water	13.57	0.36

Figure 28. Landuse Map for the Short Creek TMDL watershed.

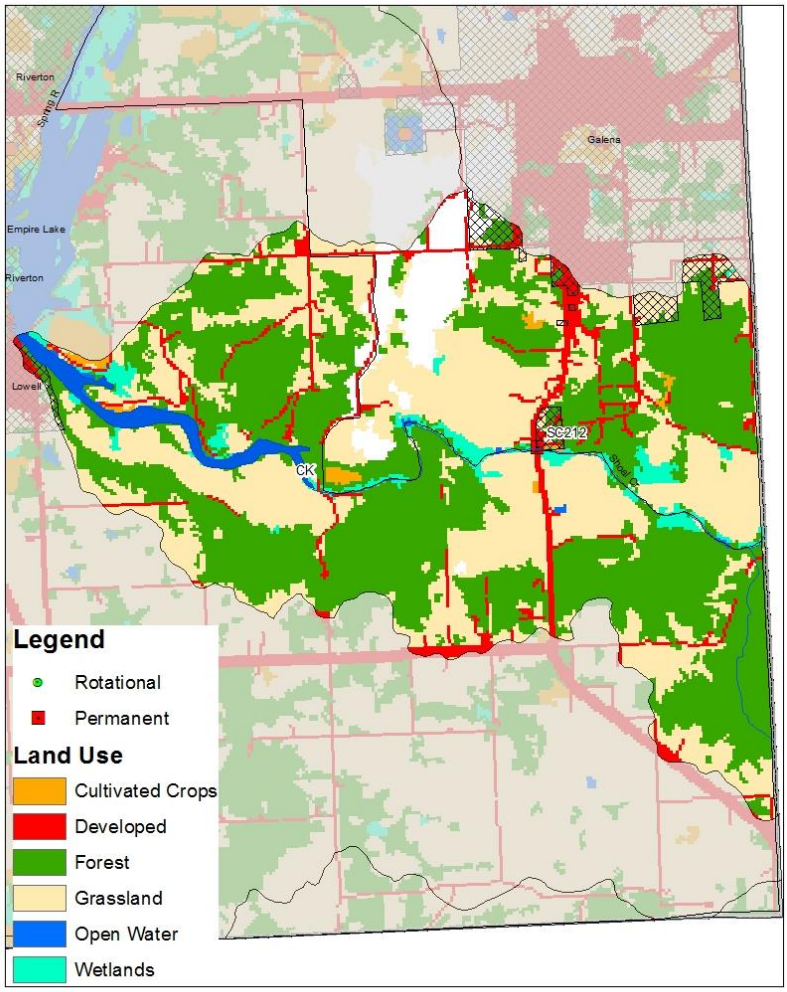


Land use within the Shoal Creek watershed in Kansas is dominated by forest (48.16%) according to the 2001 NLCD. Grassland and developed areas comprise about 35.47% and 6.52% of the watershed respectively. The land use percentages and acres within the watershed are in Table 17 and are further illustrated in the land use map (Figure 29).

Table 17. Landuse acres and percentages in the Shoal Creek Watershed.

Land Use	Acres	Percent
Forest	3,132.93	48.16
Grassland	2,307.17	35.47
Developed	423.89	6.52
Barren	307.80	4.73
Wetland	173.03	2.66
Open Water	117.65	1.81
Cropland	42.48	0.65

Figure 29. Landuse map for the Shoal Creek TMDL watershed.

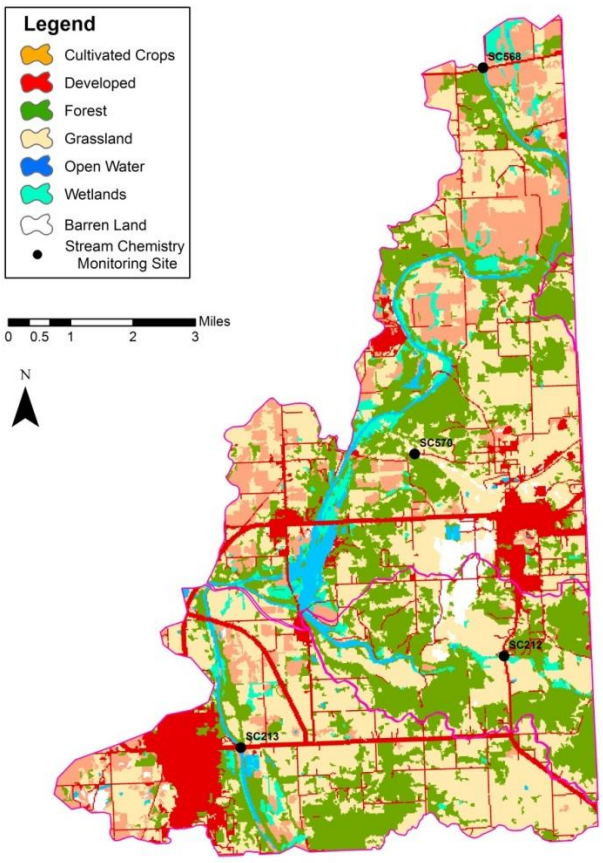


The land use in the Spring River watershed that is influenced by the water quality from Shoal Creek and Short Creek is detailed in Table 18. Land use in the Spring River watershed in Kansas is dominated by grassland (38.62%) and forest (28.68%). Figure 30 details the land use map in the watershed.

Table 18. Landuse acres and percentages in the Spring River Watershed.

Land Use	Acres	Percent
Grassland	14,983.57	38.62
Forest	11,124.59	28.68
Developed	4875.77	12.57
Cropland	4575.76	11.79
Wetland	1369.50	3.53
Open Water	1128.65	2.91
Barren	737.01	1.90

Figure 30. Landuse map for the Spring River watershed.



Contributing Runoff: The Kansas portion of the Shoal Creek watershed has a mean soil permeability value of 2.46 inches/hour, ranging from 0.01 to 4.0 inches/hour according to the NRCS STATSGO database. About 11% of the watershed has a permeability value less than 1.71 inches/hour, which contributes to runoff during low rainfall intensity

events. The majority of the watershed (75%) has a permeability values greater than 3.43 inches/hour, which contributes to runoff during very high rainfall intensity events.

The Kansas portion of the Short Creek watershed has a mean soil permeability value of 1.88 inches/hour, ranging from 0.05 to 4.0 inches/hour according to the NRCS STATSGO database. About 11% of the watershed has a permeability value less than 1.14 inches/hour, which contributes to runoff during very low rainfall intensity events. The majority of the watershed has permeability values greater than 3.43 inches/hour, which contributes to runoff during very high rainfall intensity events.

According to an USGS open-file report (Juracek, 2000), the threshold soil permeability values are set at 3.43 inches/hour for very high, 2.86 inches/hour for high, 2.29 inches/hour for moderate, 1.71 inches/hour for low, 1.14 inches/hour for very low, and 0.57 inches/hour for extremely low soil permeability. As the watersheds' soil profiles become saturated, excess overland flow is produced. The majority of the nonpoint source nutrient runoff will be associated with cropland areas throughout the watershed that are in close proximity to the stream corridors.

Background levels: Phosphorus is present over the landscape, in the soil profile as well as terrestrial and aquatic biota. Wildlife can contribute phosphorus loadings, particularly if they congregate to a density that exceeds the assimilative capacity of the land or water.

4.0 ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

This TMDL will be established in two stages to progressively reduce phosphorus loadings and ambient concentrations with periodic assessment of the biological endpoints on the lower reaches of Shoal Creek and Short Creek, which ultimately reduce TP loads and concentrations on the Spring River. The stages of this TMDL are detailed in Table 19. The TMDL is additionally displayed in Figures 31 and 32. The initial stage will entail reductions in phosphorus levels that should translate to an instream median concentration of 0.140mg/L, approaching the average TP concentration of the pooled data set of the eight KDHE stream chemistry stations with the lowest TP concentration averages within ecoregion 40d. TP load reductions will occur throughout the stream and be monitored at KDHE sampling stations SC212, SC570 and SC213. Reduced upstream TP loading, particularly in Missouri, will be indicative as the TP concentrations approach the TP target concentrations, which will result in favorable biological support throughout the stream.

Additionally, riparian management in areas adjacent to cropland and livestock management in the vicinity of streams within the watershed should reduce nonpoint source loads under conditions of moderate flows as part of Stage Two.

Once the concentrations at stations SC212 and SC570 approach the Stage One milestone of a median TP concentration of 0.140 mg/L, an intensive assessment of

macroinvertebrate diversity will be made to determine compliance with the narrative nutrient criteria. Sestonic chlorophyll will be assessed as well.

Table 19. TP TMDL Stages, Milestones and Actions.

TMDL Phase / Stage	TP Milestone at SC212	Anticipated Action	Biological Endpoints
I – (Nonpoint source - KS) (Point source – MO)	0.140 mg/l	Riparian and Livestock Management; State of Missouri and the City of Joplin make necessary point source implementation measures to meet TMDL at the Stateline	ALUS Index Score >= 14 Sestonic Chlorophyll < 5 µg/l
II – 2 (Nonpoint - KS) (Point and Nonpoint – MO)	0.110 mg/l	Targeted Tributary Riparian Management adjacent to cropland; State of Missouri and the City of Joplin make the necessary implementation measures for both point and nonpoint sources to meet TMDL at the Stateline	

Presuming the biologic endpoints are not met at the end of Stage One, Stage Two will commence. Additional reductions in loads and phosphorus concentrations will be accomplished through enhanced implementation of controls on non-point sources. The desired target levels are comparable to the median concentrations seen in the pooled data from the eight Kansas stations with the lowest TP concentration averages in ecoregion 40d. A second intensive biological assessment will be made once phosphorus levels approach the Stage Two milestone of 0.110 mg/L of TP at SC212 and SC570.

Point Sources: The are no Kansas NPDES facilities in the Short Creek or Shoal Creek watersheds within Kansas that have any potential to contribute to the TP impairment. The O'Brien Ready Mix Galena Plant facility is a permanent ready-mix concrete batch

plant in the Short Creek watershed, which generates water from washing trucks that is collected in a three cell concrete basin. This facility has been assigned a wasteload allocation of zero since this facility has no reported discharges and has no potential for contributing to the TP impairment in the watershed.

Kansas has no authority to set wasteload allocations associated with the NPDES facilities in Missouri. The City of Joplin's wastewater treatment plant discharge is a significant contributor to the phosphorus loads crossing the Stateline into Kansas. Additionally, all facilities discharging nutrients in Missouri to streams draining to the Spring River watershed contribute to the loads entering Kansas.

Nonpoint Source Load Allocation: The load allocation for nonpoint sources encompasses the load capacity for Short Creek and Shoal Creek. During times of low flow, nonpoint sources are assumed to be very minimal. The load allocation grows proportionately with flow and increases as wet weather ensues. Additionally, all loads from Missouri, both originating from point sources and nonpoint sources, are accounted for in the load allocation of these streams in Kansas. The load allocations for Short Creek and Shoal Creek are detailed in Table 20. The load capacity for Short Creek and Shoal Creek at the Missouri and Kansas Stateline is detailed in Table 21. Load calculations were based on the watershed area ratio for the Shoal Creek and Short Creek sampling stations relative to the area contributing to the Spring River USGS gage. Loads entering from Missouri were calculated for the Shoal Creek and Short Creek by subtracting out the area weighted loads associated with the portion of the watershed within Kansas.

The TMDL on Short Creek at SC570 is detailed in Figure 31, which additionally illustrates the current loads and the TMDL at the Missouri and Kansas Stateline. The TMDL for Shoal Creek at SC212 is detailed in Figures 32, which illustrates that the TMDL at the Missouri and Kansas Stateline accounts for the majority of the TMDL since there is only a small portion of this watershed in Kansas.

Defined Margin of Safety: The margin of safety provides some hedge against the uncertainty of variable total phosphorus loads. Therefore, the margin of safety will be 10% of the original calculated total phosphorus load allocation, which has been subtracted from the assigned load allocation to compensate for the lack of knowledge about the relationship between the allocated loadings and the resulting water quality. Additionally, the Joplin Turkey Creek WWTP in Missouri will likely be implementing upgrades to reduce TP loading to Turkey Creek. This will ultimately further reduce loads and concentrations reaching the Spring River at SC213.

Table 20. TP Load Capacity and Load Allocations (lbs/day) for Shoal Creek and Short Creek under the two stages of the TMDL.

Stage One					
Stream	Percent Flow	Load Capacity (lbs/day)	WLA (lbs/day)	LA (lbs/day)	MOS (lbs/day)
Shoal Cr SC212	75%	72.94	0	65.65	7.29
Shoal Cr SC212	50%	163.78	0	147.40	16.38
Shoal Cr SC212	10%	892.69	0	803.42	89.27
Short Cr SC570	75%	1.7	0	1.53	0.17
Short Cr SC570	50%	3.83	0	3.45	0.38
Short Cr SC570	10%	20.85	0	18.77	2.09
Stage Two					
Stream	Percent Flow	Load Capacity (lbs/day)	WLA (lbs/day)	LA (lbs/day)	MOS (lbs/day)
Shoal Cr SC212	75%	57.31	0	51.58	5.73
Shoal Cr SC212	50%	128.68	0	115.81	12.87
Shoal Cr SC212	10%	701.4	0	631.26	70.14
Short Cr SC570	75%	1.34	0	1.21	0.13
Short Cr SC570	50%	3.01	0	2.71	0.30
Short Cr SC570	10%	16.38	0	14.74	1.64

Table 21. Load Capacity at the Missouri and Kansas Stateline.

Load Capacity at the Missouri and Kansas Stateline			
Stream	Percent Flow	Stage One Load Capacity (lbs/day)	Stage Two Load Capacity (lbs/day)
Shoal Creek	75%	71.67	56.31
	50%	160.91	126.43
	10%	877.09	689.15
Short Creek	75%	0.95	0.75
	50%	2.14	1.68
	10%	11.68	9.17

The resulting water quality and load reduction anticipated at SC213 on the Spring River near Baxter Springs with the achievement of the TP targets on Shoal Creek and Short Creek are detailed in Table 22 and Figure 33. With the achievement of the endpoints for Stage One and Two, TP loads are estimated to be reduced by 20.44% and 26.52%, respectively at SC213. The load reductions associated with SC213 are a result of the achievement of the TMDL at Short Creek and Shoal Creek based on the mass balance analyses seen in Table 13.

Table 22. Estimated load reductions observed at SC213 on the Spring River near Baxter Springs with the achievement of the Stage one and two endpoints on Shoal Creek and Short Creek.

Stream	Percent Flow	Current Load at SC213 (lbs/day)	Stage One Estimated Load @ SC213 (lbs/day)	Stage One % Load Reduction	Stage Two Estimated Load @ SC213 (lbs/day)	Stage Two % Load Reduction
Spring R SC213	75%	410.51	326.59	20.44	301.64	26.52
Spring R SC213	50%	921.69	733.28	20.44	677.26	26.52
Spring R SC213	10%	5023.84	3996.86	20.44	3691.55	26.52

Figure 31. TMDL on Short Creek as measured at SC570.

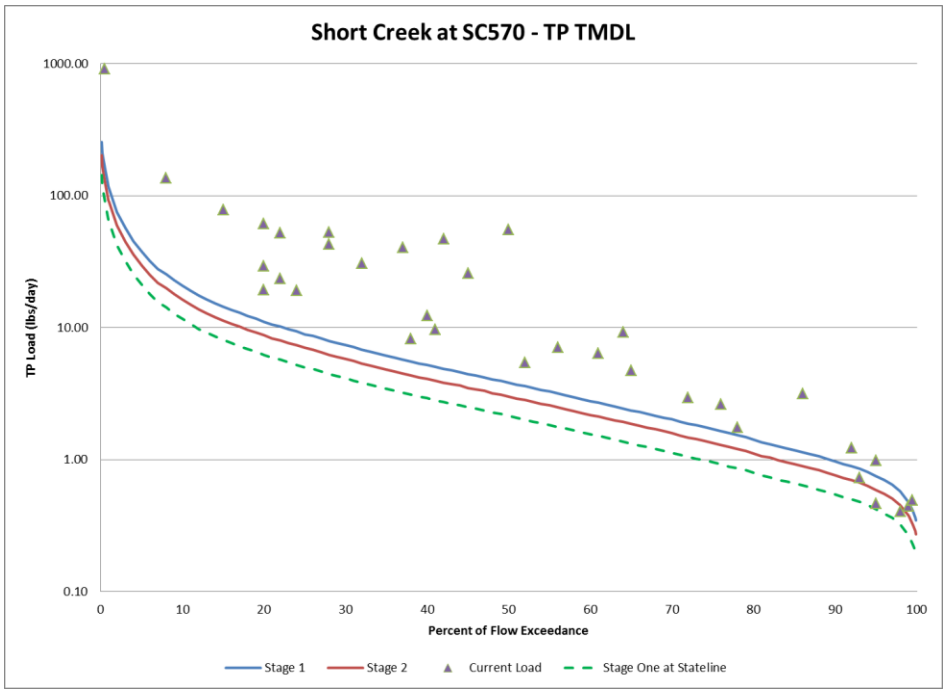


Figure 32. TMDL on Shoal Creek as measured at SC212.

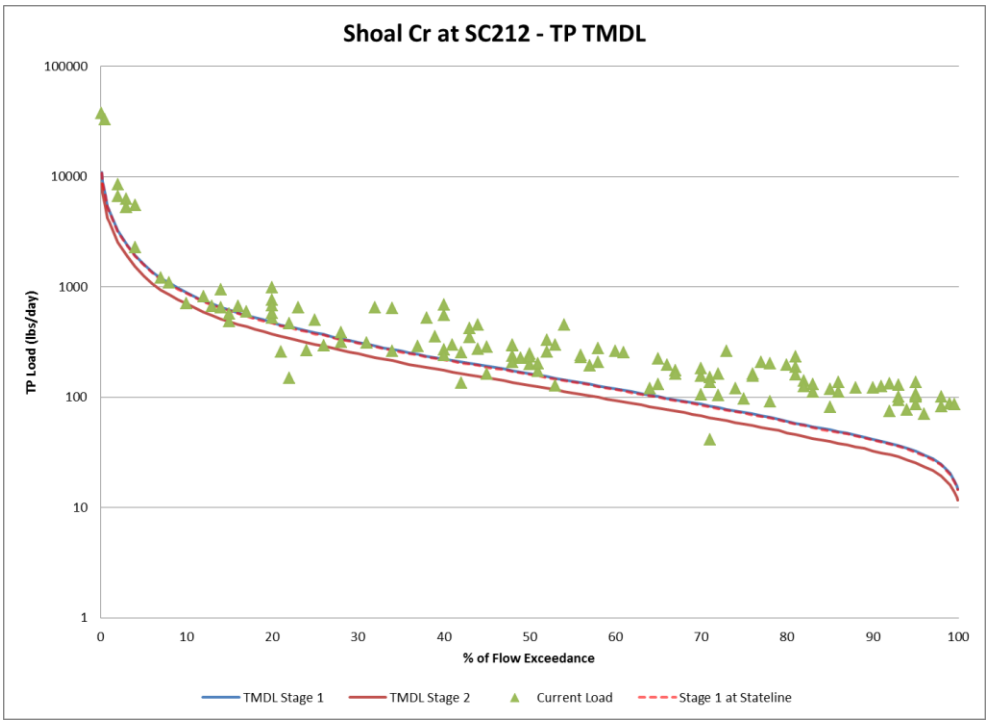
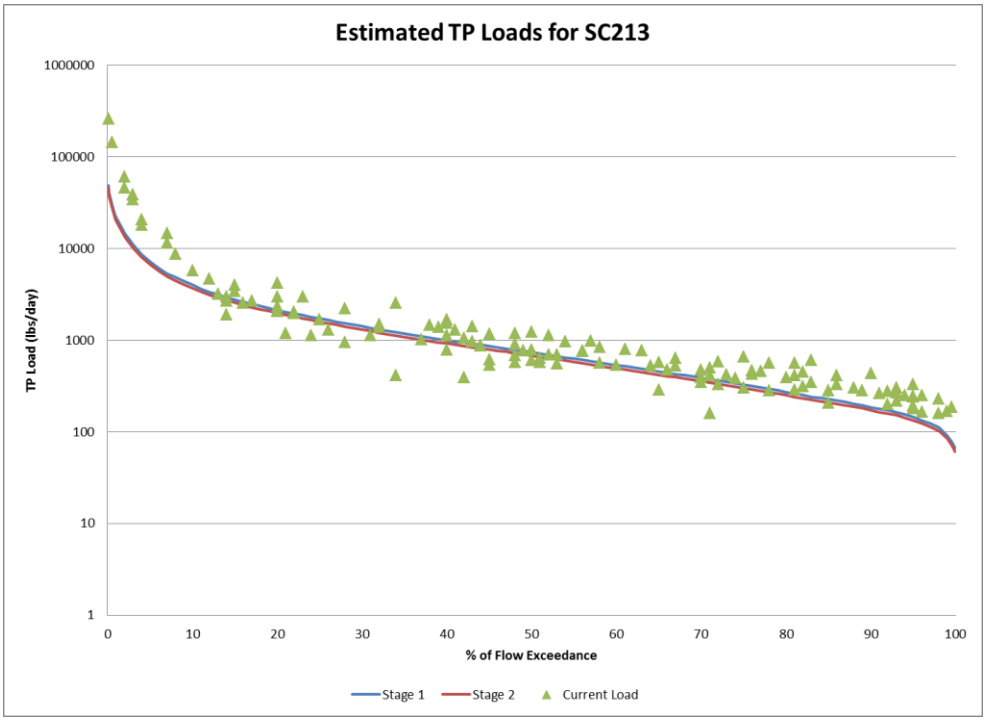


Figure. 33. Resulting estimated loads on Spring River at SC213 with achievement of the TMDL on Shoal Creek and Short Creek.



State Water Plan Implementation Priority: The implementation of this TMDL is focused on point source activities in Missouri and riparian management along the stream corridors to effectively reduce the phosphorus loading to the watershed. Due to the special aquatic life use on Shoal Creek and its contribution to the lower Spring River, this TMDL will be High Priority for Implementation.

5. IMPLEMENTATION

Desired Implementation Activities:

1. Implement and maintain conservation farming, including conservation tilling, contour farming, and no-till farming to reduce runoff and cropland erosion.
2. Improve riparian conditions along stream systems by installing grass and/or forest buffer strips along the stream and drainage channels in the watershed.
3. Perform extensive soil testing to ensure excess phosphorus is not applied.
4. Ensure land applied manure is being properly managed and is not susceptible to runoff by implementing nutrient management plans.
5. Install pasture management practices, including proper stock density to reduce soil erosion and storm runoff.
6. Ensure proper on-site waste system operations in proximity to the main stream segments.
7. Ensure that labeled application rates of chemical fertilizers are being followed and implement runoff control measures.
8. Establish any state and federal permits and inspect permitted facilities for permit compliance.
9. Work with Missouri to reduce nutrient loading to Turkey Creek, Short Creek, and Shoal Creek. According to the Missouri Department Natural Resources, a 319-waterhsed based plan is being developed from groups in Missouri. This plan is being developed by Kansas State University, the Harry S. Truman Coordinating Council, and the Missouri Department of Natural Resources Soil and Water Conservation Program.
10. Work with Missouri to reduce nutrient loading from the Joplin wastewater treatment facilities. Consider alternative disposal such as irrigation and, if necessary, install enhanced nutrient reduction technology to reduce loading.
11. Encourage urban stormwater management in Joplin to abate pollutant loads.
12. Implement management practices through efforts of the Spring River WRAPS.

NPDES and State Permits – KDHE

a. Inspect permitted livestock facilities to ensure compliance.
b. New livestock permitted facilities will be inspected for integrity of applied pollution prevention technologies.
c. New registered livestock facilities with less than 300 animal units will apply pollution prevention technologies.

d. Manure management plans will be implemented, to include proper land application rates and practices that will prevent runoff of applied manure.
e. Collaborate with EPA and Missouri DNR to ensure Missouri permits are appropriate to meet the TMDL at the state line.
f. Promote nutrient reduction practices among Galena homeowners to manage application on lawns and gardens.

Nonpoint Source Pollution Technical Assistance – KDHE

a. Support Section 319 implementation projects for reduction of phosphorus runoff from agricultural activities as well as nutrient management.
b. Provide technical assistance on practices geared to the establishment of vegetative buffer strips.
c. Provide technical assistance on nutrient management for livestock facilities in the watershed and practices geared toward small livestock operations, which minimize impacts to stream resources.
d. Collaborate with Missouri DNR to engage the City of Joplin to discuss stormwater BMPs.
e. Support the Spring River WRAPS to install practices directed at nutrient control.

Water Resource Cost Share and Nonpoint Source Pollution Control Program-KDA-DOC

a. Apply conservation farming practices and/or erosion control structures, including no-till, terraces, and contours, sediment control basins, and constructed wetlands.
b. Provide sediment control practices to minimize erosion and sediment transport from cropland and grassland in the watershed.
c. Install livestock waste management systems for manure storage.
d. Implement manure management plans.

Riparian Protection Program – KDA-DOC

a. Establish or re-establish natural riparian systems, including vegetative filter strips and streambank vegetation.
b. Develop riparian restoration projects along targeted stream segments, especially those areas with baseflow.
c. Promote wetland construction to reduce runoff and assimilate sediment loadings.
d. Coordinate riparian management within the watershed and develop riparian restoration projects.

Buffer Initiative Program – KDA-DOC

a. Install grass buffer strips near streams.

Extension Outreach and Technical Assistance – Kansas State University

a. Educate agricultural producers on sediment, nutrient, and pasture management.

b. Educate livestock producers on livestock waste management, land applied manure applications, and nutrient management planning.
c. Provide technical assistance on livestock waste management systems and nutrient management planning.
d. Provide technical assistance on buffer strip design and minimizing cropland runoff.
e. Encourage annual soil testing to determine capacity of field to hold phosphorus.
f. Educate resident, landowners, and watershed stakeholders about nonpoint source pollution.
g. Work with Missouri on incorporating nutrient reduction in the 319 Spring River watershed plan.

Timeframe for Implementation: Pollutant reduction practices should be installed within the watershed before 2020, with follow-up implementation over 2020-2024. If biological conditions warrant, Stage Two will begin in 2030 and continue through 2040.

Targeted Participants: The primary participants for implementation will be the City of Joplin, Missouri Department of Natural Resources (MDNR), Spring River WRAPS and agricultural and livestock producers operating immediately adjacent to Shoal Creek and Short Creek. Conservation District personnel and county extension agents should assess possible sources adjacent to streams. Implementation activities to address nonpoint sources should focus on those areas with the greatest potential to impact nutrient concentrations adjacent to these creeks.

Targeted Activities to focus attention toward include:

1. Overused grazing land adjacent to the streams.
2. Sites where drainage runs through or adjacent to livestock areas.
3. Sites where livestock have full access to the stream as a primary water supply.
4. Poor riparian area and denuded riparian vegetation along the stream.
5. Unbuffered cropland adjacent to the stream.
6. Conservation compliance on highly erodible areas.
7. Total row crop acreage and gully locations.
8. Residents of Galena and Joplin, Missouri should be informed on fertilizer and waste management to reduce urban runoff loads.

Milestone for 2022: In accordance with the TMDL development schedule for the State of Kansas, the year 2022 marks the next review of the 303(d) activities in the Neosho Basin. At that point in time, phosphorus data from SC212 and SC570 should show indications of declining concentrations relative to the pre-2014 data, particularly during normal flow conditions.

Delivery Agents: The primary delivery agents for program participation will be KDHE, MDNR and the Environmental Protection Agency (EPA) to engage the City of Joplin, the City of Galena, Spring River WRAPS and Kansas State Extension.

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. 65-117d 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. 2-1915 empowers the Kansas Department of Agriculture, Division of Conservation to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

4. K.S.A. 75-5657 empowers the Kansas Department of Agriculture, Division of Conservation to provide financial assistance for local project work plans developed to control nonpoint source pollution.

5. 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.

6. 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.

7. The Kansas Water Plan and the Neosho Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority 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 area and should receive support for pollution abatement practices that lower the loading of sediment and nutrients.

Effectiveness: Nutrient control has been proven effective through conservation tillage, contour farming and use of grass waterways and buffer strips. In addition, the proper implementation of comprehensive livestock waste management plans has proven effective at reducing nutrient runoff associated with livestock facilities.

6. MONITORING

Future stream sampling will continue to occur quarterly at sampling stations SC212 and SC213. Sampling will continue to occur quarterly every four years at sampling station SC570. The monitoring will include sestonic chlorophyll sampling at SC212, SC570 and SC213. Monitoring of levels of TP during runoff events will help direct abatement efforts toward important nonpoint sources. Runoff event sampling is conducted ad hoc when conditions are favorable to capture representative runoff samples. KDHE monitors the USGS stream gage network and local rainfall to assess runoff sampling potential. Dissolved oxygen and pH will be assessed for indications of heightened primary productivity.

Commencing in 2017, macroinvertebrate sampling will occur at SC212 and SC570. The streams will be evaluated for possible delisting after Stage One implementation in 2024. If the biological endpoints are achieved over 2019-2023, the conditions described by the narrative nutrient criteria will be viewed as attained and Shoal Creek at SC212 and Short Creek at SC570 will be moved to Category 2 on the 2024-303(d) list. If they are not, Stage Two of this TMDL begins in 2030.

Once the water quality standards are attained, the adjusted ambient phosphorus concentrations on Shoal Creek and Short Creek will be the basis for establishing numeric phosphorus criteria through the triennial water quality standards process to protect the restored biological and chemical integrity of the rivers.

7. FEEDBACK

Public Notice: An active Internet Web site is established at http://www.kdheks.gov/tmdl/planning_mgmt.htm to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Neosho Basin. This TMDL was posted to the web site on April 22, 2015.

Public Hearing: A public Hearing on this TMDL was held in Frontenac on May 19, 2015 to receive public comments. The comment period was held open from May 7th through June 5th and no comments were received regarding this TMDL.

Basin Advisory Committee: The Neosho River Basin Advisory Committee met to discuss the TMDLs in the basin on March 6, 2014 in Marion.

Milestone Evaluation: In 2022, evaluation will be made as to the degree of implementation that occurred within the watershed. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: Shoal Creek at SC212 will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2015-2023. Therefore, the decision for delisting will come about in the preparation of the 2024-303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision would come in 2016, which will emphasize implementation of WRAPS activities. At that time, incorporation of this TMDL will be made into the WRAPS watershed plans. Recommendations for this TMDL will be considered in the *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2015-2023.

Nutrient Reduction Framework Priority Reduction Ranking: This watershed lies within the Spring subbasin (HUC8: 11070207), which is among the top sixteen HUC8s targeted for state action to reduce nutrients.

Rev October 5, 2015

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