NEOSHO BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody / Assessment Unit: Labette Creek
Water Quality Impairment: Total Phosphorus

1. INTRODUCTION

Subbasin: Middle Neosho

Counties: Neosho, Labette

HUC8: 11070205

HUC10 (12): **04** (01, 02, 03, 04)
05 (01, 02, 03, 04, 05)

Ecoregion: Central Irregular Plains, Osage Cuestas (40b), and Cherokee Plains (40d)

Drainage Area: Approximately 388 square miles.

Main Stem Water Quality Limited Segments and Tributaries *(Designated Uses detailed in Table 1)***:**

Main Stem	**Tributaries**
Labette Creek (22)	Tolen Creek (39)
	Little Labette Creek (23)
Labette Creek (21)	Bachelor Creek (396)
	Spring Creek (30)
	Unnamed Stream (305)
	Unnamed Stream (304)
	Unnamed Stream (303)
	Unnamed Stream (298)
Labette Creek (20)	Hackberry Creek (460)
	Lake Creek (24)
	Deer Creek (27)
	Turkey Creek (29)

Main Stem/ *Tributary*	**Segment #**	**Aquatic Life Use**	**Contact Recreation**	**Drinking Supply**	**Food Procurement**	**Ground Water Recharge**	**Industrial Water Use**	**Irrigation Use**	**Livestock Watering Use**
Labette Cr	**22**	**E**	**B**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Tolen Cr	*39*	*E*	*a*	*N*	*Y*	*N*	*N*	*Y*	*Y*
Little Labette Cr	*23*	*E*	*a*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*
Labette Cr	**21**	**E**	**C**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Bachelor Creek	*396*	*E*	*b*	*N*	*Y*	*N*	*N*	*Y*	*Y*
Spring Creek	*30*	*E*	*B*	*N*	*Y*	*Y*	*N*	*Y*	*Y*
Unnamed Stream	*305*	*E*	*b*	*Y*	*N*	*Y*	*Y*	*Y*	*Y*
Unnamed Stream	*304*	*E*	*b*	*N*	*Y*	*Y*	*N*	*Y*	*Y*
Unnamed Stream	*303*	*E*	*b*	*Y*	*N*	*Y*	*Y*	*Y*	*Y*
Unnamed Stream	*298*	*E*	*b*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*
Labette Cr	**20**	**S**	**C**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Hackberry Creek	*460*	*E*	*C*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*
Lake Creek	*24*	*E*	*C*	*Y*	*N*	*Y*	*Y*	*Y*	*Y*
Deer Creek	*27*	*E*	*b*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*
Turkey Creek	*29*	*E*	*B*	*N*	*Y*	*N*	*N*	*Y*	*Y*

Table 1. Designated uses for main stem water quality limited segments and tributaries. Y = Yes (use is designated); N = No (use is not designated); E=Expected aquatic life; S=Special Aquatic Life

303(d) Listings: Station SC564, Labette Creek near Labette (**Figure 1**): 2008, 2010, 2012, and 2014 listed for Total Phosphorus (TP) impairment, Neosho River Basin Streams; SC571 Labette Creek near Chetopa currently and historically not impaired for TP; SC214 Neosho River near Chetopa currently and historically not impaired for TP, 2014 listed for Biology impairment, Neosho River Basin Streams.

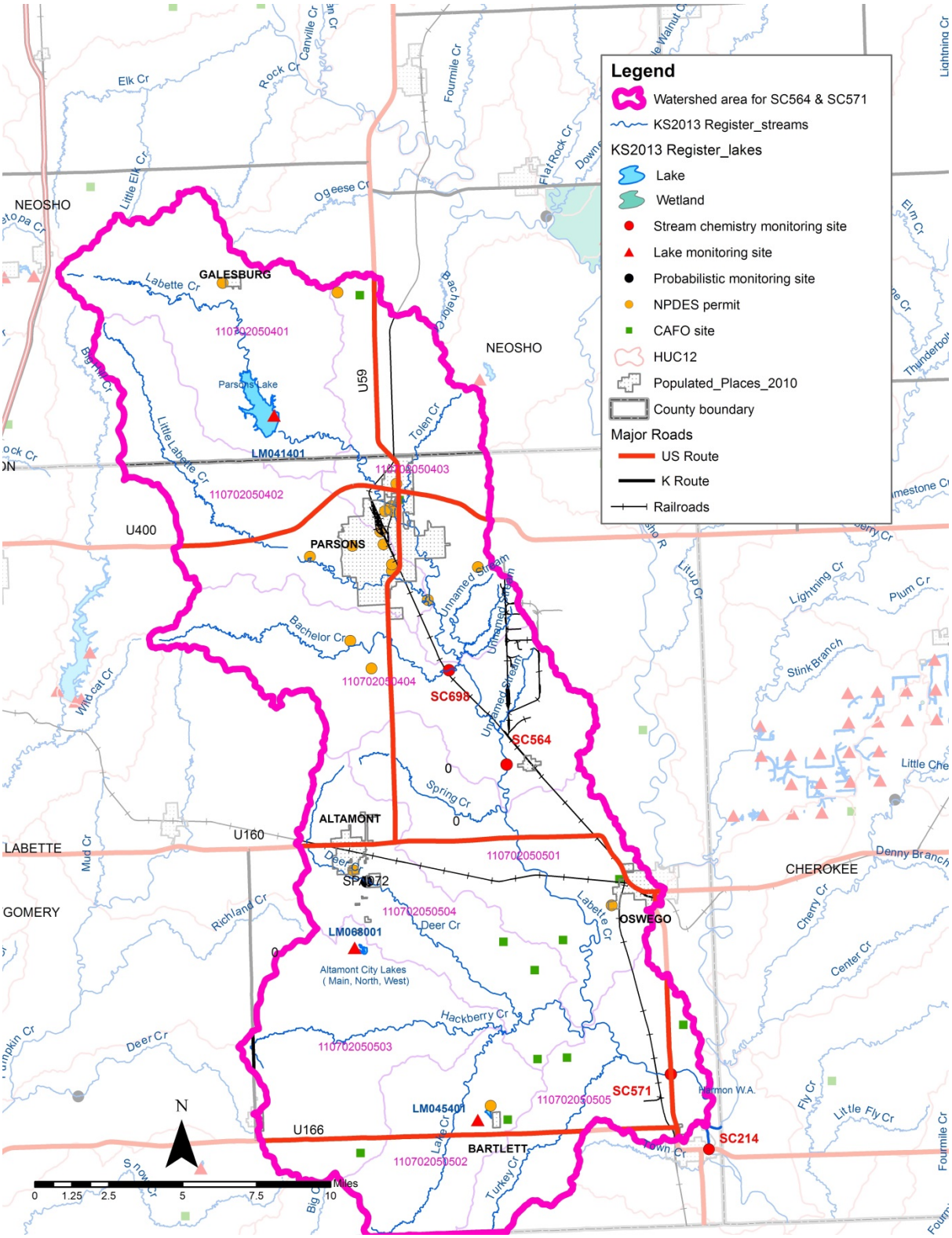


Figure 1. Labette Creek Watershed Map.

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

Water Quality Criteria:
Nutrients – Narratives: The introduction of plant nutrients 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)).

2. CURRENT WATER QUALITY CONDITIONS AND DESIRED ENDPOINT

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

Stream Monitoring Sties and Period of Record:
Station SC564: Active KDHE permanent station located on Labette Creek at a county road bridge 0.75 miles west of Labette. Period of Record: 4/10/1990 through 8/11/2014.

Station SC571: Active KDHE permanent station located on Labette Creek at a US59 highway bridge 2.0 miles north of Chetopa. Period of Record: 4/10/1990 through 8/11/2014.

Station SC698: Inactive KDHE rotational station located on Bachelor Creek at a county road bridge 1.5 miles west of Labette. Period of Record: 1/7/1997 through 12/2/2008.

Station SC214: Active KDHE permanent station located on the Neosho River at a US166 highway bridge 0.5 miles east of Chetopa. Period of Record: 1/31/2006 through 8/11/2014.

Station SB214: Active KDHE biological station located on the Neosho River at a US166 highway bridge 0.5 miles east of Chetopa. Period of Record: 9/6/1990 through 6/6/2012.

Flow Record: Daily estimated flows at USGS gage 07183500 on the Neosho River near Parsons (1/1/1974-10/31/14) and USGS gage 07185000 on the Neosho River near Commerce, OK (1/1/1974-10/31/2014) were used to estimate flow conditions in Labette Creek at SC564 and SC571. Long term estimated flows for Labette Creek and its tributaries (Perry, et al., 2004) are displayed in **Table 2**.

Stream	CUSEGA	USGS Site ID	County	Drainage Area (mi^2)	Flow (cfs)						
					Mean	90%	75%	50%	25%	10%	2-year Peak
Labette Cr	22	4593	NO	8.73	9.32	0	0.01	1.39	4.52	12.2	1,580
Labette Cr	22	4671	NO	26.2	25.3	0	0.48	3.58	12.4	34.6	2,970
Labette Cr	22	4818	LB NO	54.5	47.5	0	1.20	6.52	22.9	66.1	4,240
Tolen Cr	39	4817	LB NO	21.4	18.5	0	0.09	2.19	7.93	23.2	2,590
Labette Cr	22	4860	LB	81.8	66.7	0	1.73	8.75	31.3	92.9	5,210
Little Labette Cr	23	4845	LB NO	35.4	31.4	0	0.48	3.91	14.3	41.7	3,460
Little Labette Cr	23	4862	LB	44.4	38.4	0	0.71	4.80	17.5	51.4	3,700
Labette Cr	21	4873	LB	127	99.7	0.18	2.68	12.9	46.8	142	6,770
Unnamed Trib	305	4872	LB	7.73	7.11	0	0	0.63	2.54	8.02	1,460
Labette Cr	21	4900	LB	136	106	0.25	2.85	13.6	49.5	151	6,870
Unnamed Trib	304	4899	LB	2.87	2.32	0	0	0	0.15	1.65	826
Labette Cr	21	4902	LB	139	108	0.27	2.90	13.8	50.3	154	6,970
Unnamed Trib	303	4906	LB	5.05	4.58	0	0	0.26	1.29	4.64	1,150
Labette Cr	21	4917	LB	144	111	0.32	2.99	14.3	51.9	159	7,080
Bachelor Cr	396	4929	LB	33.4	31.7	0	0.48	4.04	14.8	42.9	3,480
Labette Cr	21	4990	LB	182	140	0.62	3.82	18.0	65.9	204	7,920
Unnamed Trib	298	4989	LB	11.2	10.3	0	0	1.00	3.97	12.1	1,850
Labette Cr	21	5066	LB	202	154	0.77	4.19	19.7	72.2	226	7,830
Spring Cr	30	5075	LB	18.7	17.9	0	0	1.99	7.61	22.5	2,570
Labette Cr	21	5231	LB	248	188	1.16	5.15	24.0	88.4	279	8,330
Lake Cr	24	5407	LB	30.1	26.4	0	0.24	2.98	11.2	33.4	4,860
Hackberry Cr	460	5271	LB	32.3	26.5	0	0.01	2.43	10.0	31.5	4,090
Lake Cr	24	5245	LB	63.9	50.9	0	0.78	5.38	20.9	65.0	6,180
Deer Cr	27	5225	LB	43.4	39.2	0	0.50	4.41	17.1	51.5	4,820
Lake Cr	24	5250	LB	113	88.9	0	1.81	9.82	38.0	120	8,200
Labette Cr	20	5262	LB	364	268	2.11	7.36	34.1	126	408	11,000
Turkey Cr	29	5408	LB	26.6	23.8	0	0.08	2.54	9.86	29.7	3,200
Labette Cr	20	5326	LB	399	292	2.42	8.06	37.2	138	447	11,300

Table 2. Long term estimated flows for Labette Creek and its tributaries (Labette and Neosho Counties, Perry et al., 2004).

Table 3 displays estimated contributions of flow from tributaries and intervening areas along the Neosho River between Parsons, Kansas and Commerce, Oklahoma from daily data measured at the USGS gages between 1974 and 2014. **Figure 2** displays annual flows during that time period at the area USGS gages.

Stream or Station	Drainage Area (mi^2)	90% (cfs)	75% (cfs)	50% (cfs)	25% (cfs)	10% (cfs)
USGS 07183500 Neosho River near Parsons, KS	4,905	47	132	790	3,490	8,870
Intervening area and flow below the Parsons gage	120	2.0	7.9	34	122	286
Neosho River near Oswego – SC566	5,025	49	140	824	3,612	9,156
Cherry Creek – SC605	128	2.1	8.4	36	130	305
SC571 Labette Creek near Chetopa	388	6.5	26	110	396	924
Intervening Area and flow between Neosho R-Oswego and Labette Cr-Chetopa	284	4.7	19	81	289	676
Neosho River near Chetopa – SC214	5,825	62	192	1,051	4,428	11,060
USGS 07185000 Neosho River near Commerce, OK	5,926	64	199	1,080	4,530	11,300

Table 3. Flow contributions to the Neosho River between Parsons, KS and Commerce, OK from tributaries and intervening areas over 1974 – 2014. All flows based on relative contribution based on watershed size as measured at USGS gages at Parsons and Commerce, OK.

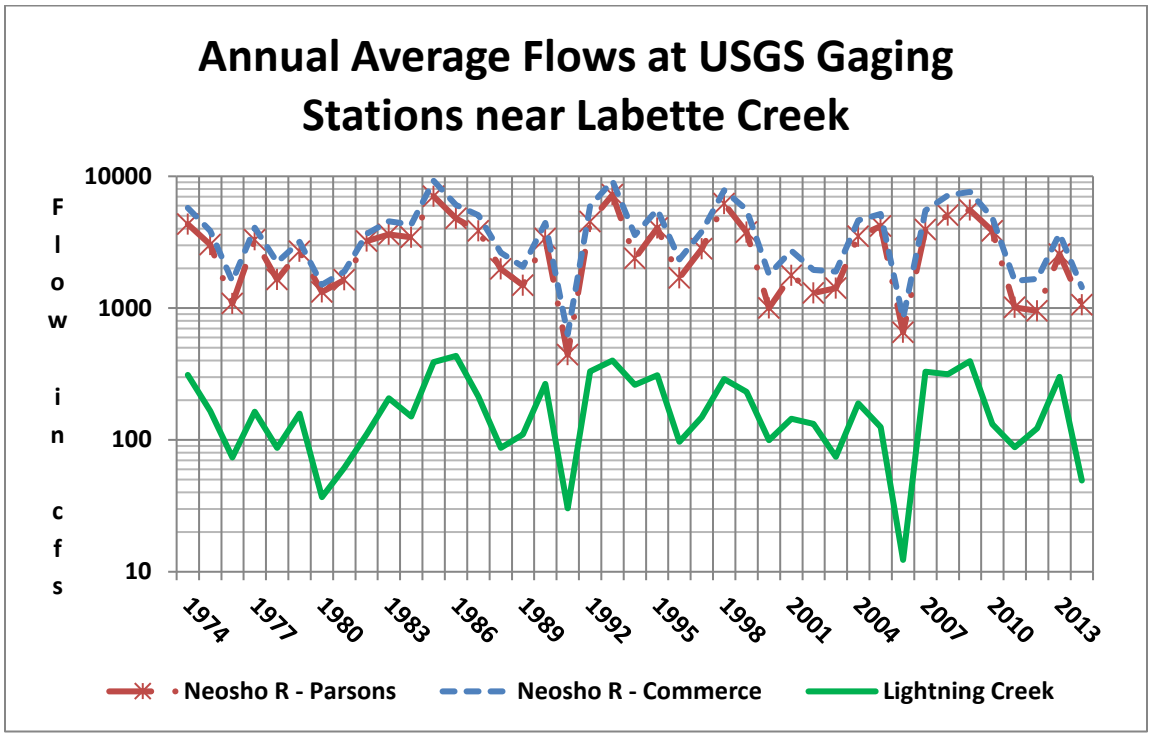


Figure 2. Annual average flows (1974- 2014) at USGS gaging stations on Lightning Creek (surrogate for Labette Creek) and the Neosho River near Parsons, KS and Commerce, OK.

For the purposes of developing the total phosphorus TMDL in Labette Creek, flows from Lightning Creek were used to estimate flows on Labette Creek in the vicinity of SC564. Concurrent gaging records (1938-1945) between the Lightning Creek near McCune station (07184000) and an old station on Labette Creek (07184500) were summarized into common flow percentiles. Regressions of Labette Creek flows on Lightning Creek flows at a common flow percentile were then performed. Displays of the concurrent flow percentiles and regression lines can be seen in Appendix A. Three regression equations were used to estimate Labette Creek flows.

1. For Lightning Creek flows below 70 cfs, the average of results from
   *Labette Q = 1.34+1.02*Lightning Q* **(R2= 0.996; MSE=19)** and;
   *Labette Q = 10^[0.232+0.896*log(Lightning Q)]* **(R2=0.962; MSE=0.032)**
2. For Lightning Creek flows between 70 cfs and 300 cfs,
   *Labette Q = 1.34+1.02*Lightning Q* **(same as above)**
3. For Lightning Creek flows over 300 cfs,
   *Labette Q = 10^[0.041+1.01*log(Lightning Q)]* **(R2=0.988; MSE = 0.0029)**

Results then were increased by the ratio of drainage area between SC564 and SC571 near the mouth (388 sq.mi./212 sq.mi.).

Phosphorus: Phosphorus concentrations have been highest on upper Labette Creek (SC564), likely because of large contributions from wastewater from the City of Parsons in the past **(Figure 3**). Those contributions diminished once Parsons installed and operated Biological Nutrient Removal technology in their upgraded wastewater treatment plant. Recent samples from the Neosho River near Chetopa downstream from the confluence of Labette Creek show similar concentrations of phosphorus to those seen at the outlet of the Labette Creek watershed.

Looking at annual median values, a clear pattern of decline emerges for upper Labette Creek (SC564) and recent decreases in phosphorus at the lower station (SC571) on Labette Creek near Chetopa **(Figure 4)**. A station on Bachelor Creek (SC698), a tributary watershed entering Labette Creek above SC564 show phosphorus in that largely rural watershed to be indistinguishable from the lower outlet station, SC571. Median phosphorus on the Neosho River near Chetopa (SC214) shows wider range of values than seen on Labette Creek. Other factors are likely influencing the phosphorus levels seen on the Neosho River as it approaches the Oklahoma stateline.

Discharge monitoring records from the Parsons wastewater treatment plant show a marked decline in effluent phosphorus with the upgrades to treatment technology **(Figure 5).** Marked assimilation of phosphorus through adsorption to sediments and uptake by stream plankton and macrophytes can be observed by the rapid falloff of concentrations from the Parsons outfall to the SC564 downstream. There is some apparent decrease in concentrations of phosphorus seen at SC564 since the Parsons upgrade but nothing significant at the lower SC571 station. Currently the phosphorus levels seen at the two Labette Creek stations are comparable to each other and to concentrations seen on the Neosho River near Chetopa.

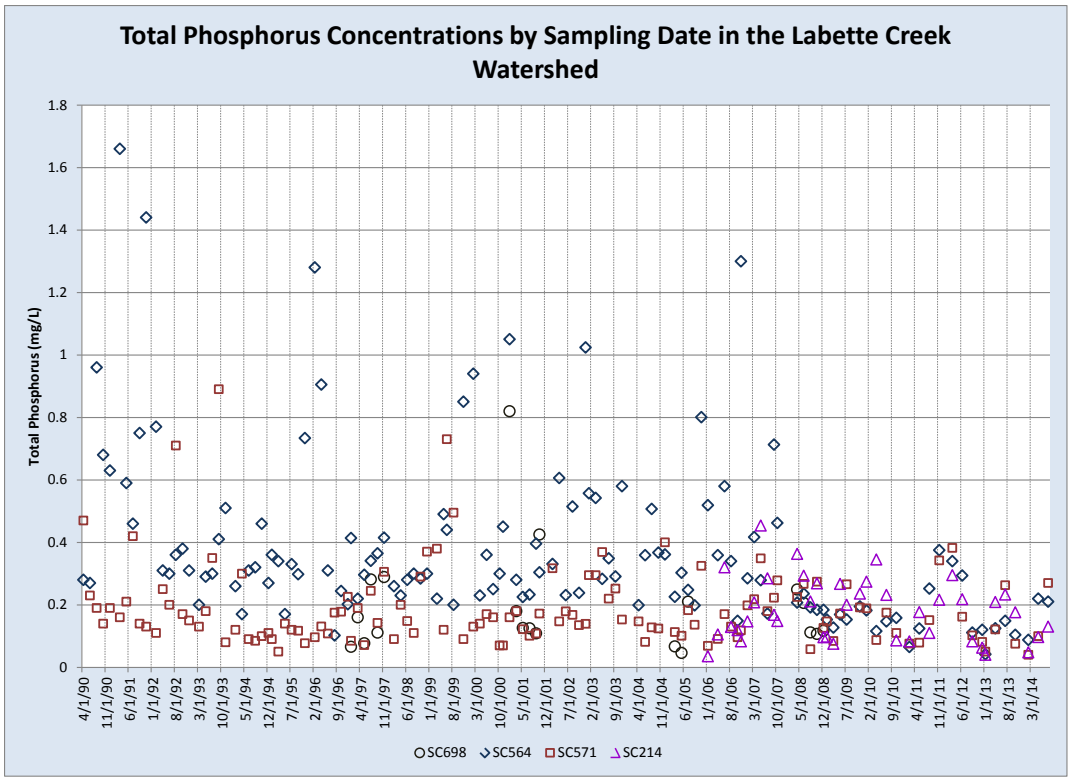


Figure 3. Total Phosphorus (TP) concentrations in the Labette Creek watershed and in the Neosho River near Chetopa.

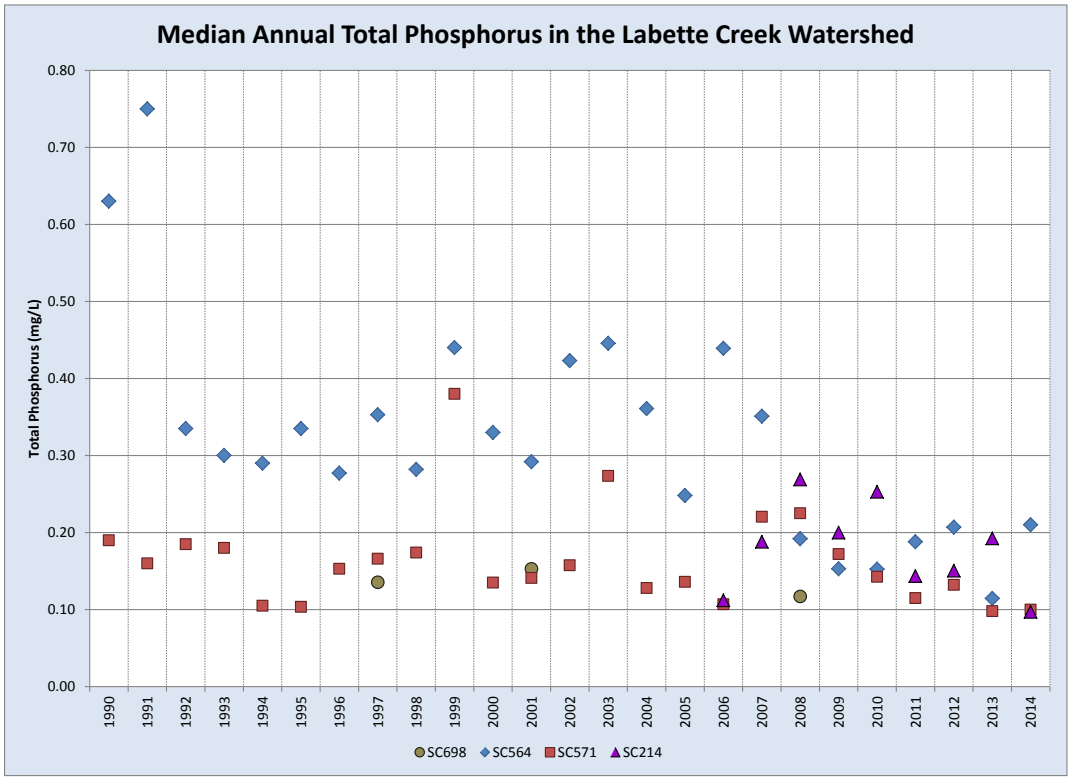


Figure 4. Median annual total phosphorus in the Labette Creek watershed and in the Neosho River near Chetopa.

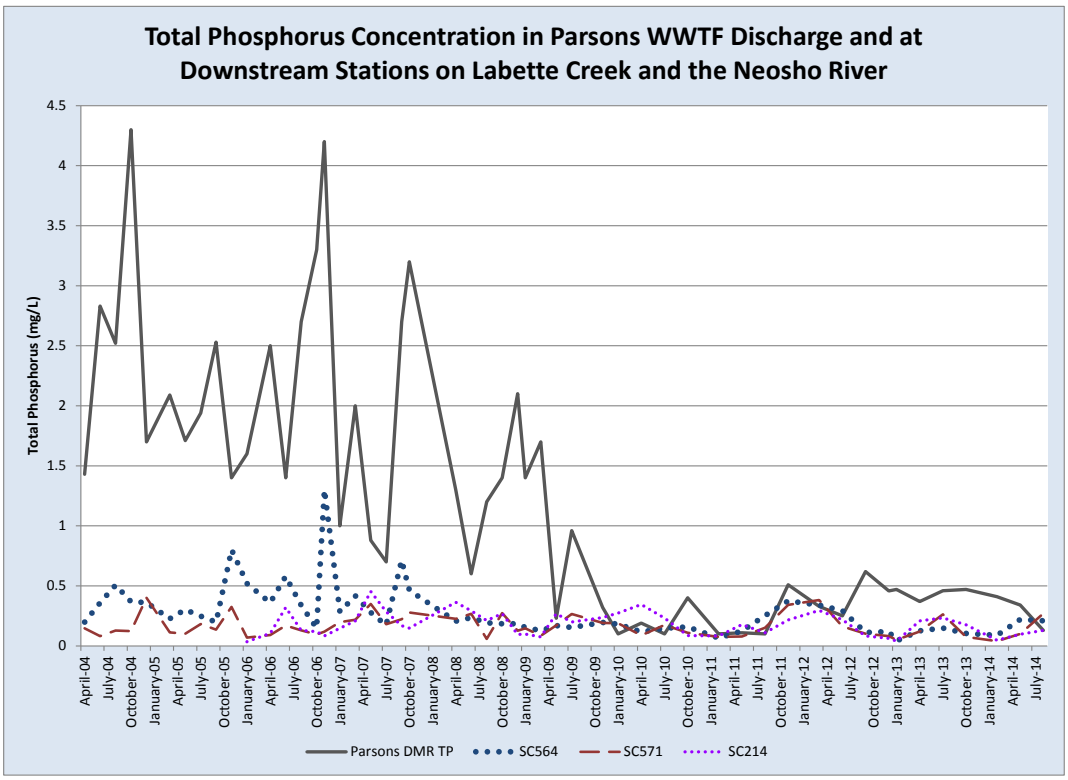


Figure 5. Monthly average TP in Labette Creek at SC564 and SC571 and in the City of Parsons WWTF discharge.

Table 4 displays the median and average concentrations of phosphorus at the Labette Creek watershed stations and the Neosho River near Chetopa. Overall statistically, there has been a significant difference in phosphorus concentrations between SC564 and SC571. Most of that difference has been among the data prior to 2008-09. From 2009 to 2014, the phosphorus levels at the upstream station, SC564 have been slightly greater than those at the downstream SC571, but the difference is not significant. While the phosphorus concentrations at SC564 are significantly different between the time periods 1990-2008 and 2009-2014, any decrease in concentrations seen since 2009 at SC571 is not significant, i.e., the averages for the two periods at the downstream station are not significantly different. There is also no significant difference between phosphorus levels at the SC571 outlet and on the Neosho River near Chetopa over the period 2006-2014, although the river will see higher concentrations at times than the creek.

Month-to-month, the older sample median values from SC564 were clearly the largest on Labette Creek and, most often, exceeded medians on the Neosho River (**Figure 6**). At the lower station on Labette Creek, SC571, older medians tended to be higher than recent medians for more months. The same situation occurs on the Neosho River at SC214. Recent medians are higher on the river than the creek during the early months (Jan – June), but that reverses during the lower flow periods over July through December.

	Total Phosphorus (mg/L)							
	SC698		SC564		SC571		SC214	
	Average	Median	Average	Median	Average	Median	Average	Median
1990	*	*	0.564	0.630	0.244	0.190	*	*
1991	*	*	0.980	0.750	0.212	0.160	*	*
1992	*	*	0.405	0.335	0.265	0.185	*	*
1993	*	*	0.342	0.300	0.326	0.180	*	*
1994	*	*	0.298	0.290	0.134	0.105	*	*
1995	*	*	0.372	0.335	0.099	0.104	*	*
1996	*	*	0.507	0.277	0.152	0.153	*	*
1997	0.164	0.1355	0.342	0.353	0.173	0.166	*	*
1998	*	*	0.276	0.282	0.201	0.174	*	*
1999	*	*	0.440	0.440	0.363	0.380	*	*
2000	*	*	0.422	0.330	0.123	0.135	*	*
2001	0.24	0.13	0.415	0.292	0.141	0.141	*	*
2002	*	*	0.491	0.423	0.181	0.158	*	*
2003	*	*	0.434	0.446	0.264	0.274	*	*
2004	*	*	0.359	0.361	0.176	0.128	*	*
2005	0.13	0.13	0.355	0.248	0.172	0.136	*	*
2006	*	*	0.541	0.439	0.112	0.107	0.132	0.112
2007	*	*	0.388	0.351	0.241	0.221	0.235	0.188
2008	0.16	0.12	0.201	0.192	0.190	0.225	0.246	0.269
2009	*	*	0.159	0.153	0.172	0.172	0.175	0.200
2010	*	*	0.151	0.153	0.140	0.143	0.234	0.253
2011	*	*	0.204	0.188	0.162	0.115	0.147	0.144
2012	*	*	0.216	0.207	0.182	0.132	0.165	0.151
2013	*	*	0.105	0.115	0.127	0.098	0.165	0.193
2014	*	*	0.173	0.210	0.137	0.100	0.092	0.097
1990-2008	0.174	0.126	0.428	0.320	0.198	0.153	0.204	0.168
2009-2014	*	*	0.168	0.151	0.153	0.134	0.168	0.177

*Data not available

Table 4. Average and median annual total phosphorus concentrations at KDHE sampling stations in the Labette Creek watershed.

Perhaps lower flow conditions put a premium on the proximity of sources to influence the conditions seen on the river, hence, Labette Creek becomes more significant during those times. Recent medians are very close between the two Labette Creek stations. The same patterns appear when months are aggregated into seasons (**Figure 7**).

When framed by flow conditions (**Figure 8**), SC564 on upper Labette Creek shows definitive influence by Parsons' wastewater. The highest phosphorus concentrations are seen at the lowest flows when the streamflow has a high proportion of effluent from the city. After 2009, the concentrations at low flow moderated, reflecting lower levels coming out of the wastewater treatment plant. There is an increase during runoff conditions as well, but it is dwarfed by the low flow dominance of past wastewater and recent years have been marked by pervasive dry conditions limiting sampling of runoff events. Conversely, runoff seems to be the primary factor in high phosphorus at SC571 on the lower Labette Creek or at SC214 on the Neosho River (**Figures 9 & 10**)

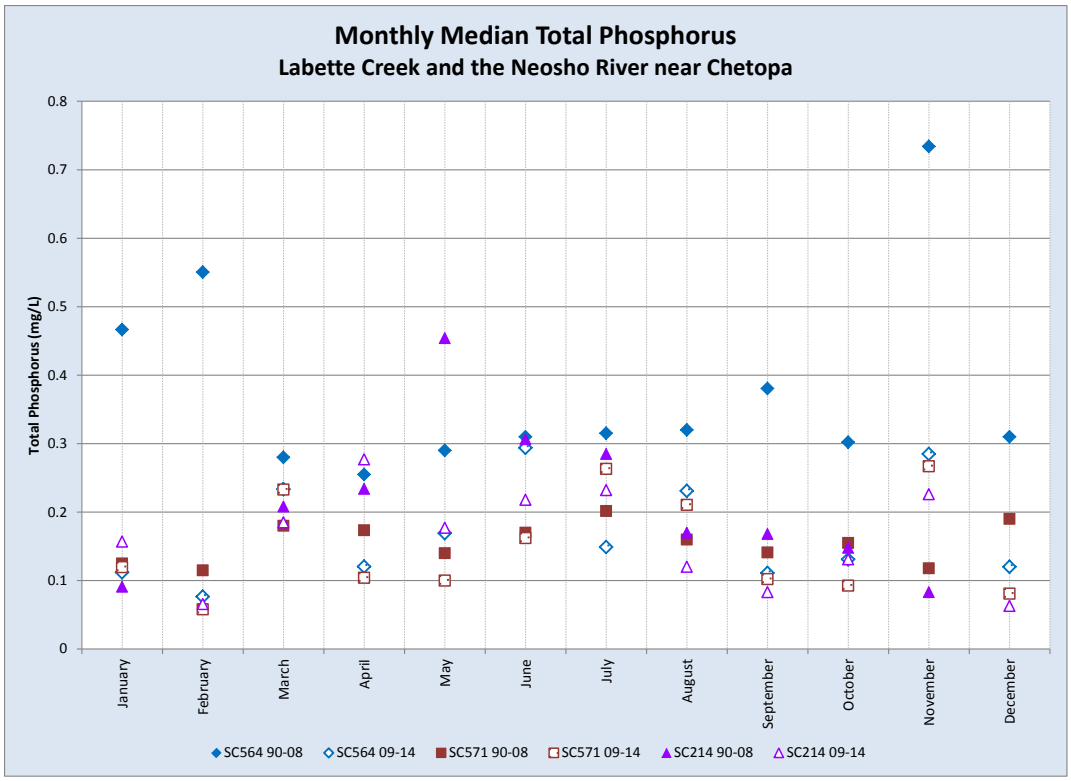


Figure 6. Median total phosphorus by month in Labette Creek at SC564 and SC571 and in the Neosho River at SC214. Period of record is split between 1990-2008 and 2009-2014 to reflect the improvement in the effluent TP concentration from the Parsons WWTF.

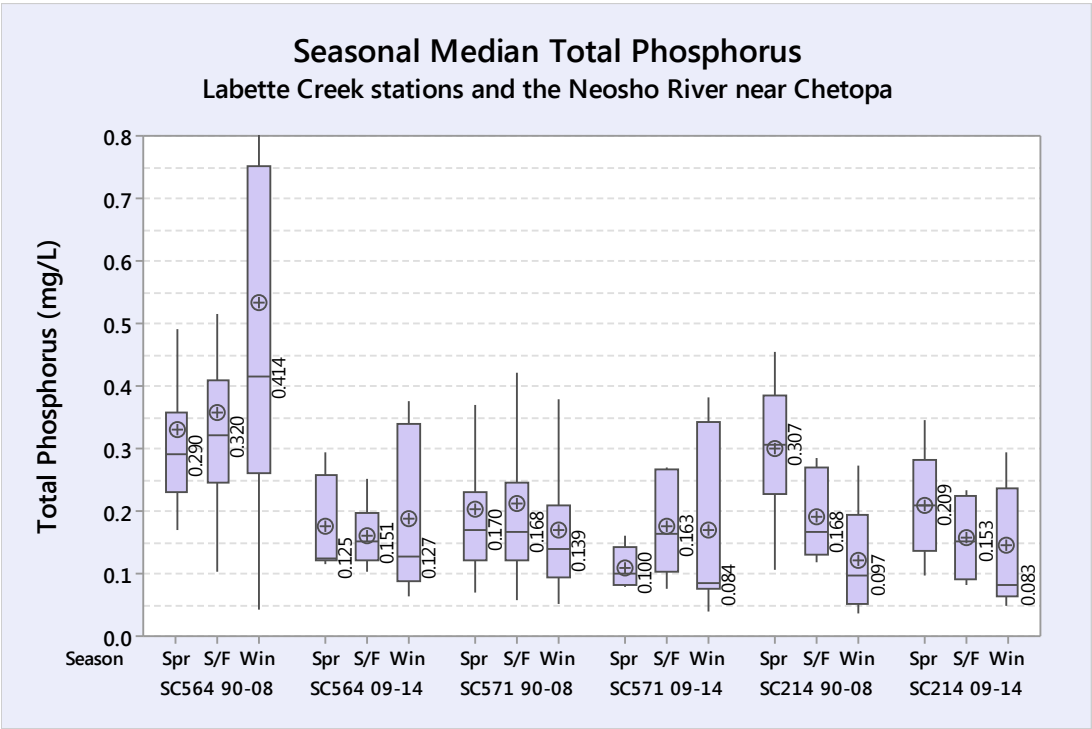


Figure 7. Median total phosphorus by season in Labette Creek at SC564 and SC571 and in the Neosho River at SC214.

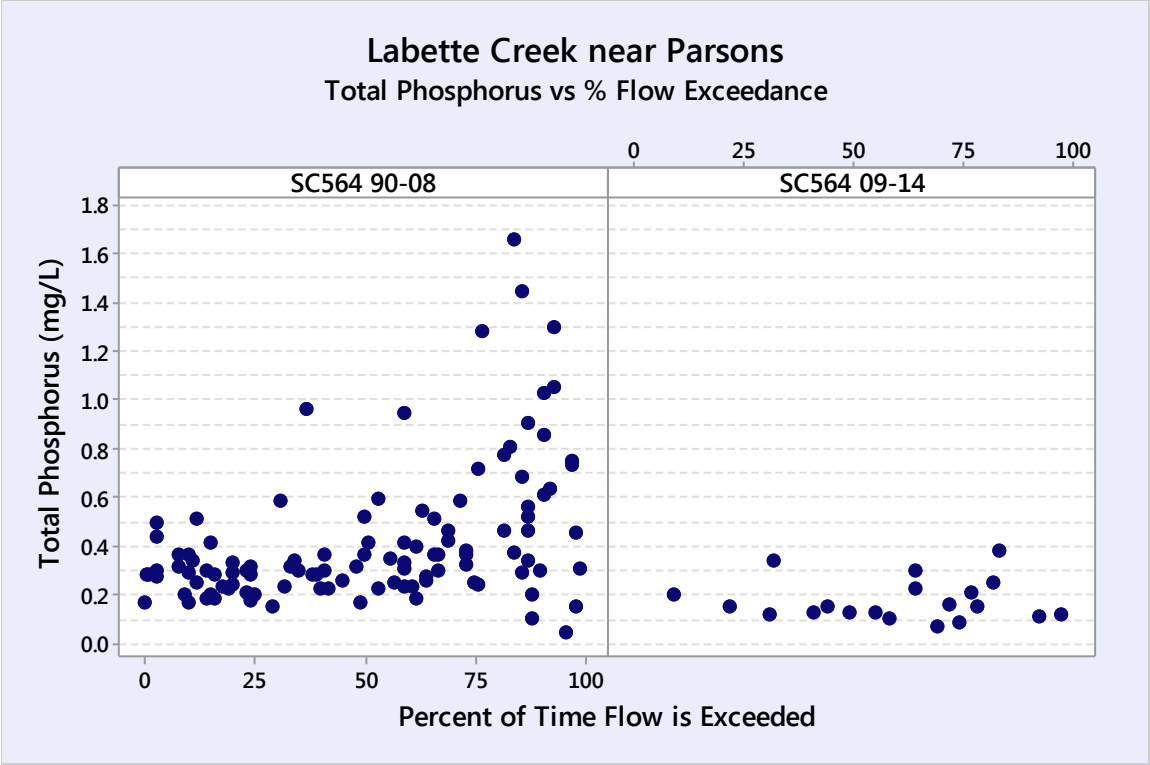


Figure 8. Total phosphorus concentrations versus percent flow exceedance in Labette Creek at SC564 on day of sampling.

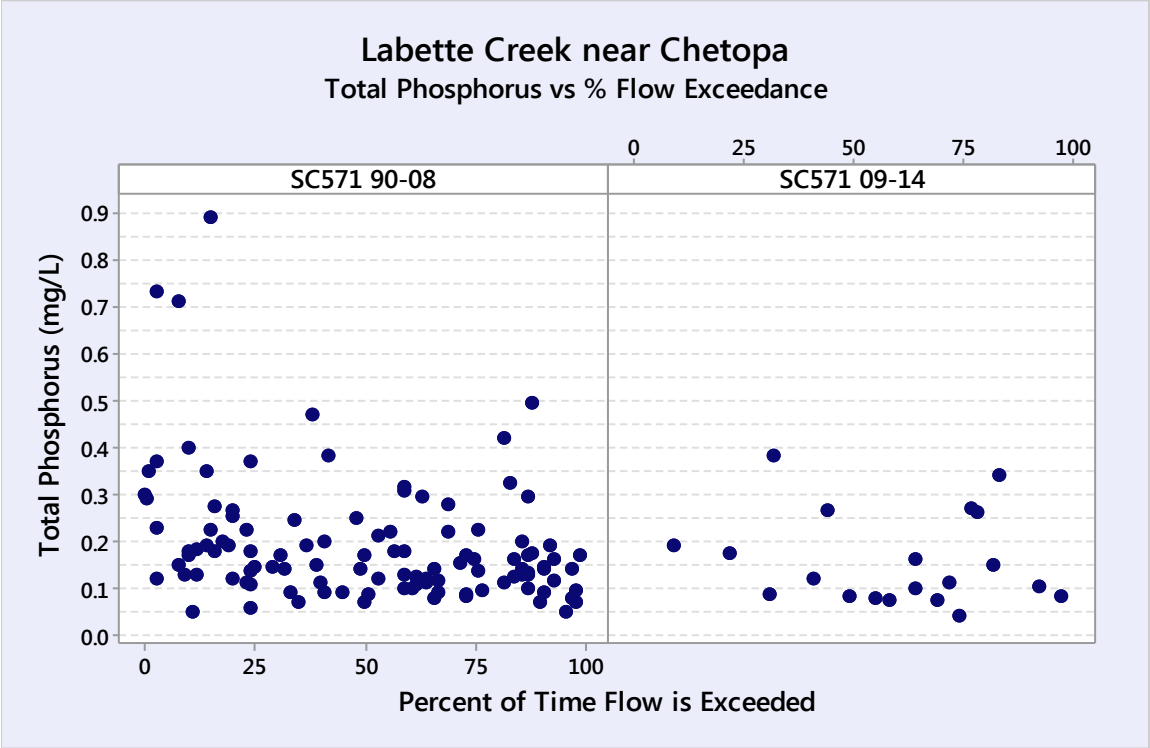


Figure 9. Total phosphorus concentrations versus percent flow exceedance in Labette Creek at SC571 on day of sampling.

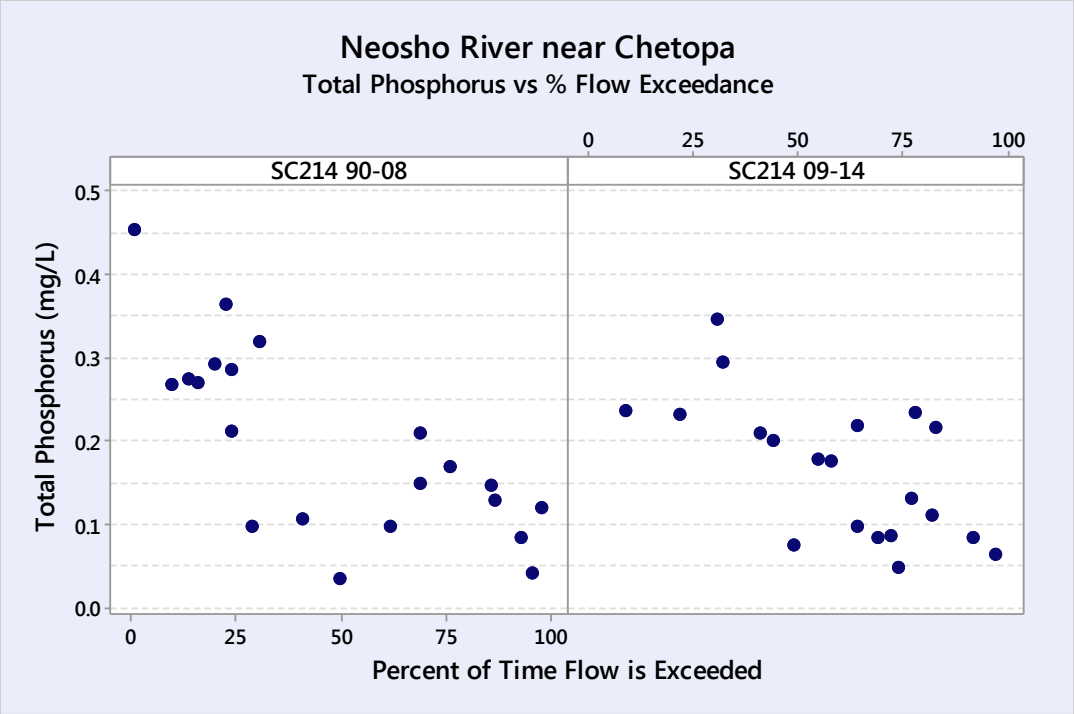


Figure 10. Total phosphorus concentrations versus percent flow exceedance in the Neosho River at SC214 on the day of sampling.

Chlorophyll *a* concentrations taken in Labette Creek at SC564 and in the Neosho River at SC214 are displayed in **Figure 11**. Annual average chlorophyll *a* concentrations in Labette Creek at SC564 have deteriorated over the period of record from an average of 12.5 µg/L over the 1990-2008 period to an average 16.2 µg/L during the 2009-2014 time period (**Table 5**). Average Chlorophyll *a* in the Neosho River for the 2010-2014 period of record is 13.2 µg/L.

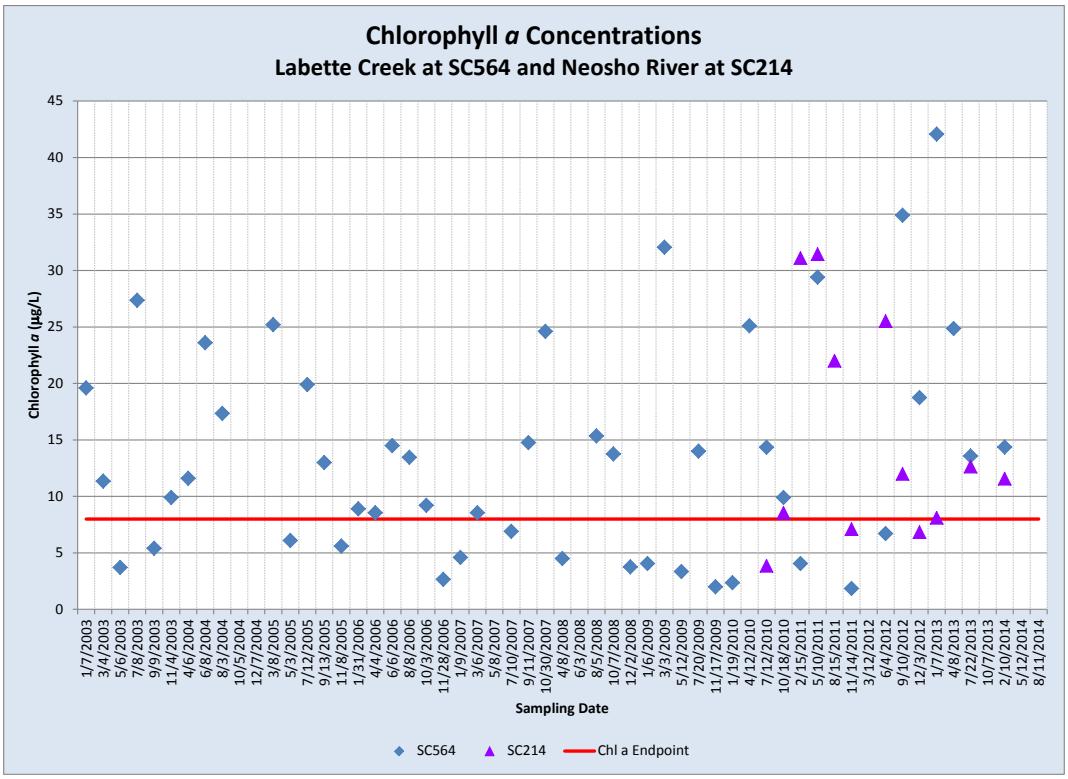


Figure 11. Chlorophyll *a* concentrations in Labette Creek near Parsons and in the Neosho River near Chetopa for the period of record.

Chlorophyll *a* (µg/L)		
Year	**SC564**	**SC214**
2003	12.9	*
2004	17.5	*
2005	14.0	*
2006	9.5	*
2007	11.9	*
2008	9.3	*
2009	11.1	*
2010	12.9	6.2
2011	11.8	22.9
2012	20.1	14.8
2013	26.8	10.4
2014	14.4	11.6
1990-2008 Average	12.5	*
2009-2014 Average	16.2	13.2
1990-2014 Average	14.4	13.2

Table 5. Annual average chlorophyll *a* at SC564 on Labette Creek and SC214 on the Neosho River. *No data available.

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 12**, TSS and TP show a strong correlation at SC571 and at SC214 both before and after the upgrade to the Parsons WWTF. In streams influenced by wastewater effluent, the correlation between TSS and TP deteriorates due to TP concentrations outpacing the TSS concentration in the stream as can be seen in the relationship between TSS and TP at SC564 during the 1990-2008 time period. The improvement in the relationship at SC564 after the upgrade at Parsons is indicative of improved phosphorus loading to Labette Creek near Parsons.

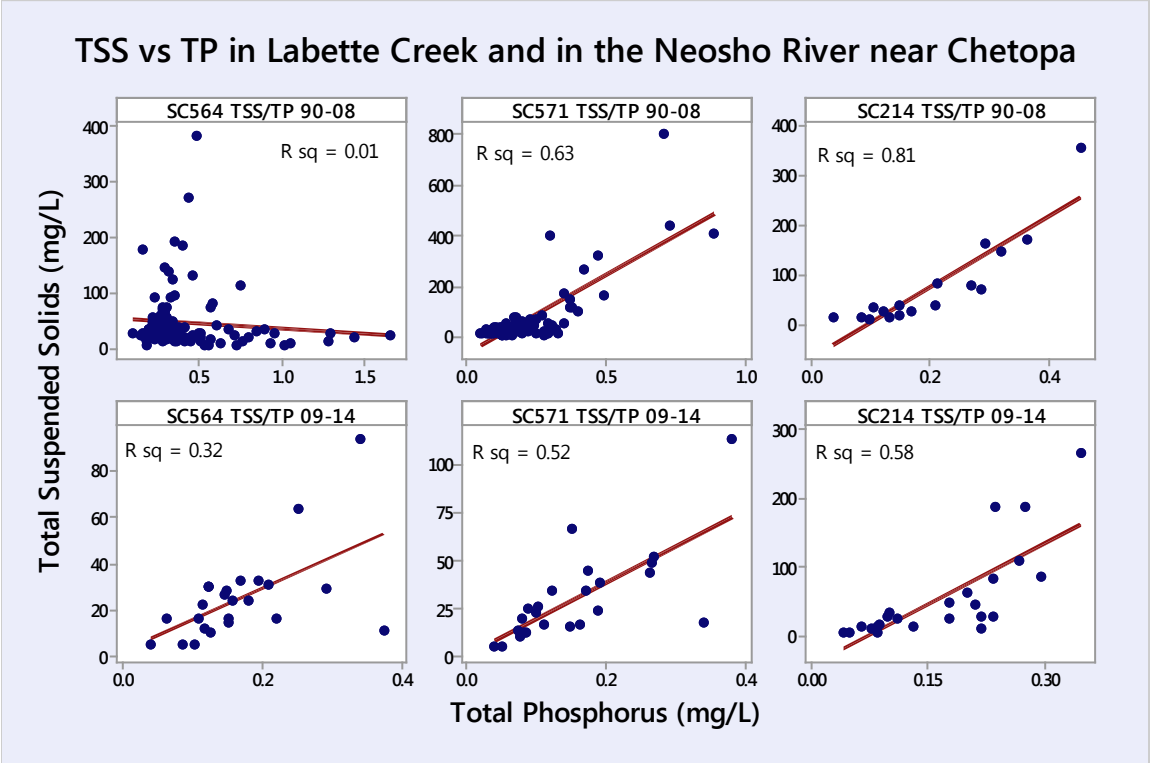


Figure 12. Relationship of total phosphorus and total suspended solids at SC564, SC571, and SC214.

Relationship between Phosphorus and Biological Indicators: The narrative criteria of the Kansas Water Quality Standards are based on conditions of the prevailing biological community. Excessive primary productivity may be indicated by extreme swings in dissolved oxygen or pH as the chemical reaction of photosynthesis and respiration alter the ambient levels of oxygen or acid-base balance of the stream. Dissolved oxygen is inversely related to the ambient temperature in the stream at SC564, SC571, and SC214 as displayed in **Figures 13, 14, and 15**, respectively.

To discount the impacts of temperature on the solubility of oxygen in the water column, the percent of saturated dissolved oxygen was computed from the data collected at the Labette Creek and Neosho River near Chetopa station (**Figure 16**). A seasonal pattern remained with a high percentage of dissolved oxygen saturation seen during cooler months while declines in percent saturation are associated with summer months (**Table 14**).

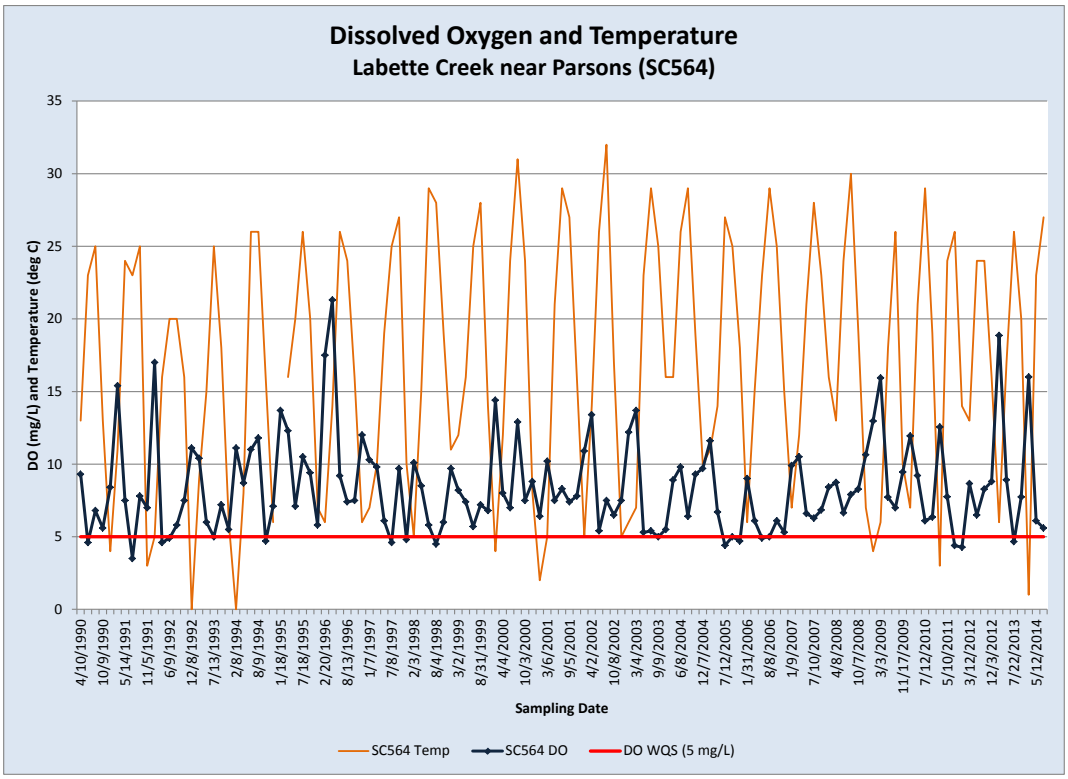


Figure 13. Dissolved oxygen concentrations and temperature over time in Labette Creek near Parsons (SC564) for the period of record.

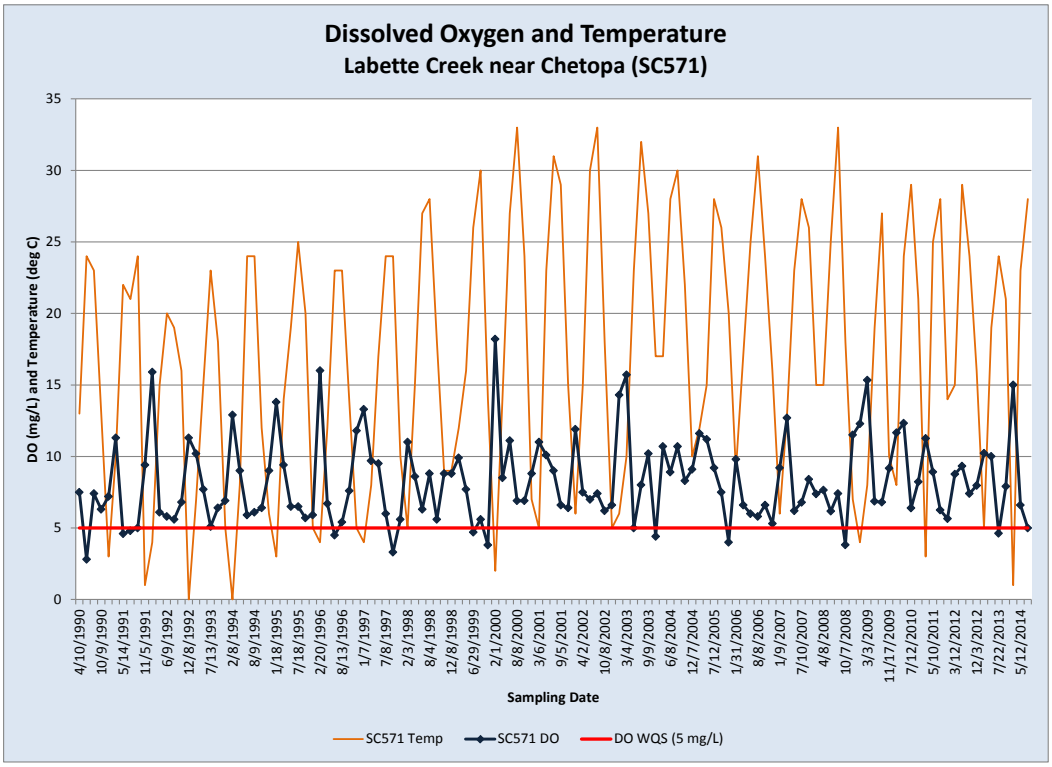


Figure 14. Dissolved oxygen concentrations and temperature over time in Labette Creek near Chetopa (SC571) for the period of record.

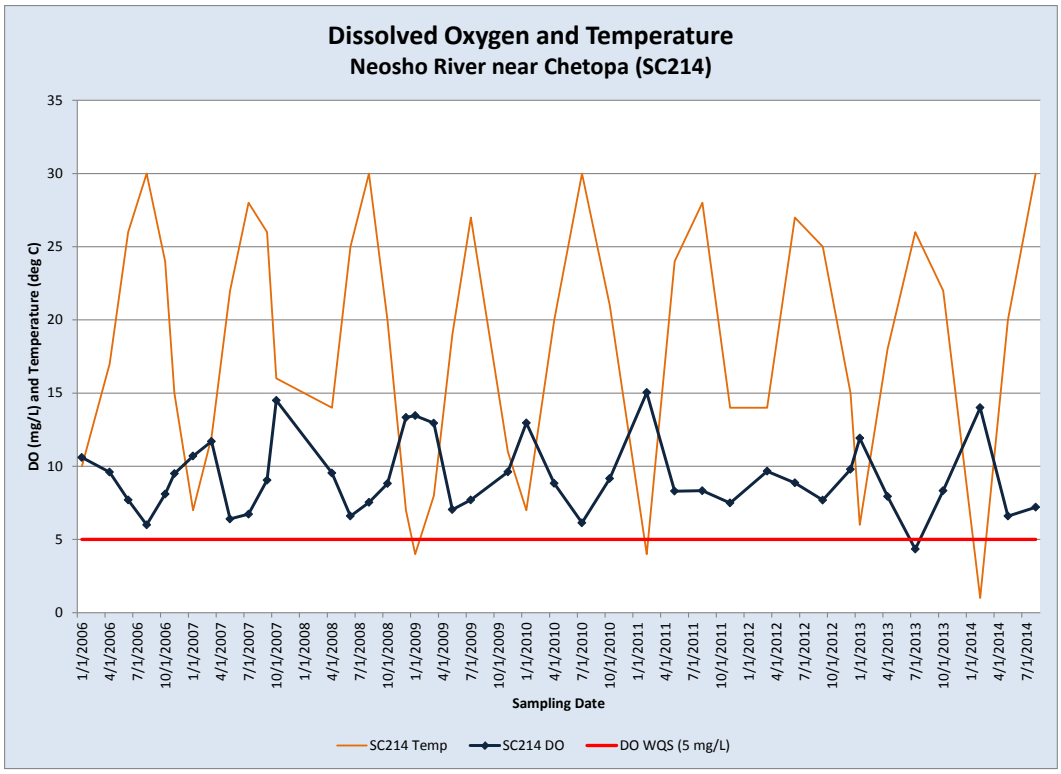


Figure 15. Dissolved oxygen concentrations and temperature over time in the Neosho River near Chetopa (SC214) for the period of record.

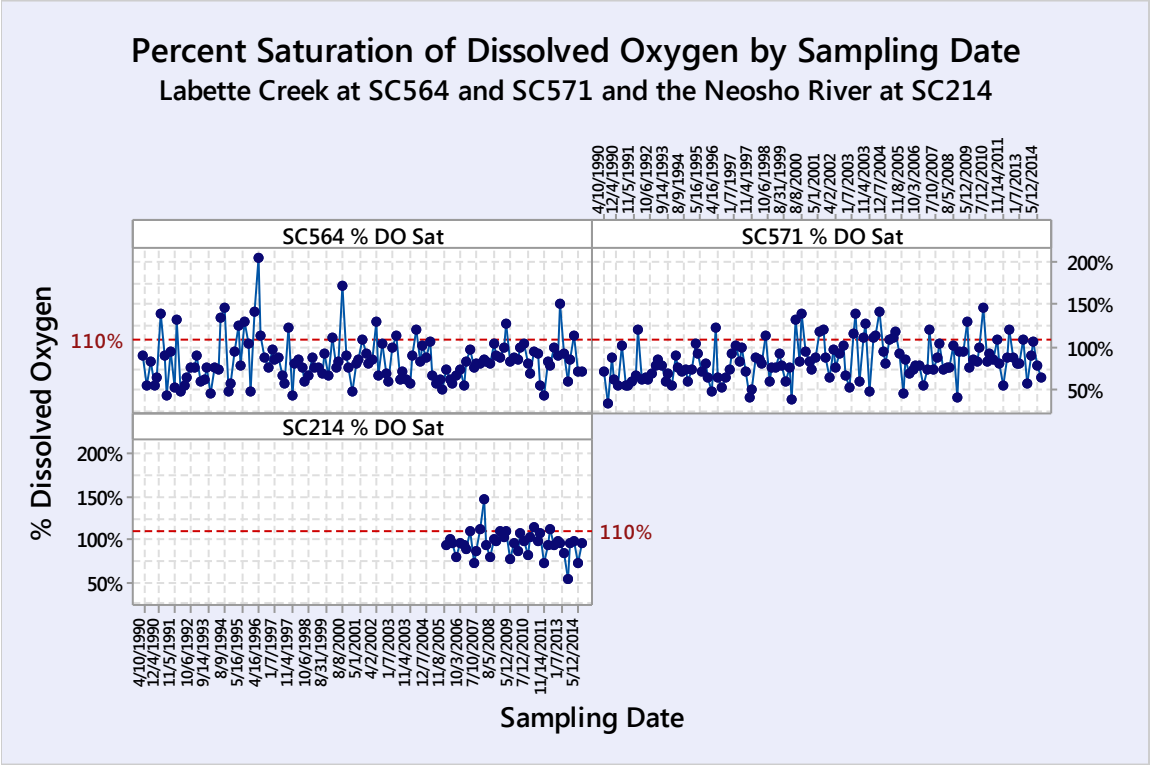


Figure 16. Dissolved oxygen saturation at SC564, SC571, and SC214 by sampling date for the period of record.

Higher pH values tend to occur during periods when photosynthesis is ramped up. At SC564 and SC571, pH has exceeded the criterion of 8.5 six times over the period of record with the last exceedance occurring in 2002 at SC564 and in 2004 at SC571 (**Figure 17**). The pH at SC214 did not exceed 8.5 for the period of record.

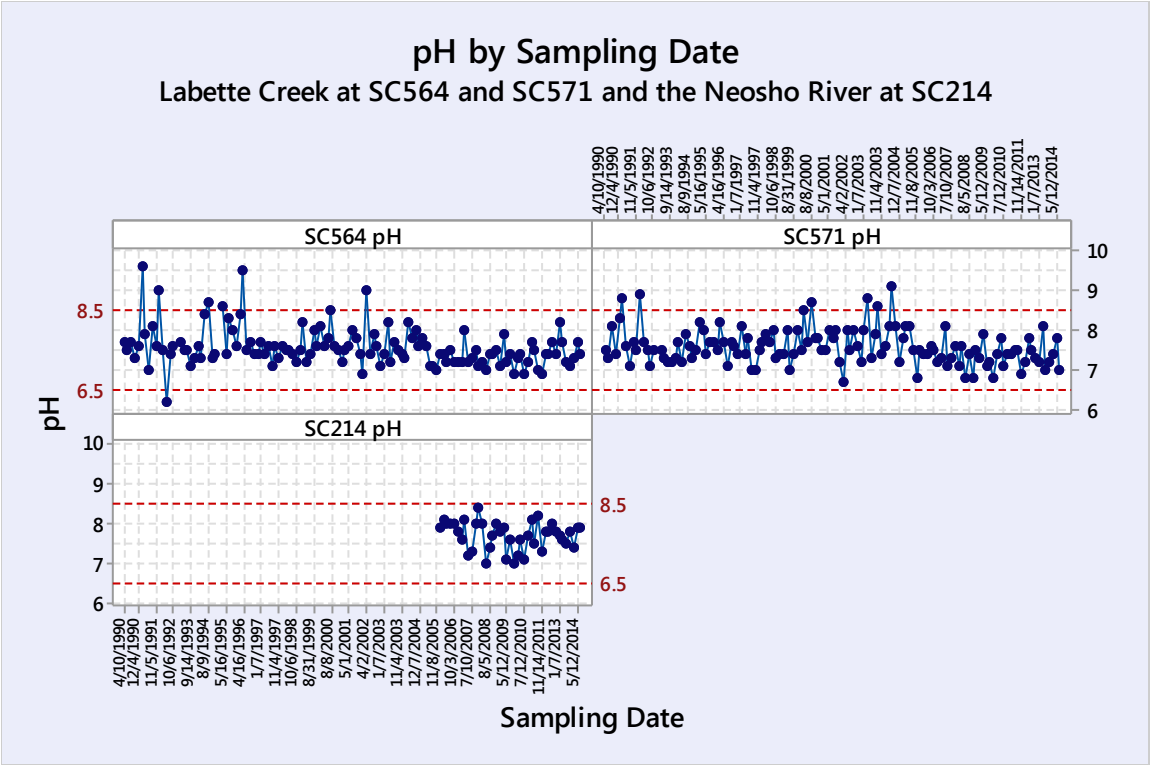


Figure 17. pH at SC564, SC571, and SC214 by sampling date.

Parameter	Site	Season		
		Spring	Summer -Fall	Winter
Dissolved Oxygen (mg/L)	SC564	7.75	6.91	10.30
	SC571	7.86	6.80	9.95
	SC214	7.95	7.97	11.51
Temperature (^{0}C)	SC564	19.67	23.77	7.91
	SC571	19.25	23.89	8.60
	SC214	21.09	25.53	9.00
Oxygen Saturation (%)	SC564	84%	82%	85%
	SC571	84%	81%	83%
	SC214	89%	96%	98%
pH	SC564	7.56	7.52	7.61
	SC571	7.60	7.56	7.59
	SC214	7.61	7.77	7.69

Table 6. Average DO, temperature, % DO saturation, and pH in samples collected in Labette Creek at SC564 and SC571 and in the Neosho River at SC214 for the spring (April-June), summer-fall (July-October), and winter (November-March) seasons for the period of record.

As mentioned previously, median phosphorus levels on the Neosho River tend to exceed those of Labette Creek, particularly under normal and wet years (**Figure 18**). Such conditions introduce contributions from a number of sources throughout the watershed below John Redmond Reservoir as well as any high flow releases from John Redmond itself. However, as regional drought ensues, the more proximate sources become more influential. The four points in Figure 18 lying closest to a line of equivalent concentrations, generally near or below 0.15 mg/l, also reflect the four driest years between 2006 – 2014. Under those conditions, Labette Creek phosphorus loads may have some impact on conditions seen on the Neosho River near the stateline.

There are biological data available from the Neosho River near Chetopa (**Figure 19**). These data show good to very good biological support during the 1980's More recent samples have only been fair and partially supporting the macroinvertebrate community of the river. Median phosphorus concentrations below 0.175 saw a range of biological support spanning fair to very good conditions. Concentrations exceeding that value were fair. Median concentrations below 0.15 mg/l saw five years of full support and four of partial support. Analysis of the flow conditions associated with each sample year reveals that the four years with median phosphorus below 0.15 mg/l but only fair biological values were also among the driest since 1980. Therefore, habitat impacts from drought conditions might be responsible for the lower levels of support provided to the macroinvertebrates. Median phosphorus at the outlet of Labette Creek for the most recent five years of biological sampling ranged from 0.098 – 0.143 mg/l. There are no biological data available from Labette Creek.

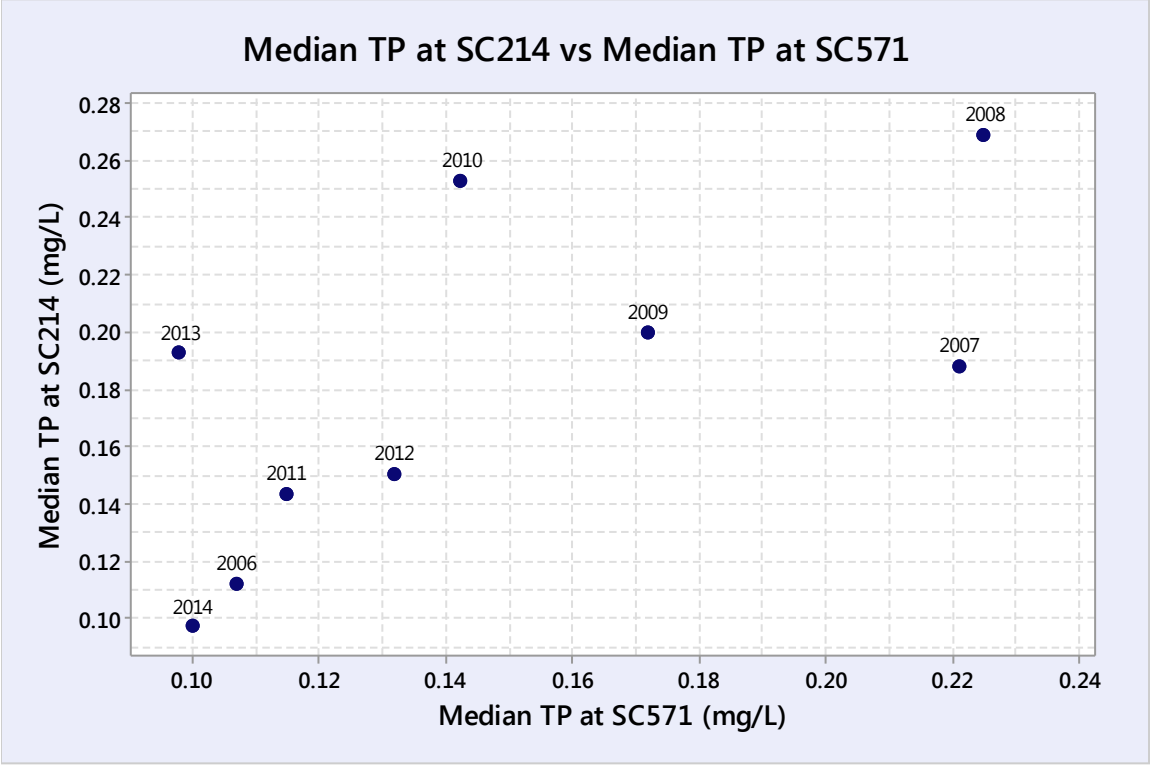


Figure 18. Correlation between TP in Labette Creek near Chetopa to TP in the Neosho River near Chetopa.

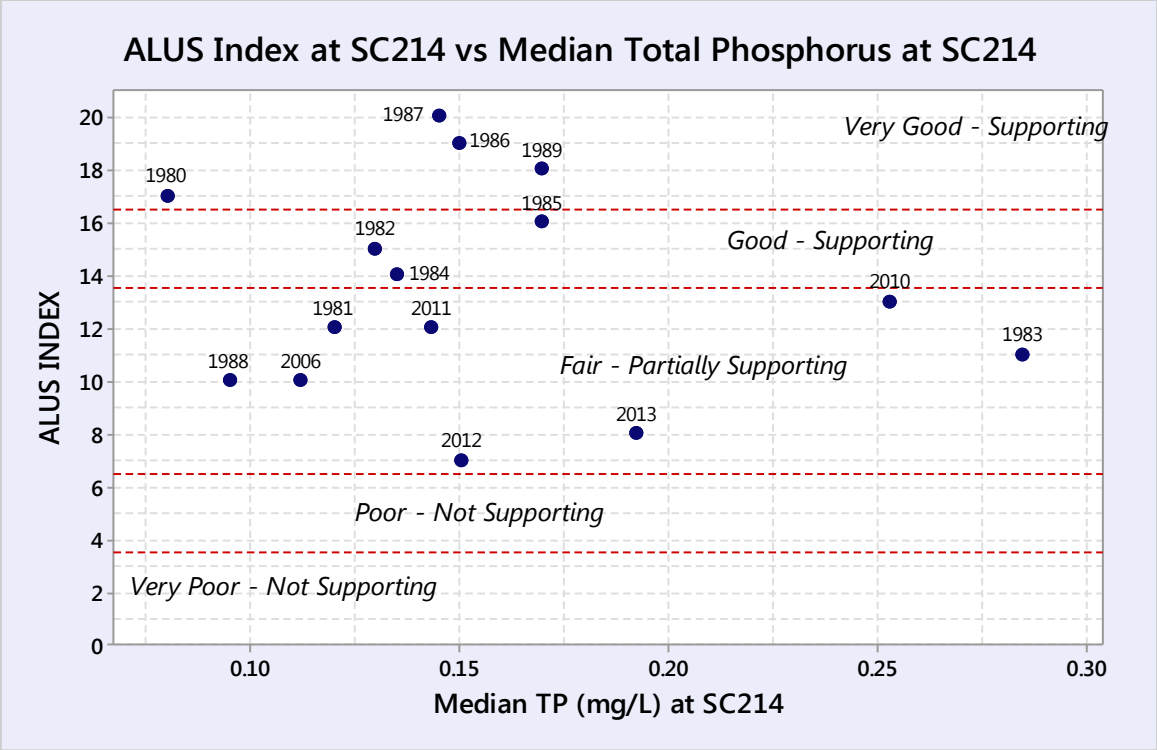


Figure 19. Biological conditions versus Median TP on the Neosho River at SC214

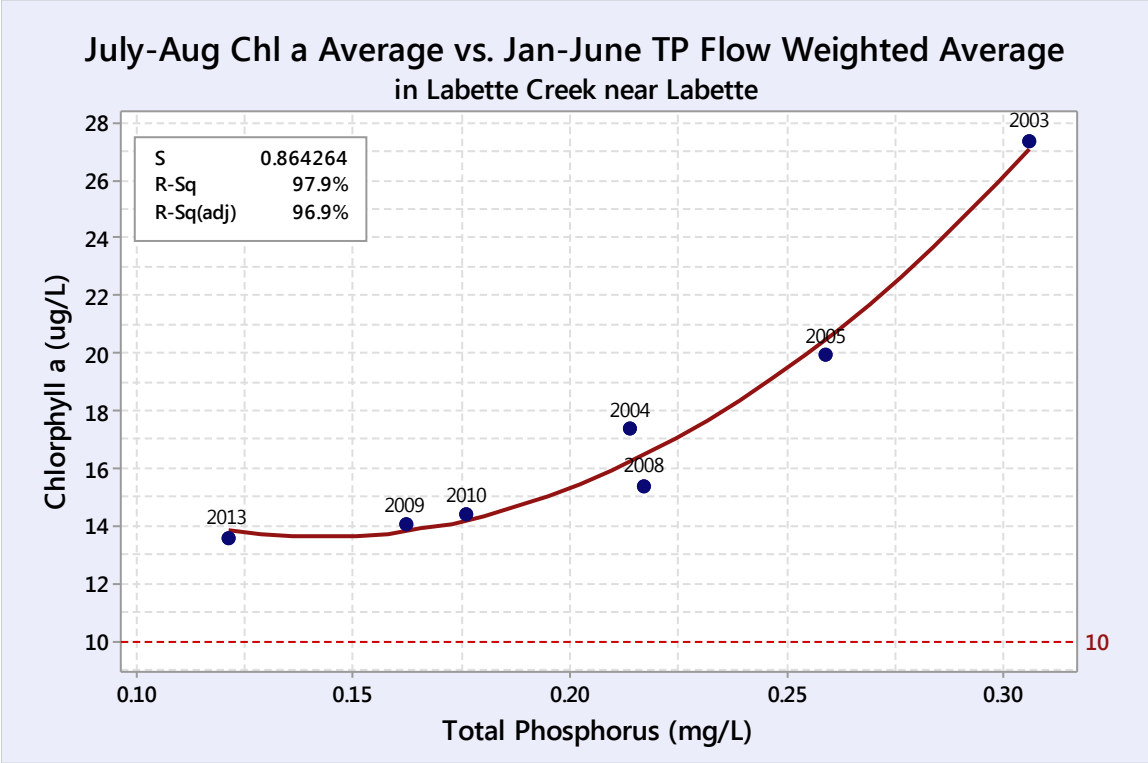


Figure 20. Relationship between chlorophyll *a* and total phosphorus at SC564.

Desired Endpoints of Water Quality (Implied Load Capacity) in Labette Creek at SC564 and SC571 and on the Neosho River at SC214.

The ultimate endpoint of this TMDL will be to achieve the Kansas Water Quality Standards by eliminating the impacts to aquatic life, domestic water supply, or recreation and objectionable flora associated with excessive phosphorus 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 SC564 came about because of median values that were greater than 0.201 mg/l, but were also influenced by high phosphorus concentrations seen prior to 2008. Since 2009, median concentrations at SC564 have been near 0.15 mg/l. In the twenty five years of sampling on the lower Labette Creek at SC571, only four years have seen median phosphorus concentrations over 0.2 mg/l and the recent median level since 2009 has been 0.134 mg/l. On the Neosho River near Chetopa at station SC214, sampling resumed in 2006. The median phosphorus concentration over 2006 – 2014 has been 0.174 mg/l. That value coincides with biological conditions trending away from full support of the aquatic community. Good biological support in the 1980's occurred when median phosphorus at SC214 was 0.145 mg/l.

For this TMDL, the primary desired endpoint will be based on the Aquatic Life Use Support Index (ALUS Index) as measured on the Neosho River at SC214 to track recovery, renewed diversity, and minimal disruptive impacts from excessive nutrients as described in the narrative criteria for nutrients on aquatic life, recreation, and domestic water supply. The five categorizations of biotic conditions make up the ALUS Index score:

1. Macroinvertebrate Biotic Index (MBI): A statistical measure that evaluates the effects of nutrients and oxygen demanding substances 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 assigned a score according to **Table 7**, the scores are tallied, and a support category assigned according to **Table 8**.

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 7. ALUS Index metrics with scoring ranges.

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	

Table 8. ALUS Index score range, associated biotic condition, and support level.

The primary endpoint will supplemented by occasional biological sampling on Labette Creek near SC564 and SC571 and assessed using the metrics and scores outlined above. Additionally, sampling of sestonic chlorophyll a will be done on Labette Creek and the Neosho River. From EPA's work on ambient water quality criteria pertaining to nutrients, median values for summer cholorphyll 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. The trichromatic method measures chlorophyll a, chlorophyll b, and chlorophyll c as total chlorophyll. The fluorometric and spectrometric methods measure chlorophyll a only. Therefore, a reasonable endpoint for sestonic chlorophyll on Labette Creek and the Neosho River would be the average of the median and lower quartile values for the fluorometric and spectrophotometric methods. The average of the 4 values is 9 µg/l, therefore, the chlorophyll endpoint for this TMDL will be a five year median below 9 µg/l.

Secondary indicators of the health of the in-stream biological community include:

1. Percent dissolved oxygen saturation is the measure of oxygen in the water relative to the water's potential dissolved oxygen concentration. Dissolved oxygen concentrations below 5.0 mg/L reflect disproportionate organic material production, respiration rates and decomposition and put aquatic life under stress while dissolved oxygen percent saturation levels greater than 110% are indicative of excessive primary productivity leading to oxygen sags once nightfall ensues.
2. Excessive nutrients can contribute high levels biological activity and vigorous photosynthesis which is known to cause pH to rise above 8.5, another indicator of excessive primary production.

The biological endpoints have to initially be maintained over three consecutive years on the Neosho River at SC214 to constitute full support. Additionally, occasional biological monitoring on Labette Creek at SC564 and SC571 should result in ALUS scores over 14 for a majority of samples taken in a ten-year period. Summertime median chlorophyll levels in the water column of Labette Creek and the Neosho River for the previous five years should remain below 9 µg/l. Routinely collected dissolved oxygen and pH measurements will be assessed against the secondary indicators. Should either parameter exceed the indicator values, subsequent chlorophyll and biological monitoring should proceed.

Median phosphorus concentrations will be used as milestones to indicate progress in reducing phosphorus loads in Labette Creek, and subsequently, the Neosho River. Downward trends in rolling five year median concentrations have been seen on Labette Creek and the Neosho River

in recent years (**Figure 21**). The purpose of implementing this TMDL is to secure those trends and facilitate further reductions such that the median phosphorus levels on Labette Creek remain below 0.125 mg/l. Corresponding median concentrations of 0.15 mg/l on the Neosho River would be expected. These milestones should result in favorable values relative to the biological and chlorophyll endpoints described above. Achievement of the biological endpoints indicates phosphorus loads 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.

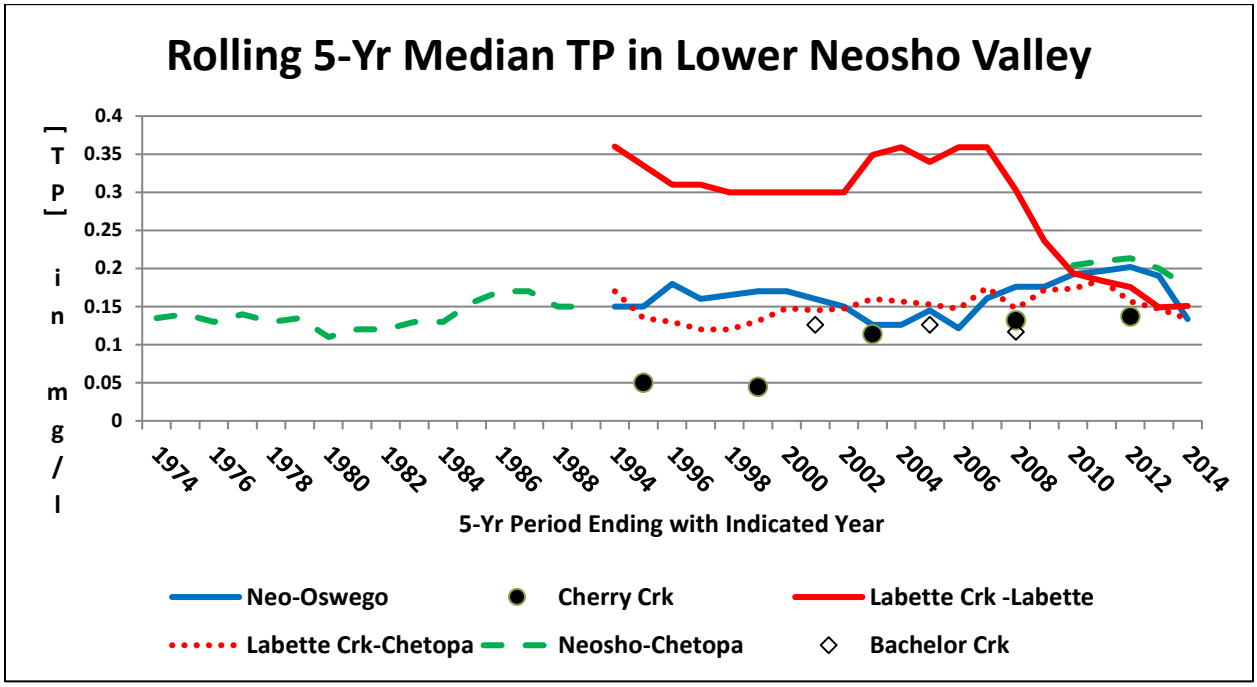


Figure 21. Five year median phosphorus concentrations on Labette Creek and Neosho River.

3. SOURCE INVENTORY AND ASSESSMENT

Point Sources: There are twelve NPDES permitted facilities located in the SC564 watershed and three NPDES permitted facilities in the SC571 watershed (**Table 9)**. Of the twelve dischargers within the contributing area of SC564, one is a municipal mechanical plant discharging to Labette Creek and one is a municipal lagoon systems discharging to Labette Creek via unnamed tributaries. All three municipal permits have been assigned a total phosphorus wasteload allocation. There are also two concrete plants and a rock quarry in the SC564 watershed that are permitted to discharge to the watershed. However, the likelihood of the discharge containing phosphorus is very low, hence, no wasteload allocation has been assigned to the concrete plant and rock quarry permits. The remaining seven permitted facilities in the SC564 watershed are not permitted to discharge and have not been assigned a wasteload allocation. The three facilities in the SC571 watershed are discharging municipal lagoons that have been assigned a wasteload allocation.

Permitee	NPDES Permit #	KS Permit #	Type	Receiving Stream	SC Site	Permit Expires	Permitted Flow (MGD)	Avg. TP (mg/L)
City of Parsons	KS0097560	M-NE55-OO02	Mechanical Plant BNR/UV	Labette Cr	SC564	6/30/18	2.5	0.6
City of Galesburg	KS0092193	M-NE29-OO02	3-Cell Municipal Lagoon	Labette Cr via unnamed trib	SC564	6/30/18	0.024	Assume 2
Midwest Minerals - #3 Parsons Quarry	KS0115525	I-NE55-PO01	Pit Dewatering and Stormwater Runoff	Labette Cr via Bachelors Cr	SC564	7/31/15	NA	Assume 0
O'Brien Ready Mix – Parsons Plant	KSG110106	I-NE55-PR01	Concrete Plant with Retention Basins	Labette Cr	SC564	9/30/17	NA	Assume 0
Individual Mausoleum Co.	KSG110155	I-NE55-PR02	Concrete Plant with Retention Basins	Labette Cr via unnamed trib	SC564	9/30/17	NA	Assume 0
USD #506 Meadow View School	KSJ000346	M-NE55-NO02	1-Cell Lagoon	NA	SC564	1/31/19	NA	NA
Lakins Development	KSJ000546	C-NE55-NO01	2-Cell Lagoon	NA	SC564	9/30/14*	NA	NA
Kanza Services Railway Shops	KSJ000492	I-NE55-NO04	Wet wells to 2-Cell Lagoon	NA	SC564	3/31/14*	NA	NA
Alexander Manufacturing Co.	KSP000065	P-NE55-OO05	Industrial Pretreatment	NA	SC564	6/30/15	NA	NA
Dayton Superior Corp.	KSP000097	P-NE55-OO07	Industrial Pretreatment	NA	SC564	6/30/17	NA	NA
Ducommun Inc.	KSP000064	P-NE55-OO04	Industrial Pretreatment	NA	SC564	12/31/17	NA	NA
Ruskin Co.	KSP000069	P-NE55-OO02	Industrial Pretreatment	NA	SC564	6/30/18	NA	NA
City of Oswego	KS0047554	M-NE53-OO01	3-Cell Municipal Lagoon	Labette Cr via unnamed trib	SC571	6/30/18	0.305	Assume 2
City of Altamont	KS0045918	M-NE01-OO01	3-Cell Municipal Lagoon	Deer Cr via unnamed trib	SC571	6/30/18	0.130	Assume 2
City of Bartlett	KS0080900	M-NE04-OO01	3-Cell Municipal Lagoon	Lake Cr via unnamed trib	SC571	6/30/18	0.0285	Assume 2

Table 9. NPDES permitted facilities that are discharging into the watershed. NA= Not Applicable, *permit pending.

The City of Parsons generates the most wastewater and has the highest phosphorus wasteload. Parsons has implemented and operated BNR since 2008 and the rolling average of its phosphorus reflects the impact of that reduction technology (**Figure 22**). Currently, reduction is based on biological processes with no supplemental chemical feed to further precipitate remaining phosphorus from the waste stream.

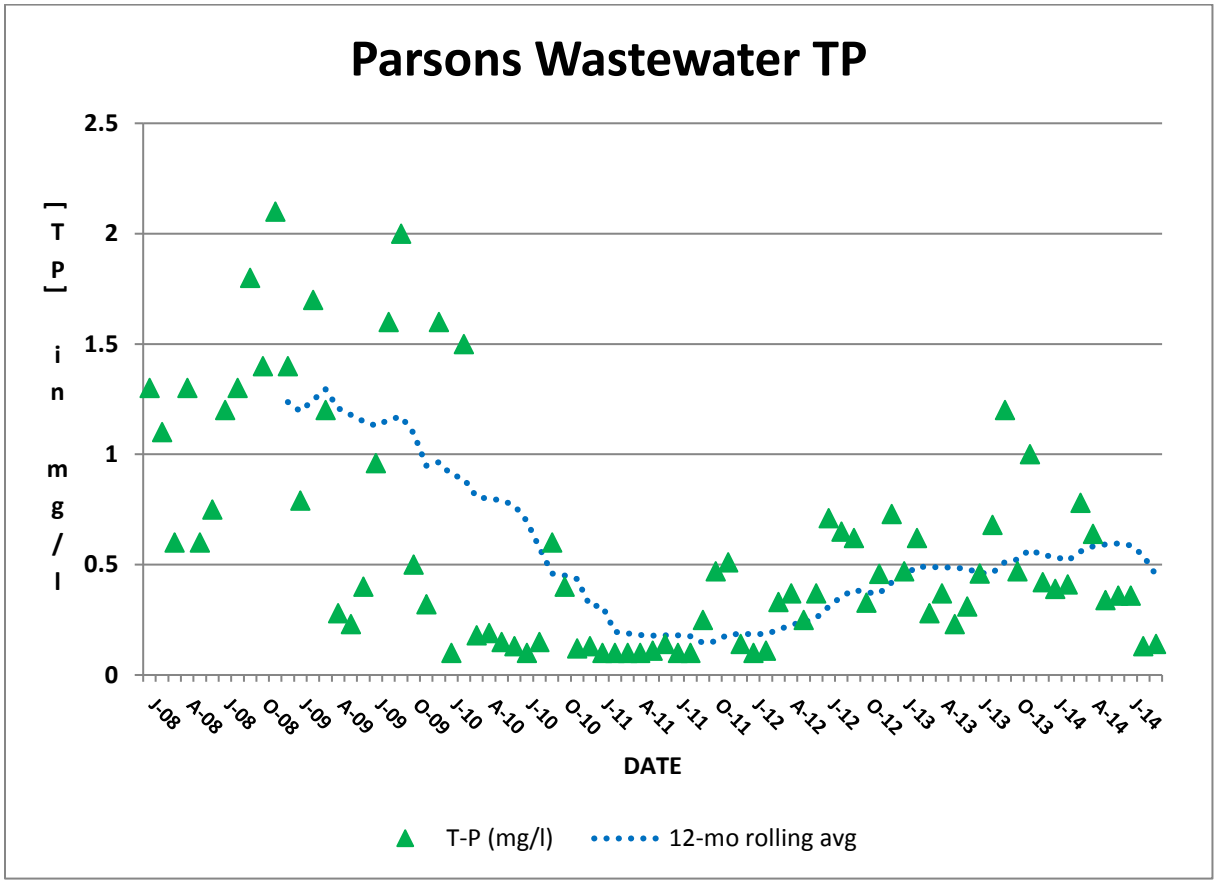


Figure 22. Parsons wastewater phosphorus concentrations over 2008 – 2014.

Municipal Separate Storm Sewer System (MS4) Permits: There is one MS4 permit, KSR044016 expiring January 31, 2019, that is assigned to the City of Parsons in the SC564 watershed. Using the 2010 US Census' GIS populated area coverage it was determined that about 5% of the SC564 watershed falls within the jurisdiction of the City of Parsons (~10.7 mi^2) and about 60% of the City of Parsons is considered developed land according to the 2001 NLCD. The runoff of fertilizers applied to cropland and residential areas will contribute to phosphorus loading in the watershed, particularly to riparian areas that are subject to fertilizer applications.

Land Use: Land use within the Labette Creek watershed is mostly grass and pastureland (57%) and cultivated crops (27%) as can be seen in **Figure 23** (2001 NLCD). The land use characterization of both the SC564 and SC571 watersheds are very similar as can be seen in **Table 10**, however, the SC564 watershed has more developed land due to the presence of the City of Parsons.

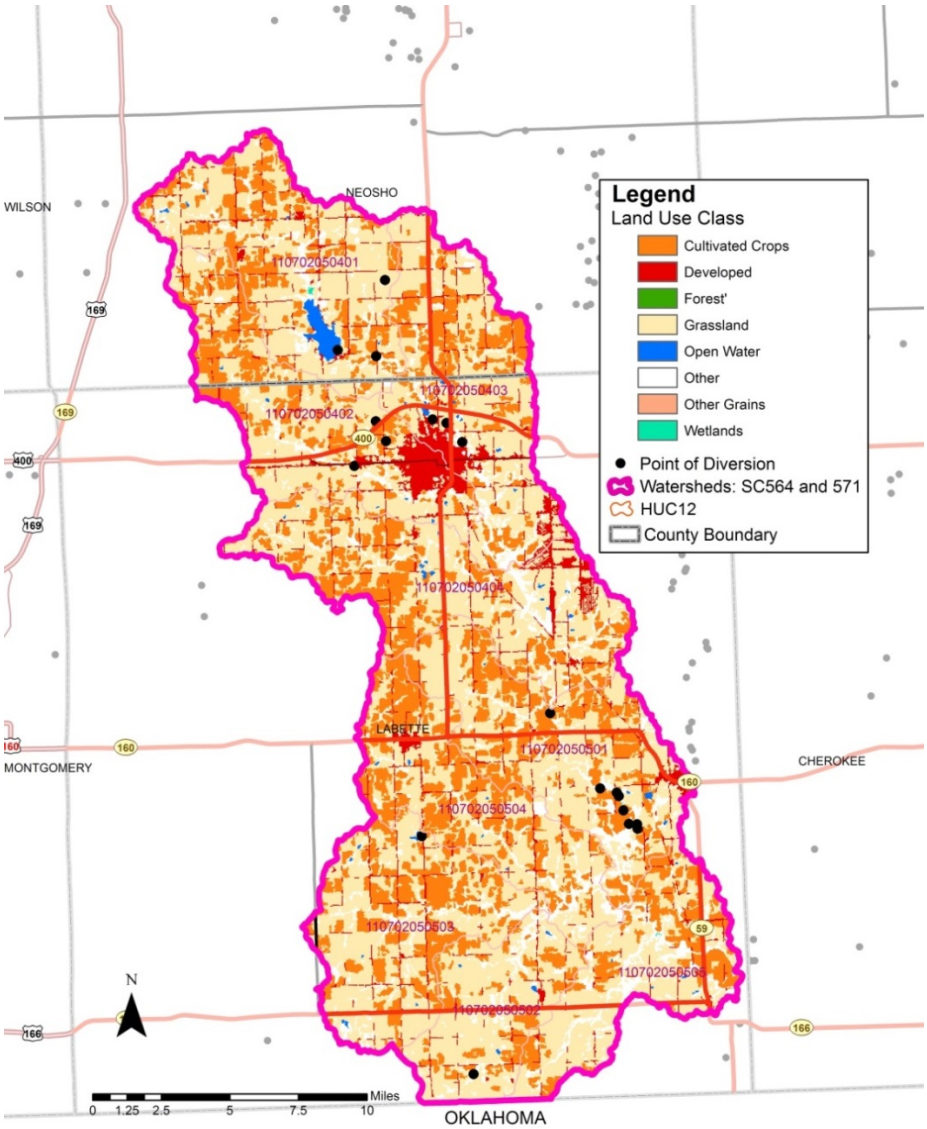


Figure 23. Land use in the Labette Creek watershed.

Watershed	Approximate Land Area (mi^2)	Grassland/ Pasture	Cultivated Crops	Developed Land	Forest	Wetlands	Open Water
SC564 Labette Creek near Labette	194	57%	25%	9%	7%	1%	1%
SC571 Labette Creek near Chetopa	190	56%	29%	6%	8%	0.5%	0.5%
Total	384	57%	27%	7%	7%	1%	1%

Table 10. Land use in the Labette Creek watershed.

Livestock Waste Management Systems: There are fourteen certified or permitted animal feeding operations (CAFOs) within the Labette Creek watershed. Of the fourteen, three are located in the SC541 watershed and 11 are located in the SC571 watershed (**Table 11**). 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 is less than 1-5% flow exceedance.

According to the USDA National Agricultural Statistics Service (NASS), on January 1, 2013 there were a total of 49,500 and 69,000 head of cattle, including calves, in Neosho and Labette Counties, respectively. NASS also reported 2,000 head of hogs in Neosho County and 900 head of hogs in Labette County as of December 1, 2012. The animal waste from both confined and unconfined feeding sites is considered a potentially significant source of total phosphorus loading in the Labette Creek watershed. Manure spreading, if occurring in the watershed, is also a likely contributor of total phosphorus. CAFOs in the watershed are assigned a total phosphorus wasteload allocation of zero.

SC Site	Permit #	County	Animal Total	Type	Animal Type(s)
SC564	A-NELB-BA01	Labette	600	Certification	Beef
SC564	A-NELB-B001	Labette	135	Permit	Beef
SC564	A-NENO-MA01	Neosho	75	Certification	Dairy
SC571	A-NELB-BA02	Labette	876	Certification	Beef
SC571	A-NELB-S008	Labette	200	Renewal	Swine
SC571	A-NELB-L001	Labette	175	Permit	Goats
SC571	A-NELB-M014	Labette	120	Permit	Dairy
SC571	A-NELB-M013	Labette	66	Permit	Dairy, Horses
SC571	A-NELB-M015	Labette	35	Renewal	Dairy
SC571	A-NELB-MA04	Labette	75	Certification	Dairy
SC571	A-NELB-M016	Labette	66	Permit	Dairy, Horses
SC571	1184**	Labette	555	Application	Sheep, Beef
SC571	A-NELB-M001	Labette	154	Permit	Dairy, Horses
SC571	A-NELB-MA02	Labette	100	Certification	Dairy

Table 11. Active registered, permitted, and certified CAFOs in the Labette Creek watershed.
******Temporary placeholder while the application is being processed.

On-Site Waste Systems: The Labette Creek watershed is a mixture of rural agricultural areas and small cities that lies in Neosho and Labette counties. It can be assumed that all of the rural residences in the watershed are not connected to public sewer systems and according to the Spreadsheet Tool for Estimating Pollutant Load (STEPL), there are a 739 and 725 septic systems in the SC564 and SC571 watersheds, respectively, with a 0.93% failure rate. Failing on-site septic systems have the potential to contribute to nutrient loading in the watershed.

Population Density: Census results from the 2000 and 2010 U.S. Census reveal population in the Parsons and the Labette Creek watershed are on the decline (**Table 12**). Peak population in

Labette County occurred in 1920 and even the largest city, Parsons, has seen a 3.2% decline in population over 2010 – 2013.

Watershed or City	Year of Census		% Difference
	2000	2010	
SC564 (Labette Creek near Parsons)	14,013	13,087	-7%
SC571 (Labette Creek near Chetopa)	4,262	4,064	-5%
City of Parsons	11,514	10,461	-9%

Table 12. U.S. Census results for populations in the Labette Creek watershed.

Contributing Runoff: The SC564 and SC571 watersheds have a mean soil permeability of 0.51 and 0.54 inches/hour, respectively, according to the NRCS STATSGO database (**Figure 24)**. Permeability for the SC564 watershed ranges from 0.01 to 2.51 inches an hour with 50% of the watershed having low to very low permeability values of 1.22 inches/hour or lower. The range of permeability values in the SC571 is 0.01 to 2.38 inches/hour with 50% of the watershed having a very low permeability of 1.05 inches/hour or lower. According to a USGS open-file report (Juracek, 2000), the threshold soil-permeability values are set at 3.43 inches/hour for very high, 2.86 inches/hour for high, 2.29 inches/hour for moderate, 1.71 inches/hour for low, 1.14 inches/hour for very low, and 0.57 inches/hour for extremely low soil-permeability. Runoff is primarily generated as infiltration excess with rainfall intensities greater than soil permeability. As the watershed's soil profiles become saturated, excess overland flow is produced.

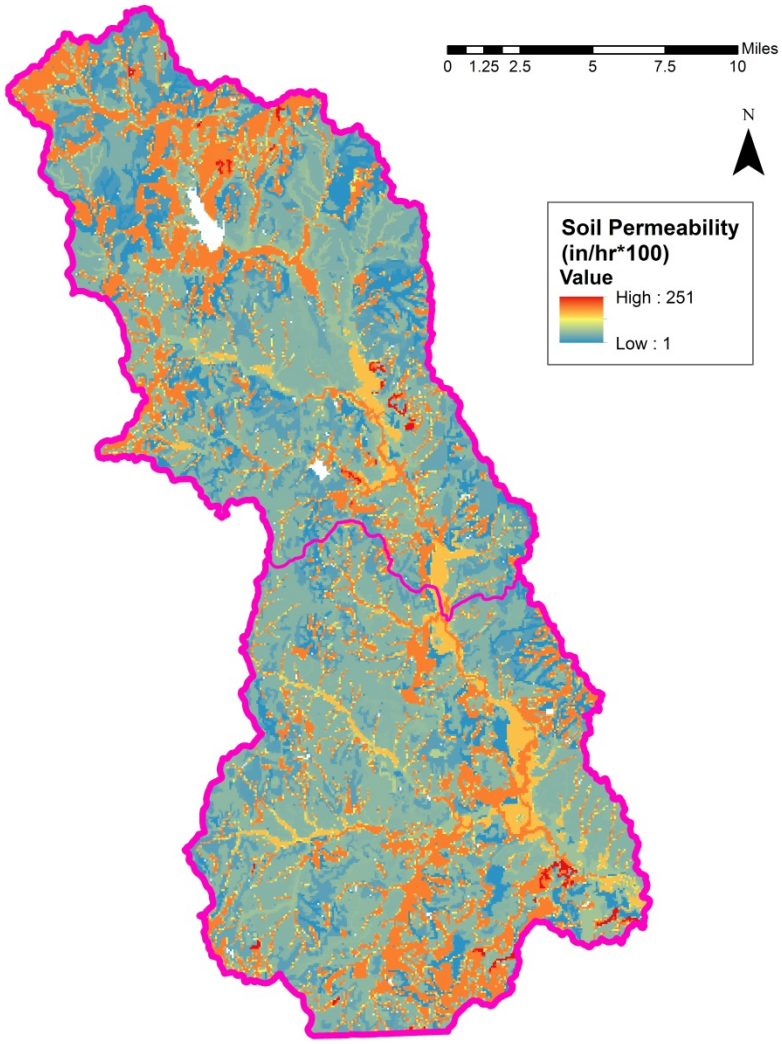


Figure 24. Soil permeability in the Labette Creek watershed.

Background and Natural Sources: 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. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

The endpoints for this TMDL are reduced chlorophyll levels seen on Labette Creek and the Neosho River near Chetopa and improved biological conditions seen on the Neosho River as a result of reduced phosphorus load contributions from Labette Creek into the Neosho River above Chetopa. Because the predominant source of phosphorus on Labette Creek, the City of Parsons, has already installed biological nutrient removal and the phosphorus levels of its effluent are already lower than that expected from BNR treatment, this TMDL will be established in a single phase with stages set over time to facilitate necessary reductions from non-point sources, other wastewater systems and any subsequent enhanced reduction at Parsons.

Median phosphorus concentrations on Labette Creek at SC564 near Labette have seen a decline to 0.15 mg/l. While not definitive, there appears to be a downward trend in median phosphorus at the downstream station, SC571, since 2011. The current levels of phosphorus in Parsons' wastewater will be maintained through continued operation of their BNR operation until 2020 to see if the downstream downward trend continues. During that time, efforts to reduce non-point source contributions will be the primary activity of implementation. Corresponding decreases in incremental loading on the Neosho River between Oswego and Chetopa will also be monitored as well as improvement in the macroinvertebrate community on the river. Concurrent steps to lower contributions from urban stormwater in Parsons, minor point source wastewater and non-point sources will be implemented.

The established TMDL is detailed in **Figure 25** for Labette Creek at SC571 and the anticipated wasteload and load allocations are outlined in **Table 13**.

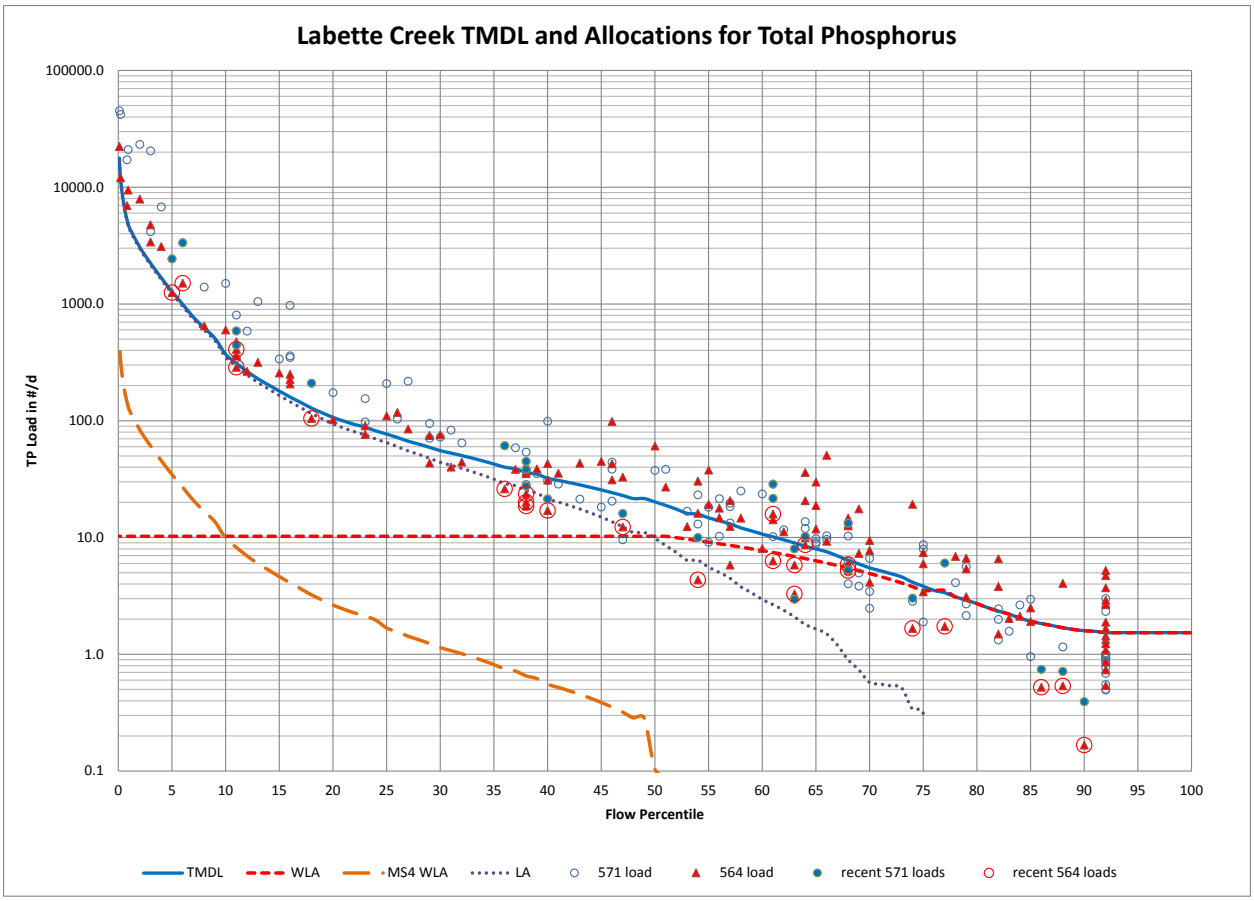


Figure 25. Labette Creek Phosphorus TMDL and associated allocations of loads.

Flow Condition	Expected Flow (cfs)	Load Capacity (#/d)	WW Wasteload Allocation (#/d)	MS4 Wasteload Allocation (#/d)	NPS Load Allocation (#/d)
90%	**2.36**	**1.59**	**1.59**	**0.00**	**0.00**
75%	**5.68**	**3.84**	**3.52**	**0.00**	**0.31**
50%	**29.94**	**20.21**	**10.24**	**0.10**	**9.87**
25%	**113.91**	**76.89**	**10.24**	**1.68**	**64.97**
10%	**550.46**	**371.56**	**10.24**	**9.86**	**351.46**

Table 13. Labette Creek phosphorus load capacity and allocations at various flows.

Point Sources: The Wasteload Allocations (WLA) associated with the wastewater treatment facilities in the watershed are detailed in **Table 14**. These wasteload allocations represent what would be allowable from Parsons and the four smaller communities using intermittently discharging lagoons. All wasteload allocations are calculated based on their design flows and a TP discharge concentration of 0.75 mg/l for Parsons and 2.0 mg/L for the lagoon systems, similar to effluent TP concentrations commonly seen from Kansas lagoon systems.

There will be no reserve wasteload allocation assigned for future growth among the municipalities. Current concentrations in their respective wastewater tend to be below the levels expected from a BNR operation or lagoon systems. The projected demographics of these communities is expected to follow the declining trend of the past decade. The current design flows of the city systems will continue to serve future populations and serve as a cap on wasteloads influencing the productivity of Labette Creek and the Neosho River.

The City of Parsons has implemented and operated BNR since 2008 and its phosphorus reduction is based on biological processes with no supplemental chemical feed to further precipitate remaining phosphorus from the waste stream. As such, adherence to fixed limits can be subject to climatic conditions, causing some bounce around the current central tendency. To

safeguard the city from unintended and transient deviations from that central tendency, which has been below 0.5 mg/l in the past, Parsons' wasteload allocation will be based on an anticipated phosphorus concentration of 0.75 mg/l. The resulting wasteload allocation avoids compliance problems and allows for growth in the city. Since 2010, only 4 monthly samples exceeded 0.75 mg/l at Parsons out of 57 samples. Adhering to a value that is 25 – 50% lower than typical BNR expected goals, recognizes the stellar performance of the plant the past five years and protects the stream against backsliding loads in the future. The wasteload allocation will be implemented as a rolling average load in future permits, but even on an individual month basis, exceedances in the allowable mass are infrequent (**Figure 26**).

In the future, should additional reduction in phosphorus be necessary, Parsons will need to investigate using an alum or ferric chemical feed into their wastewater to further precipitate out phosphorus.

The four lagoon systems routinely discharge and two, Oswego and Galesburg, have limited phosphorus data from their effluent in 2013 and 2014. Both averages are relatively low, 1.3 and 0.6 mg/l, respectively. No data are available from Altamont or Bartlett so they are assumed to discharge an average of 2 mg/l as typical of lagoon systems. All lagoon wasteload allocations will be based on the assumed average of 2 mg/l. These towns have diminished populations such that their wastewater discharge volumes are a fraction of their design flows.

Wasteload allocations of zero will be applied to aggregate-oriented dischargers (quarries, ready mix plants, etc. as depicted in **Table 15**), the non-discharging lagoon systems, and any present or future confined animal feeding operation in the watershed. None of these facilities should be discharging nutrients if they discharge at all.

The discrepancy between wasteload allocations identified by facility in Table 14 and the resulting wasteload allocations expected to be seen near the outlet of Labette Creek at Station SC571 (Table 13) reflects the assimilative loss of phosphorus in the stream system. Phosphorus can be absorbed by stream biology and adsorbed by sediments and organic matter in the stream. Comparison of phosphorus loads from Parsons and in-stream at SC564 over 2008 – 2014 indicated only 43% of the wasteload at Parsons made it to the monitoring station. Hence, the expected wasteloads were decreased by 57%.

Additionally, at low flows, there is an expectation that wastewater will be recycled and used for irrigation rather than discharged. Lagoon systems likely will not discharge under the warm conditions associated with the low flows seen on the creek. Therefore, the wasteload allocation at low flow conditions conforms with the overall load capacity and makes up the entire load seen on the creek.

The breakout in flows, load capacities and allocations on Labette Creek at SC564 and SC571 is displayed in Appendix B as well as the anticipated altered load delivery from Labette Creek to the Neosho River.

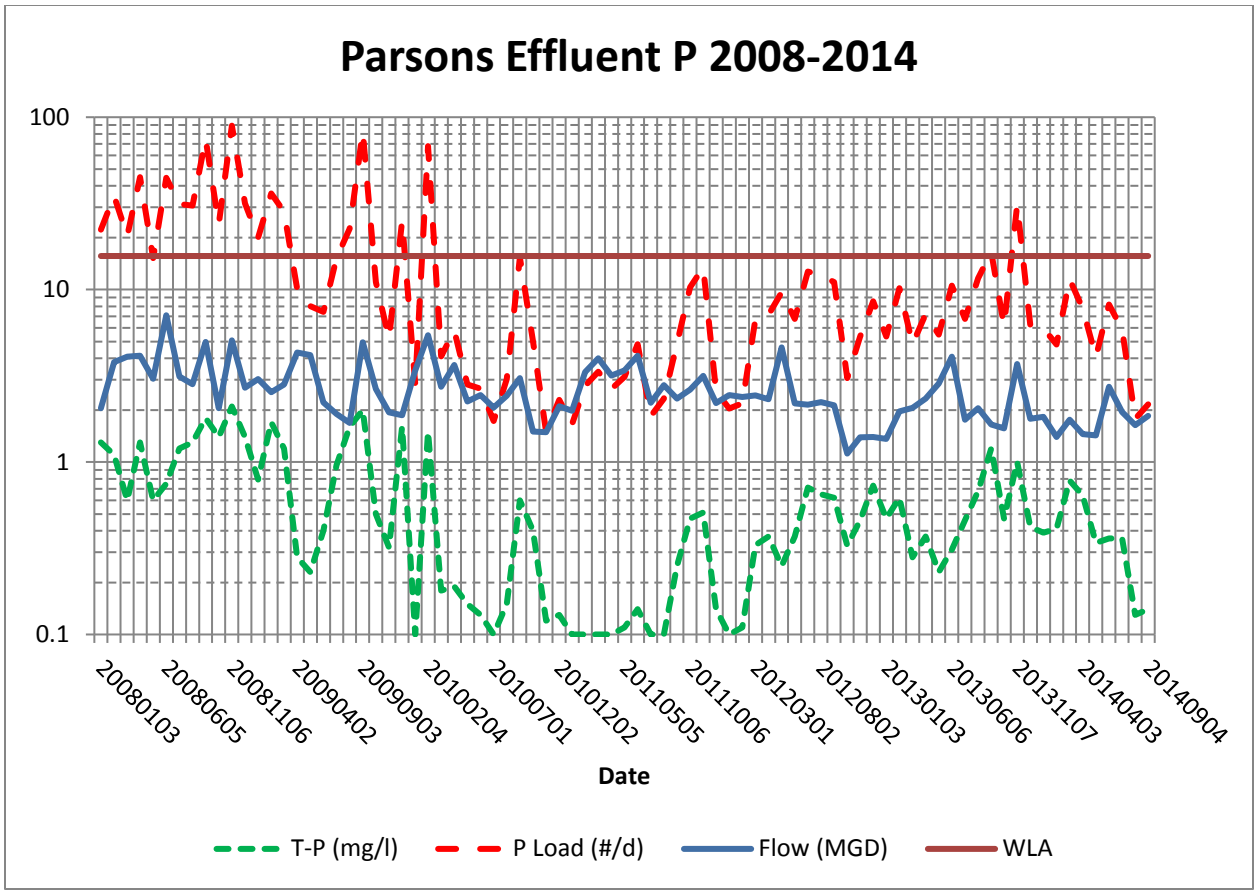


Figure 26. Parsons historic wastewater flows, phosphorus concentrations and wasteloads.

MS4 Stormwater: Parsons also has a Municipal Separate Storm Sewer System (MS4) NPDES permit for any urban stormwater generated within its municipal jurisdiction. The City of Parsons comprises 5% of the area in the watershed above SC564. To account for any future expansion or annexation of lands currently outside the jurisdiction of Parsons, the wasteload allocation for the MS4 permit will be set as 5.5% of the non-point load allocation for phosphorus generated by runoff in the watershed above SC564. That resulting wasteload is carried down the lower reaches of the creek to SC571 without any assumed assimilation.

Permitee	NPDES Permit #	KS Permit #	Type	Receiving Stream	SC Site	Current Permit Expires	Permitted Flow (MGD)	Avg. TP (mg/L)	Expected TP (mg/l)	WLA (#/d)
Discharging Facilities Above Monitoring Site SC564										
City of Parsons	KS0097560	M-NE55-OO02	Mechanical Plant BNR/UV	Labette Cr	SC564	6/30/18	2.5	0.59	0.75	15.67
City of Galesburg	KS0092193	M-NE29-OO02	3-Cell Municipal Lagoon	Labette Cr via unnamed trib	SC564	6/30/18	0.024	0.63	2.0	0.40
Discharging Facilities Above Monitoring Site SC571										
City of Altamont	KS0045918	M-NE01-OO01	3-Cell Municipal Lagoon	Deer Cr via unnamed trib	SC571	6/30/18	0.130	Assume 2	2.0	2.17
City of Bartlett	KS0080900	M-NE04-OO01	3-Cell Municipal Lagoon	Lake Cr via unnamed trib	SC571	6/30/18	0.0285	Assume 2	2.0	0.48
City of Oswego	KS0047554	M-NE53-OO01	3-Cell Municipal Lagoon	Labette Cr via unnamed trib	SC564	6/30/18	0.305	1.3	2.0	5.10
Non-discharging Facilities										
WP Property Holdings, LLC	KSJ000492	I-NE55-NO04	Wet wells to 2-Cell Lagoon	NA	SC564	11/30/20	NA	NA	0.0	0.0
Lakins Development	KSJ000546	C-NE55-NO01	2-Cell Lagoon	NA	SC564	9/30/19	NA	NA	0.0	0.0
USD #506 Meadow View School	KSJ000346	M-NE55-NO02	1-Cell Lagoon	NA	SC564	1/31/19	NA	NA	0.0	0.0

Table 14. Total phosphorus wasteload allocations for facilities in the Labette Creek watershed.

Permitee	NPDES Permit #	KS Permit #	Type	Receiving Stream	SC Site	Current Permit Expires	Permitted Flow (MGD)	Avg. TP (mg/L)
Individual Mausoleum Co.	KSG110155	I-NE55-PR02	Concrete Plant with Retention Basins	Labette Cr via unnamed trib	SC564	9/30/17	NA	Assume 0
Midwest Minerals - #3 Parsons Quarry	KS0115525	I-NE55-PO01	Pit Dewatering and Stormwater Runoff	Labette Cr via Bachelors Cr	SC564	7/31/15	NA	Assume 0
O'Brien Ready Mix – Parsons Plant	KSG110106	I-NE55-PR01	Concrete Plant with Retention Basins	Labette Cr	SC564	9/30/17	NA	Assume 0

Table 15. Aggregate-based dischargers in the Labette Creek watershed with low probability of contributing phosphorus.

Nonpoint Source Load Allocation: The load allocation for nonpoint sources is the remaining load capacity after assimilated wasteloads for NPDES wastewater and the MS4 stormwater wasteload have been accounted for (**Table 13**). CAFOs in the watershed are assigned a total phosphorus wasteload allocation of zero. Nonpoint sources are assumed to be very minimal at lower flows and steadily increase as runoff conditions increase with wet weather. Current implementation will focus on riparian and livestock management within the watershed to reduce nonpoint source loads. These reductions should maintain median concentrations near 0.125 mg/l on Labette Creek at SC564 and SC571.

Defined Margin of Safety: The Margin of Safety provides some hedge against the uncertainty in phosphorus loading into Labette Creek, predominantly from the point source dischargers in the watershed. This TMDL uses an implicit margin of safety, relying on conservative assumptions to be assured that future wasteload allocations will not cause further excursion from the nutrient criteria. First, design flows are used for the five municipal wastewater discharge facilities to set wasteload allocations, despite the ongoing trend of diminished population in those communities. Additionally, multiple biological endpoints are used to assess the narrative criteria and have to be maintained for three consecutive years before attainment of water quality standards can be claimed. Finally, this TMDL will be backed up by supplemental monitoring of chlorophyll and biology on Labette Creek to confirm the full support of the aquatic life use on the targeted stream.

State Water Plan Implementation Priority: Priority is focused on aggressive non-point source abatement now that advanced wastewater treatment to remove phosphorus has been successful at Parsons. Cropland conservation treatment and riparian management along the tributaries and lower reaches of Labette Creek is intended to effectively reduce the phosphorus loading to the creek. Due to the need to reduce any high nutrient loads in the watershed contributing to the phosphorus levels in the Neosho River impacting the biological community as well as impacts to Oklahoma's Grand Lake, and the presence of an active Watershed Restoration and Protection Strategy group in the Middle Neosho subbasin, including Labette Creek, this TMDL will be High Priority for implementation.

Nutrient Reduction Framework Priority Ranking: This watershed lies within the Middle Neosho (HUC8: 11070205) Subbasin which is among the top sixteen HUC8s targeted for state action to reduce nutrients by 2022.

Priority HUC12s: Because this TMDL has implementation underway because of point source treatment improvements at Parsons, priority HUC12s within the watershed can be identified based on the cropland areas adjacent to the streams within the watershed (**Table 16**). Priority HUC 12s in the Labette Creek watershed are primarily located in the portion of the watershed immediately above and below monitoring station SC564. The Priority HUC 12s that have a high percentage of cropland and area adjacent to the streams in the Labette Creek watershed are indicated by shading in **Table 16**.

HUC 12	Urban Acres	Cropland Acres	Pasture and Grazing Land Acres	Forest Acres	SC Site
110702050401	206	8,095	18,535	2,013	SC564
110702050402	1,765	7,754	15,226	1,752	SC564
110702050403	1,406	7,033	17,588	1,966	SC564
110702050404	439	8,487	19,113	2,826	SC564
110702050501	528	10,019	15,365	2,516	SC571
110702050502	108	2,602	13,466	1,295	SC571
110702050503	105	8,066	16,089	1,925	SC571
110702050504	274	9,044	12,014	1,846	SC571
110702050505	189	5,373	13,499	2,326	SC571

Table 16. HUC 12 land use in the Labette Creek watershed by KDHE sampling site as determined by STEPL. Priority subwatersheds indicated by shading

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. Make operational changes in municipal wastewater treatment plants and implement alternative disposal such as irrigation and, if necessary, install enhanced nutrient reduction technology to reduce wasteloads.

9. Renew state and federal permits and inspect permitted facilities for permit compliance.
10. Facilitate urban stormwater management in the City of Parsons to abate pollutant loads.

NPDES and State Permits – KDHE

a. Monitor influent into and effluent from the discharging permitted wastewater treatment facilities, continue to encourage wastewater reuse and irrigation disposal and ensure compliance and proper operation to control phosphorus levels in wastewater discharges.
b. Inspect permitted livestock facilities to ensure compliance.
c. New livestock permitted facilities will be inspected for integrity of applied pollution prevention technologies.
d. New registered livestock facilities with less than 300 animal units will apply pollution prevention technologies.
e. Manure management plans will be implemented, to include proper land application rates and practices that will prevent runoff of applied manure.
f. Reduce runoff in the City of Parsons through respective stormwater management program and MS4 permit.
g. Establish TP concentration effluent limit or goal of 0.75 mg/L or lower in the discharge of the City of Parsons WWTF.
h. Establish nutrient reduction practices among urban homeowners to manage application on lawns and gardens, through the City of Parsons stormwater management program.
i. Interact with Middle Neosho WRAPS on opportunities to offset load reductions between Parsons and agricultural producers in the watershed.

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 towards small livestock operations, which minimize impacts to stream resources.
d. Support the implementation efforts of the Middle Neosho WRAPS and incorporate long-term objectives of this TMDL into their 9-element watershed plan.
e. Engage the City of Parsons to discuss stormwater load trading opportunities.

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 reestablish 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.
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 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 residents, landowners, and watershed stakeholders about nonpoint source pollution.

Timeframe for Implementation: Reduction performance for the wastewater treatment facility operated by the City of Parsons should be evaluated by the end of 2020 with subsequent planning and design of any necessary enhancements to the current biological nutrient reduction system completed by 2023 in anticipation of construction within the next permit cycle after 2017. Urban stormwater and rural runoff management should commence in 2015 in Parsons. Nonpoint pollutant reduction practices should be installed within the priority HUC 12 sub-watersheds (Table 14) over 2015-2020. If biological conditions warrant additional implementation, treatment and management practices in other HUC12 sub-watersheds will begin in 2021.

Targeted Participants: The primary participants for implementation will be the City of Parsons wastewater and stormwater programs and the Middle Neosho WRAPS working together with agricultural and livestock producers operating immediately adjacent to Labette Creek and its tributaries within the priority sub watersheds in Labette County. 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. Unbufferred cropland adjacent to the stream.
6. Conservation compliance on highly erodible areas.
7. Total row crop acreage and gully locations.
8. High-density urban and residential development in proximity to streams and tributary areas.
9. Residents of Parsons should be informed on fertilizer and waste management through the City of Parsons Stormwater Management Program to reduce urban runoff loads.

Milestone for 2020: In 2020, evaluation of the total phosphorus milestones at SC564, SC571 and SC214 will be performed together with ongoing assessment of the biological community at SB214. At that point in time, the City of Parsons should have maintained appropriate nutrient reduction in its wastewater and nonpoint pollutant reduction practices should have been installed in the watershed, and median phosphorus levels in the watershed should show declining concentrations since 2014.

Delivery Agents: The primary delivery agents for program participation will be the City of Parsons, KDHE, the Middle Neosho 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. 65-171d 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 71 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 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.

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

7. K.S.A. 82a-901, et. seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

8. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the Kansas Water Plan, including selected Watershed Restoration and Protection Strategies.

9. The Kansas Water Plan and the 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: Operation of Biological and Enhanced Nutrient Removal technology has been well established to reduce nutrient levels in wastewater, including phosphorus. Additionally, 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 occur quarterly on an annual basis at SC564, SC571 and SC214, as well as upstream on the Neosho River near Oswego (SC566). The monitoring will include the initiation of sestonic chlorophyll *a* sampling. Dissolved oxygen and pH levels will be assessed for indications of heightened primary productivity. Monitoring of tributary levels of TP during runoff events will help direct abatement efforts toward major nonpoint sources. Monitoring TP by the City of Parsons on Labette Creek below their outfall will help assess improvements stemming from their nutrient removal processes. Monitoring of TP should be a condition of the MS4 permits within the watershed.

Commencing in 2015, summer sestonic chlorophyll *a* sampling will occur at SC564 and SC571 on Labette Creek and SC214 on the Neosho River. Additionally, ongoing macroinvertebrate sampling will be conducted at Chetopa and examined for signs of favorable responses in the aquatic community, consistent with the narrative nutrient criteria. Occasional biological sampling of Labette Creek will occur during 2015 – 2021. If the biological endpoints are achieved over 2015-2021, the conditions descried by the narrative nutrient criteria will be viewed as attained and the Labette Creek at SC564 and Labette Creek at SC571 will be moved to

Category 2 on the 2022 303(d) list. Presuming one or more biological endpoints are not met, additional reductions in loads and phosphorus concentrations will be accomplished through enhanced implementation of controls on point and nonpoint sources after 2022.

Once the water quality standards are attained, the adjusted ambient phosphorus concentrations in Labette Creek at SC564 and SC571 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 Labette Creek at SC564 and SC571.

7. FEEDBACK

Public Notice: An active Internet Web site is established at http://www.kdheks.gov/tmdl/index.htm to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Neosho River Basin. This TMDL was posted on the website on April 22, 2015 and notice was posted in the Kansas Register on May 7, 2015 with an open comment period lasting through June 5, 2015. No comments were received on this TMDL.

Public Hearing: A Public Hearing on this TMDL was held in Frontenac, Kansas on May 19, 2015 to receive comments on this TMDL. No comments were received.

Milestone Evaluation: In 2020, evaluation will be made as to the degree of implementation that occurred within the watershed. Subsequent decisions will be made through regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: Labette Creek at SC564 and SC571 will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2015 - 2021. Therefore, the decision for delisting will come about in the preparation of the 2022-303(d) list. Should modifications be made to the applicable water quality criteria during the implementation period, consideration for delisting, desired endpoints of this TMDL, and implementation activities 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 2015, which will emphasize implementation of WRAPS activities and nonpoint reduction. At that time, incorporation of this TMDL will be made into the WRAPS watershed plans. Recommendations of this TMDL will be considered in the Kansas Water Plan implementation decisions under the State Water Planning Process for Fiscal Years 2015-2021.

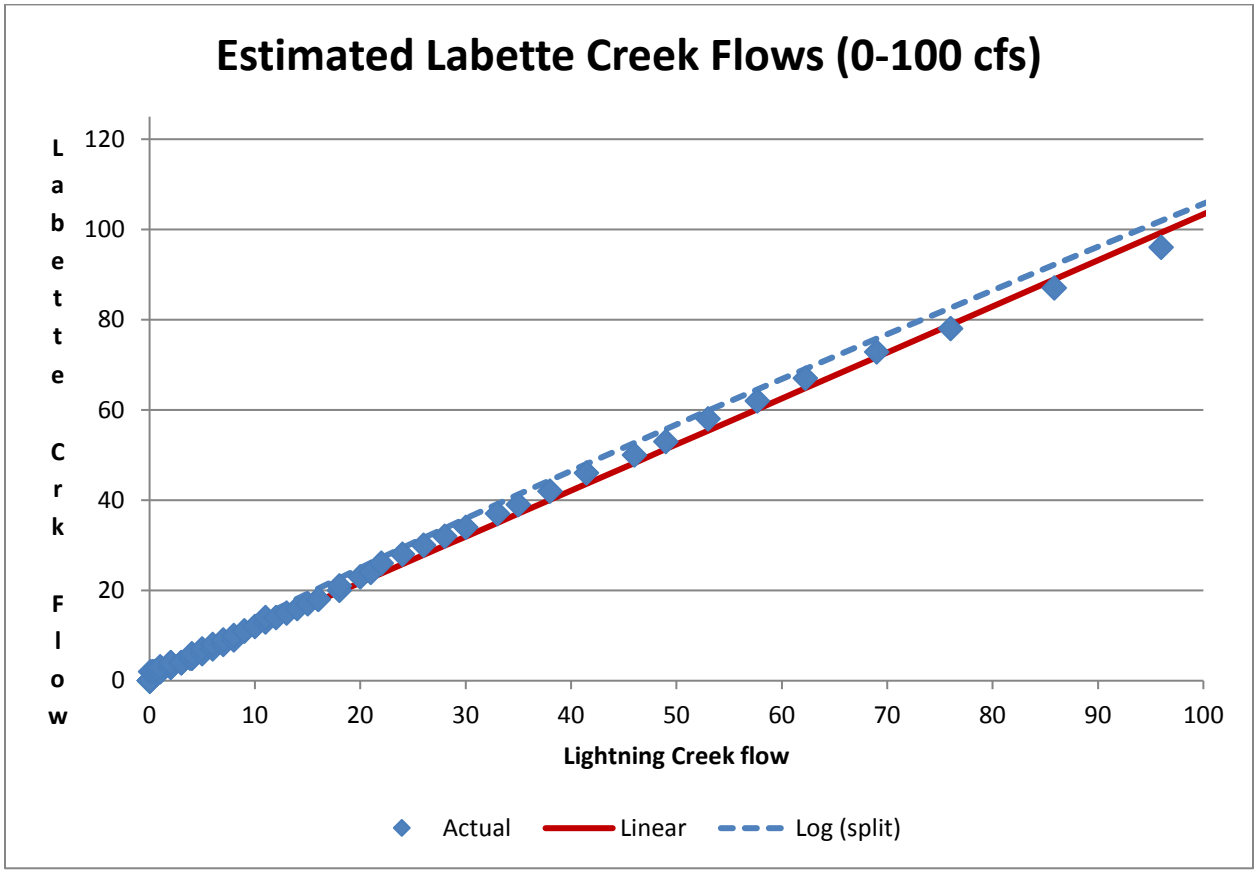
Developed 9/21/2016

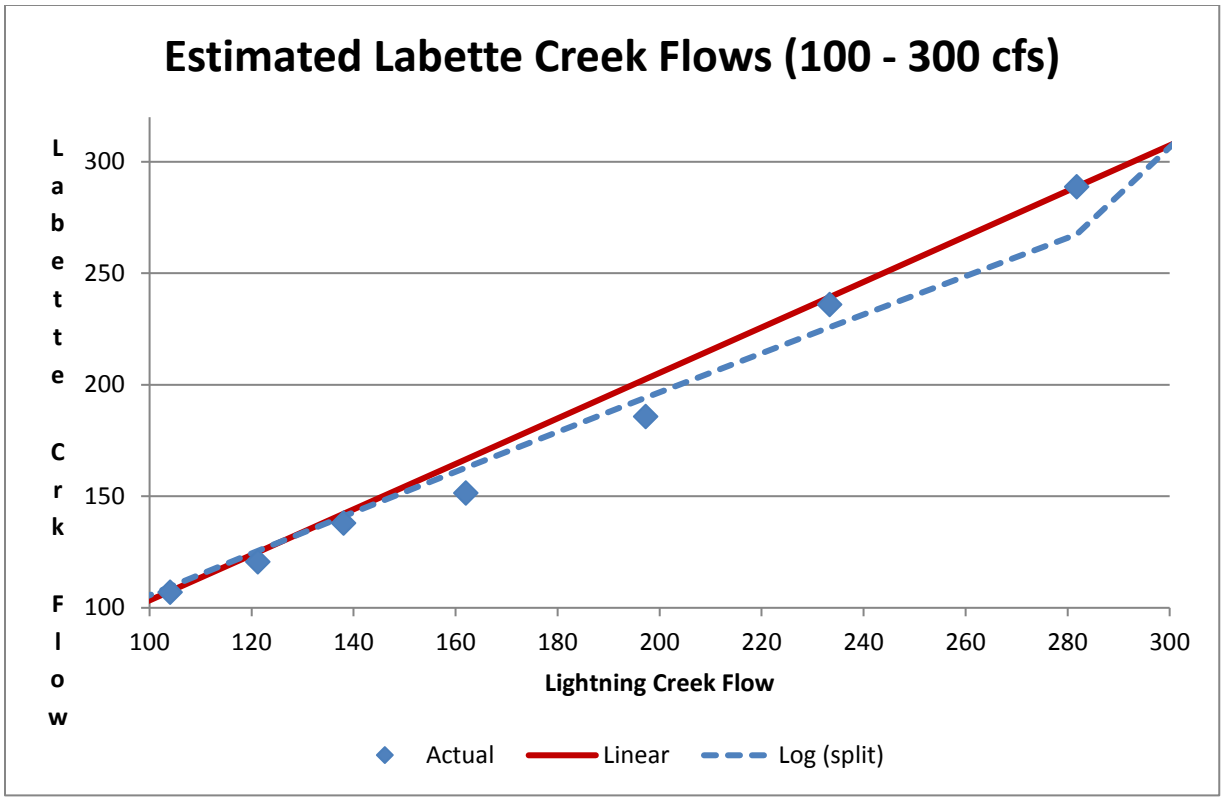
Appendix A. Flow Regressions of Labette Creek on Lightning Creek

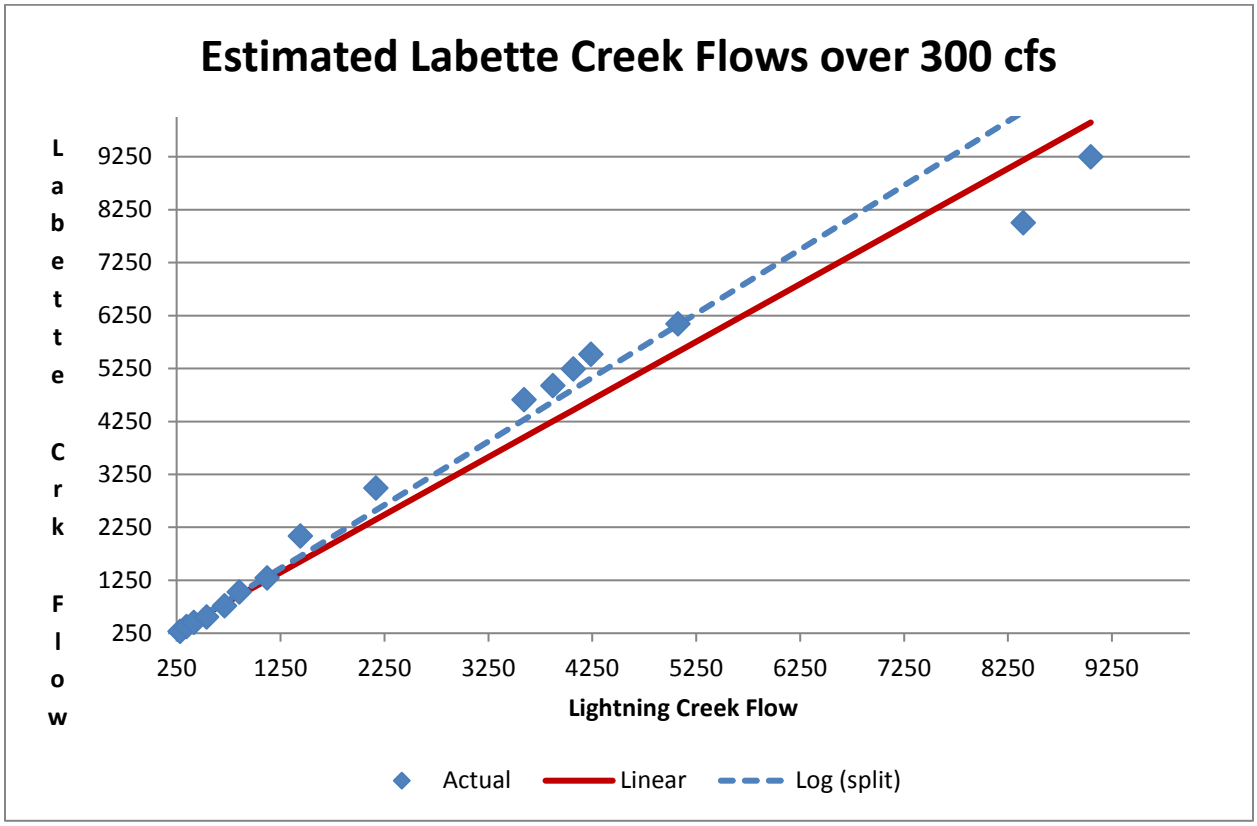
1. Linear Regression over all flow conditions:
   *Labette Q = 1.34+1.02*Lightning Q* **(R2= 0.996; MSE=19)**

2. Log Regression for flows under 300 cfs
   *Labette Q = 10^[0.232+0.896*log(Lightning Q)]* **(R2=0.962; MSE=0.032)**

3. Log Regression for flows over 300 cfs,
   *Labette Q = 10^[0.041+1.01*log(Lightning Q)]* **(R2=0.988; MSE = 0.0029)**




Estimated Labette Creek Flows (100 - 300 cfs)
Labette Crk Flow
300
250
200
150
100
100
120
140
160
180
200
220
240
260
280
300
Lightning Creek Flow
Actual
Linear
Log (split)


Estimated Labette Creek Flows over 300 cfs
Labette Crk Flow
9250
8250
7250
6250
5250
4250
3250
2250
1250
250
250
1250
2250
3250
4250
5250
6250
7250
8250
9250
Lightning Creek Flow
Actual
Linear
Log (split)

Appendix B. Estimated change in loading to Neosho River from Labette Creek with achievement of phosphorus TMDL milestones. Flows were developed by assessing the relative contribution of each watershed based on watershed size as measured at USGS gages at Parsons and Commerce, OK as depicted in Table 3. Current condition total phosphorus (TP) concentrations for the 10%, 25%, 50%, 75% and 90% flows are the average TP value at each station for the flow ranges 0-19%, 20-39%, 40-59%, 60-79%, and 80-100%, respectively.

Stream		Current Condition					TP Milestone Condition		
		Neosho R at Oswego	Cherry Cr	Labette Cr nr Chetopa	Intervening Area	Nesosho R at Chetopa	Labette Cr nr Chetopa	Resulting Condition at Neosho R at Chetopa	Percent Change in Load in Neosho R at Chetopa
Station		**SC566**	**SC605**	**SC571**	**n/a**	**SC214**	**SC571**	**n/a**	**n/a**
Drainage Area (mi^2)		5,025	128	388	284	5,825	388	n/a	n/a
10%	Flow (cfs)	9,156	305	924	676	11,060	924	n/a	n/a
	TP (mg/L)	0.312	0.149	0.207	not measured	0.300	0.125	0.293	n/a
	TP Load (lbs/day)	15,425	245	1,032	1,214	17,917	624	17,507	**2.3%**
25%	Flow (cfs)	3,612	130	396	289	4,428	396	n/a	n/a
	TP (mg/L)	0.235	0.191	0.192	not measured	0.271	0.125	0.265	n/a
	TP Load (lbs/day)	4,584	134	411	1,350	6,479	267	6,337	**2.2%**
50%	Flow (cfs)	824	36	110	81	1,051	110	n/a	n/a
	TP (mg/L)	0.157	0.076	0.125	not measured	0.140	0.119	0.139	n/a
	TP Load (lbs/day)	699	0.125	74	7	795	71	791	**0.45%**
75%	Flow (cfs)	140	8	26	19	192	26	n/a	n/a
	TP (mg/L)	0.122	0.051	0.143	not measured	0.138	0.125	0.136	n/a
	TP Load (lbs/day)	92	2	19	30	143	18	141	**1.8%**
90%	Flow (cfs)	49	2	7	5	62	7	n/a	n/a
	TP (mg/L)	0.102	0.116	0.145	not measured	0.110	0.125	0.108	n/a
	TP Load (lbs/day)	27	1.3	4.7	4.0	37	4.4	36	**1.9%**

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