UPPER ARKANSAS RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody / Assessment Unit (AU): Pawnee River

Water Quality Impairments: Lead and Copper

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Pawnee and Buckner

Counties: Pawnee, Hodgeman, Finney, Ford, Ness, Lane, Gary, Scott, Edwards

HUC8: 11030005

HUC10 (HUC12):
01 (01, 02, 03, 04, 05)
02 (01, 02, 03, 04, 05)
03 (01, 02. 03, 04, 05, 06, 07)
04 (01, 02, 03, 04, 05, 06, 07, 08, 09, 10)
05 (01, 02, 03, 04)
06 (01, 02, 03, 04)
07 (01, 02, 03, 04, 05)

11030006

01 (01, 02, 03, 04, 05)
02 (01, 02, 03, 04, 05, 06, 07, 08)
03 (01, 02, 03, 04, 05, 06, 07)

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

Drainage Area: Approximately 2,410 square miles

Water Quality Limited Segments:

Main Segment	Tributaries		
Pawnee R (2)	Cocklebur Cr (12)		
	Buckner Cr (1)	Saw Log Cr (3,4)	Elm Cr (5)
			Duck Cr (8)
	Buckner Cr (2)	Spring Cr (7)	
		Buckner Cr S. Fk (6)	
Pawnee R (3)	Hackberry Cr (4)		
Pawnee R (5)			

Designated Uses: For Main Stem Pawnee River (2): Expected Aquatic Life, Primary Contact Recreation Class C, Domestic Water Supply Use, Food Procurement Use, Groundwater Recharge, Irrigation Watering Use, Industrial Water Supply Use, Livestock Watering Use.

Pawnee River (3, 5): Expected Aquatic Life, Secondary Contact Recreation Class b, Domestic Water Supply Use, Food Procurement Use, Groundwater Recharge, Irrigation Watering Use, Industrial Water Supply Use, Livestock Watering Use.

Buckner Cr (1): Expected Aquatic Life, Secondary Contact Recreation Class b, Food Procurement, and Groundwater Recharge.

Designated Uses for Tributaries:
Buckner Cr (2) - Expected Aquatic Life Support, Secondary Contact Recreation Class a, Food Procurement, Groundwater Recharge.

Cocklebur Cr (12), Hackberry Cr (4), Elm Cr (5), Saw Log Cr (4), Spring Cr (7) – Expected Aquatic Life Support, Secondary Contact Recreation Class b.

Buckner Cr, S.Fk (6) – Expected Aquatic Life Support, Primary Contact Recreation Class B.

Saw Log Cr (3) – Expected Aquatic Life Support, Primary Contact Recreation Class C.

Duck Cr (8) - - Expected Aquatic Life Support, Secondary Contact Recreation Class b, Food Procurement, Irrigation Watering Use, Livestock Watering Use.

303(d) Listings: Kansas Stream segments monitored by Station SC585 (Pawnee River near Larned) cited as impaired by Copper in the 2010-303(d) list and by Lead in the 2008 and 2010-303(d) list for the Upper Arkansas River Basin. Kansas Stream segments monitored by Station SC586 (Pawnee River near Burdett) cited as impaired by Copper in the 2002 and 2010-303(d) lists and by Lead in the 2010-303(d) list.

Impaired Use: Expected Aquatic Life is impaired due elevated copper (chronic and acute) and lead (chronic) concentrations.

Water Quality Criteria: Hardness dependent criteria from Table 1b of the Kansas Surface Water Quality Standards (K.A.R. 28-16-28e(c)(2)(D)(ii)). Where water effects ratio = WER is 1.0 and hardness is in mg/L.

Chronic AL Total Lead (µg/L) = WER[EXP[(1.273(LN(hardness)))-4.705]]*

Chronic AL Total Copper (µg/L) = WER[EXP[(0.8545(LN(hardness)))-1.702]]*

Acute AL Total Copper (µg/L) = WER[EXP[(0.9422(LN(hardness)))-1.700]]*

2.0 CURRENT WATER QUALITY CONDITION AND DESIRED ENPOINT

Level of Support for Designated Uses under 2010-303(d): Not supporting Aquatic Life

Stream Monitoring Sites: Active KDHE permanent Stream Chemistry sampling stations SC585 located on Pawnee River near Larned, and SC586 located on Pawnee River near Burdett.

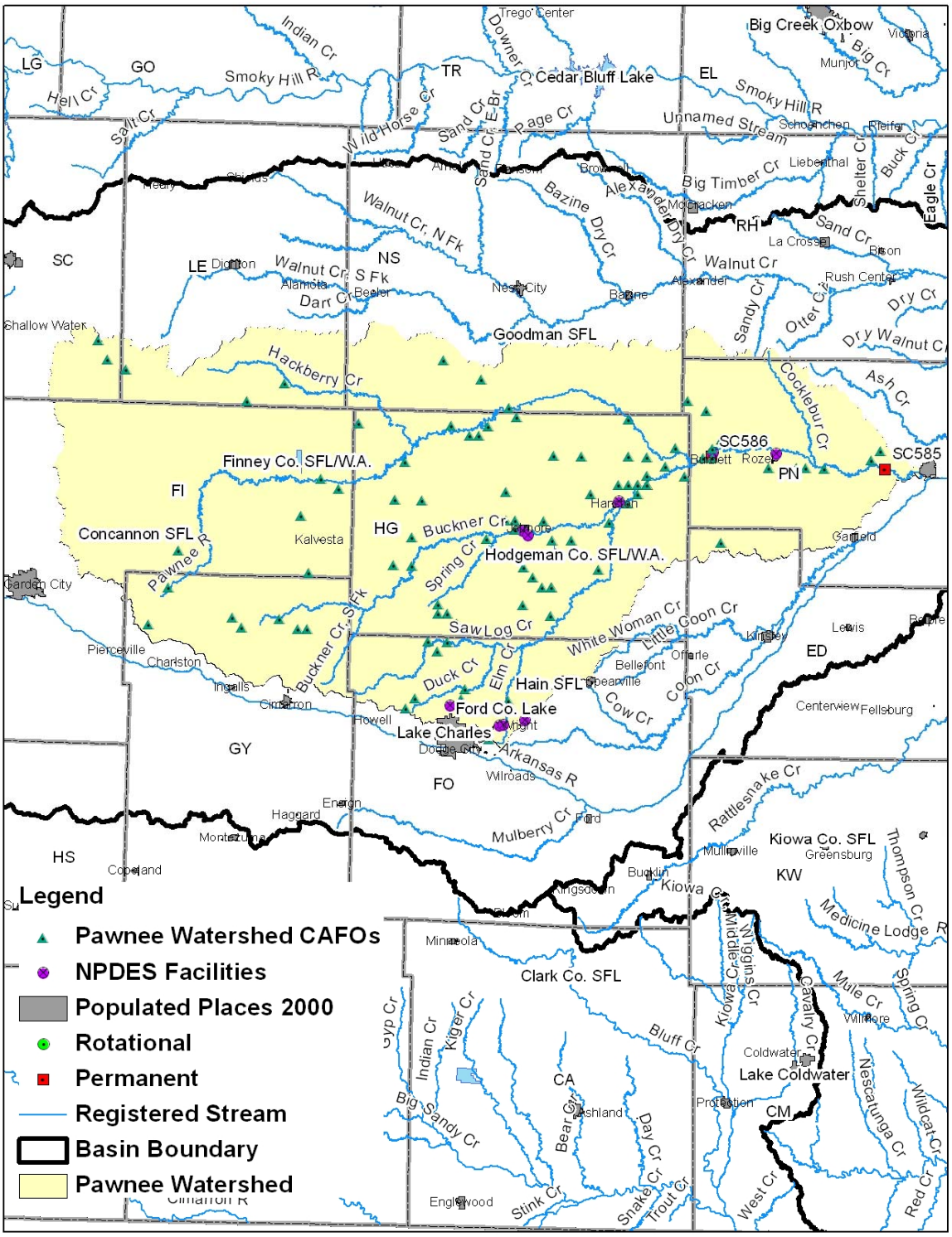
Period of Record: SC585 and SC586: 1990-2011

Flow Record: USGS Gage 07140850 on Pawnee River near Burdett (1982-2011), USGS Gage 07141175 on Buckner Cr near Burdett (1995-2011) and USGS Gage 07141200 on Pawnee River at Rozel (1982-2011) were utilized to establish long term flow conditions for SC585 and SC586. Flow conditions for SC586 were established from a common flow period (1995-2011) from USGS Gage 07140850 and Gage 07141175. For samples collected at SC586 prior to the common flow period for these gages the flow was estimated based on the USGS Gage 07140850. Flow conditions for SC585 were established based on the flow record from USGS Gage 07141200, with adjustments made based on the watershed size of the sampling station relative to this flow gage. There are low flow dams on the Pawnee River that do influence flow conditions during the lower flow periods. The Pawnee River watershed is detailed in Figure 1.

Table. 1. Long Term Flow Conditions is cubic feet per second (cfs).

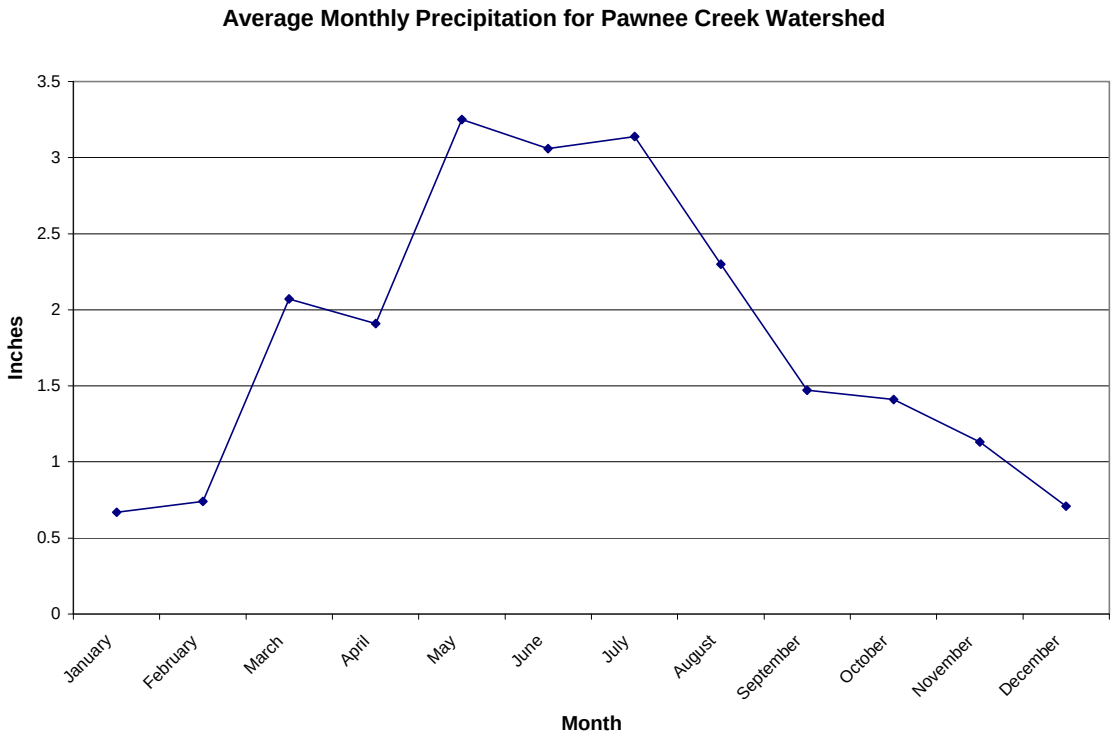
Stream Location	Avg. Q	Percent of Time Flow Exceeded				
		75%	50%	25%	10%	5%
Pawnee River near Burdett at USGS Gage 07140850 (1982-2011)	9.6	0	0	0.6	7.6	19
Buckner Cr near Burdett at USGS Gage 07141175 (1995-2011)	14.8	0	0	5.3	22	38
Pawnee River at SC586 (1995-2011)	24.2	0	0	8.8	34	68
Pawnee River at Rozell at USGS Gage 07141200 (1982-2011)	28.3	0	0	5.3	32	80
Pawnee River at SC585(1995-2011)	29.5	0	0	8.9	40.4	96.8

Figure 1. Pawnee River Watershed Base Map .



Precipitation: The average annual rainfall in the watershed is approximately 21.9 inches per year (weather.com). The average monthly precipitation for the watershed is observed in Figure 2.

Figure 2. Average monthly precipitation as reported at Jetmore, KS on weather.com as reported in 2011.



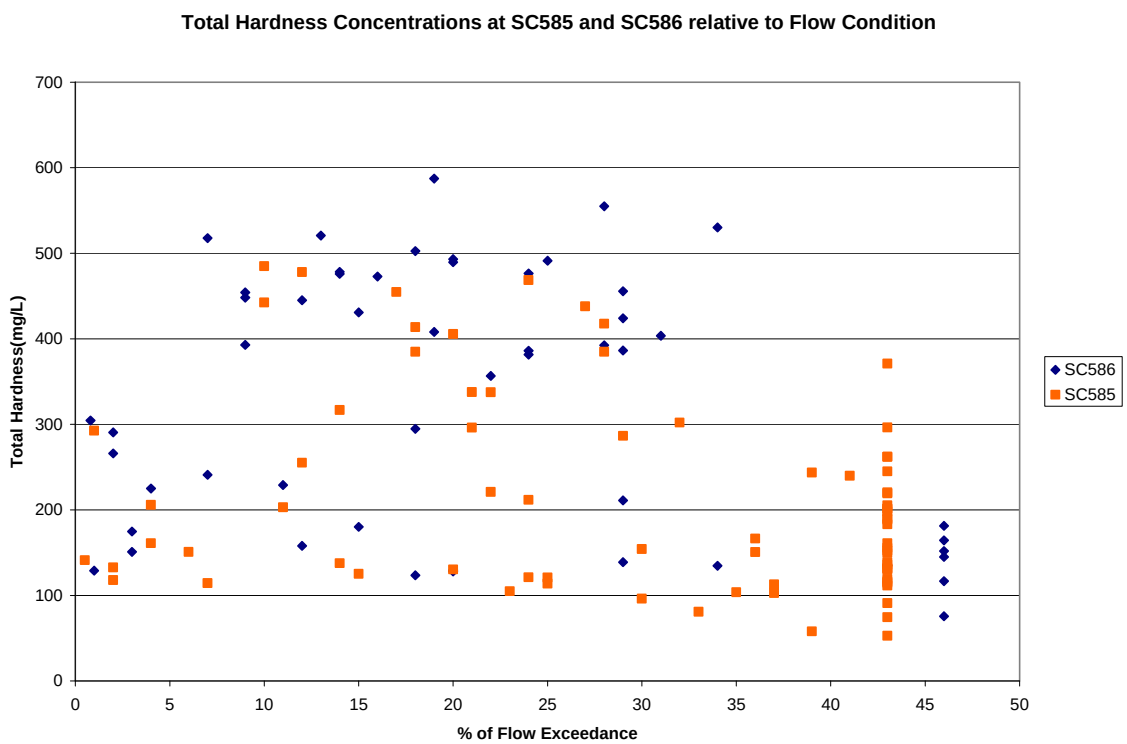
Current Conditions - Lead: Chronic Lead (Pb) excursions occur in the Pawnee River watershed throughout all seasons and under all flow conditions. There are no acute Pb violations in the Pawnee River at stations SC585 or SC586. Violations are more prevalent in the Spring (April-June) and the Summer-Fall (July-October) months. The Pb criterion is associated with the total hardness of each sample, and generally the hardness and the respective criterion is lower during higher flow conditions as seen in Figure 3. Evaluating the flow condition for the 7-day period prior to the sampling date of the impaired samples indicates that all but just a few of the violations are attributed to unstable flow conditions where a runoff event has occurred within this period. As seen at the USGS gage and in Figure 4, flow conditions in Pawnee Creek tends to see rapid rises and decreases. In addition, there are numerous samples collected when the gage is reading zero cfs. The USGS gages are not located at the sampling stations and low water dams are likely the main reason there is not any flow reported with some of sampling dates. KDHE does not collect samples if the stream is dry or pooled. KDHE samples when water is flowing over the low water dam structures in this watershed, which does not always translate into measurable flow at the USGS gages during drier periods. Therefore the low flow condition detailed in the assessment of the Pawnee River at the sampling stations encompasses flows within the 40-100% flow exceedance range which

encompasses the samples collected when the gages did not record any measurable flow. In the Pawnee River watershed, station SC585, is particularly influenced by one of these structures due to its close proximity to the low water dam at Larned.

Table 2. Number of Samples over the Chronic Lead Aquatic Life Criterion by Season (1990-2011).

Station	Season	Samples Over Chronic Pb Criterion / Total Samples	Frequency of Exceedance
SC585, Pawnee River near Larned	Spring	6/22	27%
	Summer-Fall	15/29	52%
	Winter	5/26	19%
SC586, Pawnee River near Burdett	Spring	5/16	31%
	Summer-Fall	6/19	32%
	Winter	2/16	13%

Figure 3. Total hardness values relative to the percent of flow exceedance on Pawnee River.



The resulting violations detected during unstable flow conditions typically have runoff sampling characteristics, regardless of the amount of flow associated with the sampling date. As seen in Figure 4, the sample violation occurred at the tail end of a brief runoff event also illustrating an unstable flow condition.

Figure 4. Example of unstable flow conditions at the USGS gage relative to the sampling date of a Pb sampling violation at SC586.

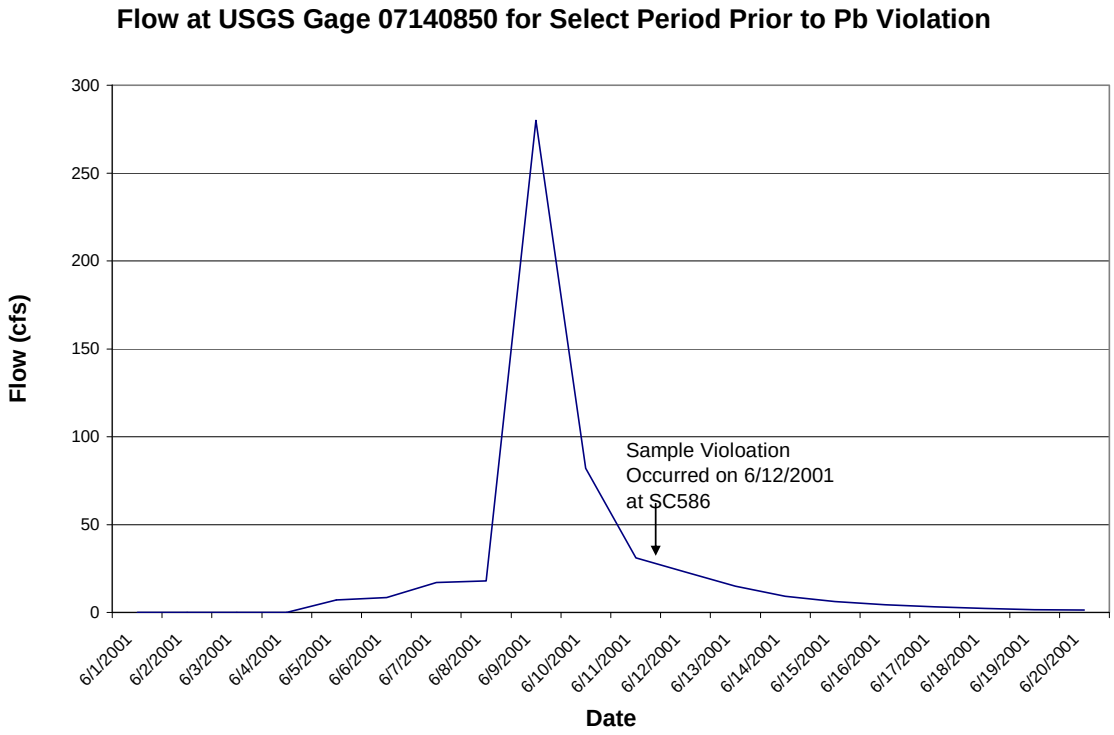


Figure 5. Pb concentrations and the respective criteria relative to the flow condition (1990-2011).

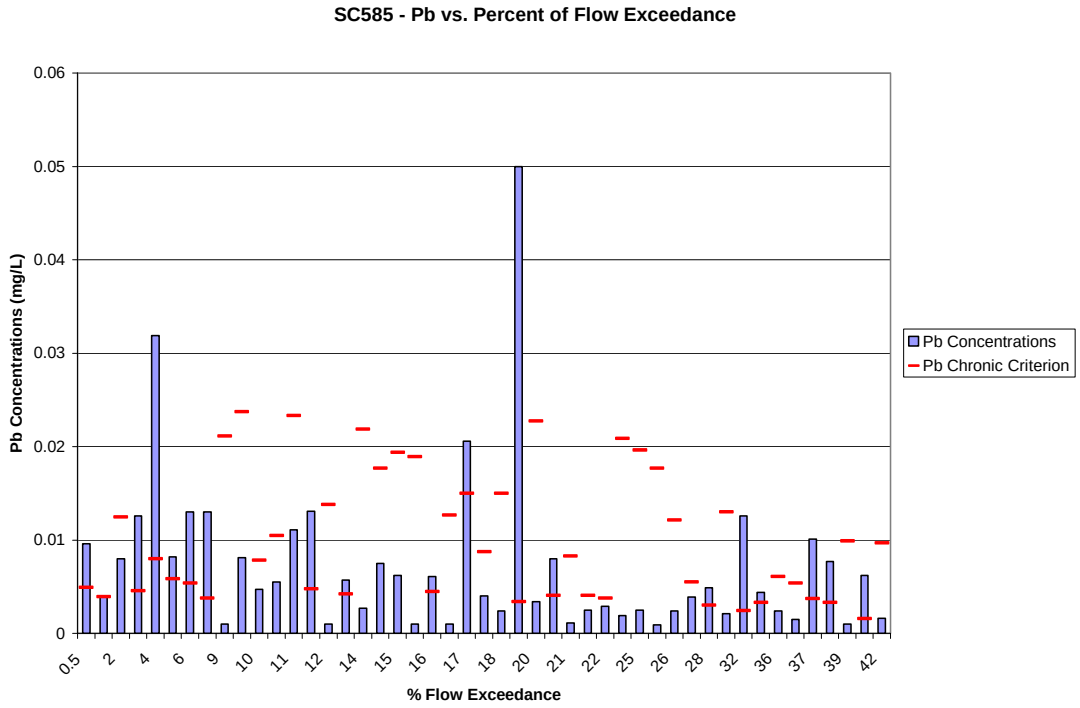


Figure 6. Pb concentrations and respective criteria at SC585 when no flow is reported based on the USGS gage, which illustrates the low flow condition samples at SC585.

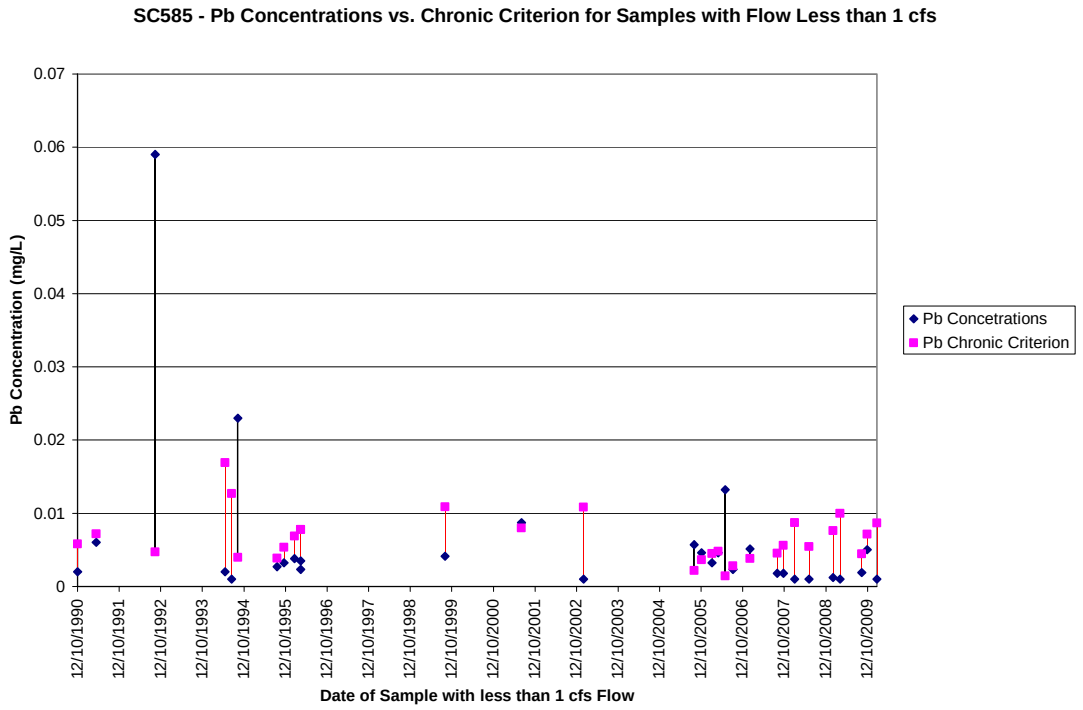
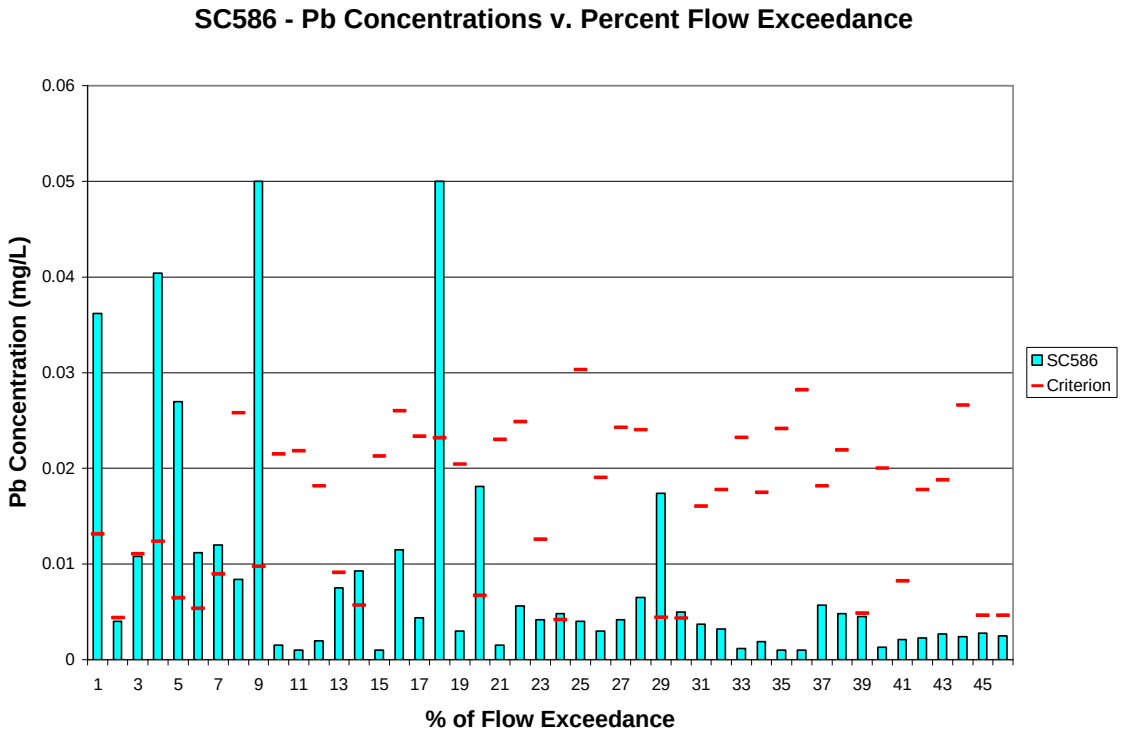
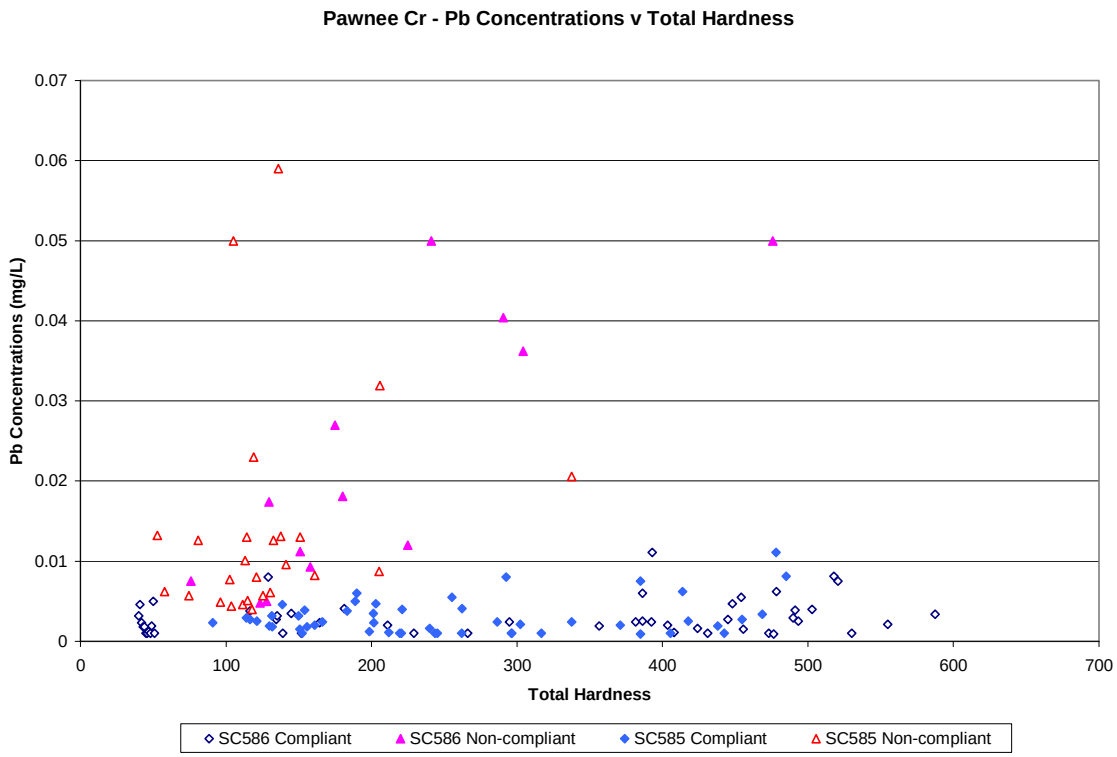


Figure 7. Pb concentrations and respective criteria at SC586 relative to flow conditions (1990-2011).



As illustrated in Figures 5, 6, and 7, the respective Pb concentrations observed at SC585 and SC586 generally indicate Pb concentrations are elevated during the higher flow conditions. The violations that occur at the lower flows are attributed to unstable flow conditions and the occurrence of a runoff event preceding the sampling date. The samples with the higher Pb concentrations and the lower criterion limits are evidence of this scenario as well, where the runoff events contribute to higher lead concentrations and lower hardness values, which is further illustrated in Figure 8.

Figure 8. Pawnee River Pb concentrations relative to the Total Hardness values at stations SC585 and SC586.



Current Conditions - Copper: Pawnee River is also impaired with acute and chronic copper (Cu) impairments. Typically the Cu excursions were detected during higher flow periods during the spring and summer-fall seasons, although violations were observed during all flow conditions. During the 1990s, the KDHE Kansas Health and Environment Laboratory commonly had Cu detections in their blank samples as a result of reusing sampling vials. It is unknown whether the violations detected at SC585 and SC586 during the 1990s were a result of cross contaminated sampling vials. Sampling vials are no longer re-used as of 2002.

As seen in Table 3, the Cu violations occur within 32- 38% of the samples during the spring and summer-fall seasons. Violations at SC586 occur less frequently in the winter and have fewer acute violations.

Table 3. Summary of Cu samples in the Pawnee River watershed.

Station	Season	Samples Over Acute Criterion / Total Samples	Samples Over Chronic Criterion / Total Samples
SC585, Pawnee River near Larned	Spring	7/24 = 29%	9/24 = 38%
	Summer-Fall	5/31 = 16%	10/31 = 32%
	Winter	1/27 = 4%	7/27 = 26%
SC586, Pawnee River near Burdett	Spring	2/18 = 11%	6/18 = 33%
	Summer-Fall	4/20 = 20%	7/20 =35%
	Winter	0/13 = 0%	1/13 = 8%

At SC586, Chronic Cu violations were detected in the majority of the sampling years, with the most recent violation occurring in 2009. Acute Cu violations have been limited, with excursions occurring in 1992, 1993, and 2001. As seen in Figures 9 and 10, the copper concentrations in the past decade have been lower compared to the 1990s. Figure 11, illustrates the detected copper concentrations relative to the season and the sampling date. Seasonal concentrations have decreased over the past decade. Chronic violations were more prevalent during higher stream flows as seen in Table 4.

Table 4. Chronic Cu violations relative to stream flow condition at SC586.

Flow Condition	Cu Chronic Violations/Samples	Percent Impaired
High 0-10%	7/13	54%
Normal 11-39%	7/20	35%
Low 40-99%	1/7	14%

Figure 9. Copper concentrations at SC586 relative to the criteria for samples from the 1990s.

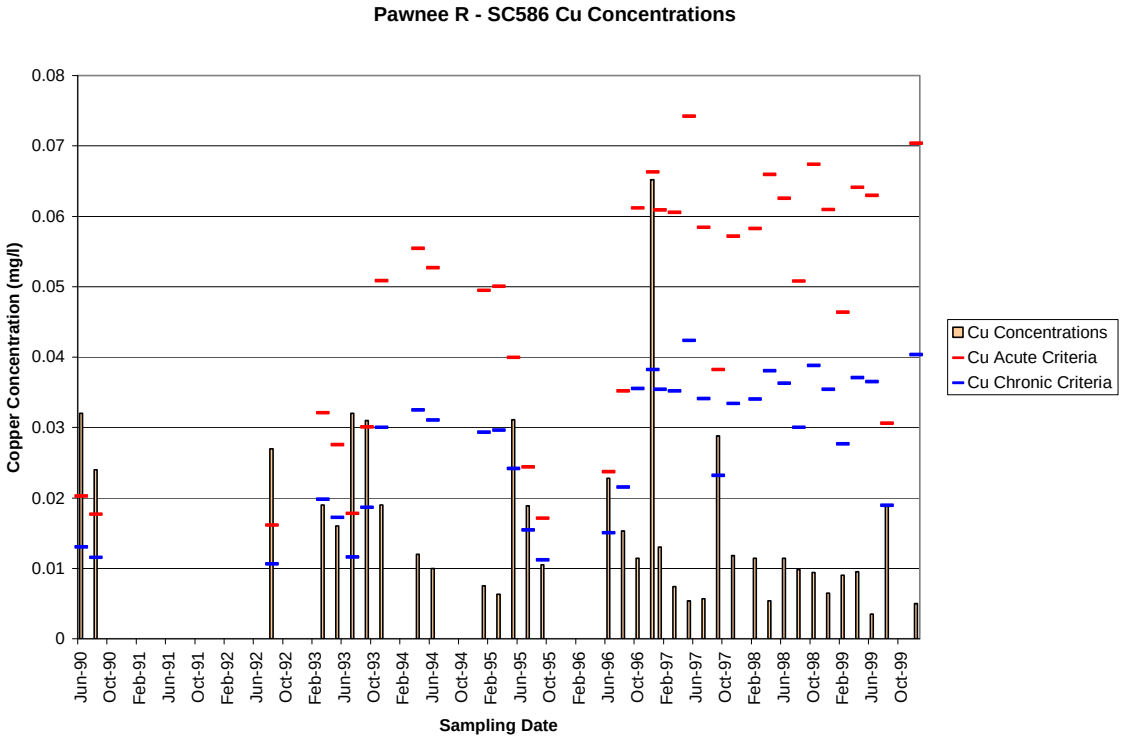


Figure 10. Copper Concentrations at SC586 relative to criteria in the past decade.

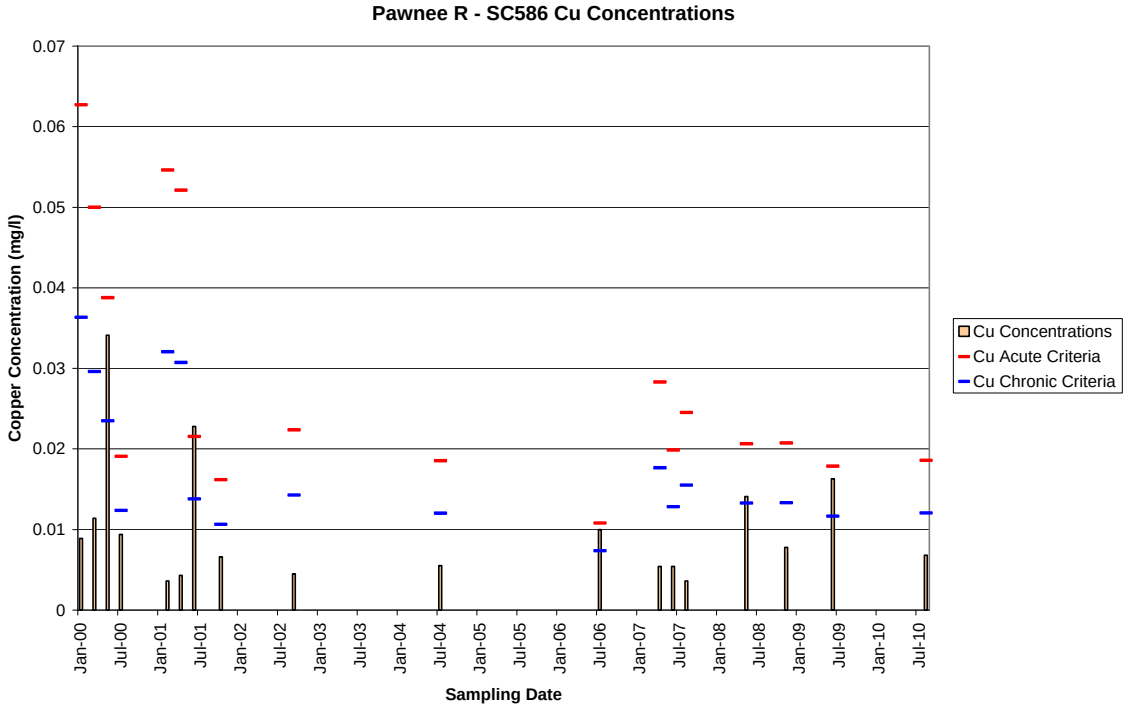
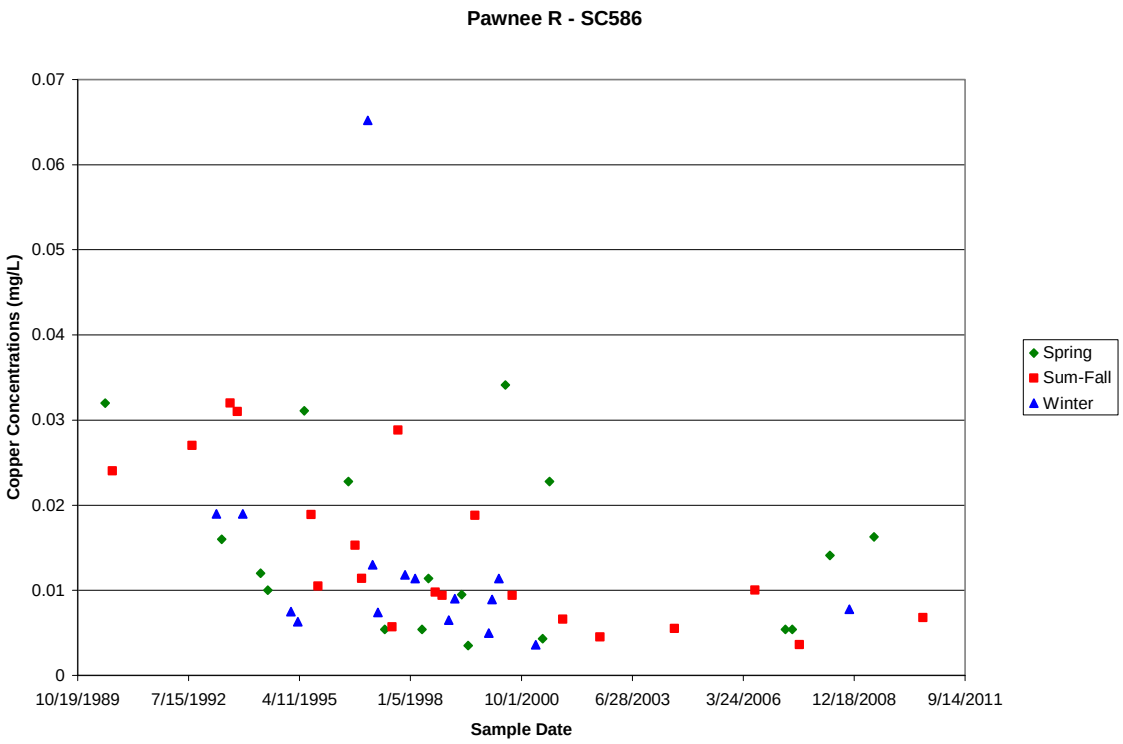


Figure 11. Seasonal Copper concentrations at SC586 relative to sampling date.



As seen in Figures 12 and 13, sampling station SC585 has chronic Cu violations throughout the period of record with the most recent violation occurring in 2010. In addition, acute Cu violations have also occurred within recent sampling years and have occurred during the sampling years of 1990, 1991, 1992, 1993, 1996, 2001, 2006, and 2010. Figure 14 indicates that generally concentrations have remained stable throughout the seasons over the past decade. Chronic copper violations consistently occurred during all flow conditions, though the highest relative percentage of impairments occur during the high flow condition as seen in Table 5.

Table 5. Chronic Cu violations relative to streamflow condition at SC585.

Flow Condition	Cu Chronic Violations/Samples	Percent Impaired
High 0-10%	7/12	58%
Normal 11-39%	10/38	26%
Low 40-99%	11/36	31%

Figure 12. Copper concentrations at SC585 relative to criteria and sampling date (1990s).

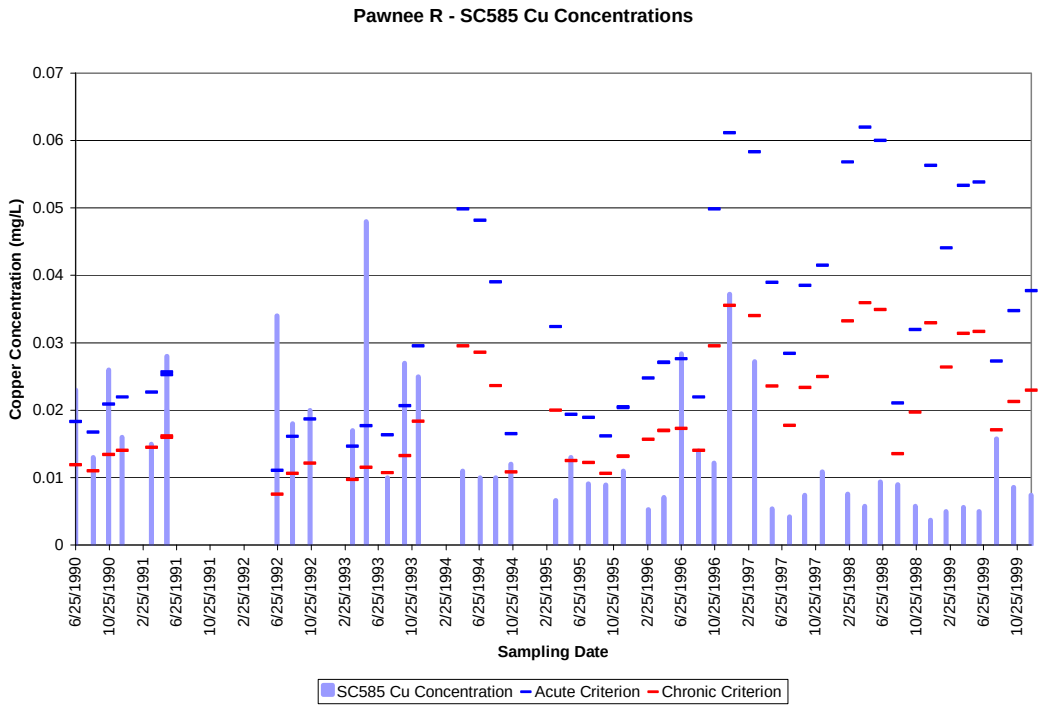


Figure 13. Copper concentrations at SC585 relative to criteria and sampling date (2000s).

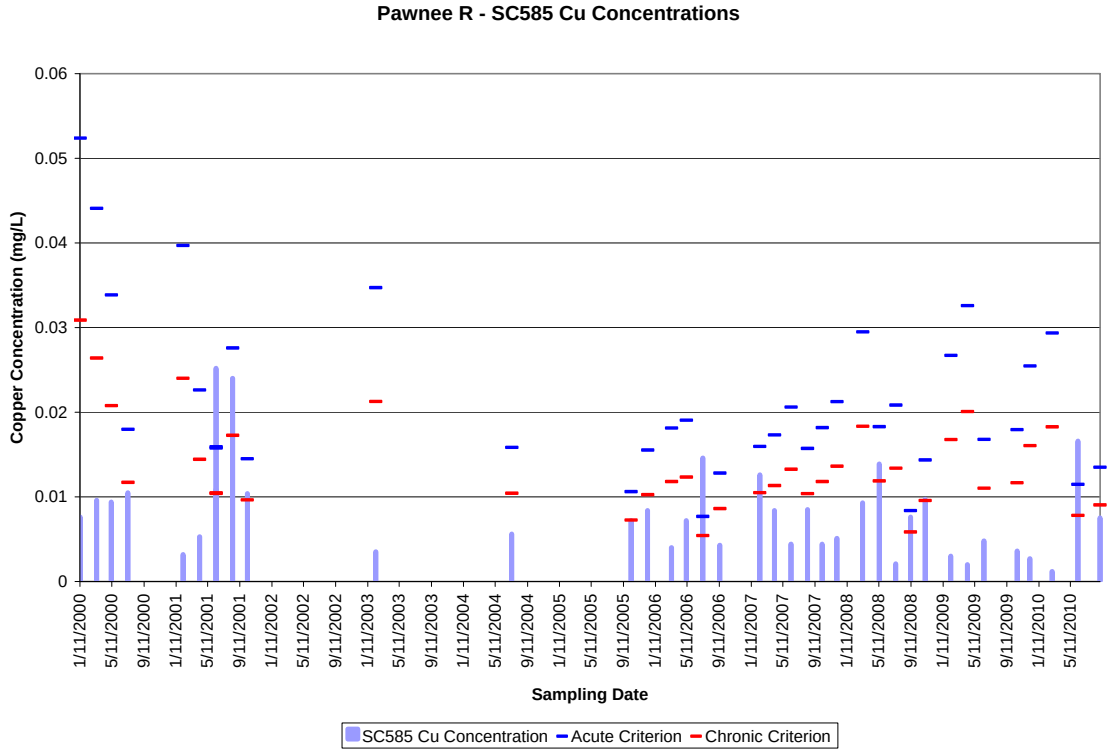
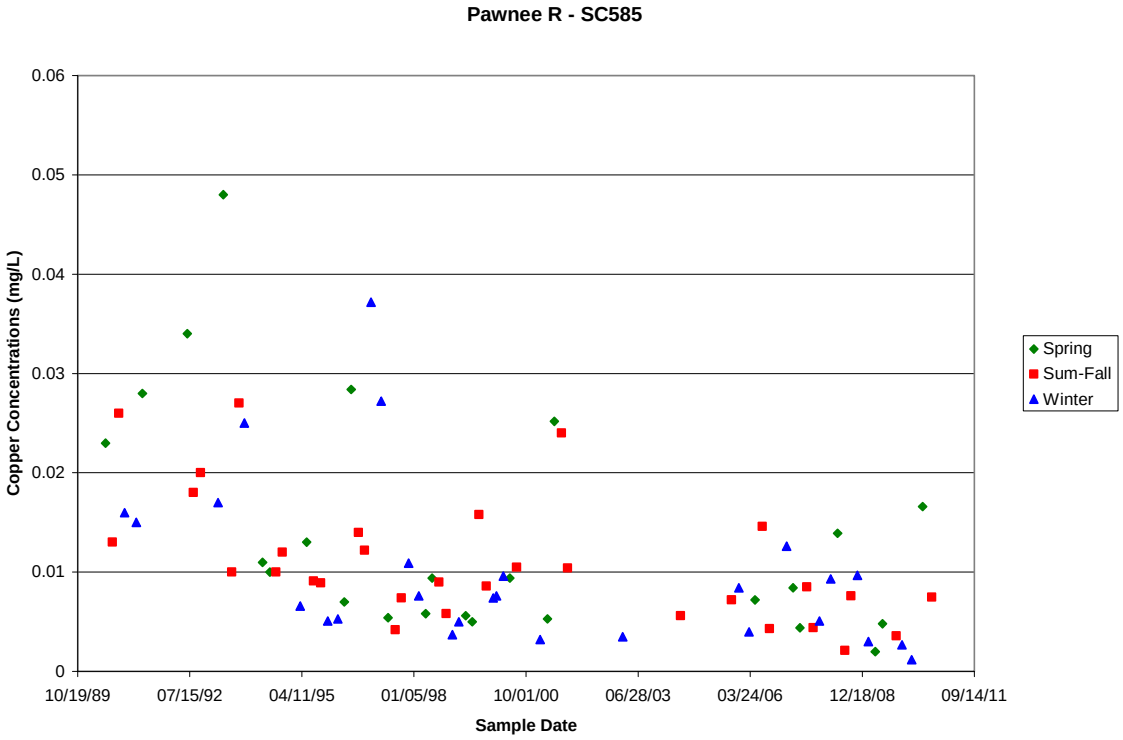


Figure 14. Seasonal Copper concentrations at SC585 over time.

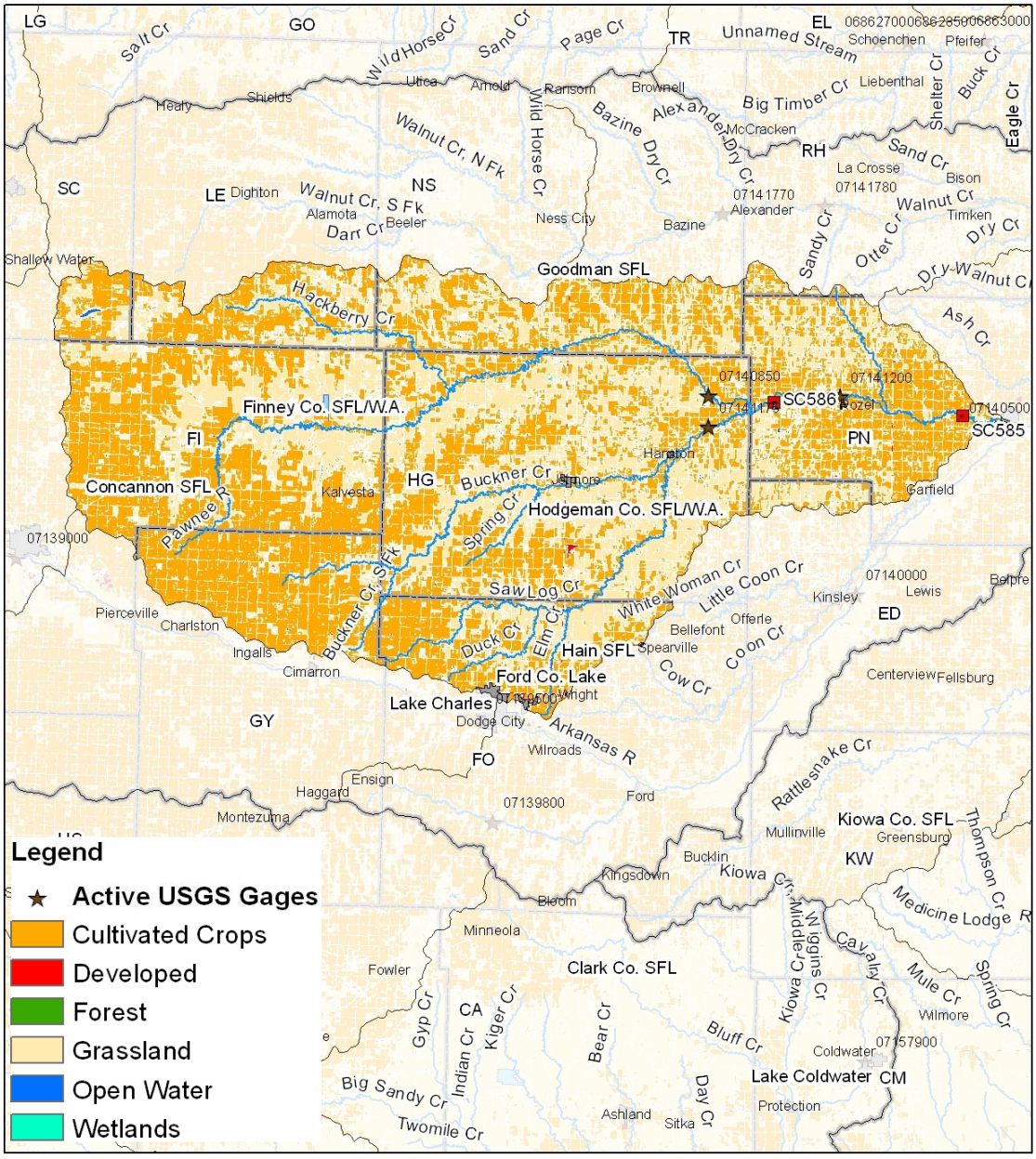


Desired Endpoint of Water Quality for the Pawnee Creek Watershed: The ultimate endpoint for this TMDL will be to achieve the chronic Pb and acute and chronic Cu Kansas Water Quality Standards fully supporting aquatic life for KDHE sampling stations SC585 and SC586. Excursions in the watershed appear to be related to runoff events and unstable flow conditions, rather than seasonality. However, seasonal variation is accounted for in this TMDL since the endpoint accounts for all flow conditions throughout the year. Achievement of this endpoint will provide full support of the aquatic life function within the Pawnee Creek watershed and attain the respective Pb and Cu water quality standards.

3.0 SOURCE INVENTORY AND ASSESSMENT:

Land Use: The cover in the Pawnee River watershed includes 60% croplands, 36% grassland, 3% developed, and less than 1% of open water, wetlands, and forest. Landuse for Pawnee River watershed is detailed in Figure 15.

Figure 15. Landuse in the Pawnee River Watershed.



Point Sources: There are eight NPDES facilities within the Pawnee River watershed. Of these, three of them are permitted discharging facilities. Dodge City is the largest discharging facility, however this is a new facility that has not reported any discharge. This facility is also designed for effluent irrigation reuse. The facilities within the watershed are detailed in Table 6 and Figure 1.

Table 6. NPDES Facilities in the Pawnee Rive Waterhsed.

Permit #	Federal NPDES #	Facility Name	Type	Receiving Stream	Design Flow (MGD)	Permit Expires
I-UA11-NP02	KSJ000481	Koch Nitrogen Co.	Non-Discharging	NA	NA	11/30/2012
I-UA11-NP04	KSJ000615	Darlings International	Non-Discharging	NA	NA	8/31/2015
M-UA06-NO01	KSJ000272	City of Burdett	Non-Discharging	NA	NA	5/31/2012
M-UA35-NO01	KSJ000255	City of Rozel	Non-Discharging	NA	NA	5/31/2012
M-UA43-NO01	KSJ000260	Wright Improvement District	Non-Discharging	NA	NA	7/31/2012
M-UA11-OO02	KS0099830	Dodge City	Mechanical, UV, Activated Sludge, Effluent Reuse	Duck Cr via Unnamed Trib	1.25	12/31/2014
M-UA17-OO01	KS0031143	City of Hanston	Mechanical	Buckner Cr	0.04	12/31/2011
M-UA21-OO02	KS0099562	City of Jemore	3-cell Lagoon	Buckner Cr	0.0942	12/31/2012

Livestock Waste Management Systems: There are 59 active certified or permitted confined animal feeding operations (CAFOs) within the Pawnee River watershed (see Appendix A). These facilities are designed to retain a 25-year, 24-hour rainfall/runoff event as well as an anticipated two weeks of normal wastewater from their operations. Typically, this rainfall event coincides with streamflow that occurs less than 1-5% of the time. Though the potential number of animals is approximately 292,698 head in the watershed, the actual number of animals at the feedlot operations is typically less than the allowable permitted number. It is not anticipated that livestock operations contribute to the lead impairment in the watershed. However, livestock may attribute to the copper impairment as copper sulfate is commonly used for treatment and nutrition of livestock. Figure 1 details the locations of these facilities.

According to the Kansas Agricultural Statistics, the estimated number of all cattle and cows for counties that are included within this watershed as of January 1, 2011 are as follows: 90,000 for Pawnee County; 84,000 for Hodgeman County; 260,000 for Finney

County; 170,000 for Ford County; 31,000 for Ness County; 63,000 for Lane County; 250,000 for Gray County; 260,000 for Scott County; and 71,000 for Edwards County.

Contributing Runoff: The watershed of Pawnee River has a mean soil permeability value of 1.02 inches/hour according to the NRCS STATSGO database. According to a USGS open-file report (Juracek, 2000), the threshold soil-permeability values that represents very high, high, moderate, low, very low, and extremely low rainfall intensity, were set at 3.43, 2.86, 2.29, 1.71, 1.14, and 0.57”/hour, respectively. The lower rainfall intensities generally occur more frequently than the higher rainfall intensities. The higher soil-permeability thresholds imply a more intense storm during which areas with higher soil permeability potentially may contribute runoff. Runoff is chiefly generated as infiltration excess with rainfall intensities greater than the soil permeability As soil profiles become saturated, excess overland flow is produced. For the Pawnee River watershed, approximately 50% of the watershed will produce runoff with rainfall events that produce 1.14 inches/hour of rain. Over 93% of the entire watershed has a low soil permeability value that will produce runoff with rainfall events that produce 1.71 inches/hour of rain. Runoff contributes to the lead and copper impairment within the watershed.

Nonpoint Sources: The Pb and Cu impairment in the Pawnee Creek watershed is likely associated with nonpoint sources. Pb attached to soil particles from exposed land is prone to runoff during rain events that produce runoff. Common Pb sources are attributed to lead based paint, leaded gasoline, and lead dust in the air. Pb will remain in the soil for prolonged periods once it is deposited and does not readily move through the soil (Rosen, 2002). Source assessments utilized to identify Pb contamination sources is difficult since Pb may remain in the environment for long periods of time.

Copper may originate from roads and highways, urban area, livestock facilities and agriculture lands. Some automobile brake pads are a source of copper as are some building products such as plumbing, wiring, and paints (Boulanger and Nikolaidis, 2003). Copper may be associated with the use of copper sulfate, which is used for treatment and nutrition of livestock, at livestock facilities. Copper is also widely used in fertilizers, particularly for the application to soybean crops to correct copper deficiencies, and copper-based pesticides are widely used in the United States (Avery, 2001). Thus, agricultural and livestock applications could contribute as the primary source of copper impairment in the watershed.

On-Site Waste Systems: Households outside of the municipalities that operate a wastewater treatment facility are presumably utilizing on-site septic systems. There are approximately 16,476 people living within the municipalities served by wastewater treatment facilities within the watershed, and therefore there are approximately 8,500 people within the watershed utilizing on-site septic systems. On-site septic systems are not a source contributing to the copper and lead impairment within the Pawnee River watershed.

Background: Background levels of Pb and Cu are derived from geological sources and detectable concentrations are naturally present in the soil. Pb and Cu attached to silt becomes suspended during high flow events as soil bank erosion occurs.

Population: The population within the watershed is approximately 25,000 people as estimated from the 2000 U.S. Census Tract information, with 15,000 of these folks residing in the portions of Dodge City that lie within the watershed. Population projections from the Kansas Water Office for Dodge City, Hanston, and Jetmore indicate populations are anticipated to be relatively stable.

4.0 ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

The cubic regression between the chronic aquatic life criterion load for the observed samples at the respective stations and the flow exceedance establishes the TMDL for Pb and Cu in the Pawnee River watershed for stations SC586 and SC585, which is derived from the observed hardness values for each sample. The regression equation is detailed in Appendix B. Generally, the hardness values within the watershed are lower during high flow conditions. Therefore, the lead and copper water quality criterion tends to be more restrictive as stream flows increase.

Point Sources: Since the Pb and Cu violations are generally associated with unstable flow conditions associated with a runoff event it is conceivable that point sources are not contributing to the Pb or Cu impairment. Regardless, a Wasteload Allocation (WLA) of 0.056 lbs/day of Pb and 0.143 lbs/day of Cu has been established for the three discharging point source facilities within the watershed. The Wasteload Allocation was conservatively established utilizing the chronic Lead (0.0048 mg/L) and Copper (0.142 mg/L) criterion concentrations based on the average total hardness value, 138.5 mg/l, during low flows at SC586. Station SC586 was utilized to establish the WLA since all the discharging point sources in the watershed are above this station. The resulting Pb and Cu WLA for each facility is detailed in Table 7.

Table 7. Waste Load Allocations for the discharging facilities in the watershed.

Facility	Pb WLA (lbs/day)	Cu WLA (lbs/day)
Dodge City	0.05	0.129
City of Hanston	0.002	0.004
City of Jetmore	0.004	0.01

Nonpoint Sources: The TMDL assigned to the Pawnee River watershed is illustrated in Figures 16 and 17. The TMDL load durations curve for each sampling station has been developed with a cubic regression based on the log transgression of the observed sample criterion load for each data set collected at the respective stations. The TMDL for various flow conditions at SC585 and SC586 are detailed in Table 8a and Table 8b.

Figure 16. Lead TMDL at Station SC586.

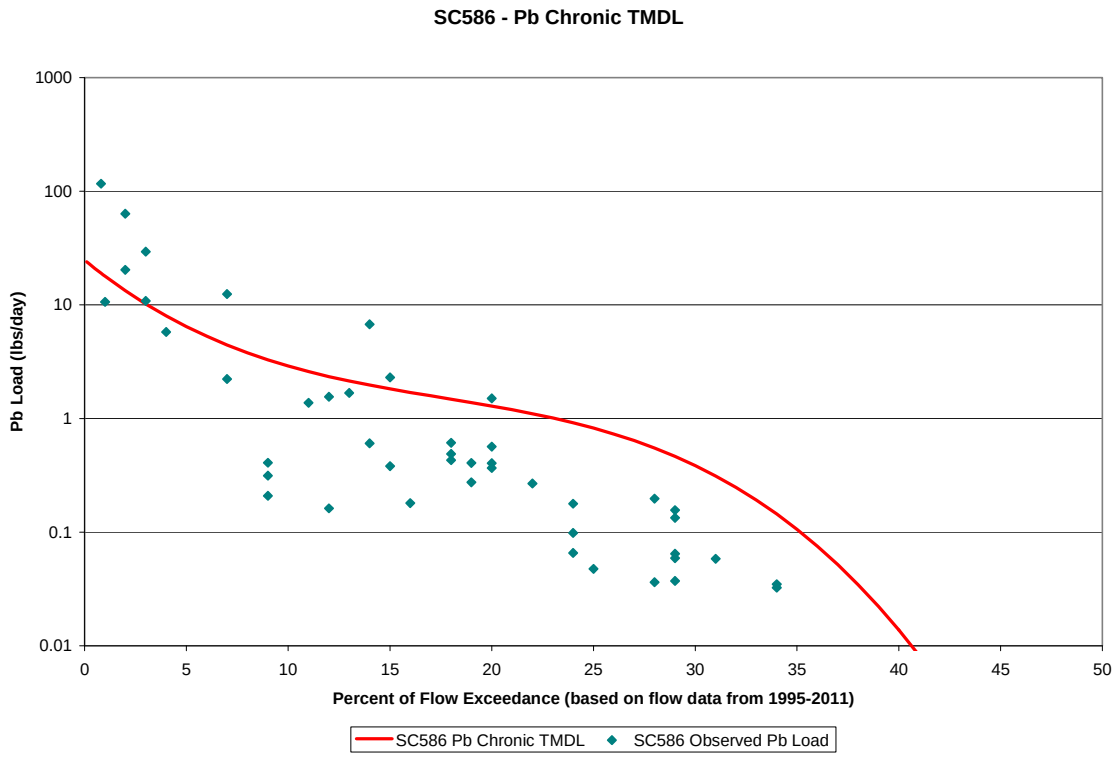


Figure 17. Lead TMDL at Station SC585.

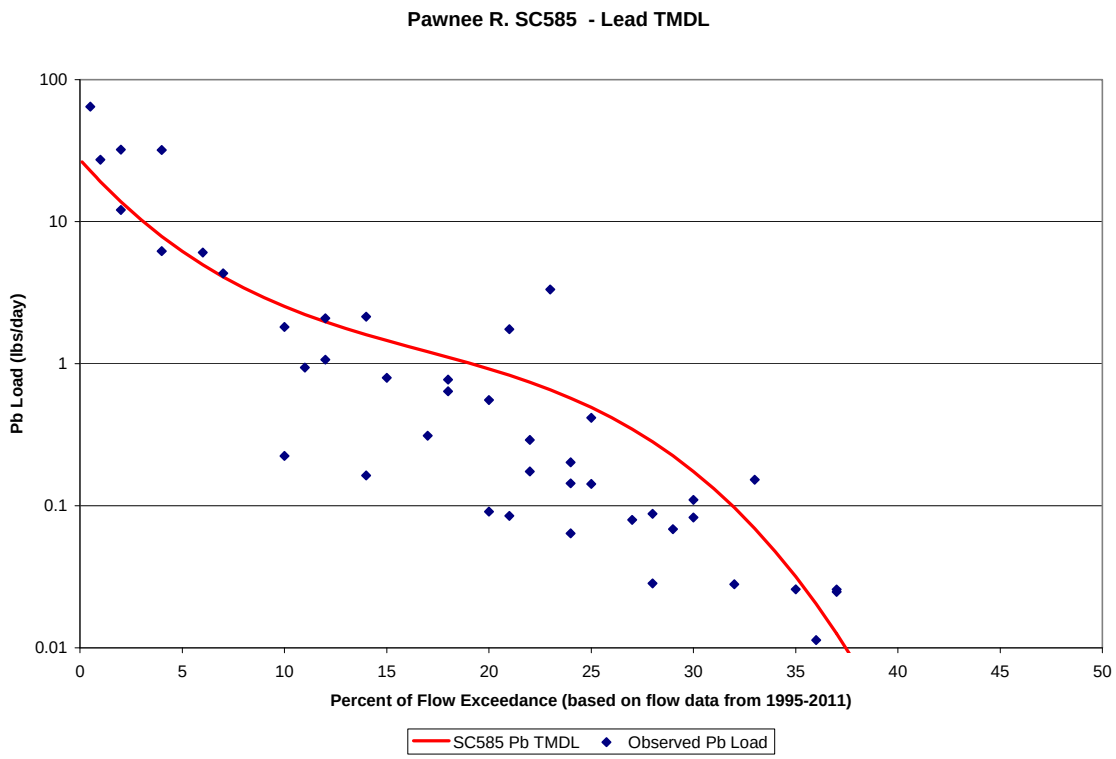


Figure 18. Copper TMDL at Station SC586

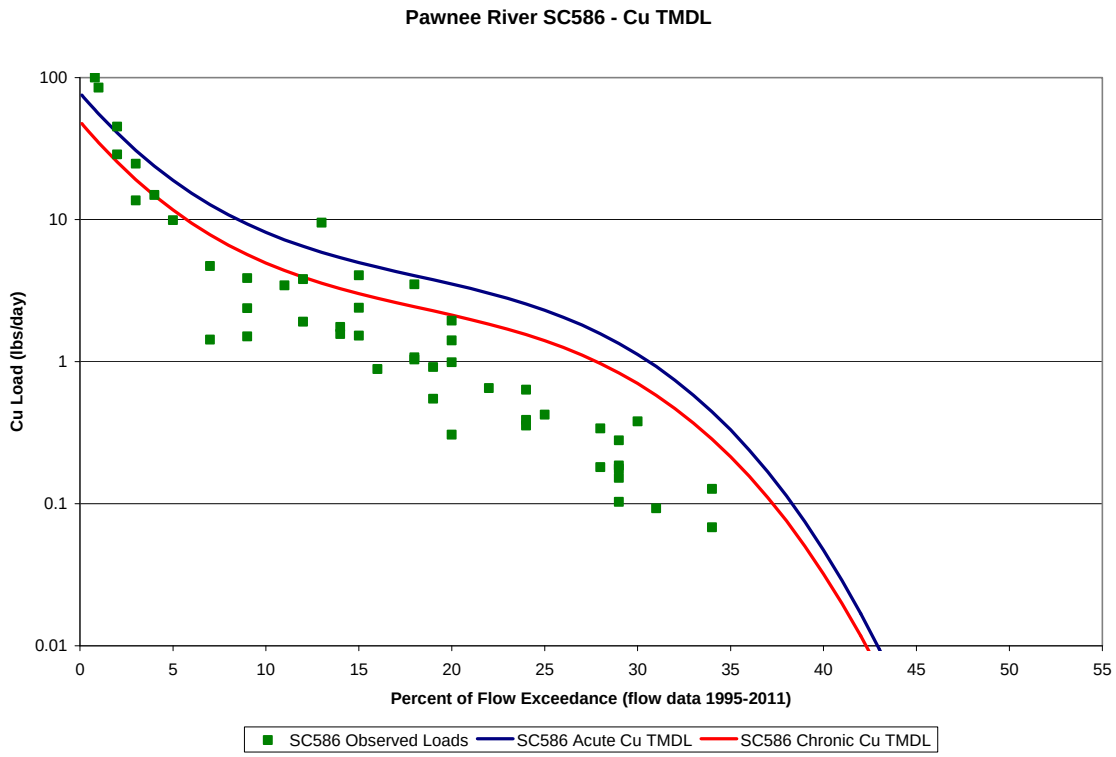


Figure 19. Copper TMDL at SC585.

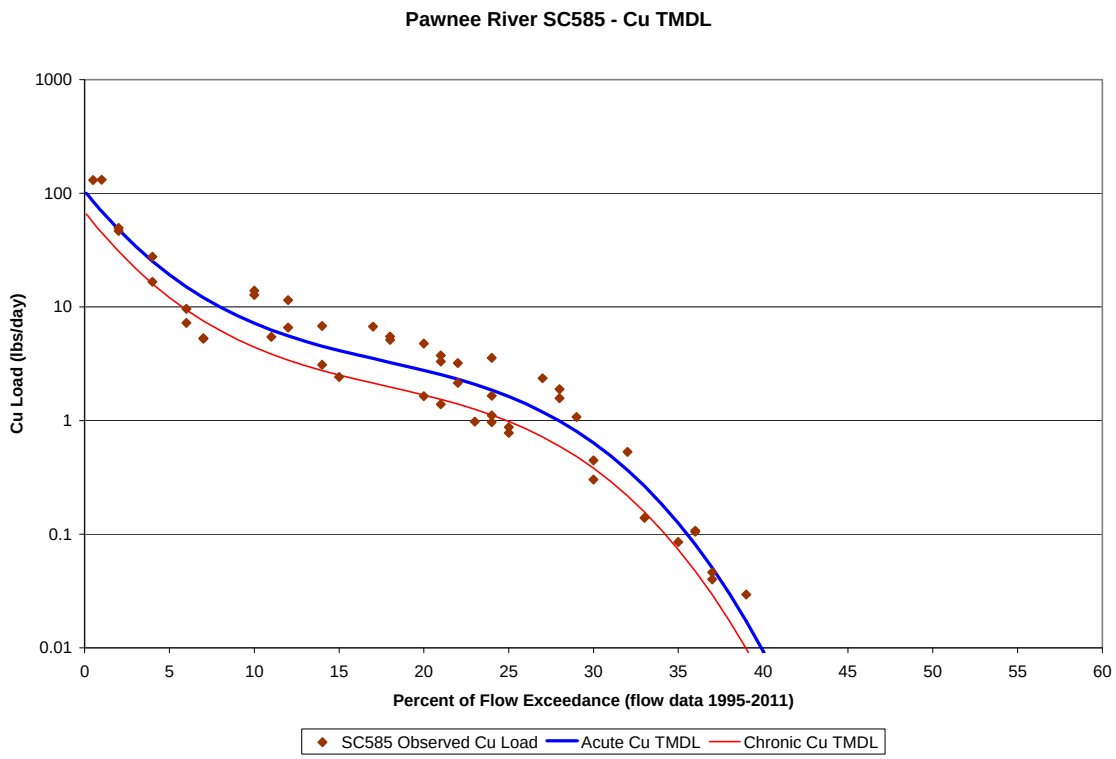


Table 8a. Pb and Cu TMDL at SC586.

% Flow Exceedance	Flow (cfs)	Load Allocation	MOS (lbs/day)	WLA (lbs/day)	TMDL (lbs/day)
SC586 – Pawnee River near Larned Pb TMDL					
10%	34	2.554	0.29	0.056	2.9
25%	8.8	0.682	0.082	0.056	0.82
Average Flow	24.2	1.717	0.197	0.056	1.97
SC586 – Pawnee River near Larned Cu TMDL (Chronic)					
10%	34	4.312	0.495	0.143	4.95
25%	8.8	1.126	0.141	0.143	1.41
Average Flow	24.2	2.8	0.327	0.143	3.27
SC586 – Pawnee River near Larned Cu TMDL (Acute)					
10%	34	7.174	0.813	0.143	8.13
25%	8.8	1.927	0.23	0.143	2.3
Average Flow	24.2	4.717	0.54	0.143	5.4

Table 8b. Pb and Cu TMDL at SC585.

% Flow Exceedance	Flow (cfs)	Load Allocation (lbs/day)	MOS (lbs/day)	WLA (lbs/day)	TMDL (lbs/day)
SC585 – Pawnee River near Larned Pb TMDL					
10%	40.4	2.221	0.253	0.056	2.53
25%	8.9	0.385	0.049	0.056	0.49
Average Flow	29.5	1.384	0.16	0.056	1.6
SC585 – Pawnee River near Larned Cu TMDL (Chronic)					
10%	40.4	3.835	0.442	0.143	4.42
25%	8.9	0.739	0.098	0.143	0.98
Average Flow	29.5	2.341	0.276	0.143	2.76
SC585 – Pawnee River near Larned Cu TMDL (Acute)					
10%	40.4	6.319	0.718	0.143	7.18
25%	8.9	1.324	0.163	0.143	1.63
Average Flow	29.5	3.925	0.452	0.143	4.52

Defined Margin of Safety: The margin of safety is explicit and provides some hedge against the uncertainty of daily allocated loading. The margin of safety for both Pb and Cu will be 10% of the load capacity under conditions when the stream is flowing. The margin of safety is detailed in Table 8.

State Water Plan Implementation Priority: Because of the uncertainty of the pollutant sources causing the lead and copper excursions seen in the Pawnee River watershed, this TMDL will be a Low Priority for implementation.

Unified Watershed Assessment Priority Ranking: A portion of this watershed lies within the Buckner Subbasin with a priority ranking of 28 (Medium Priority for restoration work).

Priority HUC 12s and Stream Segments: Because of the lack of certainty regarding potential sources and naturally occurring background concentration in the watershed, no priority subwatershed or stream segment will be identified.

5.0 IMPLEMENTATION

Desired Implementation Activities

1. Identify sources of copper and lead in the watershed and in stormwater runoff.
2. Install grass buffer strips where needed along streams.
3. Educate land owners of copper-containing chemicals that may pose a concern.

Implementation Programs Guidance

Nonpoint Source Pollution Technical Assistance-KDHE

a. Support Section 319 demonstration projects for reduction from streambank erosion, sediment runoff, and livestock operations.
b. Provide technical assistance on practices geared to the establishment of vegetative buffer strips.

Riparian Protection Program – SCC

a. Establish or re-establish natural riparian systems, including vegetative filter strips along small tributaries.

Buffer Initiative Program – SCC

a. Install buffer strips near streams.
b. Work in conjunction with Federal Conservation Reserve Enhancement Program and Conservation Security Program to hold marginal riparian land out of production.

Timeframe for Implementation: Continued monitoring over the years from 2012 to 2021.

Milestone for 2016: In accordance with the TMDL development schedule for the State of Kansas, the year 2016 marks the next cycle of 303(d) activities in the Upper Arkansas Basin to review data from the Pawnee River watershed to assess continued incidence of high lead and copper.

Delivery Agents: The primary delivery agents for program participation will be the Kansas Department of Health and Environment.

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

1. 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.

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

3. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.

4. 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.

5. 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.

6. The *Kansas Water Plan* and the Upper Arkansas Basin Plan provide guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollutant reduction activities in the state through the Kansas Water Plan. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state

allocates at least 50% of the fund programs supporting water quality protection through the WRAPS program. This watershed and its TMDL are a Low Priority consideration.

Effectiveness: Buffer strips are publicized as a means to filter sediment before it reaches a stream and riparian restoration project have been acclaimed as a significant means of stream bank stabilization. The key to effectiveness is participation within a targeted area to direct resources to the activities influencing water quality.

6.0 MONTITORING

KDHE will continue to collect samples through 2021 at the permanent stations SC585 and SC586 on the Pawnee River on a quarterly basis every year.

7.0 FEEDBACK

Public Notice: An active internet website was 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 Kansas Lower Republican Basin.

Public Hearing: A Public Hearing on the Upper Arkansas River Basin TMDLs was held in Garden City on September 20, 2012 to receive comments. There were no comments received regarding this TMDL.

Basin Advisory Committee: The Upper Arkansas River Basin Advisory Committee met to discuss these TMDLs on April 4, 2012 in Jetmore and September 20, 2012 in Garden City.

Milestone Evaluation: In 2016, evaluation will be made as to the degree of impairment continuing to occur within the watershed. Subsequent decisions will be made regarding the implementation approach, priority of allotting resources for implementation and the need for additional or follow up implementation in this watershed at the next TMDL cycle for this basin in 2016 with consultation from local stakeholders and the BAC.

Consideration for 303(d) Delisting: Pawnee River will be evaluated for delisting under section 303(d), based on the monitoring data over 2012-2021. 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 might be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality, Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision would come in 2012, which will emphasize implementation of WRAPS activities. At that time, incorporation of this

TMDL will be made into the WRAPS. Recommendation of this TMDL will be considered in the Kansas Water Plan implementation decisions under the State Water Planning Process for Fiscal Years 2012-2021.

Rev March 25, 2013

Bibliography

Avery, Alex A. 2001. Nature's Toxic Tools: The Organic Myth of Pesticide-Free Farming. Center for Global Food Issues, Hudson Institute, Churchville, Virginia.

Boulanger, Bryan and Nikolaos P. Nikolaidis. 2003. Mobility and Aquatic Toxicity of Copper in an Urban Watershed. Journal of the American Water Resources Association. 39(2):325-336.

Juracek, K.E., 2000. Soils-Potential Runoff. U.S. Geological Survey Open-File Report 00-253. Information available on the internet at www.KansasGIS.org . Accessed on February 25, 2011.

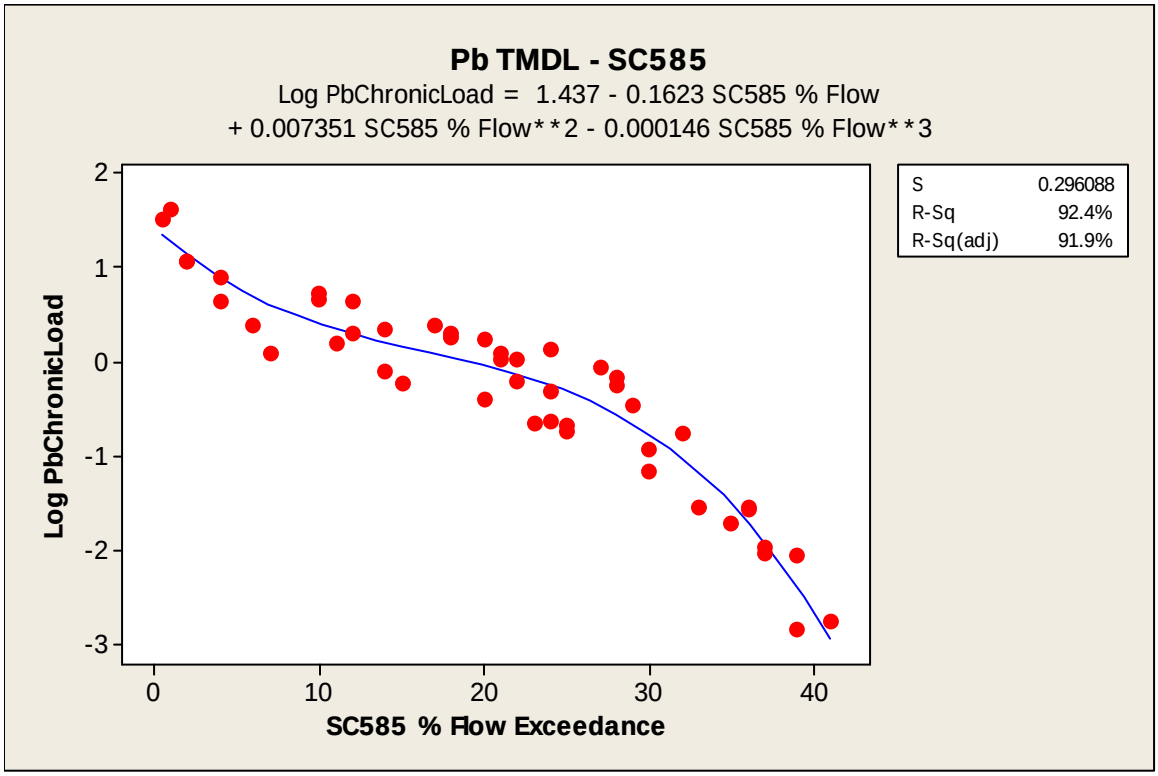
Rosen, Carl J., 2002. Lead in the Home Garden and Urban Soil Environment. University of Minnesota Extension. Accessed on the internet at http://www.extension.umn.edu/distribution/horticulture/DG2543.html . Accessed on February 21, 2011.

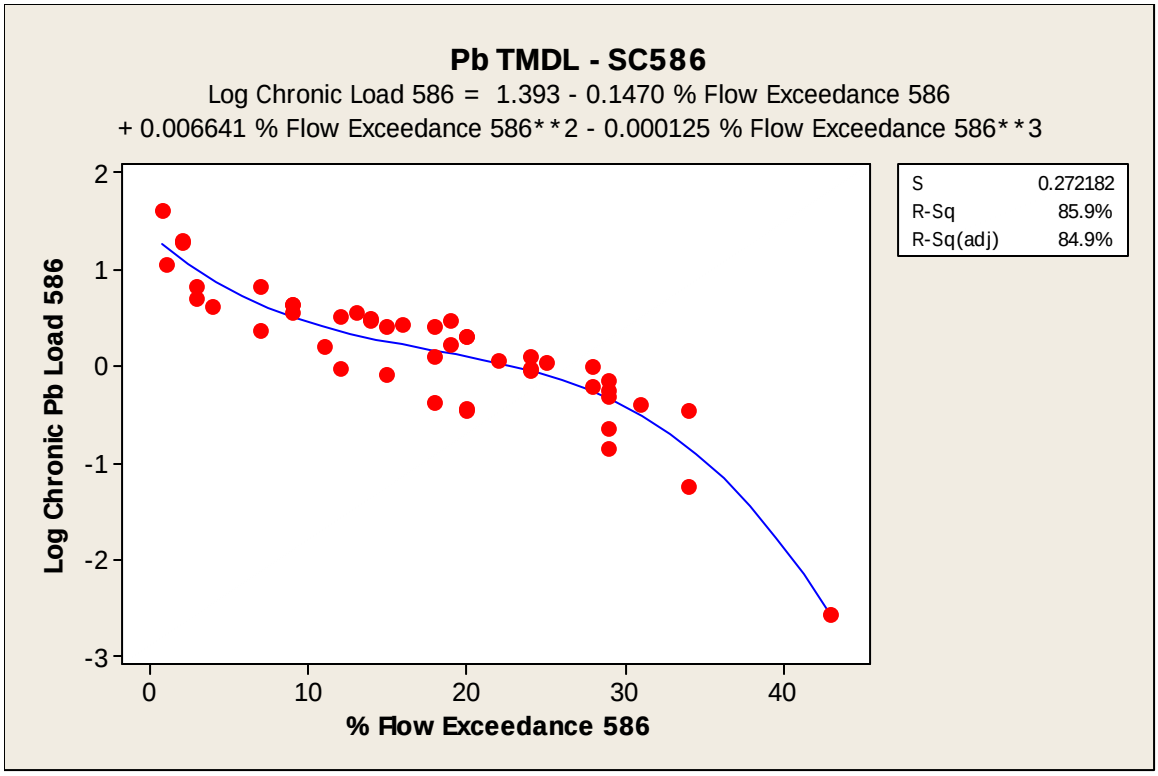
Perry, C.A., D.M. Wolock and J.C. Artman, 2004. Estimates of Flow Duration, Mean Flow, and Peak-Discharge Frequency Values for Kansas Stream Location, USGS Scientific Investigations Report 2004-5033.

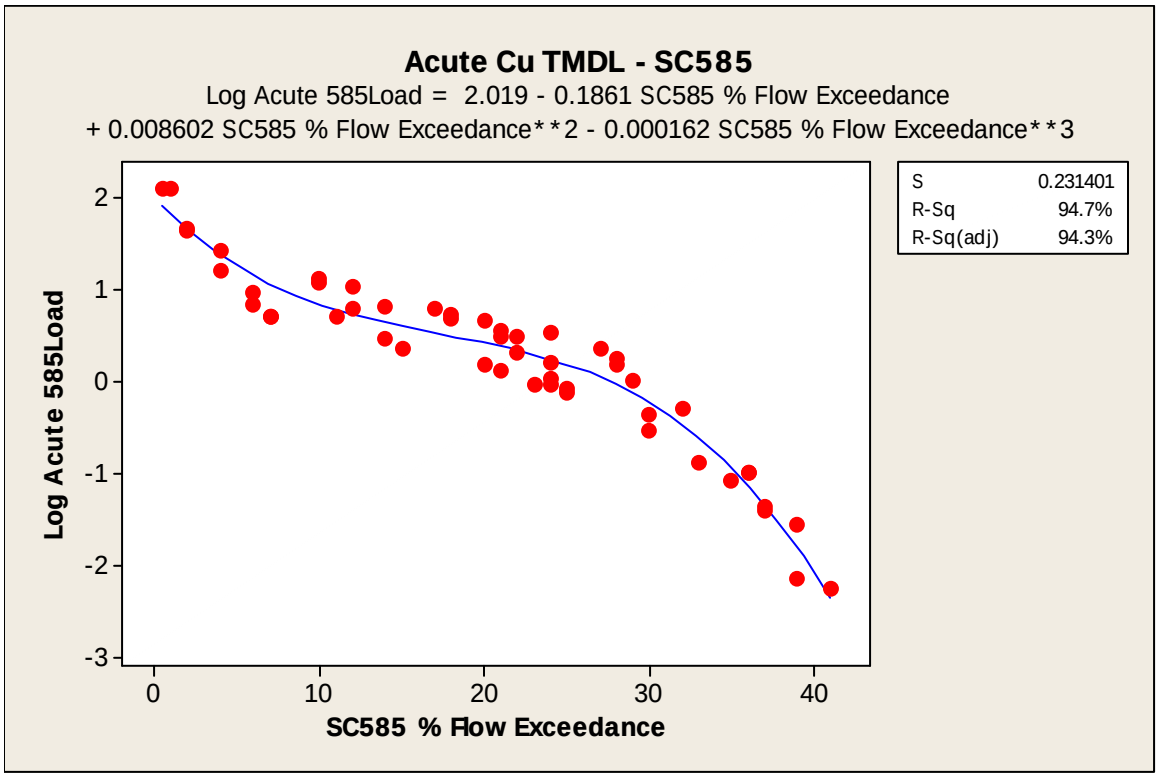
Appendix A. Confined Animal Feeding Operations in the Pawnee River Watershed.

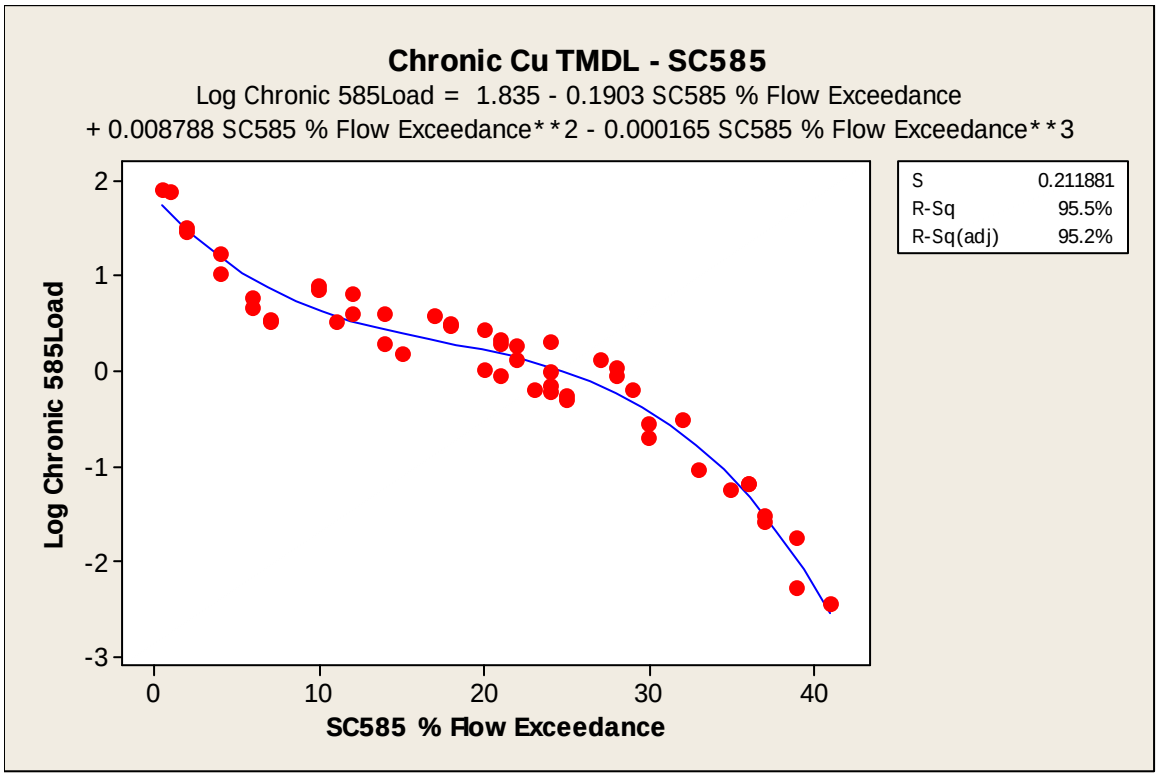
Permit	Facility County	Animal Totals	WLA
A-UAFI-BA03	Finney	999.0	0
A-UAFI-C010	Finney	7500.0	0
A-UAFO-C004	Ford	9950.0	0
A-UAFO-C011	Ford	13500.0	0
A-UAGY-C005	Gray	49000.0	0
A-UAHG-C010	Hodgeman	3500.0	0
A-UAHG-BA06	Hodgeman	700.0	0
A-UAHG-B018	Hodgeman	999.0	0
A-UAHG-M001	Hodgeman	120.0	0
A-UAHG-BA02	Hodgeman	500.0	0
A-UAHG-D001	Hodgeman	3940.0	0
A-UAHG-B008	Hodgeman	900.0	0
A-UAHG-C003	Hodgeman	17000.0	0
A-UAHG-B015	Hodgeman	900.0	0
A-UAHG-C005	Hodgeman	2000.0	0
A-UAHG-B005	Hodgeman	990.0	0
A-UAHG-C004	Hodgeman	4950.0	0
A-UAHG-B002	Hodgeman	900.0	0
A-UAHG-B003	Hodgeman	950.0	0
A-UAHG-C001	Hodgeman	22000.0	0
A-UAPN-B008	Pawnee	750.0	0
A-UALE-B002	Lane	400.0	0
A-UAPN-B002	Pawnee	950.0	0
A-UAPN-B001	Pawnee	600.0	0
A-UAFI-BA06	Finney	500.0	0
A-UAHG-B006	Hodgeman	0.0	0
A-UAPN-B010	Pawnee	990.0	0
A-UAHG-BA18	Hodgeman	500.0	0
A-UAHG-B017	Hodgeman	999.0	0
A-UAGY-C011	Gray	6750.0	0
A-UAHG-B010	Hodgeman	600.0	0
A-UAHG-C011	Hodgeman	1500.0	0
A-UASC-C020	Scott	3500.0	0
A-UAHG-BA17	Hodgeman	500.0	0
A-UAHG-B004	Hodgeman	500.0	0
A-UANS-B001	Ness	900.0	0
A-UAHG-BA14	Hodgeman	800.0	0
A-UAGY-D002	Gray	16650.0	0
A-UAFO-B009	Ford	900.0	0
A-UAGY-H001	Gray	38400.0	0
A-UAHG-C009	Hodgeman	13000.0	0
A-UAPN-BA05	Pawnee	999.0	0
N-UAHG-5779	Hodgeman	975.0	0
A-UAHG-BA15	Hodgeman	900.0	0
A-UAHG-B016	Hodgeman	600.0	0
A-UAHG-BA19	Hodgeman	900.0	0
A-UAFO-B007	Ford	999.0	0
A-UAHG-B009	Hodgeman	800.0	0
A-UAHG-B012	Hodgeman	999.0	0
A-UAGY-D001	Gray	48000.0	0
A-UAHG-BA13	Hodgeman	990.0	0
A-UAFO-BA01	Ford	600.0	0
A-UAHG-B011	Hodgeman	999.0	0
A-UAFI-BA07	Finney	900.0	0
713	Hodgeman	950.0	0
A-UAHG-BA16	Hodgeman	400.0	0
A-UAPN-B009	Pawnee	900.0	0
A-UANS-BA05	Ness	500.0	0
A-UAED-BA03	Edwards	300.0	0

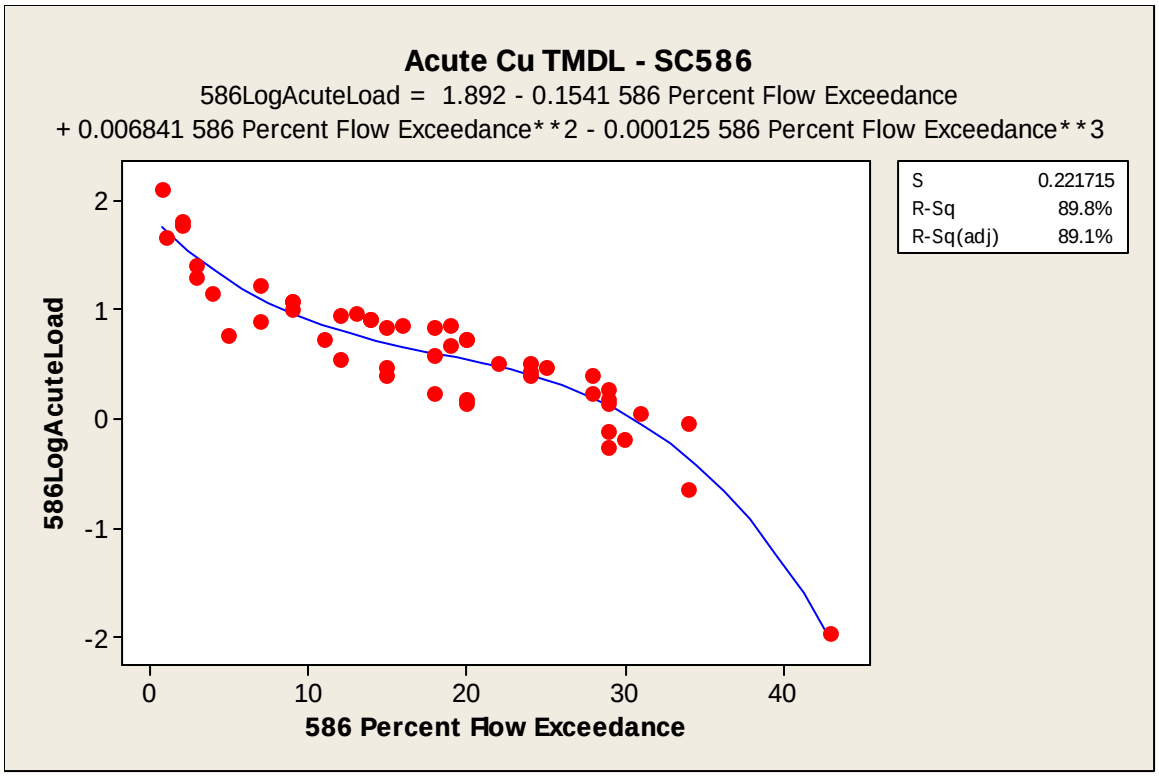
Appendix B. Cubic Regression Equations based on observed sample criterion allowable load.

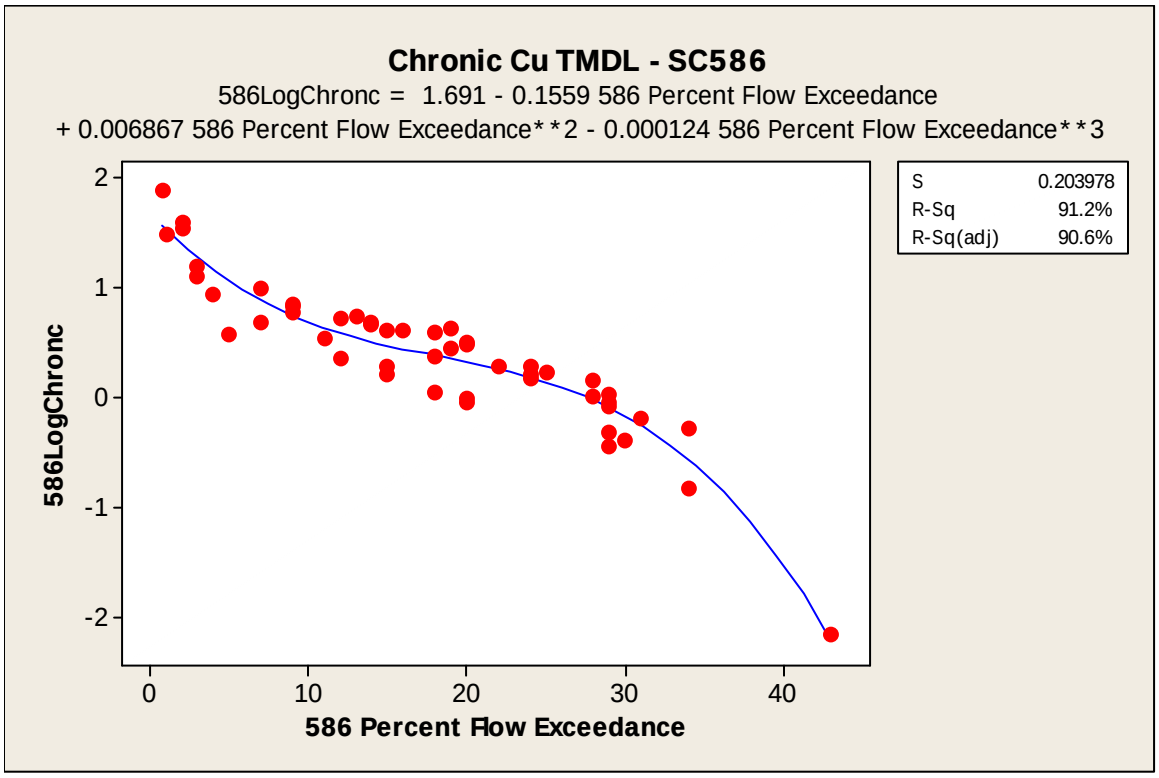





Acute Cu TMDL - SC585
Log Acute 585Load = 2.019 - 0.1861 SC585 % Flow Exceedance
+ 0.008602 SC585 % Flow Exceedance**2 - 0.000162 SC585 % Flow Exceedance**3
S 0.231401
R-Sq 94.7%
R-Sq(adj) 94.3%
Log Acute 585Load
SC585 % Flow Exceedance
2
1
0
-1
-2
-3
0
10
20
30
40


Chronic Cu TMDL - SC585
Log Chronic 585Load = 1.835 - 0.1903 SC585 % Flow Exceedance
+ 0.008788 SC585 % Flow Exceedance**2 - 0.000165 SC585 % Flow Exceedance**3
S 0.211881
R-Sq 95.5%
R-Sq(adj) 95.2%
Log Chronic 585Load
SC585 % Flow Exceedance
2
1
0
-1
-2
-3
0
10
20
30
40


Acute Cu TMDL - SC586
586LogAcuteLoad = 1.892 - 0.1541 586 Percent Flow Exceedance
+ 0.006841 586 Percent Flow Exceedance**2 - 0.000125 586 Percent Flow Exceedance**3
S 0.221715
R-Sq 89.8%
R-Sq(adj) 89.1%
586LogAcuteLoad
586 Percent Flow Exceedance


Chronic Cu TMDL - SC586
586LogChronc = 1.691 - 0.1559 586 Percent Flow Exceedance
+ 0.006867 586 Percent Flow Exceedance**2 - 0.000124 586 Percent Flow Exceedance**3
S 0.203978
R-Sq 91.2%
R-Sq(adj) 90.6%
586LogChronc
586 Percent Flow Exceedance