Shunganunga Creek-

Monitoring Stations- SC238
USGS Gaging Station- 06889700 (Rice Rd.) 10/1/1979-9/30/1981, 10/1/1993-9/30/1996
Included area-
HUC 8: 10270102
HUC 10: 09
HUC 12: 01, 02
Streams Flowing to Monitoring Station-

Station	Name	Segment #
SC238	Shunganunga Cr-	39
	Shunganunga Cr-	40
	S. Br. Shunganunga Cr -	87
	Deer Cr-	92
Unmonitored Downstream		
	Stinson Cr-	394

Watershed Size- 73.7 square miles
Monitored Area (SC239) – 62.3 square miles
Land use-

Permanent Grass	27.6%
Cropland	6.9%
Forest	10.6%
Open Water	1.8%
Developed, <20% impervious	16.8%
Developed, 20-49% impervious	24.5%
Developed, 50-79% impervious	8.6%
Developed, 80-100% impervious	3.3%

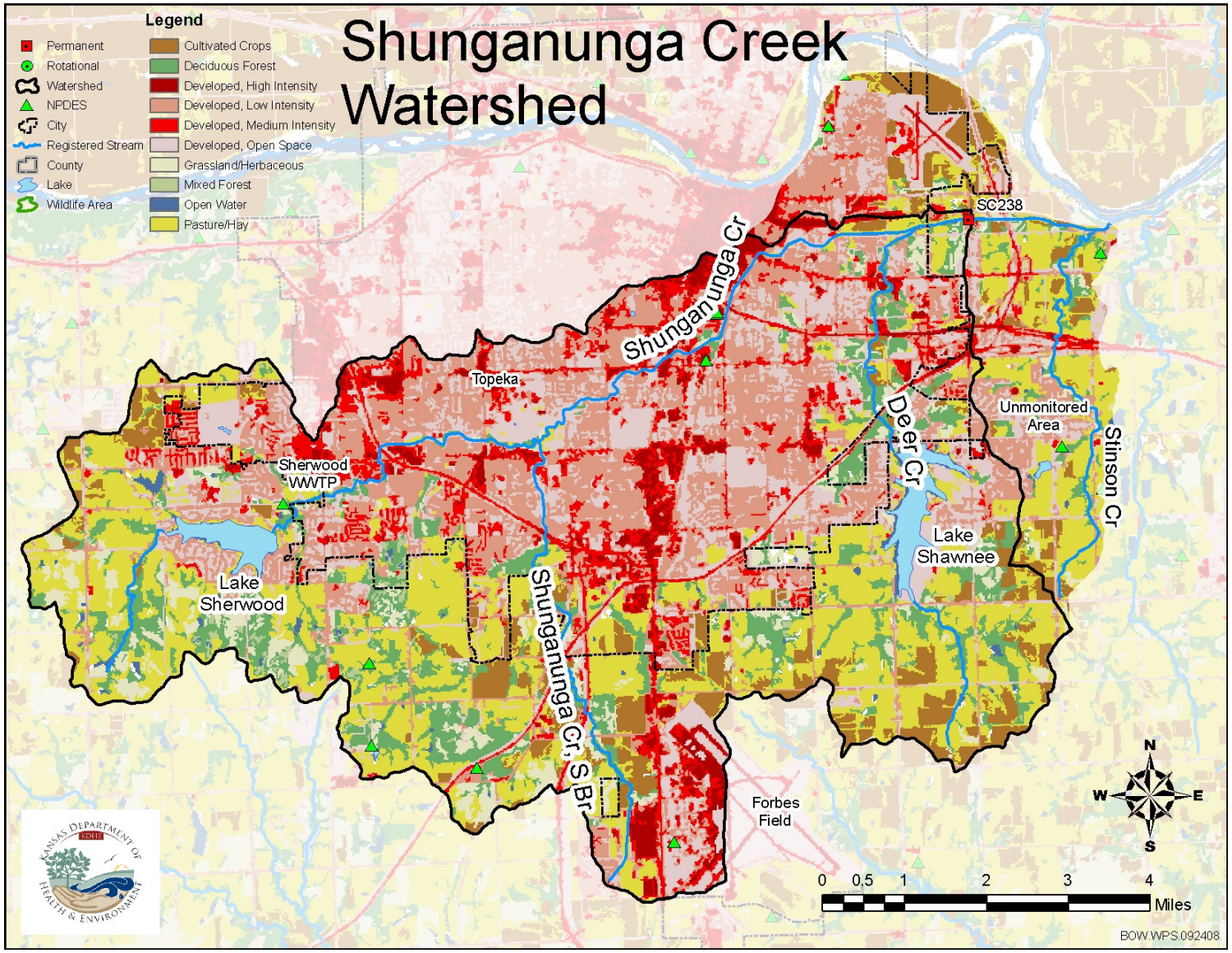
Counties- Shawnee
Cities- Topeka
2000 Population- 103,459
Kansas House Districts –51, 52, 53, 54, 55, 56, 57, 58
Kansas Senate Districts – 18, 19, 20

2008 303(d) impaired waters listing- Total phosphorus
TMDLs- Dissolved Oxygen, approved 8/3/2007, High Priority; Bacteria, approved 1/26/2000, High Priority

NPDES Permitted Facilities- Sherwood WWTP (M-KS72-OO27), Topeka Stormwater (M-KS72-SO01), Shawnee County Stormwater (M-KS72-SU01), KDOT Stormwater (M-KS72-SU02), Tecumseh Township Stormwater (M-KS98-SU01), Jay Shideler School (M-KS72-OO11), Washburn Rural Jr./Sr. High (M-KS72-OO16), Meier's Ready Mix (I-KS72-PR01, I-KS72-PR02), East Side Baptist Church (C-KS72-NO16), Shawnee Hills Mobile Home Park (C-KS72-OO11)

Permitted Confined Animal Feeding Operations-1

Animal Type	Total Animals
Dairy	180


Shunganunga Creek Watershed
Legend
Permanent
Rotational
Watershed
NPDES
City
Registered Stream
County
Lake
Wildlife Area
Cultivated Crops
Deciduous Forest
Developed, High Intensity
Developed, Low Intensity
Developed, Medium Intensity
Developed, Open Space
Grassland/Herbaceous
Mixed Forest
Open Water
Pasture/Hay
SC238
Shunganunga Cr
Topeka
Deer Cr
Unmonitored Area
Stinson Cr
Sherwood WWTP
Lake Sherwood
Lake Shawnee
Shunganunga Cr, S Br
Forbes Field
N
W
E
S
0 0,5 1 2 3 4
Miles
BOW.WPS.092408

Stream Chemistry-

Shunganunga Creek has the worst overall ranking of all the monitoring stations in the Mid-Kansas area, with the worst rankings for nutrients (both total phosphorus and total nitrogen) and very poor rankings for total suspended solids and bacteria. Suspended solids are decoupled from total phosphorus, as would be expected in a point-source impacted stream. The large discharge (1 million gallons/day average) from the Sherwood Improvement District has a significant negative impact on water quality in the mainstem of Shunganunga Creek. As expected under these circumstances, winter nutrient concentrations are higher than spring and summer concentrations. Elevated bacteria levels during spring months were noted under the previous fecal colifrom bacteria criteria, and appear to be exceeding expectations under the current *E. coli* criteria as well.

Shunganunga Creek is a largely urban stream, and is more disconnected from many typical sources of sediment, such as row crop production. During development periods streams in urban areas may experience temporary increases in sediment load, followed by a period of reduced sediment supply as impervious cover becomes responsible for an increasing amount of the runoff from the watershed. These pressures are reflected in the lower overall median concentration of suspended solids and the overall turbidity. However, spring samples show concentrations that are more than twice those of the wintertime, suggesting that other sources may still be playing an important role. Eroding streambanks would not be uncommon in a heavily urbanized area, and may be contributing sediment at higher rates during water spring periods, especially during significant storm events.

Bacteria concentrations in Shunganunga Creek remain a concern eight years after the establishment of a high priority TMDL for bacteria, especially during the spring months, when concentrations are consistently high. Over a quarter of the watershed remains in permanent grassland usage, and these areas may be contributing to the observed spring bacteria load. However, in a complex urbanizing watershed, other potential sources cannot be ruled out, including pet waste and failing on-site wastewater systems. The Sherwood wastewater treatment plant operates a UV disinfection bank, and can be ruled out as a potential contributor to this problem.

Nutrient concentrations in Shunganunga Creek are consistently elevated over levels that signify acceptable water quality measures throughout all seasons. The highest observed concentrations are noted during winter months, when relatively little precipitation occurs, in-stream nutrient processing by biofilms and other microbial processes slows, and the Sherwood wastewater treatment plant contributes most significantly to the flow of the stream. Nutrient discharge from the treatment plant typically contribute large percentages of the observed concentrations at the KDHE monitoring station, which is located 10 miles downstream (at Rice Rd.), and also receives water from the South Branch and Deer Creek.

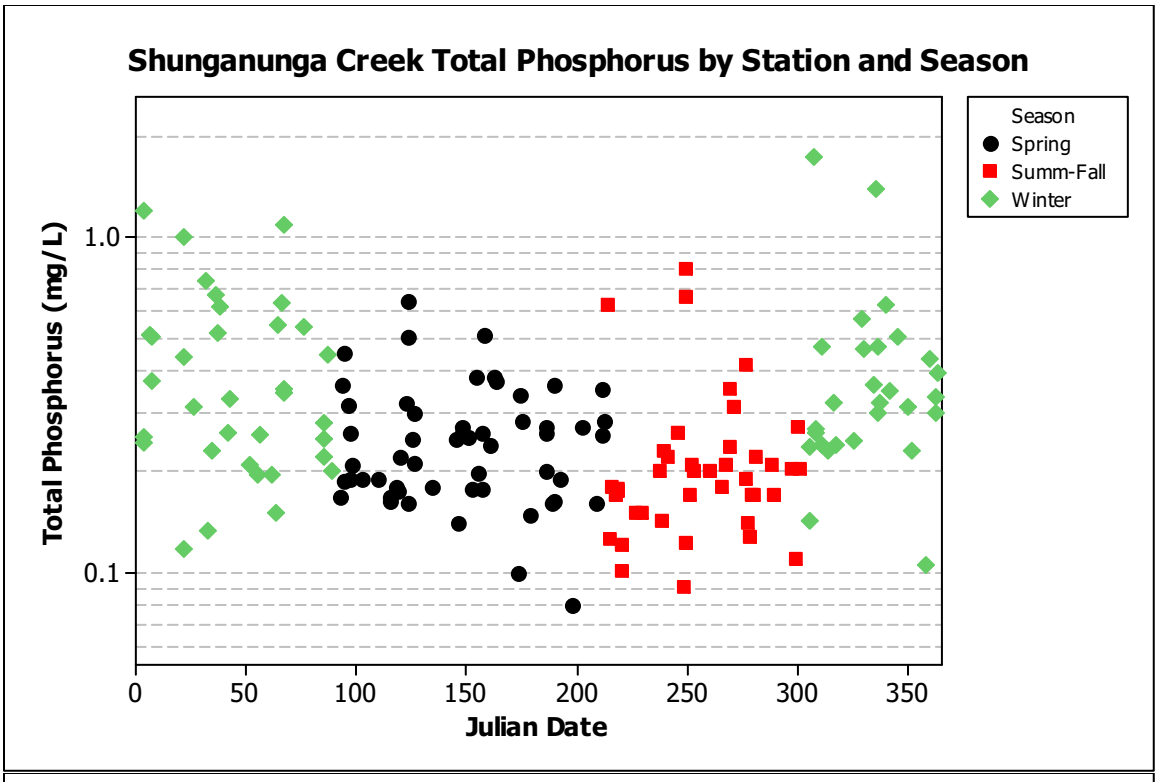
A high priority TMDL was established for inadequate dissolved oxygen in Shunganunga Creek in 2007. Critical periods for dissolved oxygen concentrations are the summer and

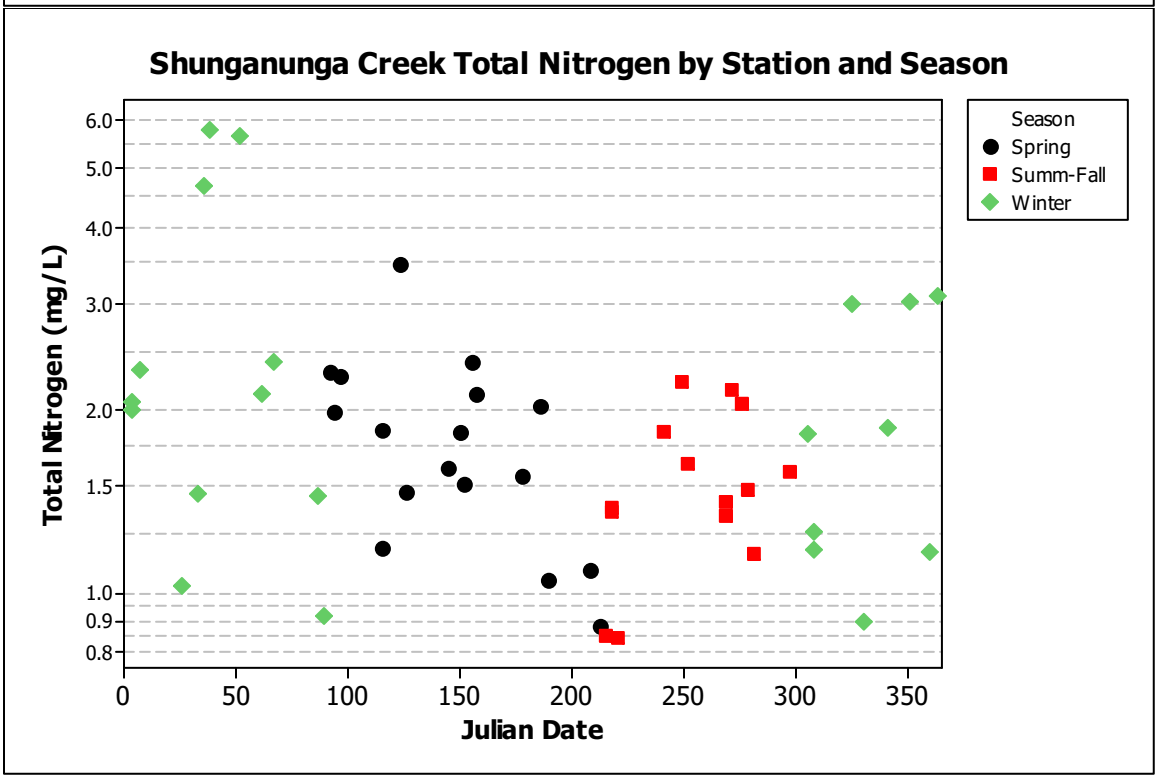
fall, when low flow conditions can be expected. The TMDL identified organic loading, or biological oxygen demand (BOD) as the pollutant of concern. The observed nutrient concentrations may also be contributing to low dissolved oxygen concentrations during low flow, warm periods, as increased algal productivity results in wider swings of dissolved oxygen and pH through the day, with low concentrations typically occurring during the late night hours as oxygen demand from these organisms exceeds available production and re-aeration rates As noted elsewhere, oxygen concentrations are expected to be highest during winter months when gas solubility is highest due to lower water temperatures.

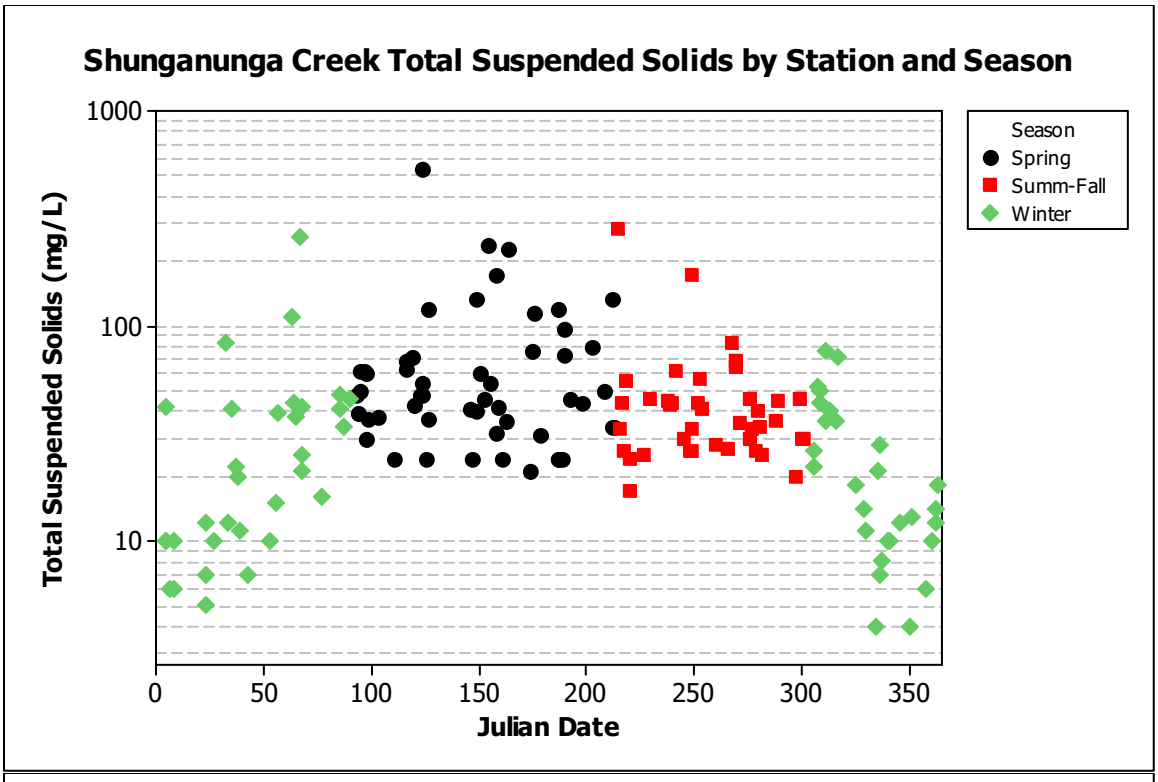
While not a stream chemistry measure, it is worth noting that urbanization and channelization, both of which are present in this watershed, contribute to predictable changes in stream hydrographs. A hydrograph, or a graph of the discharge of a stream over time, shows how quickly a stream responds to storms, and what non-stormflow conditions exist during the rest of the year. The existing gage record is too small to draw conclusions regarding the impact of urban expansion within this watershed. However, most streams undergoing urbanization experience lower base flow rates, due to reduced groundwater recharge because impervious surfaces (roofs, parking lots, roads, etc.) result in direct runoff to streams through stormwater sewers with reduced infiltration into the ground. At the same time increased peak flows, and often flooding, occur because major storms have less available infiltration surface area and more rapid delivery of storm water to the stream system. Channelization can also result in increased delivery rates for water from storm events, leading to more rapidly rising stream flows, and is often associated with reduced connectivity with the floodplain, where transient storage can slow stormwaters, reducing peak flows.

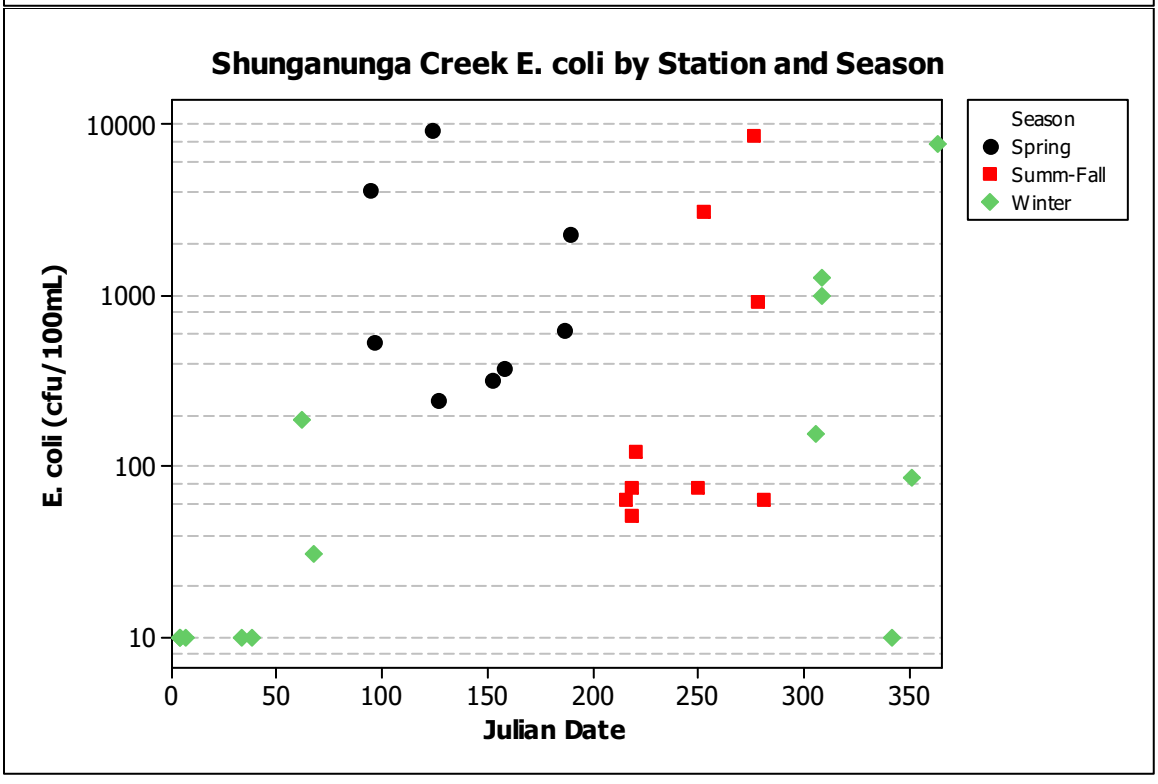
Site	Season	Turbidity Median	TSS Median	TP Median	TN Median	Kjeldahl Median	*E.coli* Median	TOC Median
Shunganunga Creek SC238	Overall	20.5 (157)	36 (153)	0.25 (157)	1.73 (52)	0.8365 (52)	172 (30)	6.808 (45)
SC238	Spring	24.3 (54)	48 (52)	0.245 (54)	1.84 (17)	0.9 (17)	577 (8)	7.29 (15)
SC238	Summer-Fall	21 (41)	36 (41)	0.19 (41)	1.4415 (14)	0.844 (14)	75 (9)	5.579 (13)
SC238	Winter	10.8 (62)	18 (60)	0.325 (62)	2.001 (21)	0.694 (21)	31 (13)	6.821 (17)

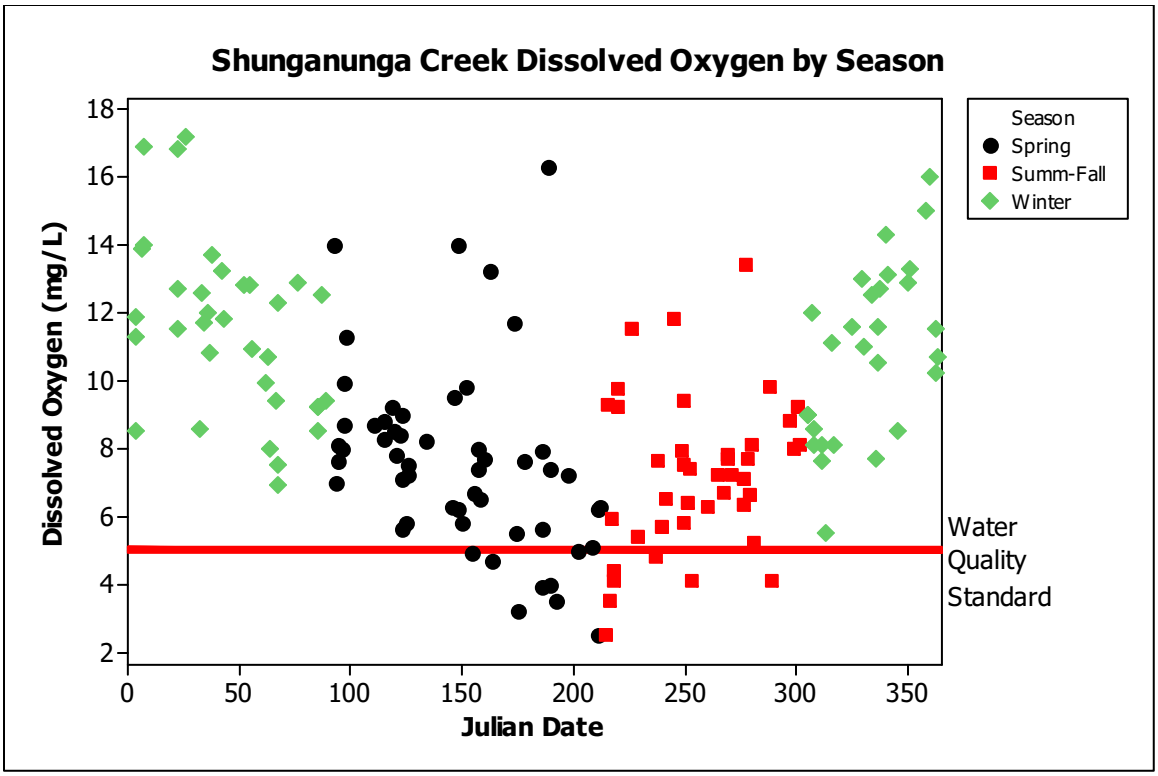
Shunganunga Creek stream chemistry data by season and overall. Number in parenthesis is sample size.


Shunganunga Creek Total Phosphorus by Station and Season
Total Phosphorus (mg/L)
1.0
0.1
0
50
100
150
200
250
300
350
Julian Date
Season
Spring
Summ-Fall
Winter

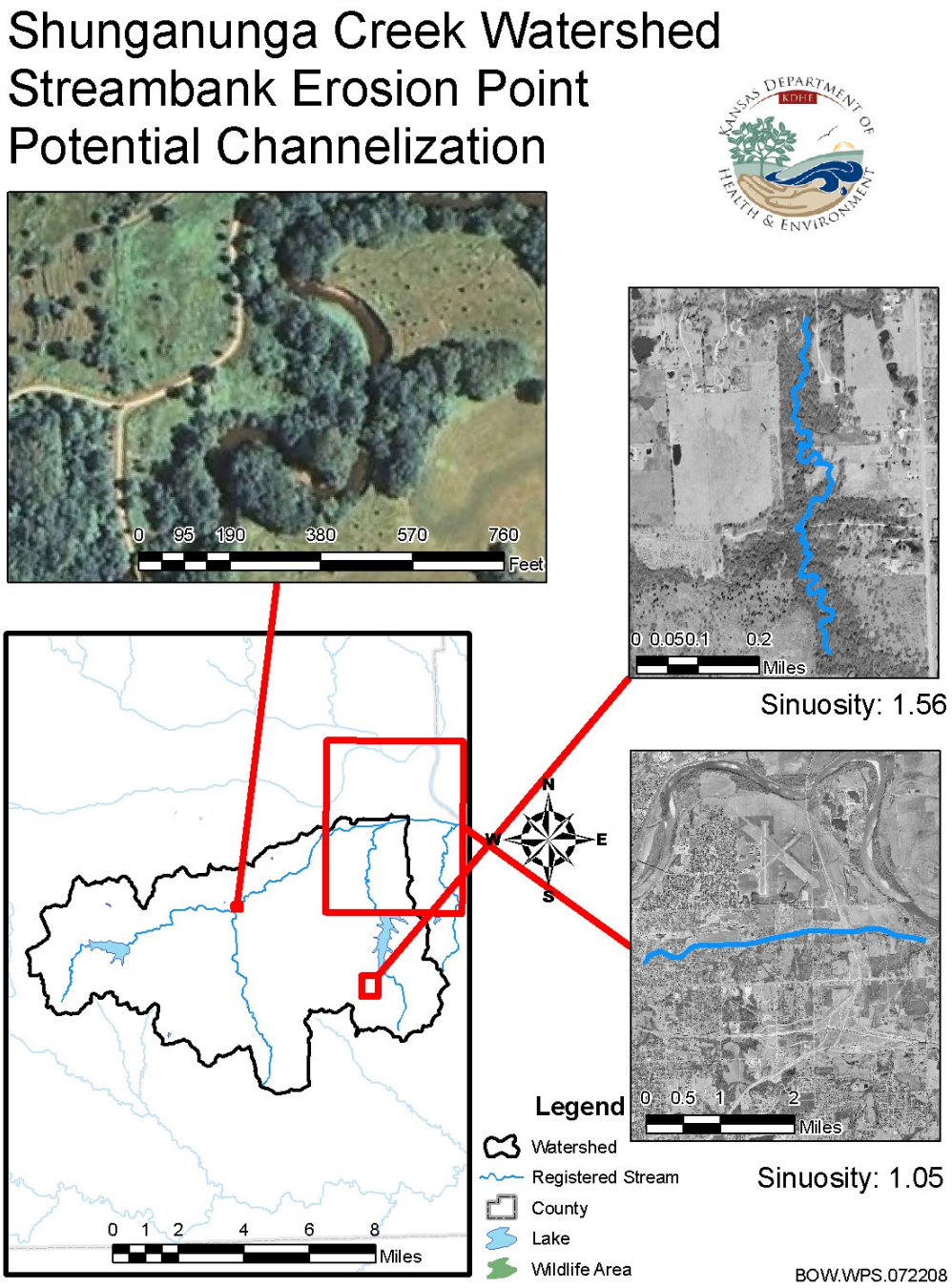

Shunganunga Creek Total Nitrogen by Station and Season
Total Nitrogen (mg/L)
6.0
5.0
4.0
3.0
2.0
1.5
1.0
0.9
0.8
0
50
100
150
200
250
300
350
Julian Date
Season
Spring
Summ-Fall
Winter


Shunganunga Creek Total Suspended Solids by Station and Season
Total Suspended Solids (mg/L)
1000
100
10
0
50
100
150
200
250
300
350
Julian Date
Season
Spring
Summ-Fall
Winter


Shunganunga Creek E. coli by Station and Season
E. coli (cfu/100mL)
10000
1000
100
10
0
50
100
150
200
250
300
350
Julian Date
Season
Spring
Summ-Fall
Winter



Relatively few points of seriously eroding stream banks are visibile in the 2002 DOQQ and 2006 NAIP 1 meter resolution photographs. While geomorphically stable streams are uncommon in urban areas, it is common for significant efforts to be made to reduce stream channel movement in an effort to protect property. Overall sinuosity is low in this watershed, and even candidate sites show lower sinuosity than adjacent watersheds. Encroachment of valuable infrastructure onto the floodplain is common in urban areas, and leaves relatively fewer options for improvement, due to the high costs associated with developed lands relative to more agricultural settings.



Uncertainty-

The lack of available gage data for most of the monitored period leaves some uncertainty regarding the interactions between discharge conditions and water quality measures. The lack of gage data also leaves uncertainty regarding the impacts of increased urbanization in this watershed over time. Changes to the pattern and magnitude

of storm and base flows can be expected to have occurred in this watershed, however no data is available to us to quantify those changes. Biological sampling has been limited, and is not included here due to the lack of long-term or recent data. Reduced habitat and reduced stream complexity is often associated with reduced biological diversity, but we lacked sufficient data to assess that potential impact at this time. Because the KDHE monitoring station is located near the outlet of Shunganunga Creek, there remains uncertainty regarding the contributions of particular sub-watersheds to the overall condition seen at SC238. In addition, we do not have data available at this time regarding the potential contributions from illicit discharges and failing on-site wastewater treatment systems. Anecdotal accounts indicate that illegal dumping and other trash remain a problem in Shunganunga Creek, but we have insufficient data to quantify the potential impacts from this source.

Adaptive Implementation-

Shunganunga Creek faces many challenges to improved water quality. The challenges include channelization, altered hydrology and other typical urban non-point impacts as well as wastewater discharged by the Sherwood treatment facility on a daily basis. The costs and opportunities are both larger in urban areas, where high population density increases the number of individuals potentially interested in watershed restoration work and potential revenue sources from municipal residents that may not be available in more rural settings. In many ways Shunganunga Creek is typical of degraded urban streams, and opportunities for improvement of water quality within the Shunganunga Creek watershed can likely learn from other urban stream improvement projects, both in Kansas and nationally.

Of all the issues facing Shunganunga Creek stakeholders, sediment concentration is likely to be the lowest concern, not only because the absolute concentrations are lower than in other more agriculturally impacted watersheds, but also because the other problems facing this creek are of such a larger magnitude. KDHE data do show a typical non-point source pattern with regards to total suspended solids, as seen in the arch shaped graph of concentrations as a function of season. Recent research by KDHE has indicated that while the magnitude of discharge has an effect on the TSS concentration, it is also impacted by land use, particularly along the riparian corridor and seasonal factors. To the extent that seriously eroding streambanks exist within the watershed, addressing them may lead to some improvement in water quality, and may result in increased resident satisfaction for adjacent landowners. Stabilization is often understood, particularly in urban settings, to mean rip-rap and other bank hardening measures, however these are temporary features on the landscape that are eventually undercut by stream action. Bank hardening efforts are less preferable than riparian forestry approaches, because forested buffers become stronger over time as trees mature and improving nearby property values.

Nutrient concentrations in Shunganunga Creek are excessively high, and any effort to address them must take into account the impact of the discharge from the Sherwood treatment facility. Rough calculations based on estimates of stream discharge at median flow (5 cubic feet per second) indicate that the nutrient load from the treatment

facility exceeds the load observed at Rice Rd by substantial amounts, suggesting some in-stream processing and removal of nutrients occur along the channel length. Should biological nutrient removal (BNR) be implemented at the treatment facility, median annual concentrations could be expected to fall significantly at both the treatment facility and downstream at the KDHE monitoring station. The impact of this reduction can be expected to be most significant during the winter when low microbial activity and reduced flows from the watershed result in the highest concentrations of TN and TP in Shunganunga Creek, visible in the U-shaped graphs of concentrations throughout the year. Assuming a similar reduction in the load is observed at Rice Rd. the concentrations (est. WWTP load w/ BNR/ current ext. WWTP load) * current Rice Rd. concentration) of both total phosphorus and total nitrogen will likely approach more acceptable levels. Use of treatment technologies with greater nutrient removal may be desirable for further improvement in water quality.

	Median Flow (gal./day)	Median Flow (cubic feet/second)	Current TP (mg/L)	Current TN (mg/L)	Current TP Daily Load (lbs/day)	Current TN Daily Load (lbs/day)	Est. TP Conc. (mg/L) w/ BNR	Est. TN Conc. (mg/L) w/ BNR	Est. TP Daily Load (lbs/day) at BNR conc. 1.5 mg/L	Est. TN Daily Load (lbs/day) at BNR conc. 6 mg/L
Sherwood WWTP	936,000	1.4	4.13	16.34	32.26	127.66	1.50	6.00	11.72	46.87
Rice Rd. Monitoring Station (SC238)	3,231,584	5	0.25	1.73	6.74	46.66	0.09	0.64	2.45	17.13

Other efforts to reduce the impact of nutrients on this stream may also have beneficial effects on water quality. Watershed wide efforts to reduce/eliminate illicit discharges, eliminate failing on-site waste systems, reduce fertilizer use by both urban and rural residents to recommended levels, and improvements to the riparian forest may also result in improvements to water quality in Shunganunga Creek. Education of urban residents on proper use and application of lawn chemicals has the potential to reduce nutrient impacts, to the extent that overuse is now occurring. Increased retention of water on the landscape, through both individual efforts, like raingardens, and municipal planned projects, like bio-retention cells, also have the potential to reduce nutrient concentrations and runoff into Shunganunga Creek.

Bacteria concentrations still exceed acceptable concentrations for the potential recreational uses of this stream many years after the adoption of a TMDL to address this issue. The Sherwood treatment facility has been successfully operating ultraviolet effluent disinfection for some years, and can therefore be eliminated as a major source of bacteria in the stream. Urban pet populations have been implicated in other areas as major sources of bacteria to streams, though genetic identification of bacterial strains is usually needed to link the bacteria to particular animal types. Stakeholders may wish to gather more detailed information regarding the relative concentrations of bacteria around the watershed, and identify the sources of those bacteria before deciding which efforts are

most likely to reduce bacteria concentrations to acceptable levels. Improved pet waste management, identification and management of potential livestock sources in the more rural areas of the watershed, and increased retention of runoff on the landscape may all be steps residents wish to take to help decrease bacteria concentrations in this stream.

Dissolved oxygen concentrations in Shunganunga Creek have been, and continue to be cause for concern, particularly during summer months when low flows and high temperatures occur. Reductions of nutrient concentrations in this stream are likely to have major impacts on dissolved oxygen concentrations, as low concentrations are often linked to high in-stream productivity, and oxygen demand from algae and other micro-organisms during night-time hours. Increases in riparian canopy may also reduce the low dissolved oxygen events, by reducing available sunlight to in-stream photosynthetic organisms. Increases in riparian forestry in the lower reaches may not be desired by watershed residents if they also result in reduced conveyance during high flow events passing through the channelized and levied lower reaches.

Shunganunga Creek has many challenges to improved water quality. Coordinated efforts by the county and city, would be beneficial to upgrade the quality of this stream. Local residents will need to invest themselves into concern for the stream, especially if public financing for the restoration projects requires is necessary. Shunganunga Creek is severely mpaired by multiple pollutants, and has the potential to be a great success story through action taken over many years. Initial improvement efforts on Shunganunga Creek would address the impact of the Sherwood treatment plant, but other issues, such as urban stormwater impacts, will remain. Development of monitoring plans to track progress will help evaluate the success of efforts to improve water quality in this watershed, and should be a part of any plan to address the issues facing this stream.

Resources for watershed planning in urban watersheds are available at http://www.cwp.org/PublicationStore/USRM.htm