

SMOKY HILL/SALINE RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body/Assessment Unit: Wolf Creek Water Quality Impairment: Selenium

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasins: Lower Saline
Counties: Lincoln & Russell
HUC 8: 10260010
Ecoregion: Central Great Plains, Smoky Hills (27a)
Drainage Area: Approximately 261 square miles from Sylvan Grove to headwaters

Water Quality Limited Segments in Wolf Creek Watershed: 10, 11, 12, 30, 31 & 33

Watershed Hierarchy of Main Stem and Tributary Segments Monitored by KDHE Stations (Figure 1)

Watershed: **Wolf Creek (Sylvan Grove)**

Station 537 **Wolf Creek (10)**

Blue Stem Cr (33)

E. Fk. Wolf Cr (11)

W. Fk. Wolf Cr (12)

Fourmile Cr (30)

Coon Cr (31)

Designated Uses of Impaired Streams: Expected Aquatic Life Support; Secondary b Recreation on streams in Wolf Creek Watershed; Food Procurement on Segments 10, 11 & 12.

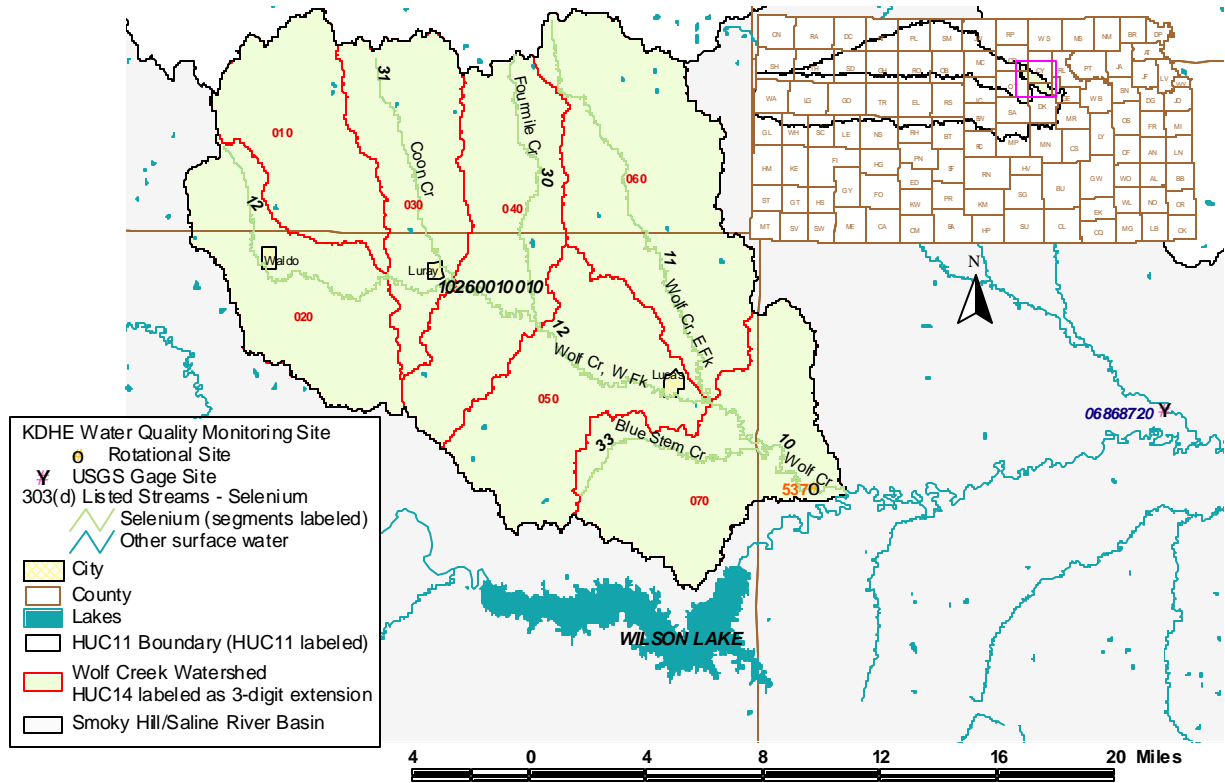
2002 303(d) Listing: Smoky Hill/Saline River Basin Streams

Impaired Use: Chronic & Acute Aquatic Life Support

Water Quality Standard: Chronic Aquatic Life: 5 ug/l; Acute Aquatic Life: 20 ug/l (K.A.R. 28-16-28e(c)(2)(F)(ii); In stream segments where background concentrations of naturally occurring substances, including chlorides and sulfates, exceed the water supply criteria listed in table 1a in subsection (d), at ambient flow, the existing water quality shall be maintained, and the newly established numeric criteria shall be the background concentration, as defined in K.A.R. 28-16-28b(e). Background concentrations shall be established using the methods outlined in the “Kansas implementation procedures: surface water quality standards,” as defined in K.A.R. 28-16-28b(ee), available upon request from the department. (K.A.R. 28-16-28e(b) (9))

Figure 1. Base Map of TMDL Area – Wolf Creek

Wolf Creek (Sylvan Grove) Watershed Selenium TMDL HUC and Stream Segment Map



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 2002 303(d): Partially Supporting Aquatic Life

Streamflow and Water Quality Monitoring Sites: Table 1 indicates the USGS Stream Gaging Stations and KDHE Ambient Stream Water Quality Monitoring Stations used in this TMDL. Data from the coincidental period of record for streamflow and water quality sampling of 1990 to 2003 were used, whenever available. A drainage area adjustment to the daily flows and flow duration data from Salt Creek near Ada was used to derive flow values for Wolf Creek near Sylvan Grove. The KDHE monitoring station (537) had 19 samples collected in 1990, 1994, 1998 & 2002.

Current Condition: There is little relationship between selenium and flow conditions on Wolf Creek (Figure 2). There is tremendous scatter in the sample data, weakening any linear relationship with streamflow. Nonetheless, selenium exceedances over the chronic criterion of 0.005 mg/l did not occur at low flows, exceedances begin once moderate flows exceeded 60% of the time or less occurred. Acute violations are noted at flows exceeded 60% and 20-25% of the time. There is little or no correlation

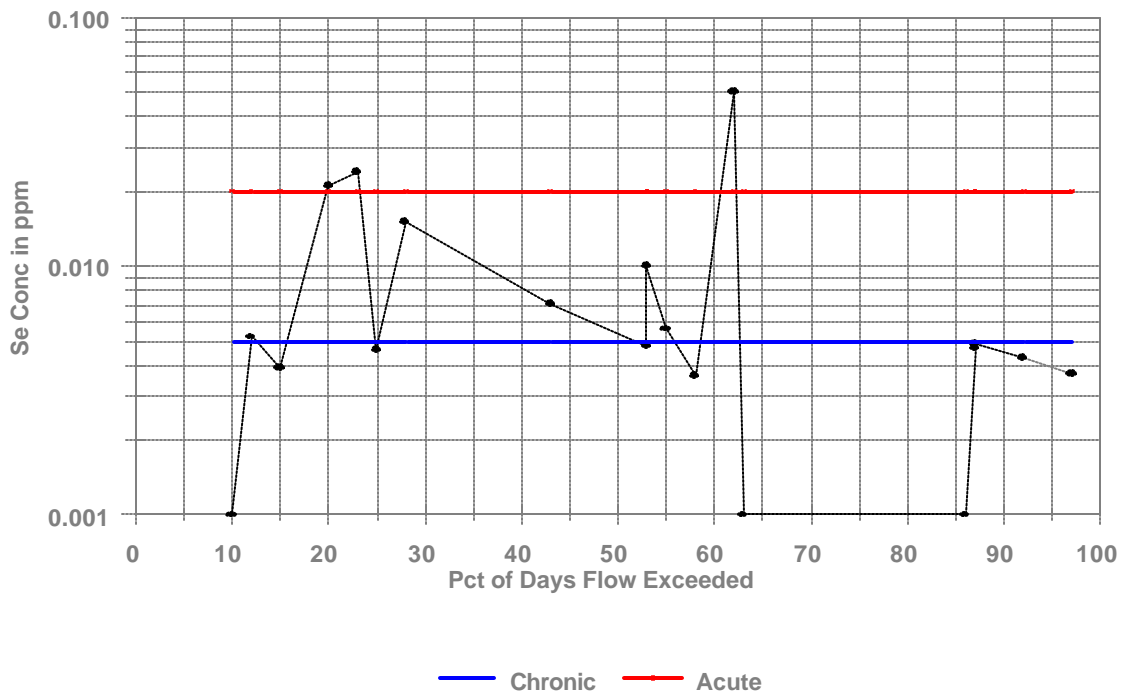
between selenium concentrations and other constituents or flow. The only moderate correlations among the original data or their log-transformed values are between selenium and calcium and sulfate, and to a lesser degree, sodium and chloride. These relationships imply that selenium minerals are acting similarly to gypsum within the soil and geologic profiles of the watershed. The weaker correlation with halite and the lack of exceedances at lower flows indicates that selenium is not being loaded via ground water inflow to the stream. It is surmised that selenium in dissolved or particulate form, is moving off the landscape under conditions producing higher flows in the stream.

Table 1. Stream Gages and Monitoring Stations on Wolf Creek

Station	Stream	Type	Record	Med Q (cfs)	Avg Se (mg/l)	Max Se (mg/l)	# of Samples	# >0.005 mg/l	# >0.20 mg/l
Wolf Crk (537)	Sal R. Trib	WQ/Qest	1990, 94, 98, 2002	10.2	0.007	0.024	19	8	3

Figure 2. Wolf Creek Selenium -Flow Relationship

**Wolf Creek near Sylvan Grove
Stat.537 Conc as f(Flow Condition)**



Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. Sample data for the sampling sites were examined for each of the three defined seasons: Spring (Apr-Jun), Summer-Fall (Jul-Oct) and Winter (Nov-Mar). Generally, exceedances were seen at higher flows throughout all three seasons. High flows and runoff equate to lower flow durations; baseflow and point source influences generally occur in the 75-99% range. A Load curve was established for the chronic and acute Aquatic Life criteria by multiplying the flow values along the curve by the applicable water quality criterion and

converting the units to derive a load duration curve of pounds of selenium per day. These load curves represent the TMDL since any point along the curve represents water quality for the standard at that flow. Historic excursions from the water quality standard are seen as plotted points above the load curve. Water quality standards are met for those points plotting below the load duration.

Interim Endpoints of Water Quality (Implied Load Capacity) on Wolf Creek.

The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards fully supporting Aquatic Life Use. This TMDL will, however, be phased. The current standard of 0.005 mg/L of selenium was used to establish the TMDL. However, the Wolf Creek system is affected by the presence of selenium-laden soils from the weathering of underlying Cretaceous formations. As such, Wolf Creek has elevated selenium levels during periods where water runoffs and runs over this natural source. The natural background of selenium at higher flows, consistently above 0.005 mg/L, and occasionally the acute criterion of 0.02 mg/l makes achievement of the Standard unlikely at higher flow conditions. The existing criterion of 0.005 mg/l can be and is achieved on Wolf Creek at lower flows.

Since the Standard is not consistently achievable at higher flows because of natural contributions of the selenium load, an alternative endpoint is needed.

Kansas Implementation Procedures for Surface Water allow for a numerical criterion based on natural background to be established from samples taken at flows less than median in-stream flow. However, in this situation, the existing criterion is achievable at lower flows. At higher flows, exceeding 60% exceedance, violations of the chronic and acute criteria occur. Therefore, in this situation, the alternative endpoint is established at the higher flow regime and will be expressed as the average concentration seen at flow exceeded less than 60% of the time. One of the samples taken was a high detection limit (0.05 mg/l) that leaves unclear the actual concentration seen in the stream at that time. Removal of that value from the data set of high flow samples makes the average concentration of 0.007 mg/l. Therefore, the TMDL load duration curve was drawn by applying the 0.005 value to flows exceeded more than 60% of the time; applying 0.007 value to flows exceeded less than 50% of the time; and interpolating between these two points over the range of flows exceeded 51-59% of the time (Figure 3). Achievement of these endpoints will help eliminate the occasional excursion over the acute criterion seen at higher flows.

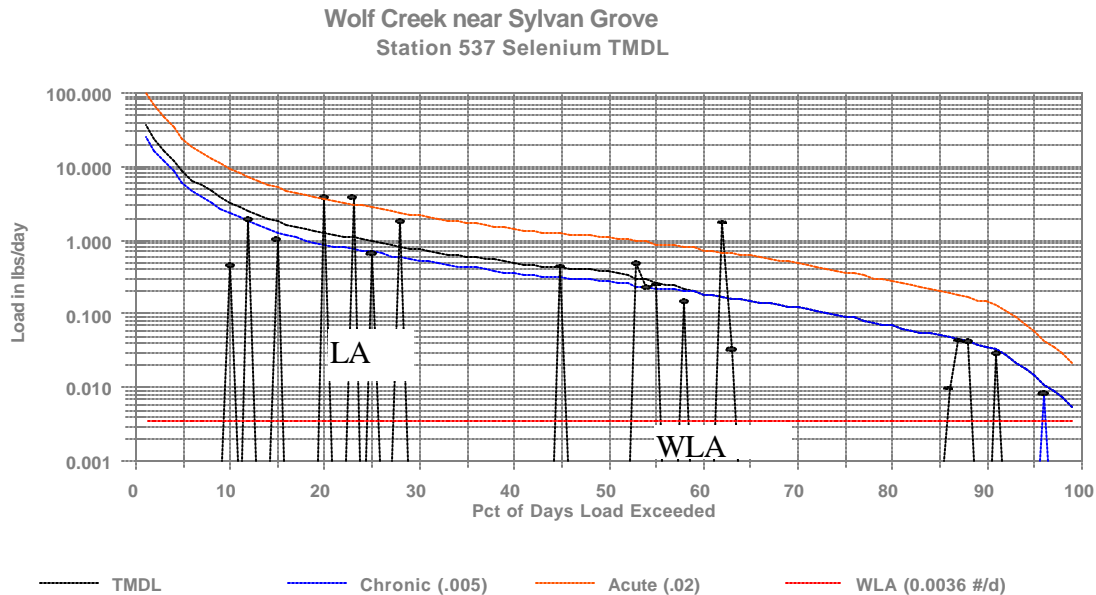
Seasonal variation has been incorporated in this TMDL through the documentation of the seasonal consistency of elevated selenium levels. Achievement of the endpoints indicate loads are within the loading capacity of the stream, water quality standards are attained and full support of the designated uses of the stream has been restored.

3. SOURCE INVENTORY AND ASSESSMENT

Geology: The main contribution of selenium to the Wolf Creek watershed is from the weathering of Upper Cretaceous bedrock underlying the upland portions of the drainage (Figure 4). The Upper Cretaceous formations comprise the Carlile Shale, Greenhorn Limestone, Graneros Shale and the Niobrara Chalk at the watershed divide. The presence of bentonite within these formations adds relatively high concentrations of selenium to the resulting soils. The arid environment of the watershed has a tendency to concentrate the selenium levels. There is a low potential for runoff from light rains, therefore, when conditions develop to generate overland flow and interflow through the soils from the

upland area, selenium may be carried into the stream system as flows increase. Since Upper Cretaceous formations tend to have gypsum beds, there is a coincidental loading of calcium and sulfate. Selenium and sulfate and calcium are moderately correlated ($r = 0.37$ and 0.48 , respectively; improving

Figure 3. Wolf Creek Selenium TMDL Curve

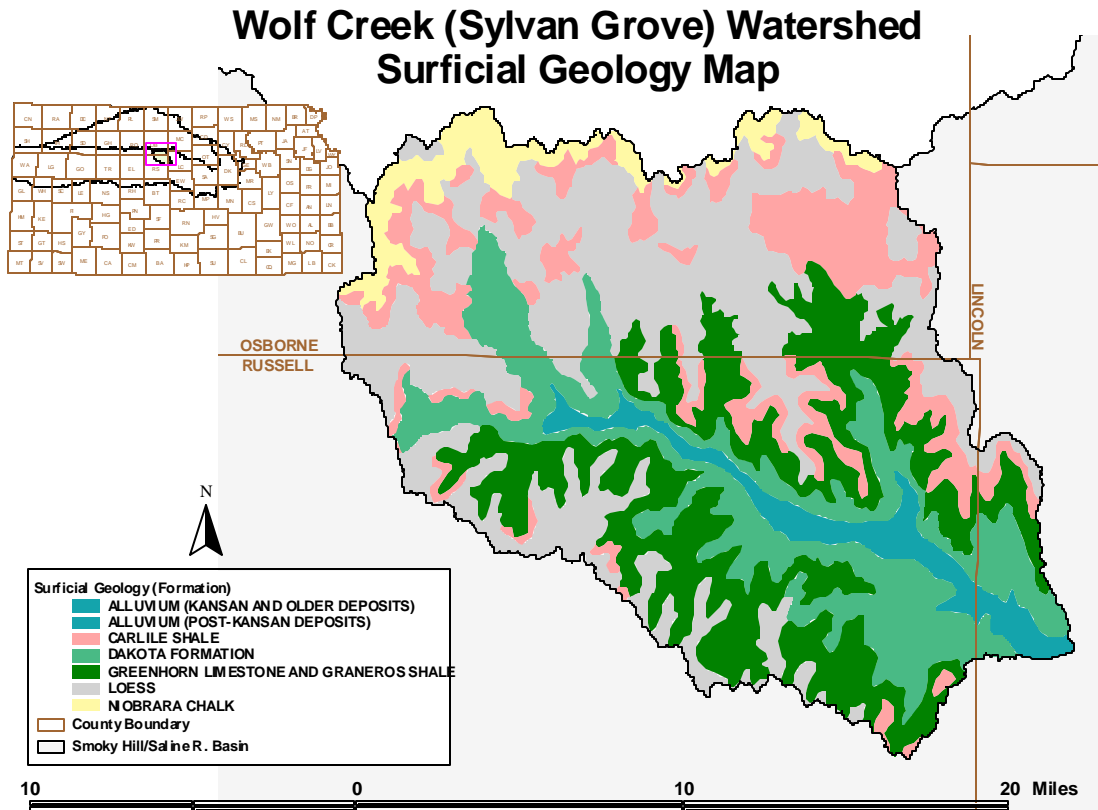


to 0.49 and 0.69 when log-transformed). Saltwater intrusion also occurs within the Wolf Creek watershed but selenium is weakly and inversely correlated to sodium or chloride ($r = -0.24$ and -0.22 , respectively, improving to -0.40 and -0.38 when log-transformed). Halite dissolution tends to be dominant at low flows, when selenium levels are below the chronic criterion. As runoff picks up, selenium levels increase, while mineralized ground water begins to dilute from the fresh water overland flow. Hence the inverse relationship between the salts is intuitively correct and indicates that ground water is not a source of excessive selenium to the streams.

NPDES: There is one permitted wastewater treatment facility discharging to Wolf Creek (Figure 5). Lucas (Permit # SA08-OO02; NPDES # KS0095222) discharges a design flow of 0.085 MGD via a two cell lagoon waste treatment system. This system came on-line in 2002. Prior to that time, Lucas operated a non-discharging system. Additionally, Luray (Permit # M-SA09-NO01) operates a non-discharging system. Therefore, any selenium impairments seen at the Sylvan Grove station would not be caused by wastewater discharges. This lack of causality is substantiated by the lack of selenium impairments at low flows when point source discharges exert their greatest influence on water quality.

Irrigation: There is only one small irrigation water right within the Wolf Creek watershed, authorized to divert 27 acre-feet, but, based on 2001 Water Use Reports, there is no irrigation occurring within the drainage. Irrigation may be limited by high chloride water present within the streams and ground water, particularly during the low flow, growing season. Once again, the lack of selenium impairment at low flows indicates that irrigation return flows or depletion of surface water is not a factor in selenium loading.

Figure 4. Surface Geology of TMDL Area

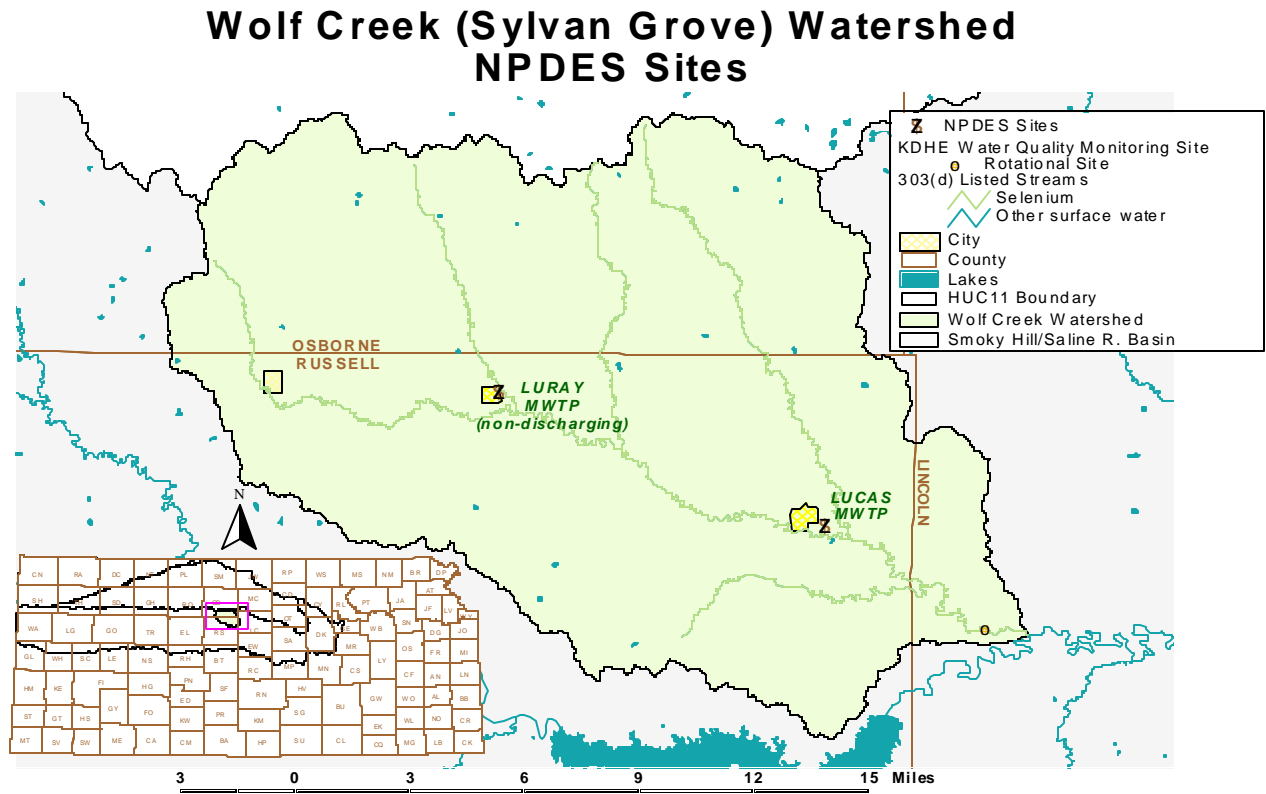


4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

Point and Non-point Sources: Analysis of the flow distribution of selenium concentrations indicates point sources are an insignificant contributor to the impairments of Wolf Creek. Furthermore, increasing streamflow tends to increase concentrations as runoff delivers selenium from upland areas to the stream and watershed outlet. Hence, the non-point source contributions are bifurcated between minor runoff and effective runoff conditions. The TMDL and allocations are displayed in the Load Duration curve of Figure 3.

Wasteload Allocation: For the two facilities located in the watershed, Luray will have a wasteload allocation of zero because of its non-discharging system. Lucas will have a wasteload allocation of 0.0036 pounds per day of selenium reflecting its design flow and an expected end-of-pipe concentration of 0.005 mg/l of selenium. These allocations may be adjusted to reflect future altered conditions by reallocation of load between the overall wasteload and load allocations allotted under this TMDL.

Figure 5. NPDES Facilities in Wolf Creek Watershed



Load Allocations: Much of the impaired condition is caused by natural background loadings. As indicated in Figure 3, the load allocations adjust to the ambient background concentrations seen as a result of flow conditions. At flows exceeded 60-99% of the time, the respective load allocation established at the criterion of 0.005 mg/l ranges from 0.18 to 0.0019 pounds per day. The criterion transitions between 0.005 to 0.007 mg/l within the flow range of 50-60% exceedance. The load allocation between median flow (50%) and the high flow (1%), corresponding to a background concentration of 0.007 mg/l is 0.38 to 35.7 pounds per day.

Margin of Safety: The margin of safety is implied by the lack of evidence implicating anthropogenic sources contributing to the impairment. The wastewater discharge at Lucas is low in volume and there are no impairments at low flows that would be influenced by point sources. There is no irrigation in the watershed to load or concentrate selenium in the stream. A background concentration will be derived to replace the default selenium chronic criterion through the water quality standard revision process. The Margin of Safety is established through the revised criterion.

State Water Plan Implementation Priority: Because the selenium impairment along Wolf Creek is primarily due to the natural interaction of runoff and geologic sources, this TMDL will be a Low Priority for implementation.

Unified Watershed Assessment Priority Ranking: This TMDL addresses streams within the Lower Saline (HUC 8: 10260010) with a ranking of 33 (Medium Priority for restoration).

Priority HUC 11s: Because of the natural geologic contribution of this impairment, no priority subwatersheds or stream segments will be identified.

5. IMPLEMENTATION

Desired Implementation Activities

1. Monitor any anthropogenic contributions of selenium loading to the streams.
2. Establish alternative background criterion.

Implementation Programs Guidance

NPDES and State Permits - KDHE

- a. Municipal permits for facilities in the watershed will be renewed after 2007 with annual selenium monitoring and any excessive selenium discharge will have appropriate permit limits which does not increase the ambient background levels of selenium.

Non-Point Source Pollution Technical Assistance - KDHE

- a. Evaluate any potential anthropogenic activities which might contribute selenium to the streams as part of an overall Watershed Restoration and Protection Strategy.

Water Quality Standards and Assessment - KDHE

- a. Establish background concentrations of selenium for Wolf Creek.

Time Frame for Implementation: Development of a background level-based water quality standard should be accomplished with the 2004 water quality standards revision.

Targeted Participants: Primary participants for implementation will be KDHE.

Milestone for 2008: The year 2008 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, sampled data from the streams covered by this TMDL should indicate no increase in average selenium levels in the streams, particularly at higher flows. Should the case of impairment remain, additional source assessment, allocation and implementation activities will ensue.

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 pollutants.

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*.
6. The *Kansas Water Plan* and the Smoky Hill/Saline 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 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 to programs supporting water quality protection. This watershed and its TMDL are a Low Priority consideration.

Effectiveness: Minimal control can be exerted on natural contributions to loading at high flows, although lower flows can be protected against anthropogenic loading from point sources.

6. MONITORING

KDHE will continue to collect samples from the rotational station near Sylvan Grove. Based on that sampling, the priority status will be evaluated in 2008 including application of numeric criterion based on background concentrations. Annual monitoring of selenium levels in effluent will be a condition of NPDES and state permits for facilities.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Smoky Hill/Saline Basin were held January 7 and March 5, 2003 in Hays. An active Internet Web site was established at <http://www.kdhe.state.ks.us/tmdl/> to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Smoky Hill/Saline Basin.

Public Hearing: A Public Hearing on the TMDLs of the Smoky Hill/Saline Basin was held in Hays on June 2, 2003.

Basin Advisory Committee: The Smoky Hill/Saline Basin Advisory Committee met to discuss the TMDLs in the basin on October 3, 2002, January 7, March 5, and June 2, 2003.

Discussion with Interest Groups: Meetings to discuss TMDLs with interest groups include:
Smoky Hill River Task Force: January 22, February 27, April 16, and May 28, 2003

Milestone Evaluation: In 2008, evaluation will be made as to the degree of implementation which has occurred within the watershed. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The streams will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2008-2012. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2005 which will emphasize revision of the Water Quality Management Plan. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2004-2008.

Bibliography

- 1. Whittemore, Don; April 24, 2004 Memo on Selenium Source assessment and analysis for the selenium TMDL for Wolf Creek.**