SMOKY HILL/SALINE RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body/Assessment Unit: Kanopolis Lake,
Smoky Hill River (Ellsworth, Wilson, Russell, and Schoenchen),
Beaver Creek, Coal Creek, Fossil Creek, Goose Creek, Landon Creek, and Sellens Creek
Water Quality Impairment: Sulfate

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Big and Middle Smoky Hill

Counties: Barton, Ellis, Ellsworth, Gove, Lincoln, Ness, Rice, Rush, Russell, Sheridan, and Trego

HUC 8: 10260006 **HUC 11** (14)**:** **010** (010, 020, 030, 040, 050, 060) (Figure 1)
020 (010, 020, 030, 040)
030 (010, 020, 030, 040)
040 (010, 020, 030, 040, 050, 060, 070)
050 (010, 020, 030, 040, 050, 060, 070)
060 (010, 020, 030, 040, 050, 060, 070, 080)

10260007 **010** (010, 020, 030, 040)
020 (010, 020, 030, 040)
030 (010, 020, 030, 040, 050)
040 (010, 020, 030, 040, 050)

Ecoregion: Central Great Plains, Smoky Hills (27a)
Central Great Plains, Rolling Plains and Breaks (27b)

Drainage Area: Approximately 2,414 square miles.

<u>Kanopolis Lake</u>

Conservation Pool: Area = 3,742 acres
Watershed Area: Lake Surface Area = 413:1
Maximum Depth = 10.0 meters (32.8 feet)
Mean Depth = 4.0 meters (13.1 feet)
Retention Time = 0.12 years (1.4 months)

Designated Uses: Primary and Secondary Contact Recreation; Expected Aquatic Life Support; Drinking Water; Food Procurement; Irrigation

Authority: Federal (U.S. Army Corps of Engineers), State (Kansas Water Office)

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

Smoky Hill River

Main Stem Segment: WQLS: 5, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 21, & 22 (Smoky Hill River) starting at Kanopolis Lake and traveling upstream to the Cedar Bluff Lake dam.

Main Stem Segments with Tributaries by HUC 8 and Watershed/Station Number:

HUC8: 10260005
Kanopolis Lake (Station 016001)
Thompson Cr (37)
Smoky Hill R (5) - part
Clear Cr (42)
Skunk Cr (48)
Ash Cr (1190)
Mud Cr (47)
Oxide Cr (45)

HUC8: 10260005
Smoky Hill River (Ellsworth) (Station 269)
Smoky Hill R (5) - part
Turkey Cr (46)
Buffalo Cr (6)
Smoky Hill R (7)
Loss Cr (44)
Wolf Cr (36)
Smoky Hill R (8)
Cow Cr (38)

HUC8: 10260006
Smoky Hill River (Wilson) (Station 723)
Smoky Hill R (9)
Blood Cr (35)
Spring Cr (41)
Wilson Cr (40)
Coal Cr (34) **(Station 733)**
Smoky Hill R (10)
Beaver Cr (33) **(Station 734)**
Smoky Hill R (11)
Goose Cr (39) **(Station 735)**
Sellens Cr (32) **(Station 736)**

HUC8: 10260006
Fossil Creek (Station 713)
Fossil Cr (13)

HUC8: 10260006
Landon Creek (Station 714)
Landon Cr (31)

HUC8: 10260006
Smoky Hill (Russell) (Station 7)

Smoky Hill R (12)
Smoky Hill R (14)
Smoky Hill R (15)
Smoky Hill R (16)
Smoky Hill R (17)
Smoky Hill R (18)

10260007 Big Cr (1)
Big Cr (3)
Eagle Creek (30)
Buck Creek (29)
Shelter Creek (43)
Big Timber Cr (24)
Big Timber Cr (25)
Big Timber Cr (27)
Walker Cr (2)
Unnamed Stream (28)
Timber Creek (26)

HUC8: 10260006

Smoky Hill River (Schoenchen) (Station 539)

Smoky Hill R (19)
Smoky Hill R (21)
Smoky Hill R (22)
Unnamed Stream (20)
Unnamed Stream (23)

Designated Uses: Primary and Secondary Contact Recreation; Drinking Water; Food Procurement; Groundwater Recharge, Industrial Water Supply, Irrigation; Livestock Watering on Main Stem Segments

Expected Aquatic Life Support on all Main Stem Segments, except on segments 5, 7, 8, & 9 which are designated as Special Aquatic Life Support

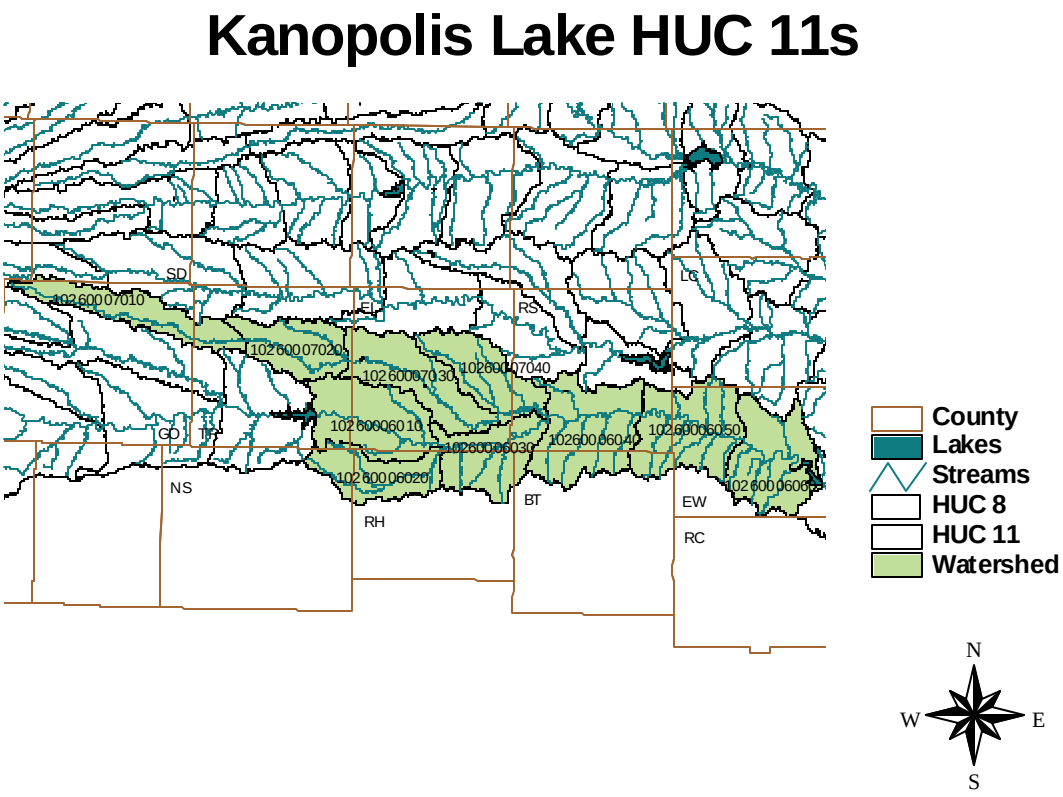
2002 303(d) Listing: Smoky Hill/Saline River Basin Streams

Impaired Use: Domestic Water Supply

Water Quality Standard: Domestic Water Supply: 250 mg/L at any point of domestic water supply diversion (K.A.R.28-16-28e(c) (3) (A)

In stream segments where background concentrations of naturally occurring substances, including chlorides and sulfates, exceed the domestic water supply criteria listed in table 1a in subsection (d), at ambient flow, due to intrusion of mineralized groundwater, the existing water quality shall be maintained, and the newly established numeric criteria for domestic water supply 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(c) (3)(B))

Figure 1



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 2002 303(d): Not Supporting Domestic Water

Lake Monitoring Sites: Station 016001 in Kanopolis Lake (Figure 2).

Period of Record Used: Five surveys during 1988 - 2000

Elevation Record: Kanopolis Lake near Kanopolis, KS (USGS Gage 06865000)

Stream Chemistry Monitoring Sites:

Monitoring and Flow Record Information for the Kanopolis Lake Basin

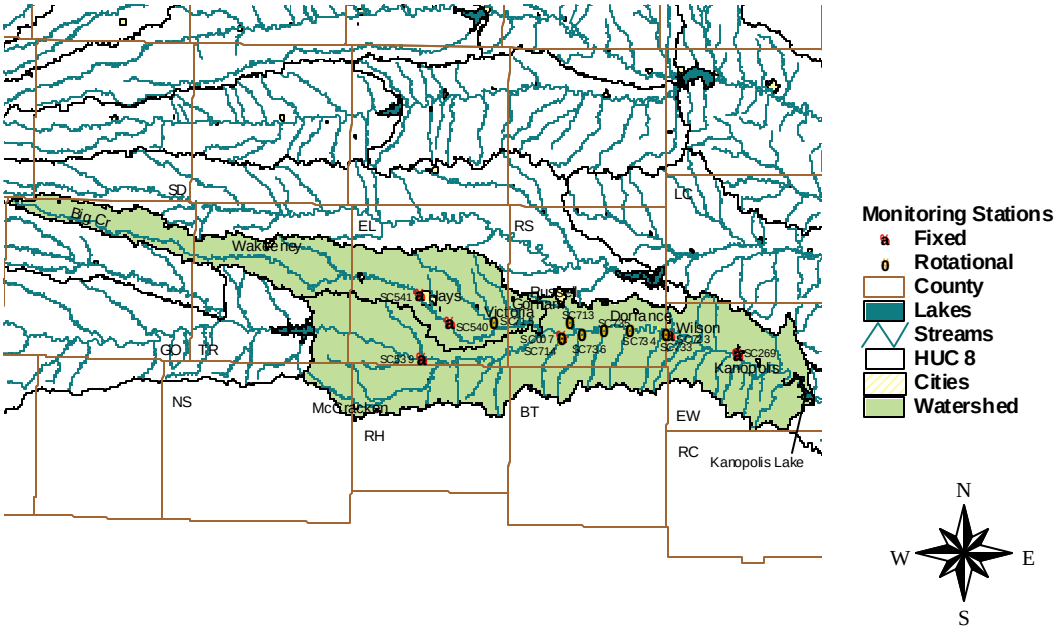
Monitoring Sites	Period of Record Used	Flow Record (USGS Gage)	Median Flows (cfs)
Station 007 near Russell (Smoky Hill River)	1985 - 2002	Smoky Hill River near Bunker Hill (USGS Gage 06864050)	35.4 cfs
Station 269 at Ellsworth (Smoky Hill River)	1985 - 2002	Smoky Hill River at Ellsworth (USGS Gage 06864500)	64.5 cfs

Station 539 near Schoenchen (Smoky Hill River)	1990 - 2002	Smoky Hill River near Schoenchen (USGS Gage 06862700)	9.9 cfs
Station 713 near Russell (Fossil Creek)	1994 - 2002	Matched to flow duration for Salt C near Ada (06876700)	0.75 cfs*
Station 714 near Russell (Landon Creek)	1994 - 2002	Matched to flow duration for Salt C near Ada (06876700)	0.98 cfs*
Station 723 near Wilson (Smoky Hill River)	2000 - 2002	Smoky Hill River at Ellsworth (USGS Gage 06864500)	64.5 cfs
Station 733 near Russell (Coal Creek)	2002	Matched to flow duration for Salt C near Ada (06876700)	0.89 cfs*
Station 734 near Dorrance (Beaver Creek)	2002	Matched to flow duration for Salt C near Ada (06876700)	0.75 cfs*
Station 735 near Bunker Hill (Goose Creek)	2002	Matched to flow duration for Salt C near Ada (06876700)	0.65 cfs*
Station 736 near Russell (Sellens Creek)	2002	Matched to flow duration for Salt C near Ada (06876700)	0.92 cfs*

* The tributary stations 714, 733, 734, 735, and 736 all had median flows below 1 cfs and thus by SB 204 were unclassified and not subject to numeric criteria. Fossil Creek, Station 713, is classified because Russell MWTP discharges into it.

Figure 2

Kanopolis Lake TMDL Reference Map



Current Condition:
Over the period of record, the sulfate concentration in Kanopolis Lake has averaged 191 mg/L (Appendix A). The exceedence above the domestic water quality standard, that caused the lake to be listed on the 1998 303(d) list, occurred in 1994. At that time, the average sulfate concentration was 288 mg/L. Since that year, the water quality in Kanopolis Lake has significantly improved averaging 184 mg/L of sulfate.

The concentration of sulfate in the Smoky Hill River gets diluted as the water flows towards Kanopolis Lake. Near the Cedar Bluff dam, at station 539, the sulfate concentration averages 397 mg/L. The average concentration drops further to 287 mg/L at station 007 then to 260 mg/L at station 723 and finally to 220 mg/L at station 269 (Figures 3, 4, 5, 6, & 7).

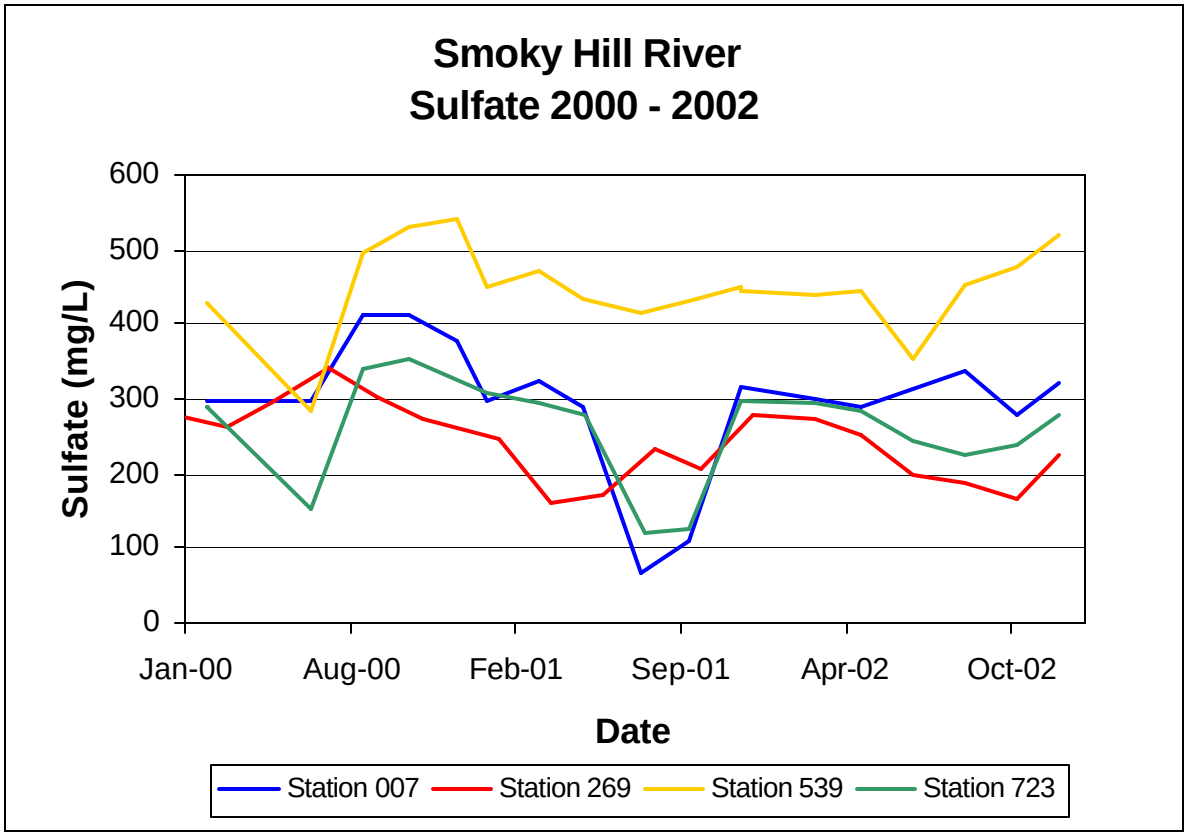


Figure 3

Figure 4

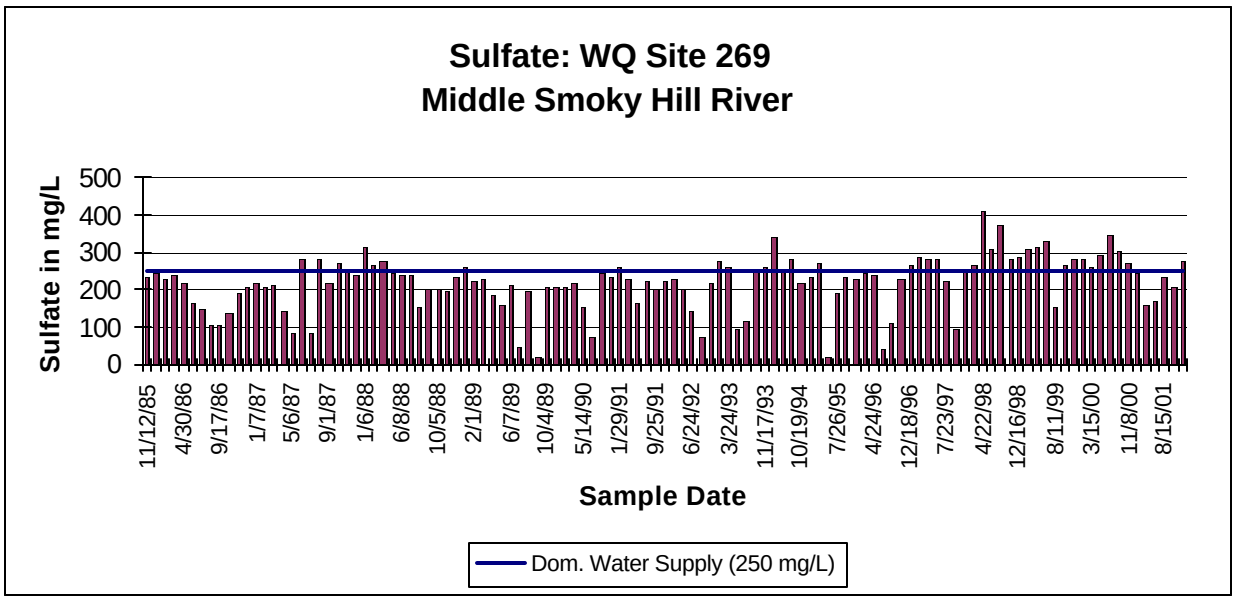


Figure 5

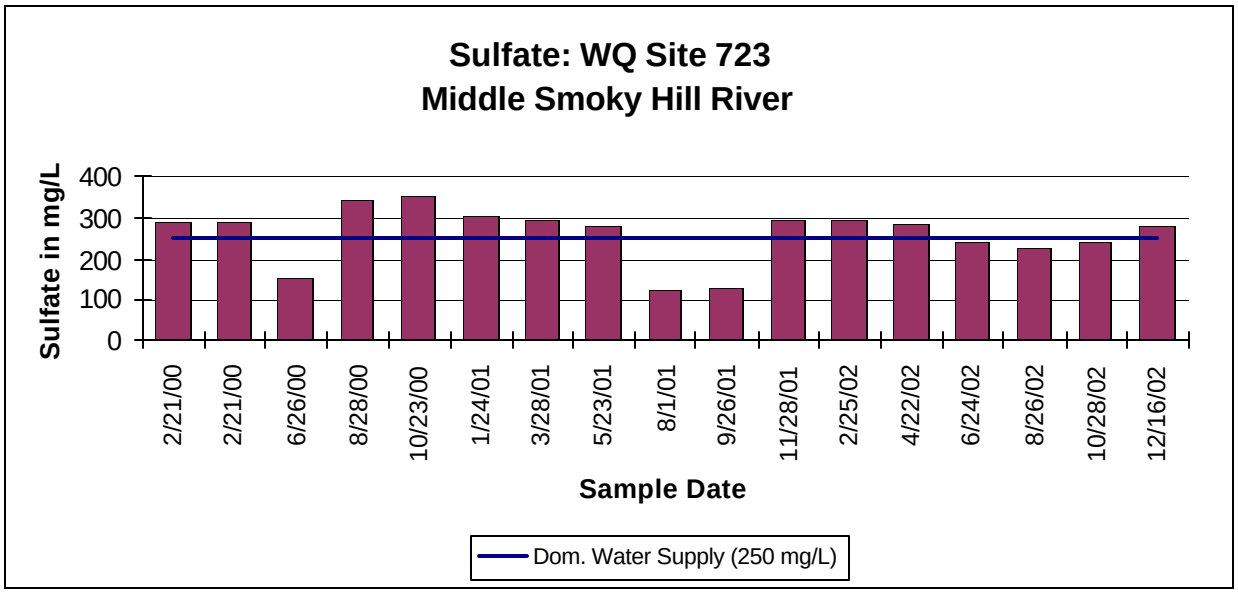


Figure 6

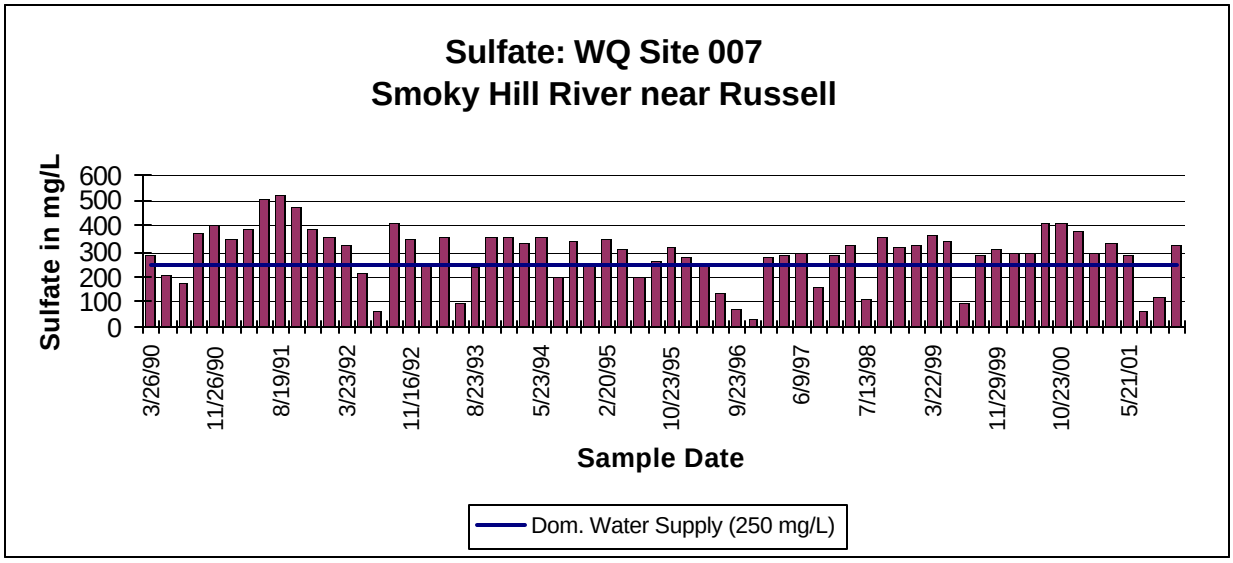
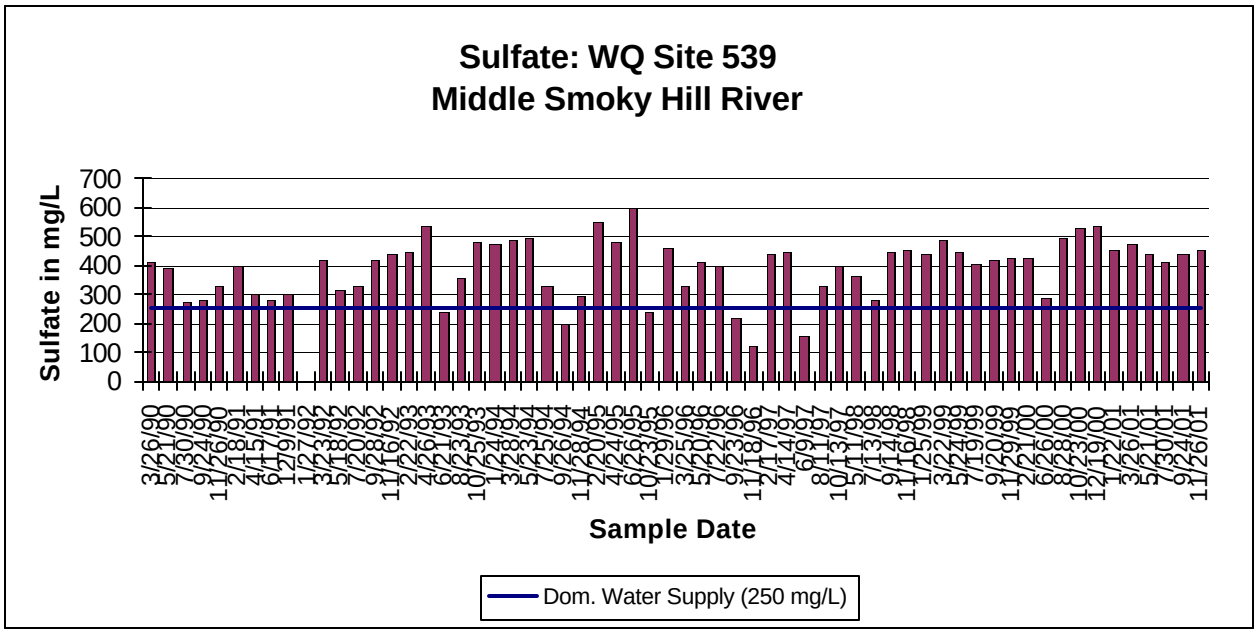


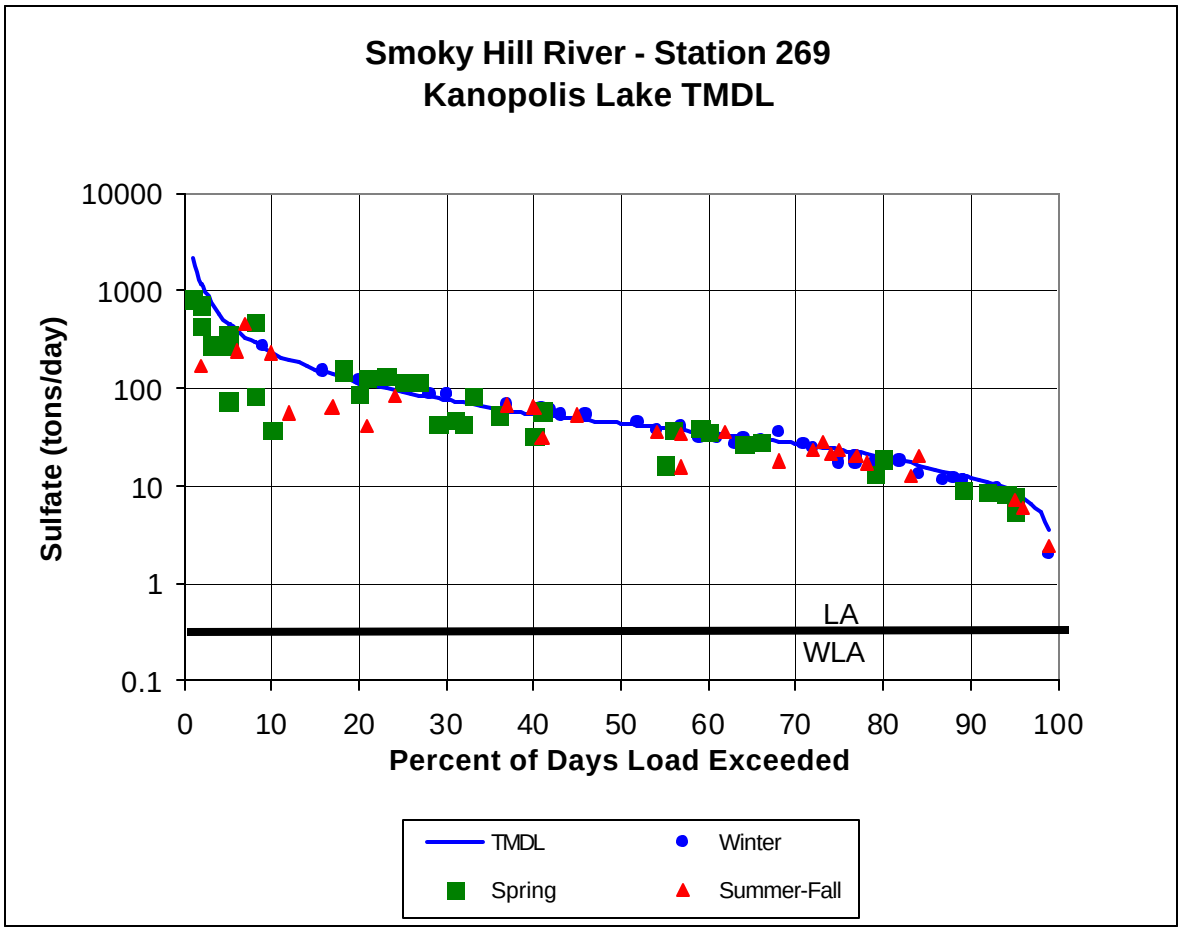
Figure 7



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 categorized for each of the three defined seasons: Spring (Apr-Jul), Summer-Fall (Aug-Oct) and Winter (Nov-Mar). 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 Domestic Water Supply criterion 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 tons of sulfate per day. This 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 curve (Figures 8, 9, 10, and 11).

Figure 8

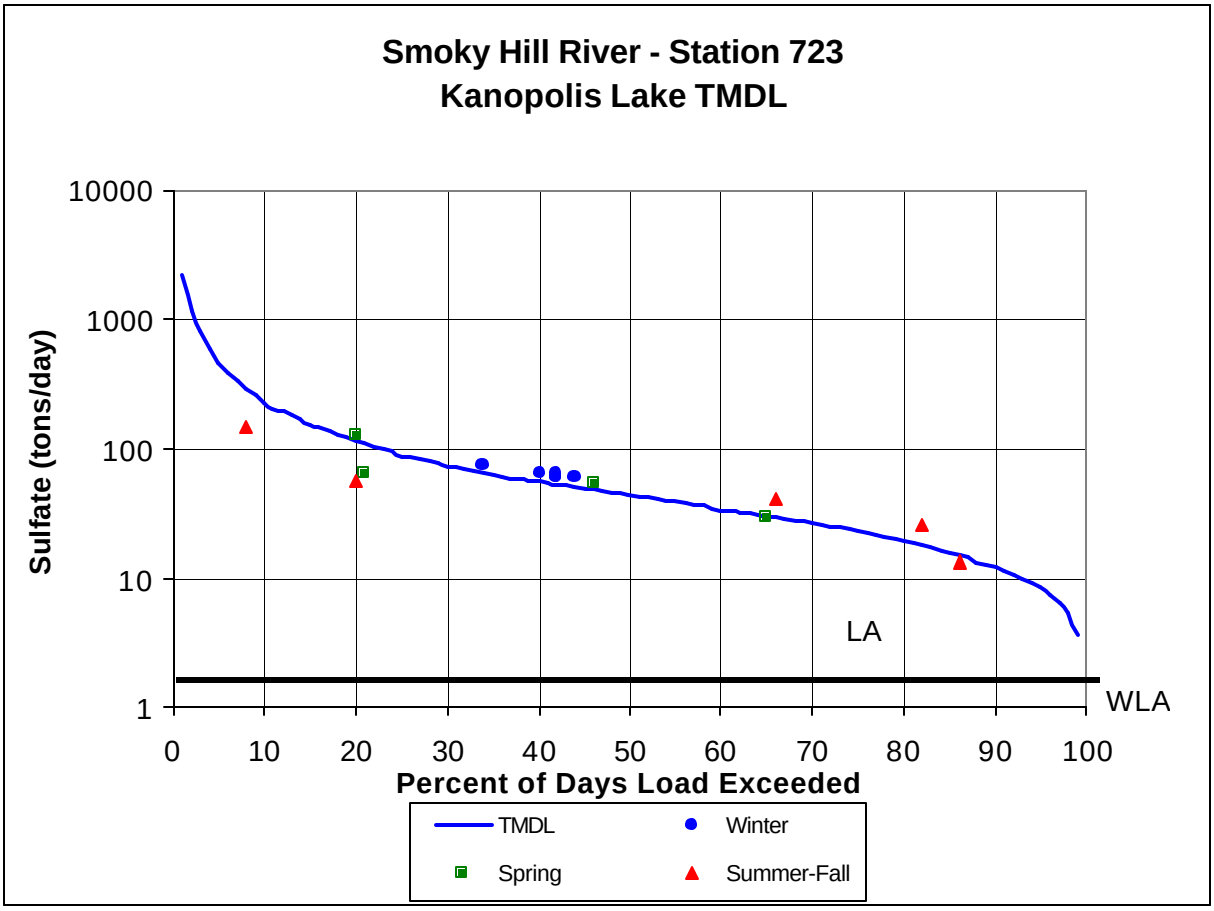


Station 269: Excursions were seen in each of the three defined seasons and are outlined below. Twenty-seven percent of Spring samples and 25% of Summer-Fall samples were over the domestic supply criterion. Forty-one percent of Winter samples were over the criterion. Overall, 31% of the samples were over the criteria. This would represent a potential baseline condition of non-support of the impaired designated use, if a point of diversion for water supply was present along the river.

NUMBER OF SAMPLES OVER SULFATE STANDARD OF 250 mg/L BY FLOW AND SEASON

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Smoky Hill River at Ellsworth (269)	Spring	1	5	3	1	0	0	10/37 = 27%
	Summer	1	0	3	2	1	0	7/28 = 25%
	Winter	1	3	6	4	0	0	14/34 = 41%

Figure 9

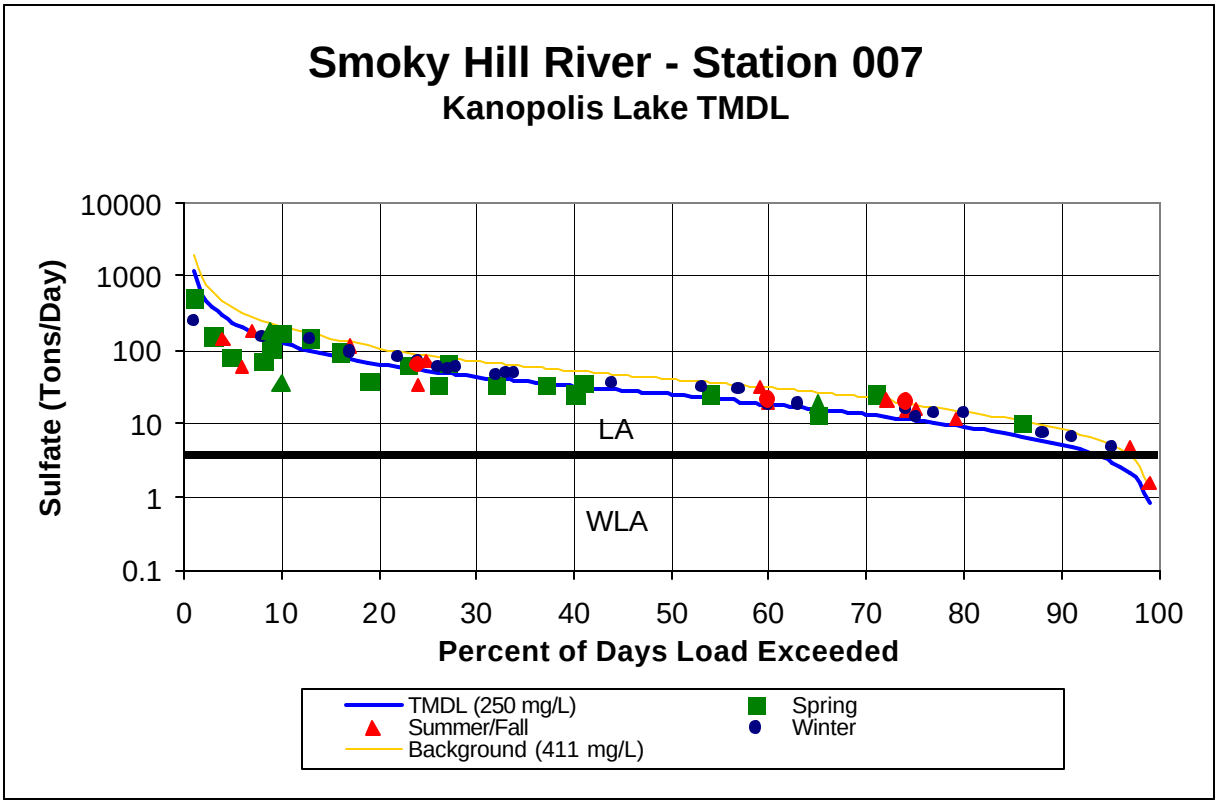


Station 723: Excursions were seen in each of the three defined seasons and are outlined below. Fifty percent of Spring samples and 40% of Summer-Fall samples were over the domestic supply criterion. One hundred percent of Winter samples were over the criterion. Overall, 64% of the samples were over the criteria. This would represent a baseline condition of non-support of the impaired designated use, if a point of diversion for water supply was present along the river.

NUMBER OF SAMPLES OVER SULFATE STANDARD OF 250 mg/L BY FLOW AND SEASON

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Smoky Hill River near Wilson (723)	Spring	0	1	1	0	0	0	2/4 = 50%
	Summer	0	0	0	1	1	0	2/5 = 40%
	Winter	0	0	5	0	0	0	5/5 = 100%

Figure 10

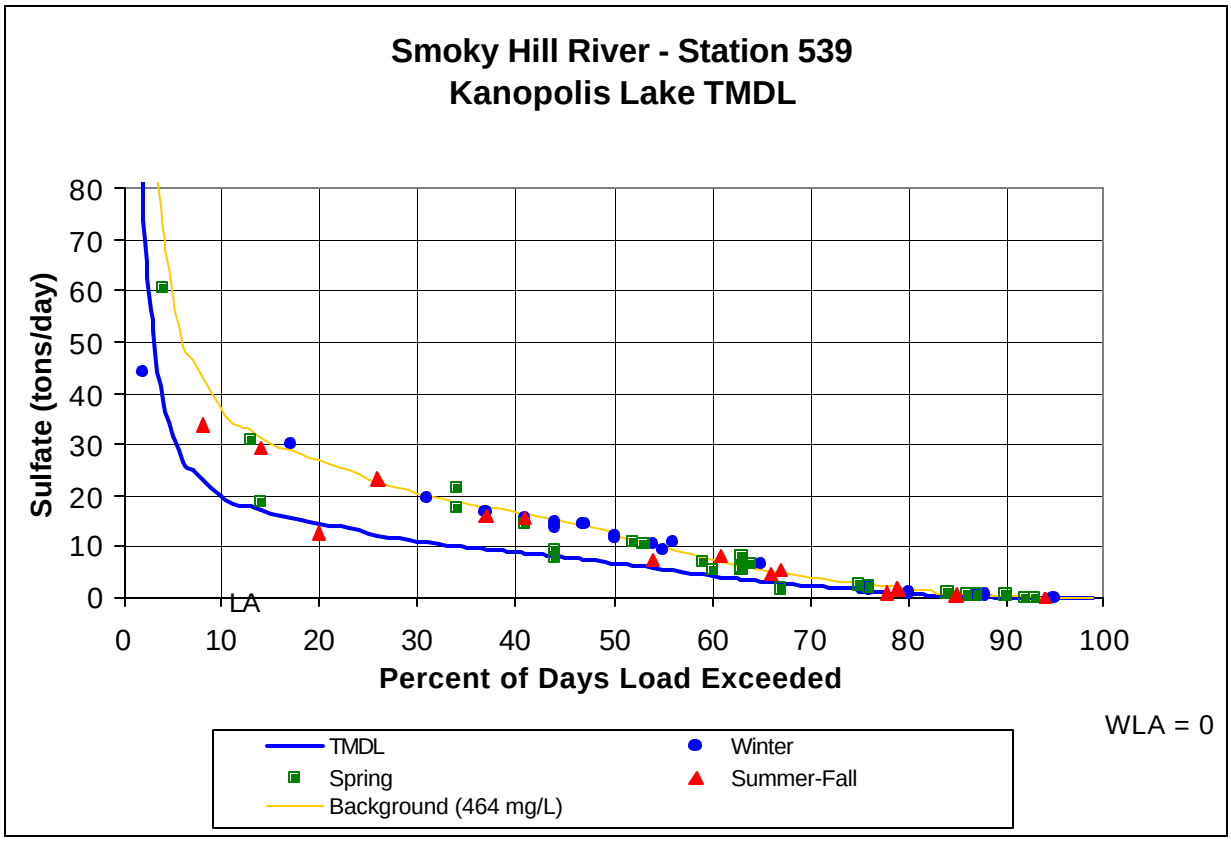


Station 007: Excursions were seen in each of the three defined seasons and are outlined below. Forty-eight percent of Spring samples and 75% of Summer-Fall samples were over the domestic supply criterion. Eighty-eight percent of Winter samples were over the criterion. Overall, 70% of the samples were over the criteria. This would represent a baseline condition of non-support of the impaired designated use.

NUMBER OF SAMPLES OVER SULFATE STANDARD OF 250 mg/L BY FLOW AND SEASON

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Smoky Hill River near Russell (007)	Spring	2	3	2	3	1	0	11/23 = 48%
	Summer	0	3	0	6	1	2	12/16 = 75%
	Winter	0	4	7	5	3	2	21/24 = 88%

Figure 11



Station 539: Excursions were seen in each of the three defined seasons and are outlined below. Sixty-eight percent of Spring samples and 71% of Summer-Fall samples were over the domestic supply criterion. Seventy-five percent of Winter samples were over the criterion. Overall, 71% of the samples were over the criteria. This would represent a baseline condition of non-support of the impaired designated use, if a point of diversion for water supply was present along the river.

NUMBER OF SAMPLES OVER SULFATE STANDARD OF 250 mg/L BY FLOW AND SEASON

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Smoky Hill River near Schoenchen (539)	Spring	1	2	5	8	1	0	17/25 = 68%
	Summer	1	1	3	4	1	0	10/14 = 71%
	Winter	0	1	7	4	0	0	12/16 = 75%

Interim Endpoints of Water Quality (Implied Load Capacity) at Kanopolis Lake and Stations 269, 723, 007, and 539 over 2008 - 2012:

To ensure that the domestic water supply is protected, the desired endpoint will be to maintain average sulfate concentrations below 250 mg/L in Kanopolis Lake.

Current Condition and Reductions for Kanopolis Lake

Parameter	Current Condition	TMDL	Percent Reduction
Sulfate (mg/L)	184	< 250	0 %

The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards fully supporting Drinking Water Use. This TMDL will, however, be phased. The current standard of 250 mg/L of sulfate was used to establish the TMDL. However, the Smoky Hill River system is affected by the discharge of saline groundwater from the Dakota aquifer. As such, the watershed's main stem and many of its tributaries have elevated sulfate levels from this natural source. In some cases, the elevation beyond natural sulfate levels can be attributed to long term consumptive use of water by irrigation. The natural background of sulfate, consistently above 250 mg/L, makes achievement of the Standard impossible for all flow conditions at Stations 007 and 539. The average sulfate concentrations at Stations 296 and 723 for flows greater and less than the median is not significantly different from the Phase One endpoint, therefore, the 250 mg/l endpoint will apply to all flows at Stations 296 and 723. At Stations 007 and 539, since the Standard is not achievable because of natural contributions to the sulfate 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. The specific stream criteria to supplant the general standard will be developed concurrent with Phase One of this TMDL following the appropriate administrative and technical Water Quality Standards processes.

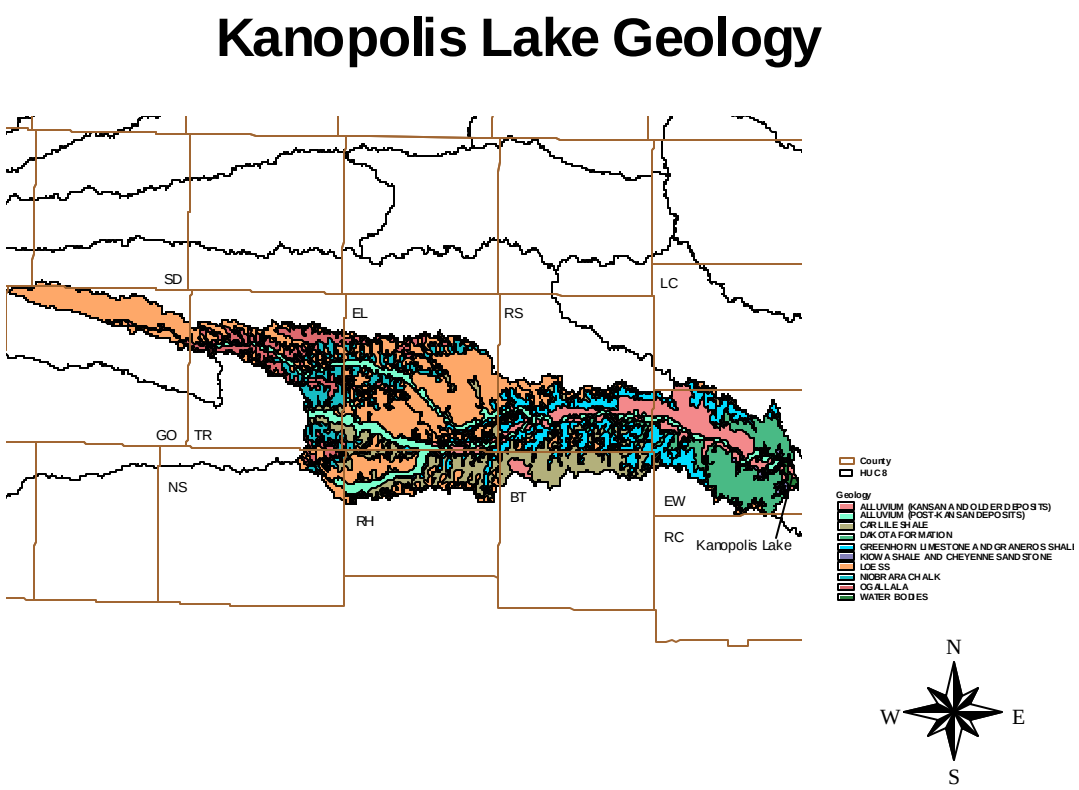
A tentative endpoint has been developed from currently available information at water quality monitoring stations 007 and 539. The average sulfate concentration at Station 007 for samples collected at flows less than the median flow is 411 mg/L and sets the tentative endpoint for this site. The average sulfate concentration at Station 539 is 464 mg/L for samples taken at flows less than the median flow and sets the tentative endpoint for this Site. The Phase Two TMDL will be based on the

future standard applied to these flows within the contributing portions of the Smoky Hill River watershed to Stations 007 and 539.

Seasonal variation has been incorporated in this TMDL through the documentation of the seasonal consistency of elevated sulfate 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

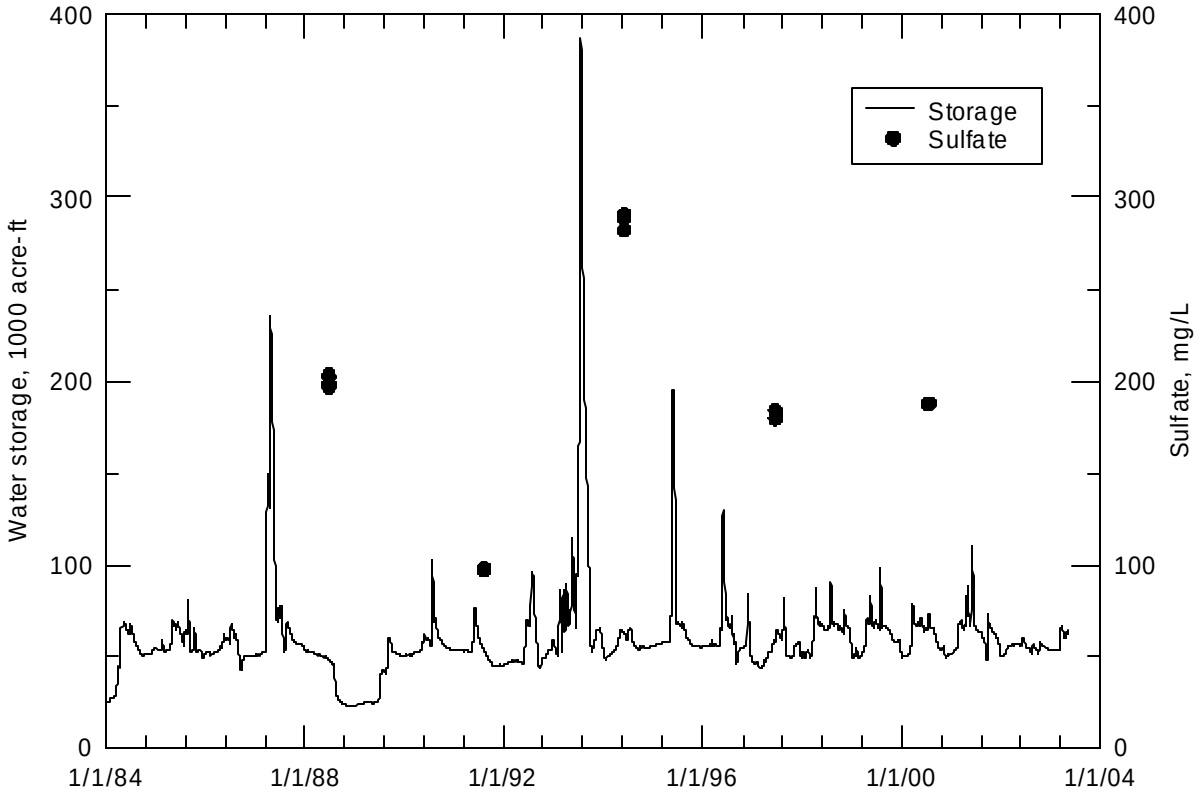
Figure 12



Sulfate Background: One of the major natural sources of sulfate in the water of Kanopolis Lake is the discharge of saline groundwater from the Dakota aquifer into the Smoky Hill River in Russell County. The saline groundwater derives its origin from upward intrusion of saltwater from the Cedar Hills Sandstone of Permian age, which underlies the Dakota aquifer in parts of central and north-central Kansas. Although the chloride content of the saltwater in the Cedar Hills Sandstone is substantially greater than the sulfate content, the sulfate is generally in the 5,000 mg/L range in Russell and Ellis Counties. Another natural sulfate source is the dissolution of gypsum (hydrous calcium sulfate) that

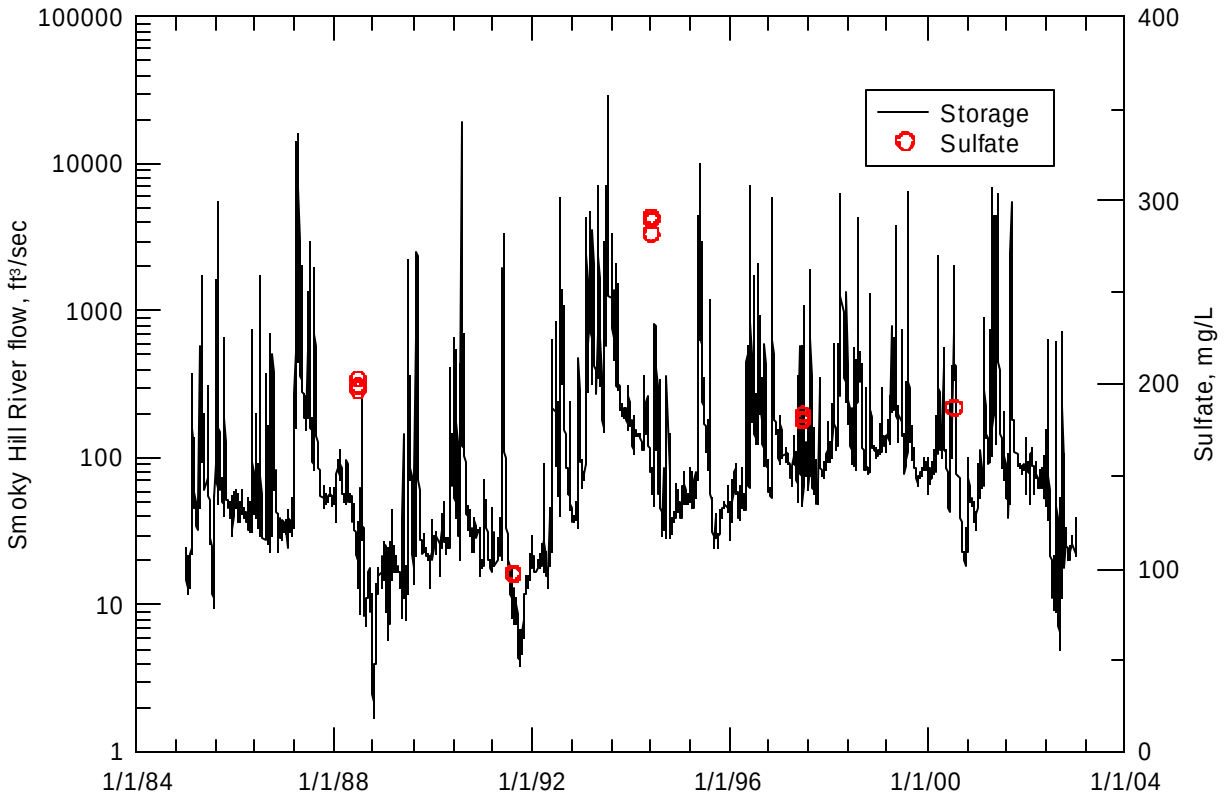
occurs in small amounts in selected units of the Cretaceous bedrock that underlies the drainage basin of Kanopolis Lake. These units include the Pierre Shale and the Smoky Hill Member of the Niobrara Chalk in the drainage area of Cedar Bluff Lake upstream of Kanopolis Lake, and the Carlile and Graneros shales in the drainage area between Cedar Bluff Lake and Kanopolis Lake. Rainfall dissolves the gypsum exposed at the surface in outcrops or in the shallow subsurface and increases the sulfate concentration of water moving through soils and shallow bedrock and sediments that discharges into streams. In addition, some shale members in the Greenhorn Limestone and the Carlile Shale and sometimes shales and sandstones in the Dakota Formation contain pyrite (iron sulfate) that weathers to produce locally high concentrations of sulfate in groundwater. This groundwater slowly flows towards streams and adds to the sulfate load of water draining into Kanopolis Lake. The discharge of saline groundwater from the Dakota aquifer, gypsum dissolution, and pyrite weathering are the main sources of the sulfate in the surface water entering the reservoir. However, evapotranspiration consumption of water in the drainage basin and evaporation from the surface of streams and the reservoir increase the sulfate concentration of the surface water.

Figure 13 - Sulfate concentration and daily water storage of Lake Kanopolis during 1984-2003.



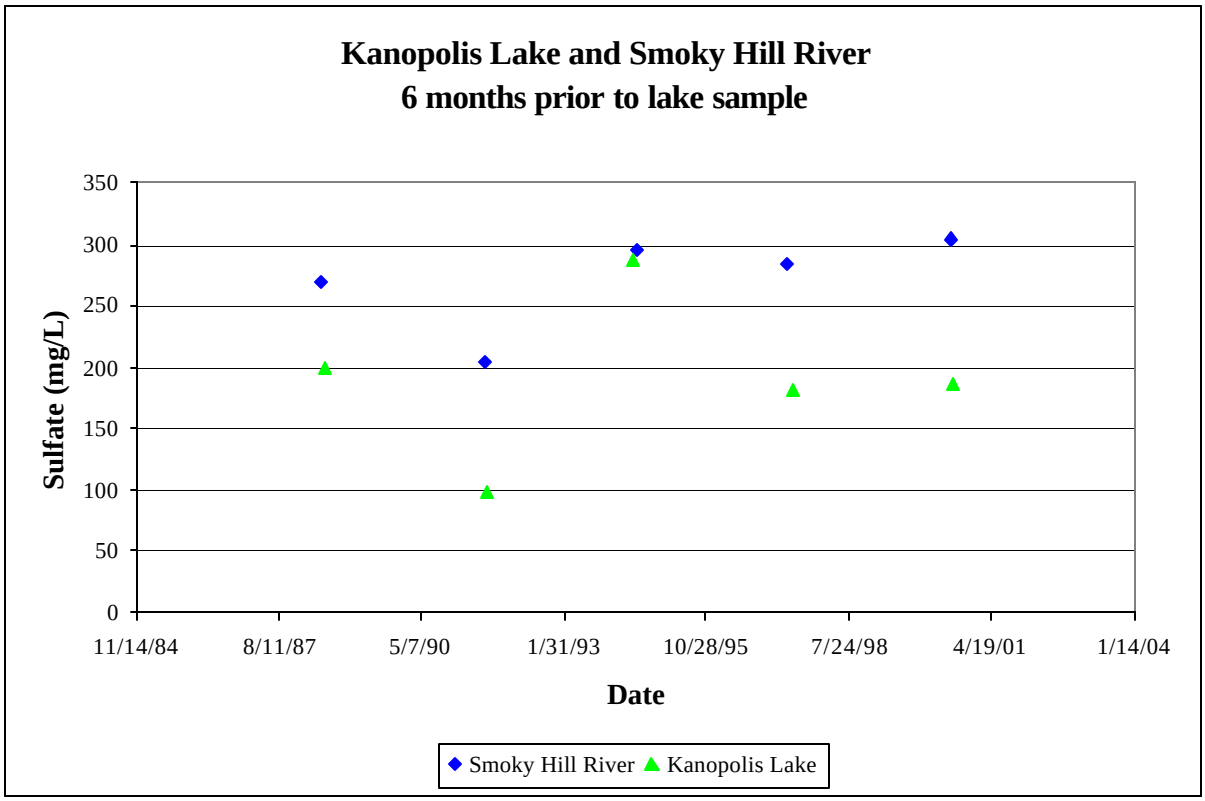
Natural Factors Controlling Variations in Sulfate: The record of water quality for Kanopolis Lake indicates that the sulfate concentration is highly variable. Large fluctuations in the amount of rainfall that runs off into lakes can cause variations in the dissolved solids content of lake

Figure 14 - Lake Kanopolis sulfate content and daily flow of the Smoky Hill River at Ellsworth, 1985-2003.



water. The runoff following substantial rain storms is appreciably fresher than most of the baseflow of streams and can dilute the dissolved solids concentration of lake water as it fills the lake. However, the relationship of flow within the drainage basin of the Smoky Hill River to the sulfate content of Kanopolis Lake water is not simple because it depends on which part of the watershed receives more rainfall and thus contributes greater flow to the lake inflow. Ground-water discharge and runoff from some portions of the basin yield more sulfate than others dependent on the geology and stream-aquifer relationships. The lack of a clear relationship between the amount of water stored in Kanopolis Lake and the sulfate concentration of the lake water (Figure 13), as well as between the lake sulfate and the flow of the Smoky Hill River at Ellsworth (Figure 14) illustrates the complexity of the factors controlling the lake water quality. If larger flow in the Smoky Hill River and the greater volumes of water in the lake were consistently representative of fresher water with lower sulfate concentration, the lake sulfate level should be inversely related to lake storage and to river flow preceding the lake survey. The sulfate content of the Smoky Hill River upstream at Ellsworth fits with the lake water sulfate (Figure 15) for some samples but not for others. This further indicates the variability of factors controlling the sulfate content but suggests that the river sulfate concentration is a major factor in controlling the lake sulfate level. The average sulfate content of the Smoky Hill River at Ellsworth during 1988-2000 was 228 mg/L, whereas the average sulfate concentration in Kanopolis Lake for the 5 surveys during the same span of years was 191 mg/L. The relatively short retention time of Kanopolis Lake (1.4 months) means that short-term runoff events are important in controlling the lake water quality. The frequency of sample collection of Smoky Hill River water upstream of the lake is every two months, thus, it is difficult to discern the details of changes in river-water quality that control the lake water quality.

Figure 15 - Sulfate concentration of Lake Kanopolis and the Smoky Hill River at Ellsworth, 1985-2003.



Irrigation Return Flows: Although there are many irrigation wells in the river valleys of the Smoky Hill River upstream of Kanopolis Lake, the irrigation impact on the watershed is minuscule. The volume of surface water used for irrigation is minimal and would not unduly influence the sulfate content. The fact that increased sulfate concentrations are seen at high flows indicates that the elevated sulfate levels are due to natural background. Additionally, natural contributions are apparent at Coal, Goose, Beaver and Fossil Creeks, and some freshwater dilution occurs from Sellers and Landon Creeks. See the point of diversion maps in Figures 16-19. Irrigation reports from 2003 show the following:

Water Use Statistics for Each Monitoring Site

Monitoring Sites	Surface Water		Groundwater	
	Area (acres)	Volume (acre-feet)	Area (acres)	Volume (acre-feet)
Station 269 at Ellsworth (Smoky Hill River)	0	0	0	0
Station 723 near Wilson (Smoky Hill River)	0	0	0	0
Station 007 near Russell (Smoky Hill River)	25	18	238	322
Station 539 near Schoenchen (Smoky Hill River)	310	246	666	545

Figure 16

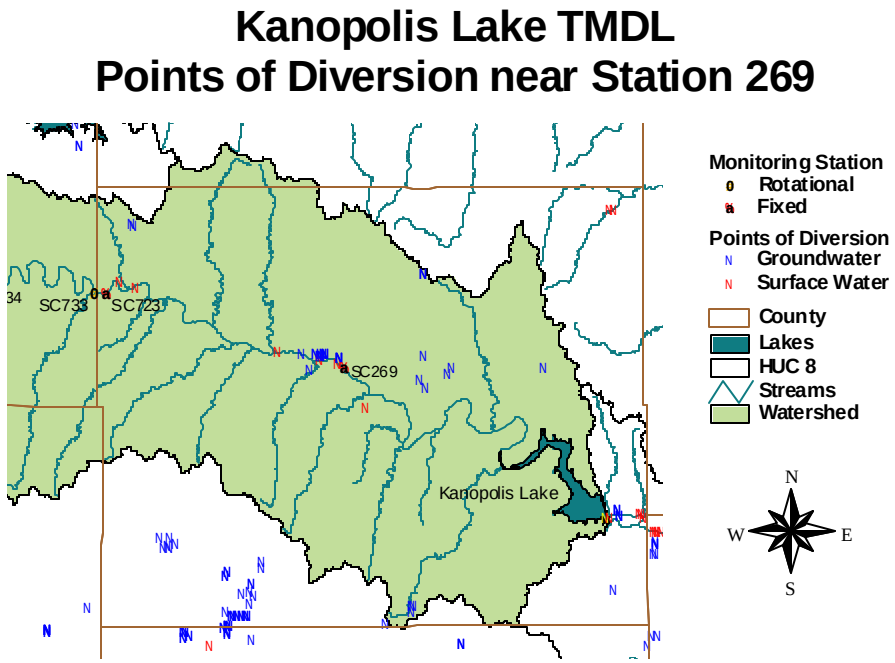
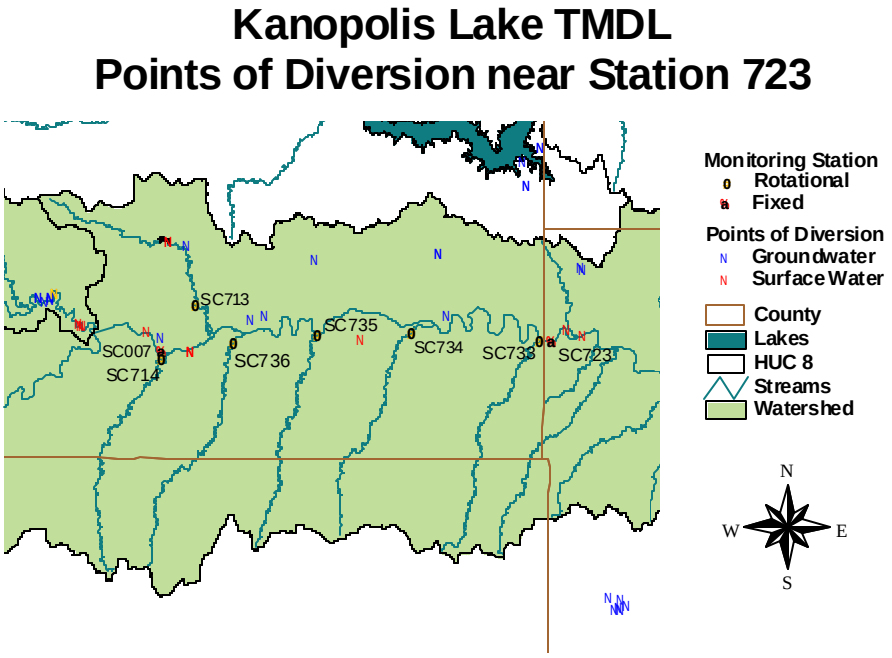
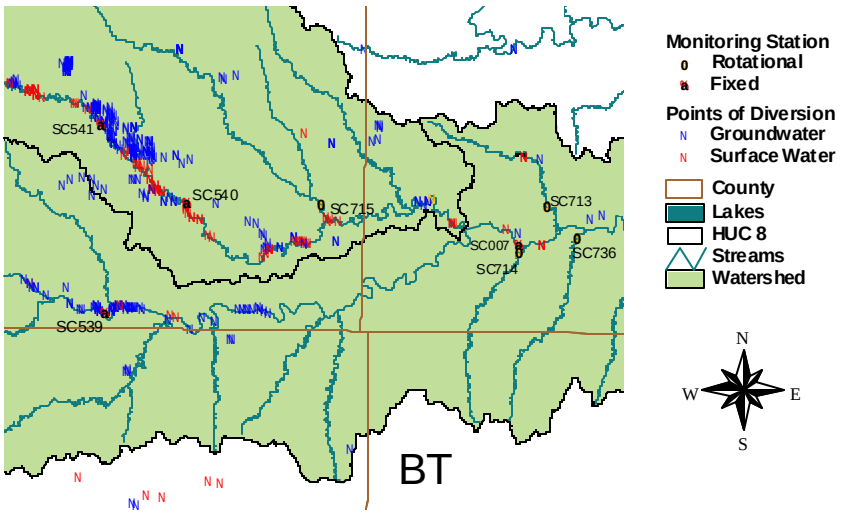


Figure 17



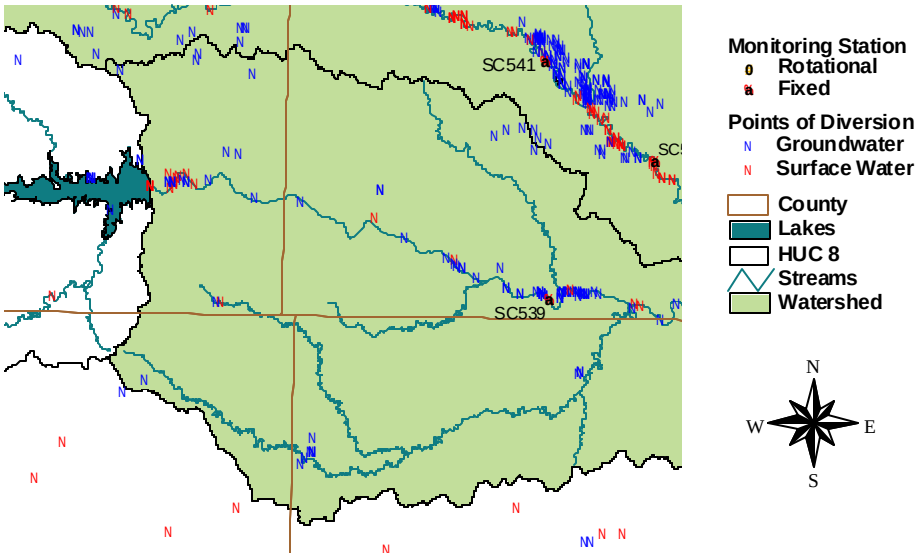
Kanopolis Lake TMDL
Points of Diversion near Station 007

Figure 18



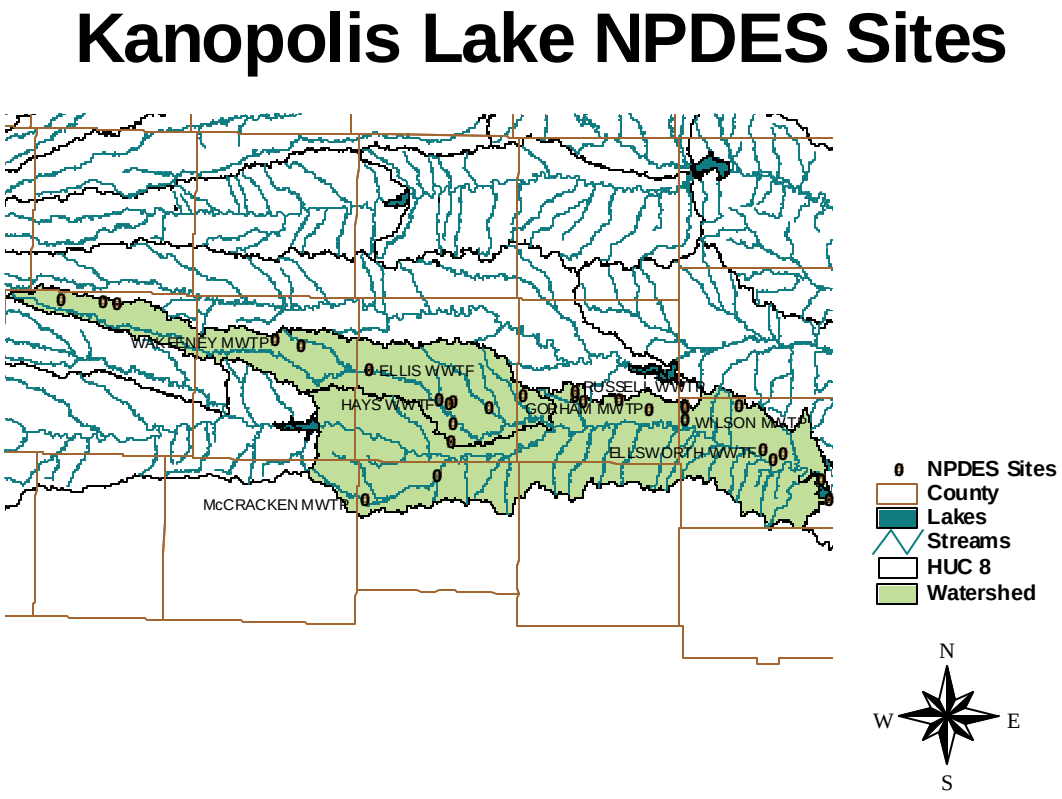
Kanopolis Lake TMDL
Points of Diversion near Station 539

Figure 19



NPDES: Twenty-six permitted waste treatment facilities are located within the watershed (Figure 20). Eighteen are non-overflowing lagoons that are prohibited from discharging and eight are discharging municipal waste treatment plants. The non-overflowing lagoons may contribute to the load under extreme precipitation events (flow durations exceeded under 5 percent of the time). Such events would not occur at a frequency or for a duration sufficient to cause an impairment in the watershed. Any anthropogenic sulfate sources or hydrologic modifications increasing the sulfate concentration would be minor in comparison with the sulfate coming from natural sources.

Figure 20



Non-overflowing Facilities in the Kanopolis Watershed

Kansas Permit Number	Facility Name	Type	SO_4 Wasteload Allocation
C-SA03-NO01	BEAR HOUSE CAFE & TRUCK STOP	2-cell Lagoon	0 lb/day
C-SA21-NO01	SERVICE OIL COMPANY-INTERSTATE HOUSE	2-cell Lagoon	0 lb/day
C-SA21-NO02	WATERING HOLE	1-cell Lagoon	0 lb/day
C-SH07-NO01	STUCKEY'S DAIRY QUEEN - ELLSWORTH	2-cell Lagoon	0 lb/day
I-SH16-NP04	ELLIS CO. HIGHWAY DEPT.	3-cell Containment Basin	0 lb/day
M-SH05-NO01	DORRANCE MWTP	2-cell Lagoon	0 lb/day
M-SH12-NO02	USD #292 GRAINFIELD-WHEATLAND SCHOOL	2-cell Lagoon	0 lb/day
M-SH12-NR02	KDOT. GOVE CO. REST AREA I-70	2-cell Lagoon	0 lb/day

M-SH14-NO01	GRINNELL MWTP	2-cell Lagoon	0 lb/day
M-SH19-NO01	KANOPOLIS MWTP	2-cell Lagoon	0 lb/day
M-SH19-NO02	KDWP - KANOPOLIS (EAST)	2-cell Lagoon	0 lb/day
M-SH19-NO03	KDWP - KANOPOLIS (SOUTH SHORE)	2-cell Lagoon	0 lb/day
M-SH20-NO01	LIEBENTHAL MWTP	4-cell Lagoon	0 lb/day
M-SH31-NR02	KDOT. RUSSELL CO. REST AREA	2-cell Lagoon	0 lb/day
M-SH37-NO01	VICTORIA MWTP	3-cell Lagoon	0 lb/day
M-SH38-NR02	KDOT. TREGO CO. REST AREA	2-cell Lagoon	0 lb/day
M-SH50-NO01	MUNJOR IMPROVEMENT DISTRICT	3-cell Lagoon	0 lb/day
M-SH34-NO01	SCHOENCHEN MWTP	3-cell Lagoon	0 lb/day

Since none of the municipal NPDES sites in the watershed are currently required to monitor for sulfate in their effluent, average sulfate concentrations for municipal sources were estimated based on the sulfate in their influent. For mechanical plants, a one to one ratio was used to estimate the sulfate in effluent from the cities in the watershed's finished water. A one and a half to one ratio was used to calculate the sulfate wasteload from lagoons.

Waste Treatment Plants in the Kanopolis Lake Watershed

Kansas Permit Number	Facility	Design Flow (MGD)	Type	SO_4 Wasteload Allocation
M-SH16-OO02	HAYS WWTF	2.80	Activated Sludge	2.34 tons/day
M-SH31-OO02	RUSSELL WWTP	1.40	4-cell Lagoon	*1.46 tons/day
M-SH07-OO01	ELLSWORTH WWTF	0.50	3-cell Lagoon	0.40 tons/day
M-SH38-OO01	WAKEENEY MWTP	0.43	Trickling Filter	0.18 tons/day
M-SH06-OO02	ELLIS WWTF	0.30	Activated Sludge, UV Disinfection	0.28 tons/day
M-SH40-OO01	WILSON MWTP	0.09	Trickling Filter, 3-cell Lagoon in construction	0.06 tons/day
M-SH10-OO01	GORHAM MWTP	0.06	3-cell Lagoon	0.06 tons/day
M-SH26-OO02	McCRACKEN MWTP	0.04	3-cell Lagoon	0.02 tons/day

*The Russell MWTP effluent is being held at the water quality standard, 250 mg/L.

Oil Field Brine: Oil-field brine in Kansas that was disposed at or near the surface in the past generally has a sulfate concentration that is relatively low in comparison with the high chloride content. Thus, oil-brine contamination in the drainage basin is not expected to be a significant source of sulfate in the lake water.

Contributing Runoff: The watershed's average soil permeability is 1.5 inches/hour according to NRCS STATSGO database. About 91.4% of the watershed produces runoff even under relatively low (1.5"/hr) potential runoff conditions. Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.5"/hr of rain will generate runoff from 4.9% of this watershed, chiefly along the stream channels.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

The source assessment has ascertained that natural sulfate loading within the watershed is overwhelmingly responsible for the excursions seen at the monitoring stations located within the Kanopolis Lake/Smoky Hill River watershed.

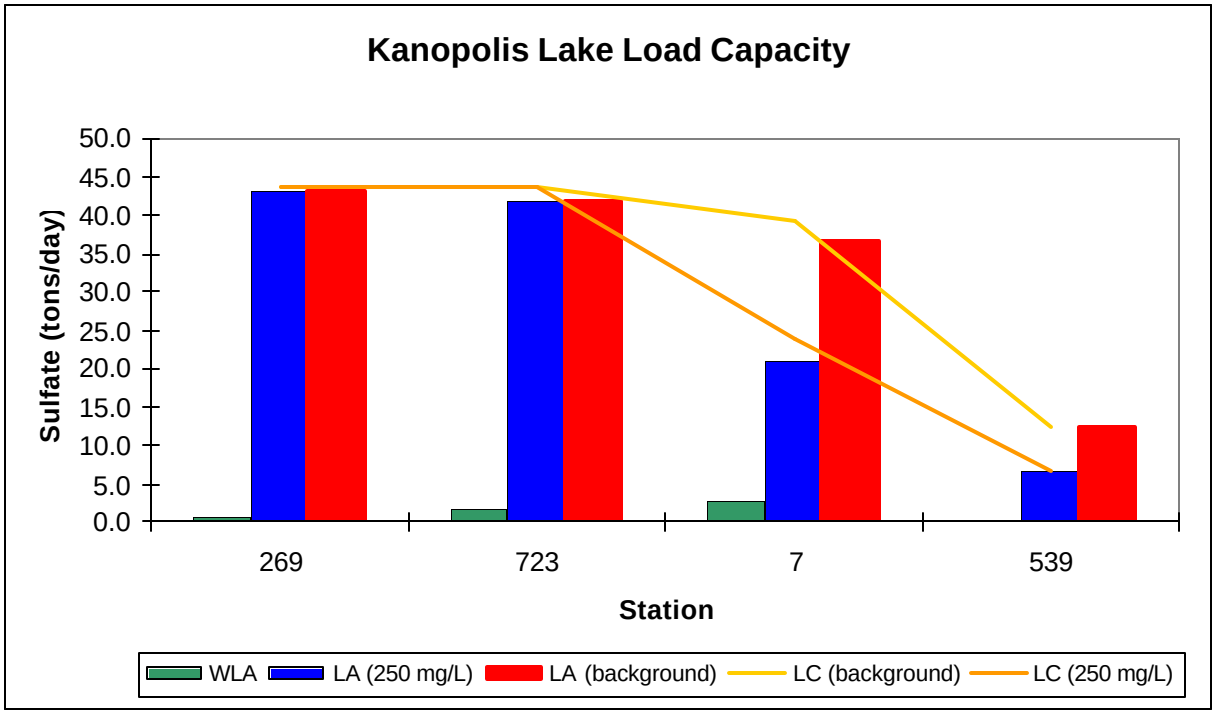
Point and Nonpoint Sources: The total wasteload allocation entering Kanopolis Lake is 4.6 tons per day. Appendix B details the calculations used to estimate the wasteload allocations.

Phase 1: TMDL (250 mg/L)				
Station	269	723	7	539
Load Capacity (tons/day)	43.5	43.5	23.9	6.7
Wasteload Allocation (tons/day)^	0.5	1.5	2.9	0.0*
Load Allocation (tons/day)	43.0	42.1	21.0	6.7
Phase 2: Background				
Station	269	723	7	539
Median Flow (cfs)	64.5	64.5	35.4	9.9
Background (mg/L)	Phase 1	Phase 1	411.0	464.0
Load Capacity (tons/day)			39.3	12.4
Wasteload Allocation (tons/day)			2.9	0.0*
Load Allocation (tons/day)			36.4	12.4

* Should future point sources be proposed in the subwatershed and discharge into the impaired segments, the current wasteload allocation will be revised by adjusting current load allocations to account for the presence and impact of these new point source dischargers.

^Wasteloads within reach between stations.

Figure 21



Defined Margin of Safety: The Margin of Safety provides some hedge against the uncertainty of loading and the sulfate endpoints for the Kanopolis Lake Watershed. Since there are no sulfate adding processes present in the municipalities discharging to the Smoky Hill River, the sulfate loads added by those facilities reflect the sulfate content of their source water. The Russell MWTP waste load allocation is being held at 250 mg/L. In the case of lagoons, there is the probability of concentration by evaporation, therefore, a effluent to influent ratio of 1.5:1 was used. The resulting loads reflect concentrations which will not alter the background levels established at the four stream stations above Kanopolis Lake. Furthermore, the lack of surface water diversion works along the river above Kanopolis Lake limit the applicability of the domestic water supply criterion.

Irrigation in the Kanopolis Watershed is a minuscule factor. The sulfate concentrations in the lower reaches of the Smoky Hill River and Kanopolis Lake are being held at 250 mg/L, despite high flow high sulfate contributions from upper watershed. The Margin of Safety implicitly assures these Load Allocations will achieve the endpoints of the TMDL through policies and objectives established under the Kansas Water Plan. Two objectives under the State Water Plan call for, by 2010; 1) reduction of water level decline rates within the Ogallala aquifer and implementation of enhanced water management in targeted areas; and, 2) reduction in the number of irrigation points of diversion for which the amount of water applied in acre-feet per acre exceeds an amount considered reasonable for the area and those [irrigation points of diversion] that overpump the amount authorized by their water rights. Pursuit of these two water conservation objectives will have water quality benefits, including assuring excessive irrigation will not directly or indirectly load surface waters with residual salts, thereby causing endpoints to be non-attained.

State Water Plan Implementation Priority: Because the sulfate impairment in Kanopolis Lake is primarily due to natural geologic sources, this TMDL will be a Low Priority for implementation.
Unified Watershed Assessment Priority Ranking: Kanopolis Lake watershed lies within the Middle Smoky Hill (HUC 8: 10260006) with a priority ranking of 51 (Low Priority for restoration) and the Big (HUC 8: 10260007) with a priority ranking of 56 (Low 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 sulfate loading to the lake and river.
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 2004 with annual sulfate monitoring and any excessive sulfate discharge will have appropriate

permit limits which does not increase the ambient background levels of sulfate.

Non-Point Source Pollution Technical Assistance - KDHE

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

Water Quality Standards and Assessment - KDHE

a. Establish background levels of sulfate for the river and tributaries.

Time Frame for Implementation: Development of a background level-based water quality standard should be accomplished with the 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 Kanopolis Lake should indicate evidence of no increase in sulfate levels in the conservation pool elevations relative to the conditions seen in 1997 and 2000. Should the case of impairment remain, 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.

6. MONITORING

KDHE will continue to collect bimonthly samples from permanent stations 269, 723, 007, and 539. Further sampling and evaluation of Kanopolis Lake should occur once before 2008. Based on that sampling, the priority status will be evaluated in 2008 including application of numeric criterion based on background concentrations. Should impaired status remain, the desired endpoints under this TMDL will be refined and direct more intensive sampling will need to be conducted under specified seasonal flow conditions over the period 2008-2012.

Annual monitoring of sulfate levels in effluent will be a condition of NPDES and state permits for facilities. This monitoring will continually assess the contributions of sulfate in the wastewater effluent released to the streams upstream of Kanopolis Lake.

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 and current condition of Kanopolis Lake. Subsequent decisions will be

made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The lake 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 2004 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.

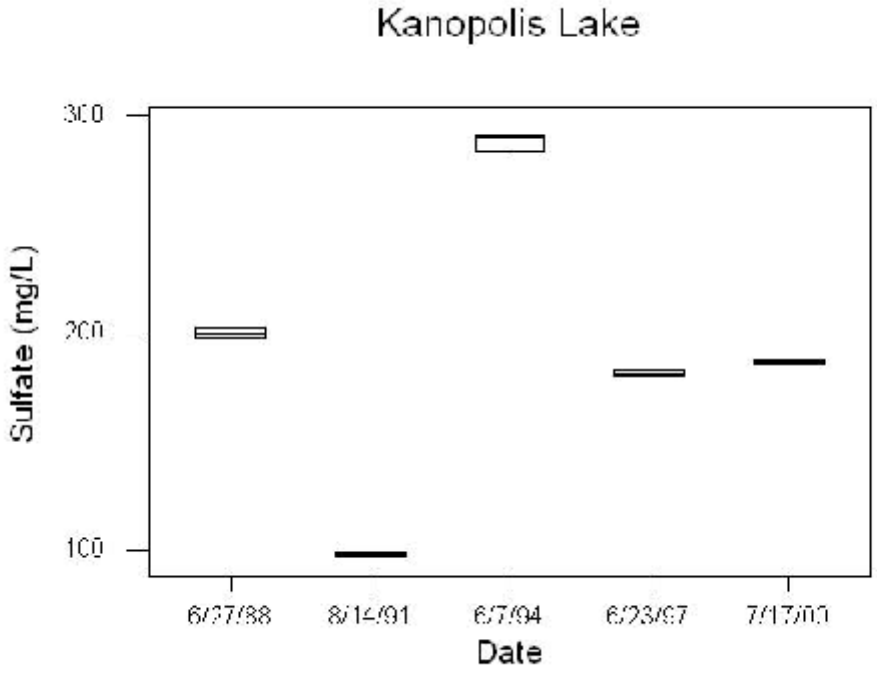
Bibliography

Liscek, Bonnie C. Methodology Used in Kansas Lake TMDLs [web page] Jul. 2001; http://www.kdhe.state.ks.us/tmdl/eutro.htm [Accessed 30 Sep 2002].

Mankin, Kyle. Smoky Hill River Watershed Assessment Project. 2003.

Whittemore, D. (2 Jun 2003). Salt source assessment and analysis for the sulfate TMDL for Kanopolis Lake.

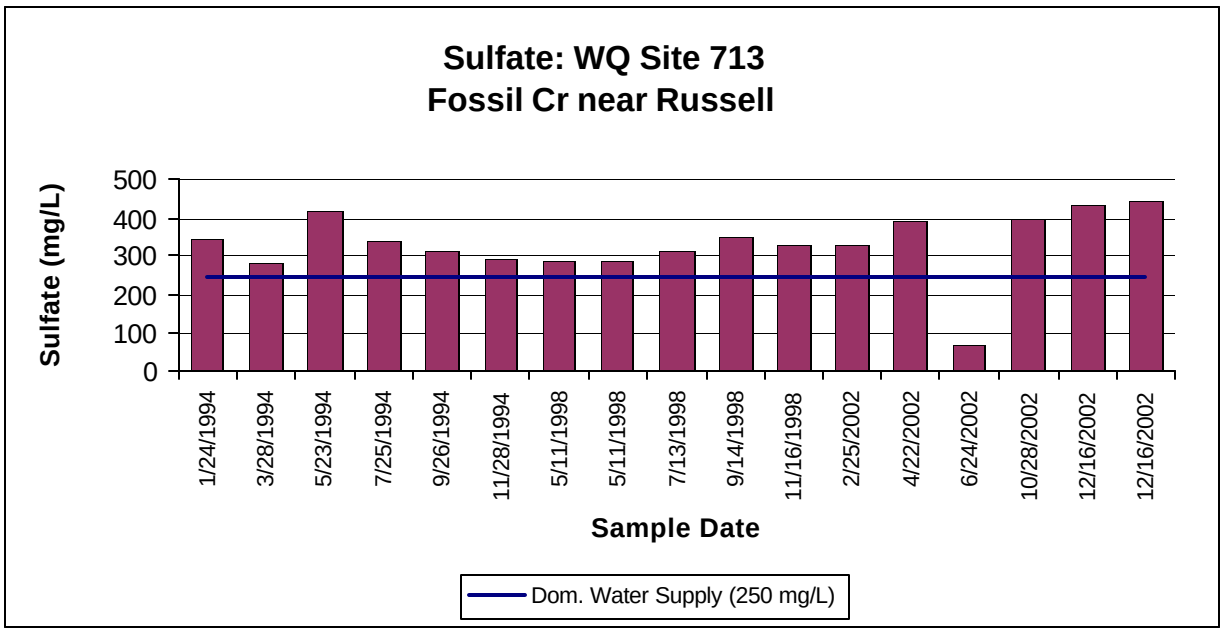
Appendix A - Boxplot

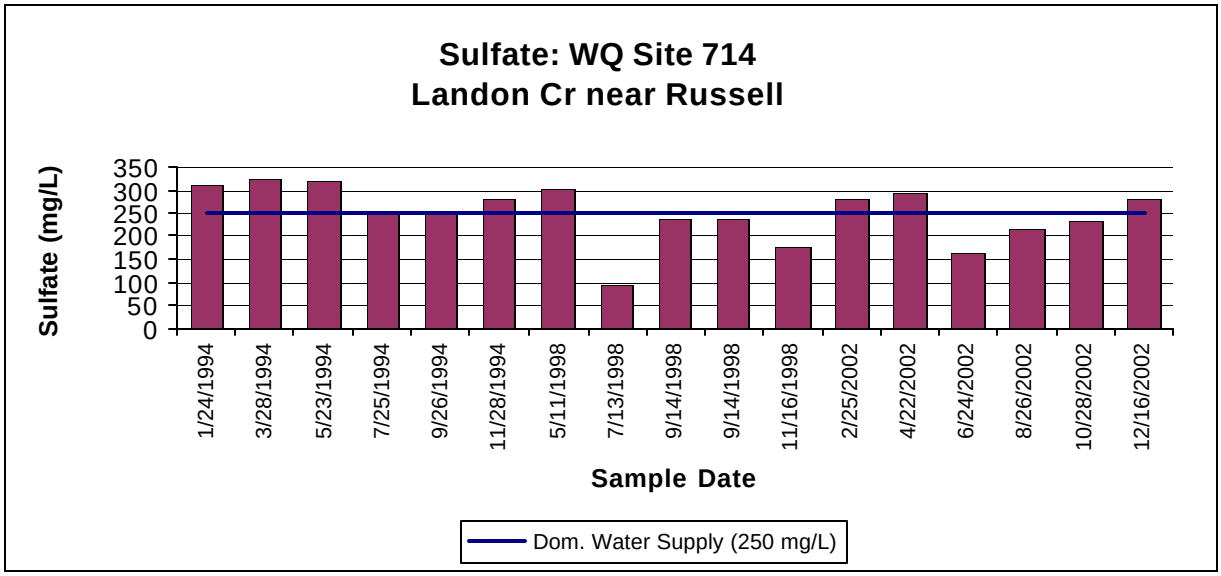


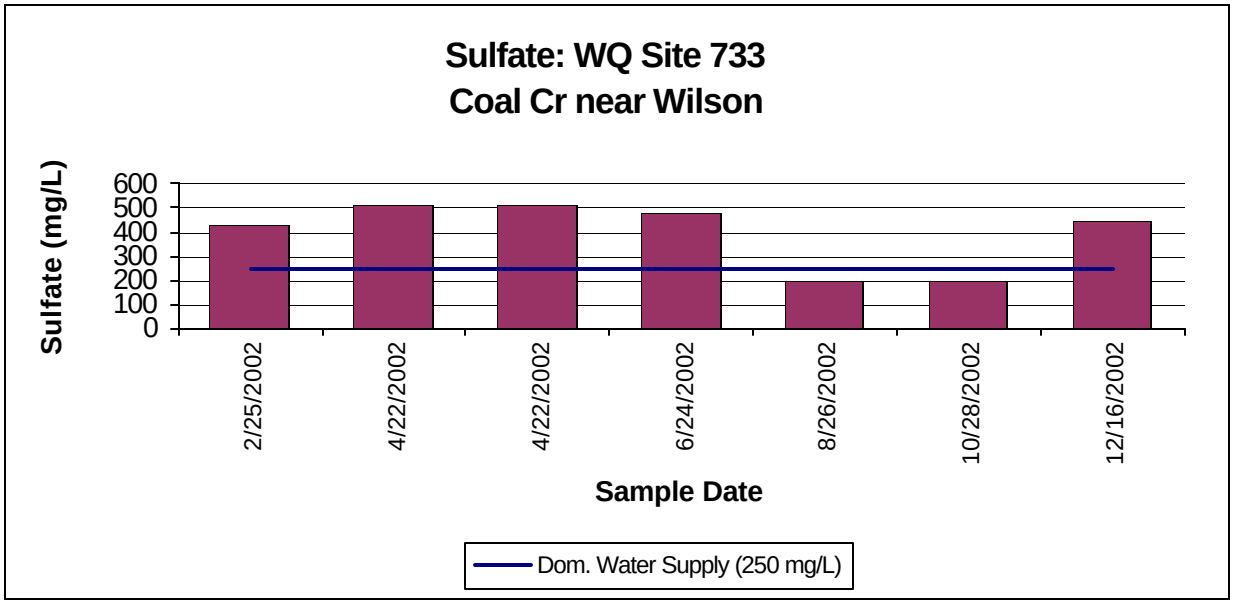
Appendix B - Wasteload Allocations Calculations

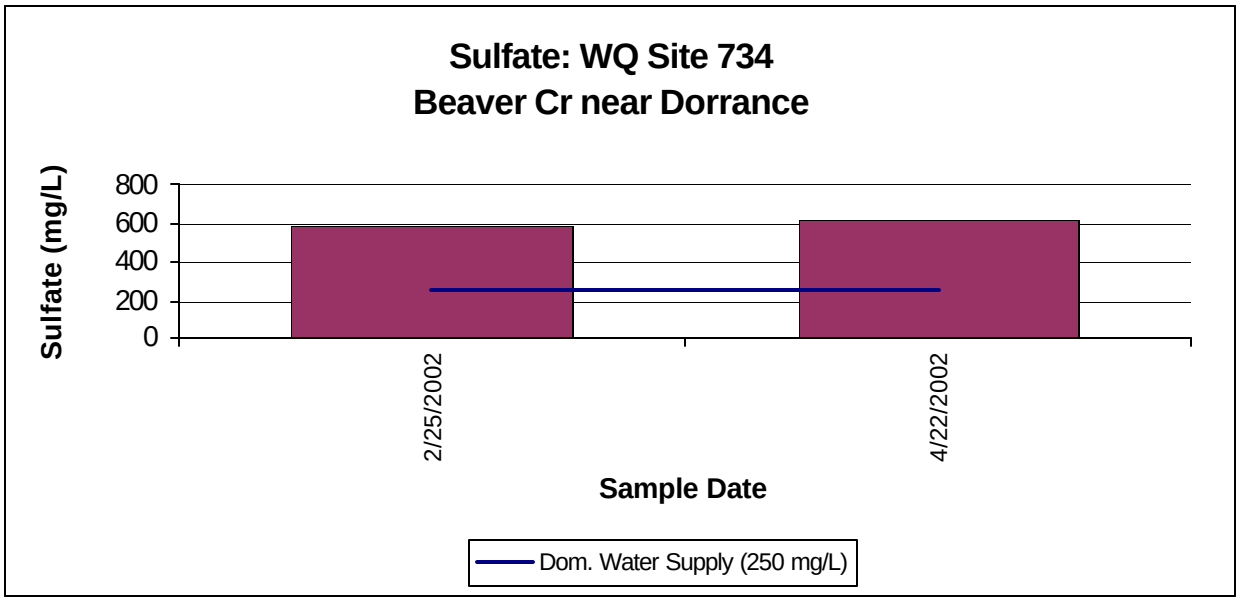
Permit Number	Facility	Public Water Supply Used to Calculate Effluent	Design Flow (MGD)	Type	Sulfate in Influent (mg/L)	Sulfate in Effluent (mg/L)	Sulfate Load (lb/day)	Sulfate Load (tons/day)
Upstream of Station 007								
M-SH10-OO01	GORHAM MWTP	Ellsworth Co. RWD #1	0.06	3-cell Lagoon	147.4	221.1	115.6	0.06
M-SH26-OO02	McCRACKEN MWTP	City of McCracken	0.04	3-cell Lagoon	69.0	103.6	30.3	0.02
M-SH16-OO02	HAYS WWTF	City of Hays	2.80	Trickling Filters	200.2	200.2	4679.7	2.34
M-SH38-OO01	WAKEENEY MWTP	City of Wakeeney	0.43	Trickling Filter	28.5	100.0	359.9	0.18
M-SH06-OO02	ELLIS WWTF	City of Ellis	0.30	Activated Sludge, UV Disinfection	224.8	224.8	563.2	0.28
							Subtotal	**2.87**
Between Stations 007 and 723								
M-SH31-OO02	RUSSELL WWTP	City of Russell	1.40	4-cell Lagoon	192.9	250.0	2922.5	1.46
							Subtotal	**1.46**
Between Stations 723 and 269								
M-SH07-OO01	ELLSWORTH WWTF	City of Ellsworth	0.50	disinfection, 3 cell Lagoon	127.2	190.7	796.3	0.40
M-SH40-OO01	WILSON MWTP	City of Wilson	0.15	Trickling Filter, Lagoon in construction	12.3	100.0	125.3	0.06
							Subtotal	**0.46**
		Total	5.68	MGD				
							Total	4.80

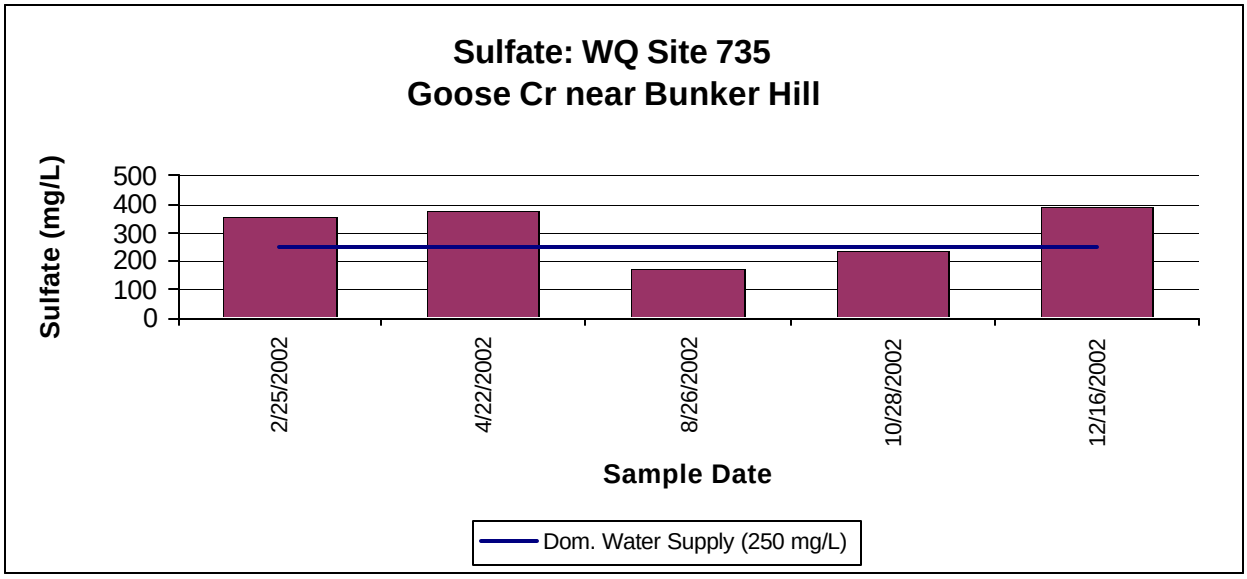
Appendix C - Concentration Graphs for Tributaries

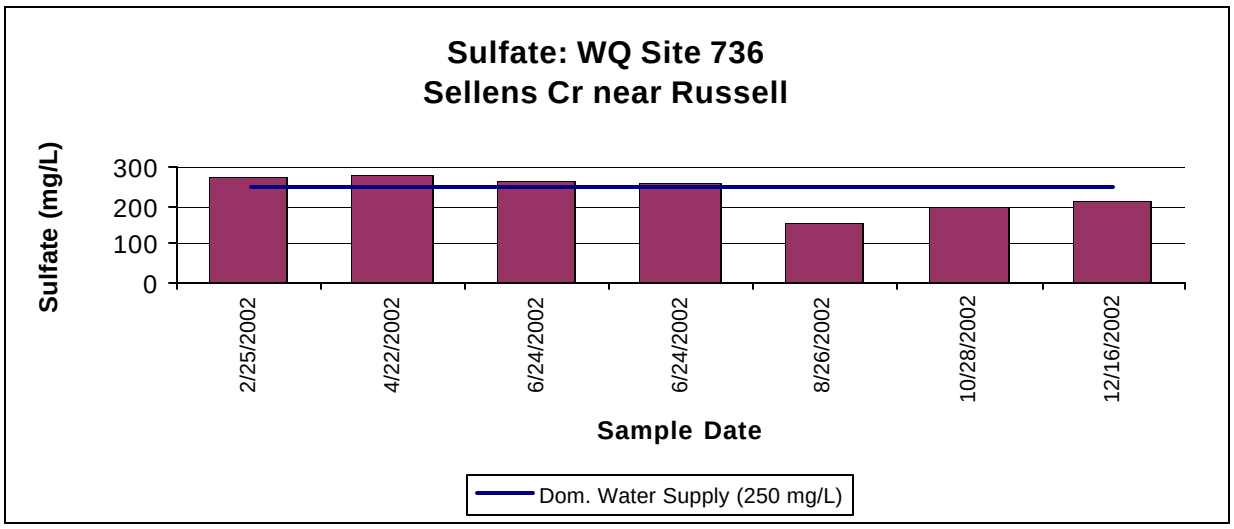




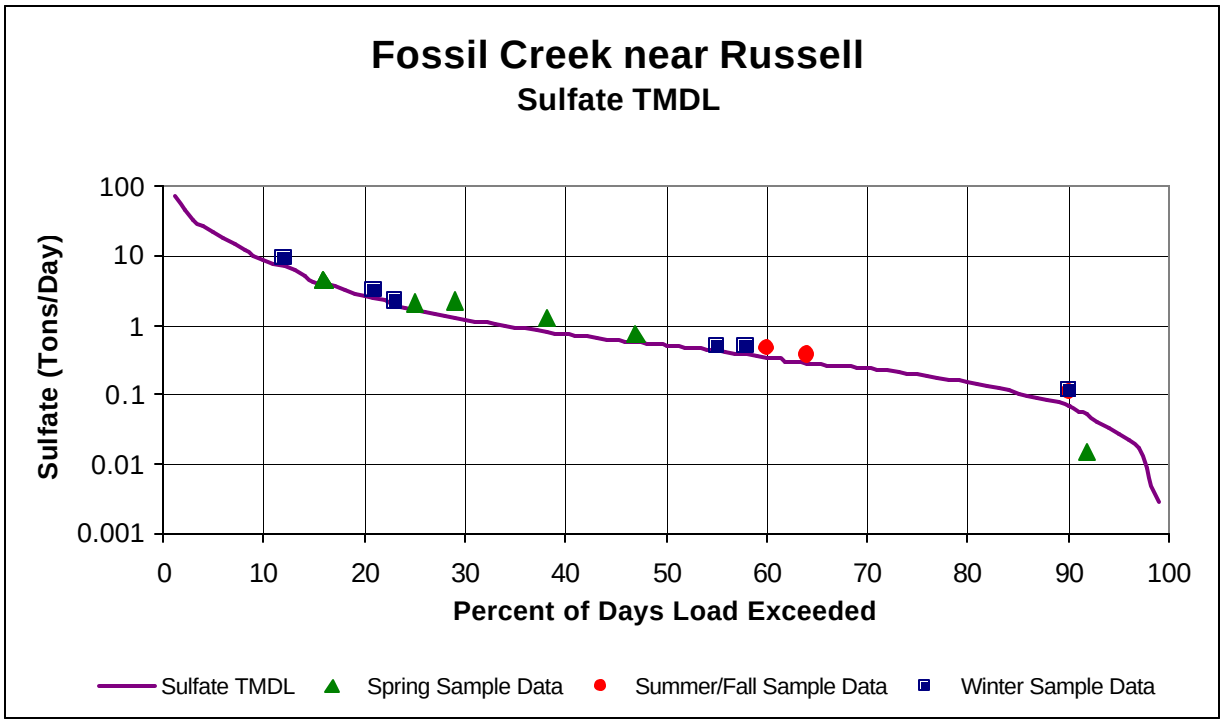

Sulfate: WQ Site 733
Coal Cr near Wilson
Sulfate (mg/L)
600
500
400
300
200
100
0
2/25/2002
4/22/2002
4/22/2002
6/24/2002
8/26/2002
10/28/2002
12/16/2002
Sample Date
Dom. Water Supply (250 mg/L)


Sulfate: WQ Site 734
Beaver Cr near Dorrance
Sulfate (mg/L)
800
600
400
200
0
2/25/2002
4/22/2002
Sample Date
Dom. Water Supply (250 mg/L)

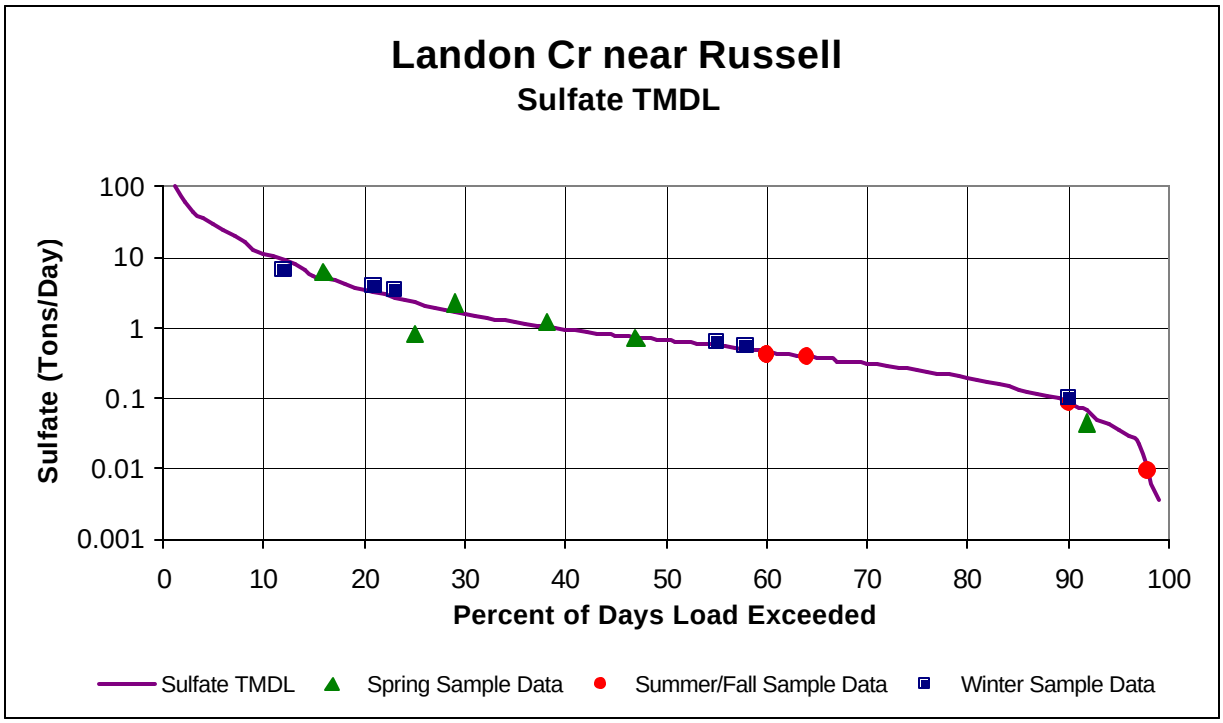

Sulfate: WQ Site 735
Goose Cr near Bunker Hill
Sulfate (mg/L)
500
400
300
200
100
0
2/25/2002
4/22/2002
8/26/2002
10/28/2002
12/16/2002
Sample Date
Dom. Water Supply (250 mg/L)


Sulfate: WQ Site 736
Sellens Cr near Russell
Sulfate (mg/L)
300
200
100
0
2/25/2002
4/22/2002
6/24/2002
6/24/2002
8/26/2002
10/28/2002
12/16/2002
Sample Date
Dom. Water Supply (250 mg/L)

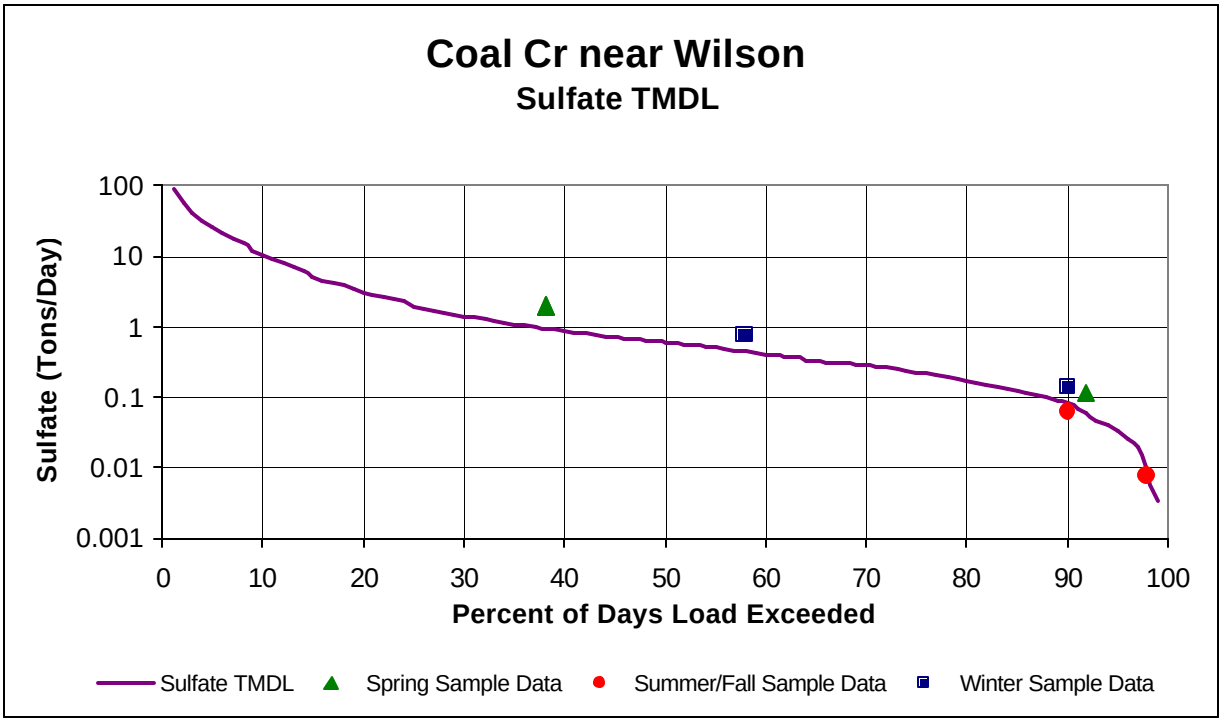
Appendix D - Load Duration Curves for Tributaries
Station 713



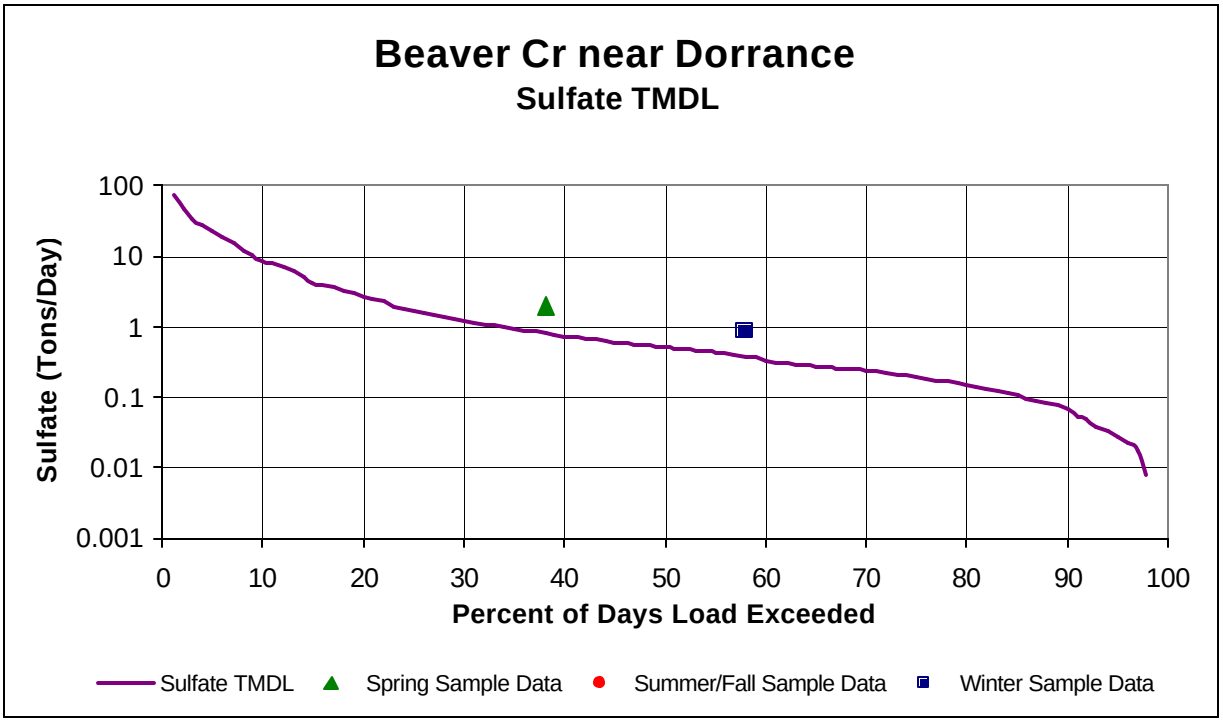
Station 714



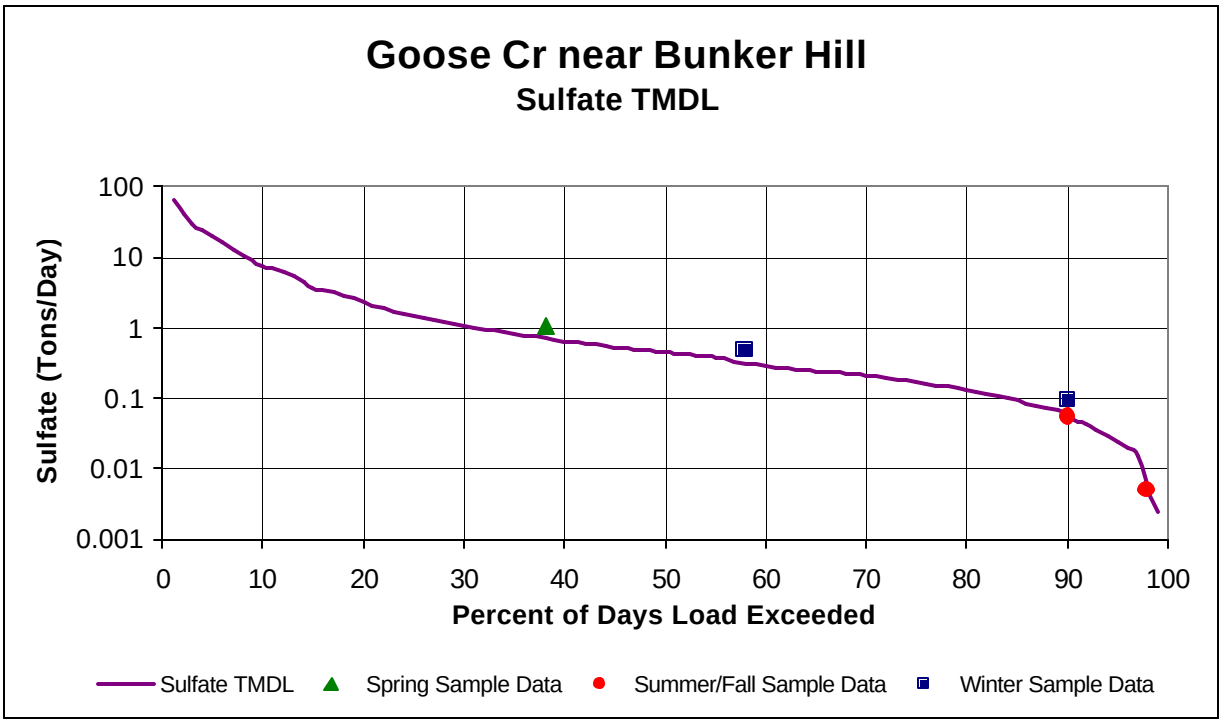
Station 733



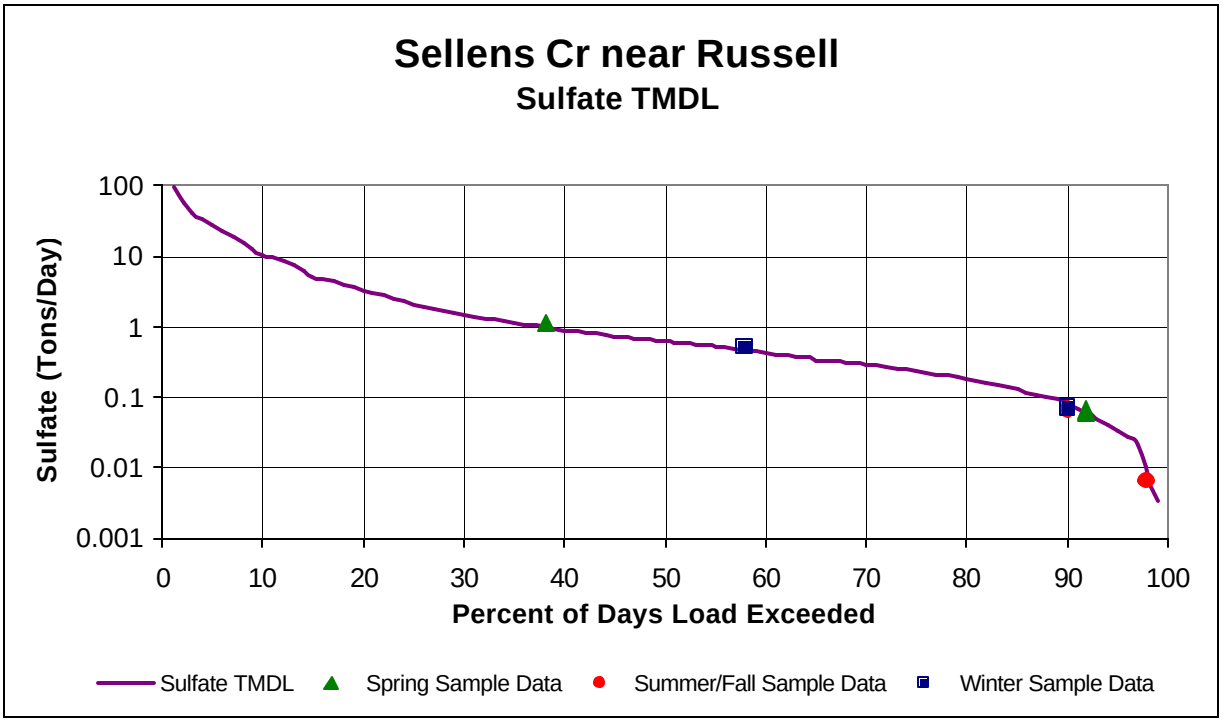
Station 734



Station 735



Station 736



Approved March 3, 2004