SMOKY HILL/SALINE RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body/Assessment Unit: Cedar Bluff Lake
and Smoky Hill River (Elkader, Gove, and Trego)
Water Quality Impairment: Sulfate

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Smoky Hill Headwaters, North Fork Smoky Hill, Upper Smoky Hill**,** Ladder, and Hackberry

Counties: Gove, Greeley, Lane, Logan, Ness, Scott, Sherman, Thomas, Trego, Wallace, and Wichita

HUC 8:	10260001	**HUC 11** (14)**:**	**010** (090, 100, 110) (Figure 1) **020** (010, 020, 030) **030** (010, 020, 030, 040) **040** (010, 020, 030, 040, 050, 060)
	10260002		**010** (060, 070, 080, 090, 100, 110, 120) **030** (010, 020, 030, 040, 050, 060)
	10260003		**010** (010, 020, 030, 040, 050, 060) **020** (010, 020, 030, 040, 050, 060, 070, 080, 090) **030** (010, 020, 030) **040** (010, 020, 030, 040, 050, 060, 070, 080) **050** (010, 020, 030, 040, 050, 060, 070, 080)
	10260004		**010** (040, 050, 060, 070, 080) **020** (030, 040, 050, 060, 070, 080, 090) **030** (010, 020, 030, 040) **040** (010, 020, 030, 040) **050** (010, 020, 030, 040, 050, 060, 070, 080, 090)
	10260005		**010** (010, 020, 030, 040, 050, 060) **020** (010, 020, 030, 040, 050, 060, 070)

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

Drainage Area: Approximately 4,305 square miles.

Cedar Bluff Lake

Conservation Pool: Area = 6,618 acres
Watershed Area: Lake Surface Area = 416:1
Maximum Depth = 19.0 meters (62.3 feet)
Mean Depth = 7.8 meters (25.6 feet)
Retention Time = 1.36 years (16.3 months)

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

Authority: Federal (U.S. Bureau of Reclamation) and State (Kansas Dept. of Wildlife and Parks)

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

Smoky Hill River

Main Stem Segment: WQLS: 1, 3, 4, 6, 8, 10, 21-part, 22, 24 (Smoky Hill River (Elkader)), 9, 10, 12, 13, 14, 16, 17-part (Smoky Hill River (Trego)), and 17-part, 19, 20, 21-part (Smoky Hill River (Gove)) starting at Cedar Bluff Lake and traveling upstream to the Colorado border.

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

HUC 10260003

Smoky Hill R (Trego) Station 550

Smoky Hill R (9)	Sand Cr (29)	E. Branch Sand Cr (40)	
Smoky Hill R (10)	Downer Cr (11)	E. Br. Downer Cr (39)	
Smoky Hill R (12)	**10260005** Hackberry Cr (1)	Spring Cr (2)	
	Hackberry Cr (3)	W. Spring Cr (8)	
		S. Branch Hackberry Cr (7)	
		M. Branch Hackberry Cr (4)	N. Br. Hackberry Cr (5)
		M. Branch Hackberry Cr (5)	
Smoky Hill R (13)	Gibson Cr (34)		
	Wild Horse Cr (28)		
Smoky Hill R (14)	Big Windy Cr (38)		
	Sand Cr (37)		
	Indian Cr (15)		
Smoky Hill R (16)	Unnamed Stream (27)		
Smoky Hill R (17-part)			

HUC 10260003

Smoky Hill R (Gove) Station 739

Smoky Hill R (17-part)	Plum Cr (18)

Smoky Hill R (19)	Cheyenne Cr (36)		
	Salt Cr (26)	E. Salt Cr (35)	
Smoky Hill R (20)	Hell Cr (25)		
Smoky Hill R (21 - part)			
HUC 10260003			
Smoky Hill (Elkader) Station 224			
Smoky Hill R (21 - part)	**10260004** Ladder Cr (1)	Twin Butte (2)	
	Ladder Cr (3)	Chalk Cr (4)	
	Ladder Cr (5)	Unnamed Stream (6)	
	Ladder Cr (7)	Middle S.F. Ladder Cr (15)	
	Ladder Cr (8)	S. Ladder Cr (12)	Middle Ladder Cr (13)
			Middle N. Fk. Ladder Cr (17)
			Middle Ladder Cr (14)
	Ladder Cr (9)	Unnamed Stream (10)	
	Ladder Cr (11)		
Smoky Hill R (22)	Sixmile Cr (23)		
Smoky Hill R (24)	West Spring Cr (33)		
	10260002 N. Fk. Smoky Hill R (1)	Sand Cr (2)	
	N. Fk. Smoky Hill R. (3)	Sandy Cr (4)	
	N. Fk. Smoky Hill R. (5)	Turtle Cr (15)	
	N. Fk. Smoky Hill R. (6)		
10260001 Smoky Hill R (1)	Lake Cr (2)	S. Fk. Lake Cr (18)	
Smoky Hill R (3)	Depperschmidt Draw (309)		
	Capper Draw (311)		
	Coon Cr (20)		
	Pond Cr (21)		
	Rose Cr (19)		
	Eagletail Cr (17)		
Smoky Hill R (4)	Goose Cr (5)		
Smoky Hill R (6)			
Smoky Hill R (8)	Unnamed Stream (9)		
Smoky Hill R (10)			

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

Special Aquatic Life Support on segments 1, 3 Smoky Hill River (Elkader)
Expected Aquatic Life Support on remaining Main Stem Segments

2002 303(d) Listing: Cedar Bluff Lake Basin Streams

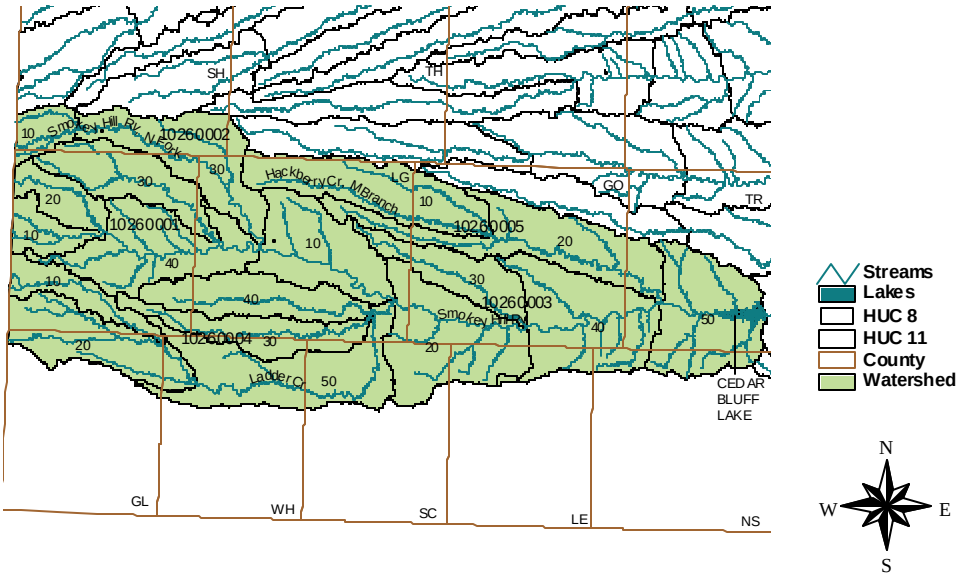
Impaired Use: Attainable Domestic Water Supply

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

Cedar Bluff Lake HUC 8 and HUC 11



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

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

Lake Monitoring Site: Station 013001 in Cedar Bluff Lake (Figure 2).

Period of Record Used: Five surveys during 1988 - 2000
Elevation Record: Cedar Bluff Reservoir near Ellis, KS (USGS Gage 06861500)

Stream Chemistry Monitoring Site:

Station 224 near Elkader (Smoky Hill River)

Period of Record Used: 1987 - 2003
Flow Record: Smoky Hill River at Elkader, KS (USGS Gage 06860000)
Long Term Flow Conditions: Median Flow = 0.5 cfs

Station 550 near Trego (Smoky Hill River)

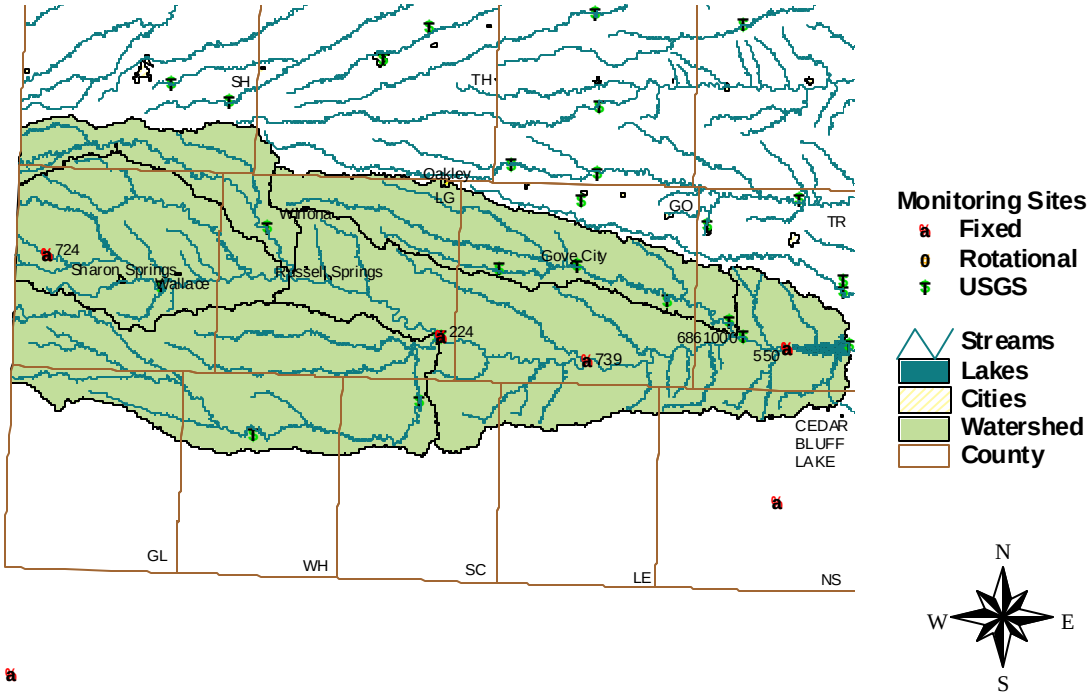
Period of Record Used: 1990 - 2003
Flow Record: Smoky Hill River near Arnold, KS (USGS Gage 06861000)
Long Term Flow Conditions: Median Flow = 1.1 cfs

Station 739 near Gove (Smoky Hill River)

Period of Record Used: 2002 - 2003
Flow Record: Smoky Hill River near Arnold, KS (USGS Gage 06861000)
Long Term Flow Conditions: Median Flow = 1.1 cfs

Figure 2

Cedar Bluff Lake TMDL Reference Map



Current Condition: In 1991, the water level in Cedar Bluff Lake was down 49 feet. The sulfate was concentrated and averaged 1,435 mg/L (Appendix A). The flood of 1993 replenished the lake (Appendix B). Since that time, the water quality has significantly improved averaging 452 mg/L of sulfate.

Average Sulfate Concentration in Cedar Bluff Lake

Date	Sulfate (mg/L)	Reservoir Forebay Elevation (ft)*
6/28/88	760.0	2,104.3
7/31/91	1,435.0	2,095.0
6/6/94	452.8	2,122.2
6/24/97	418.5	2,140.6
7/18/00	483.3	2,144.5

*Normal Pool Elevation = 2,144.0 ft

Under normal flow conditions, the concentrations of sulfate in Cedar Bluff Lake are similar to the concentrations in the Smoky Hill River at Elkader and Trego during the six months prior to the lake sampling date (Figures 3, 4, 5, & 6). With lower flow conditions, such as seen in 1991, the sulfate concentrates in the lake due to evaporation, the lack of precipitation, and the decrease of discharge of fresh groundwater.

Figure 3

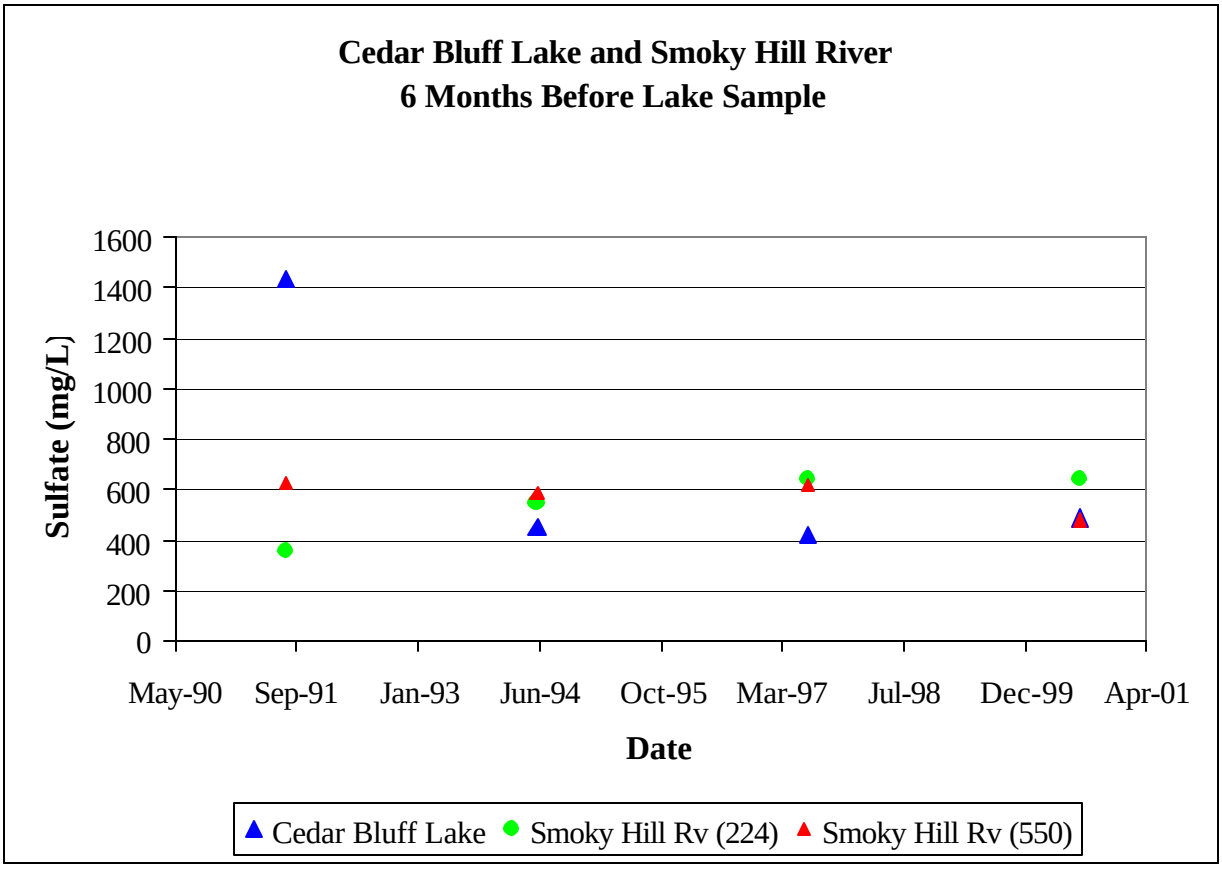


Figure 4

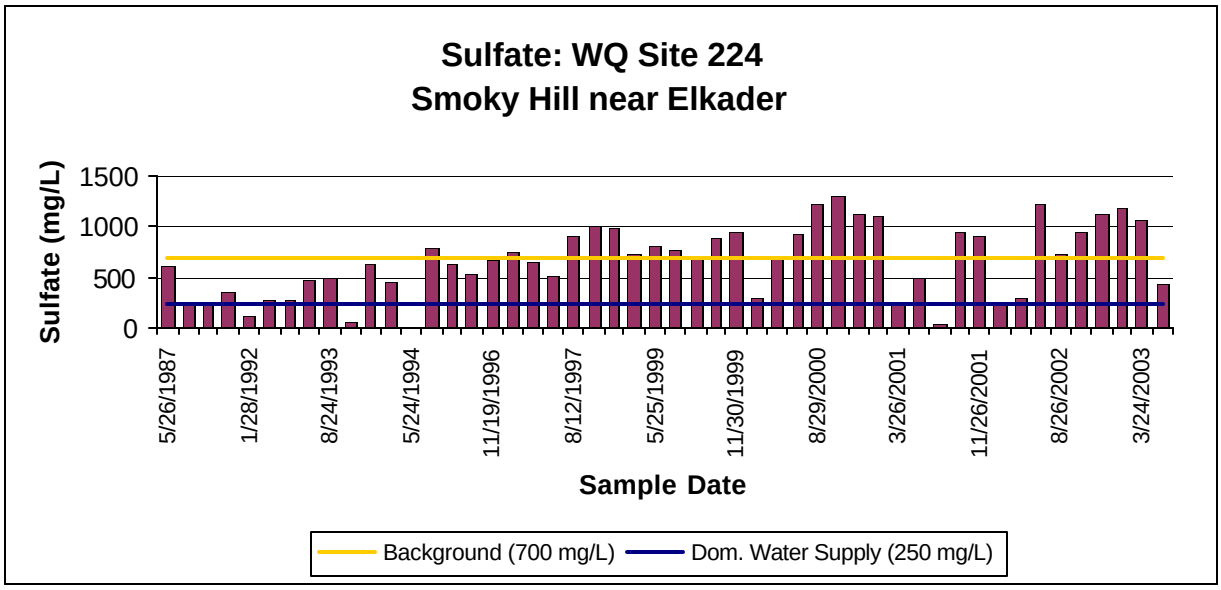
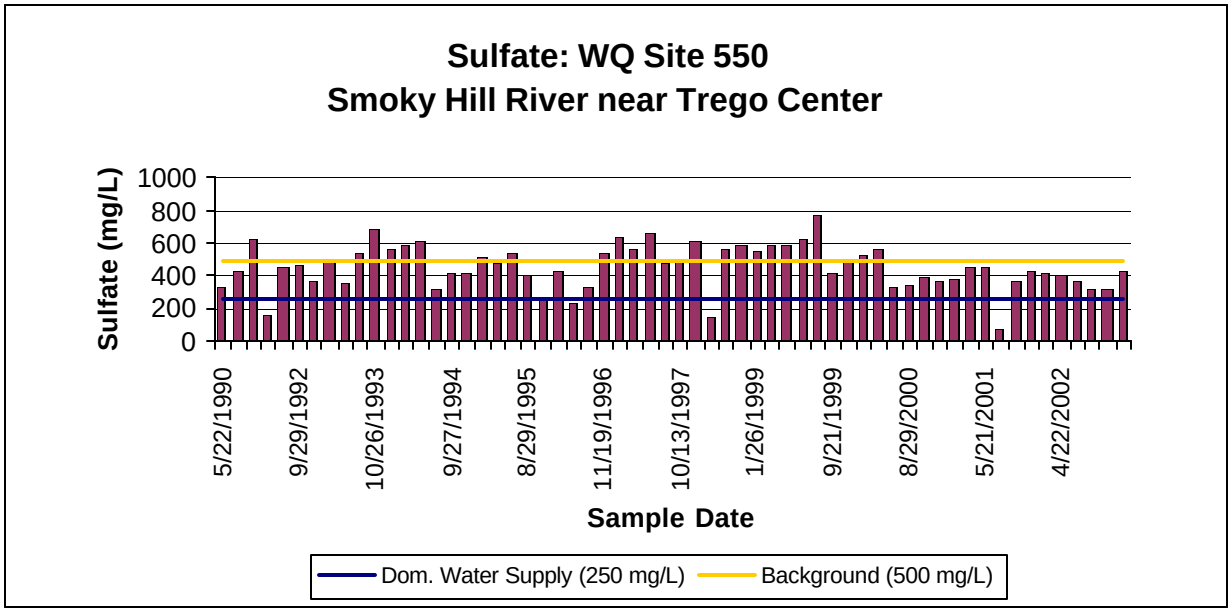
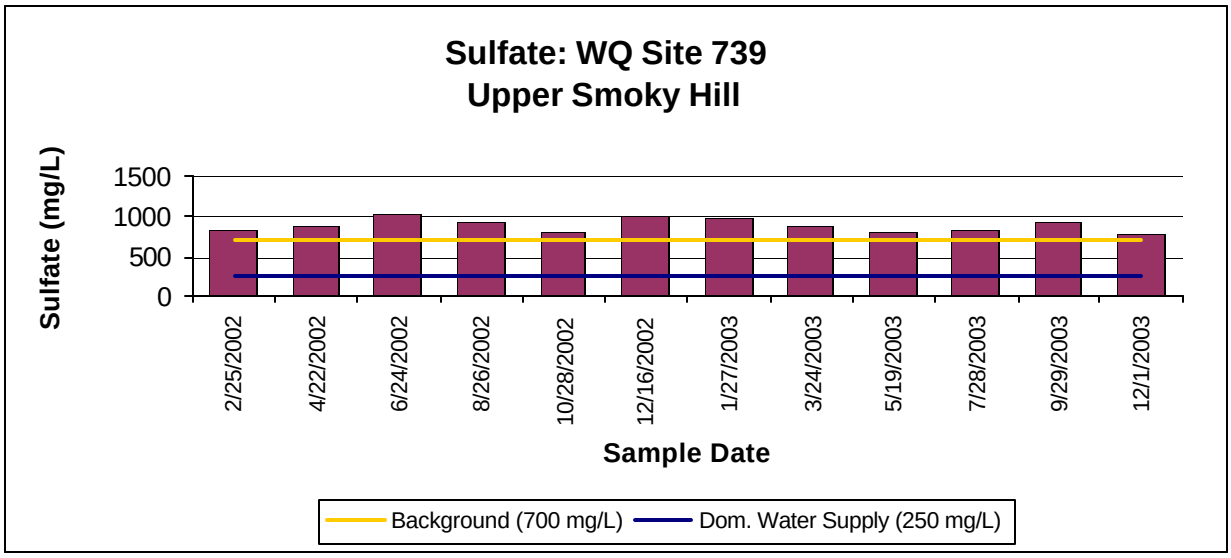


Figure 5



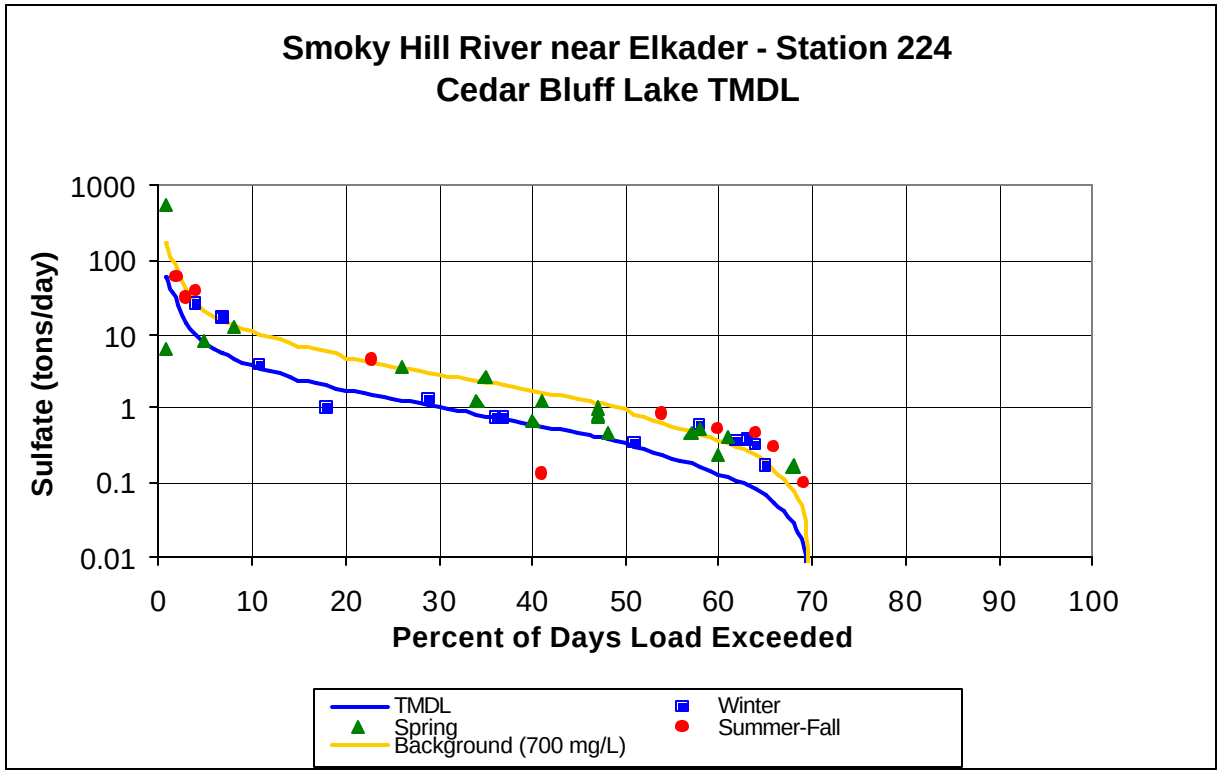
Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. Sample data for the sampling sites were categorized for each of the three defined seasons: Spring (Apr-Jul), 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. Load curves were established for the Domestic Water Supply criterion by multiplying the

Figure 6



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. 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 curves. Water quality standards are met for those points plotting below the load duration curves (Figures 7, 8, & 9).

Figure 7

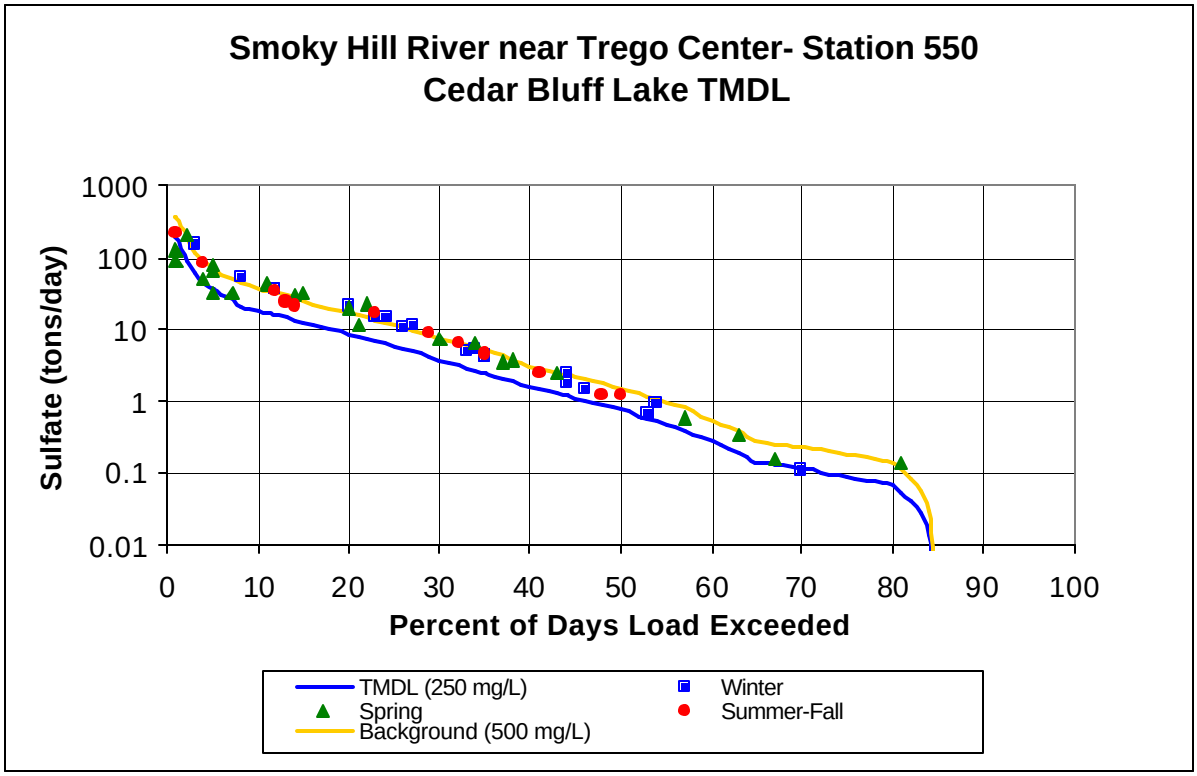


Station 224: Excursions were seen in each of the three defined seasons and are outlined below. Ninety-five percent of Spring samples and 90% of Summer-Fall samples were over the domestic supply criterion. Eighty-six percent of Winter samples were over the criterion. Overall, 91% of the samples were over 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.
Station 224 near Elkader (Smoky Hill River)	Spring	3	0	9	6	0	0	18/19 = 95%
	Summer	3	1	0	5	0	0	9/10 = 90%
	Winter	2	1	2	7	0	0	12/14 = 86%

Figure 8

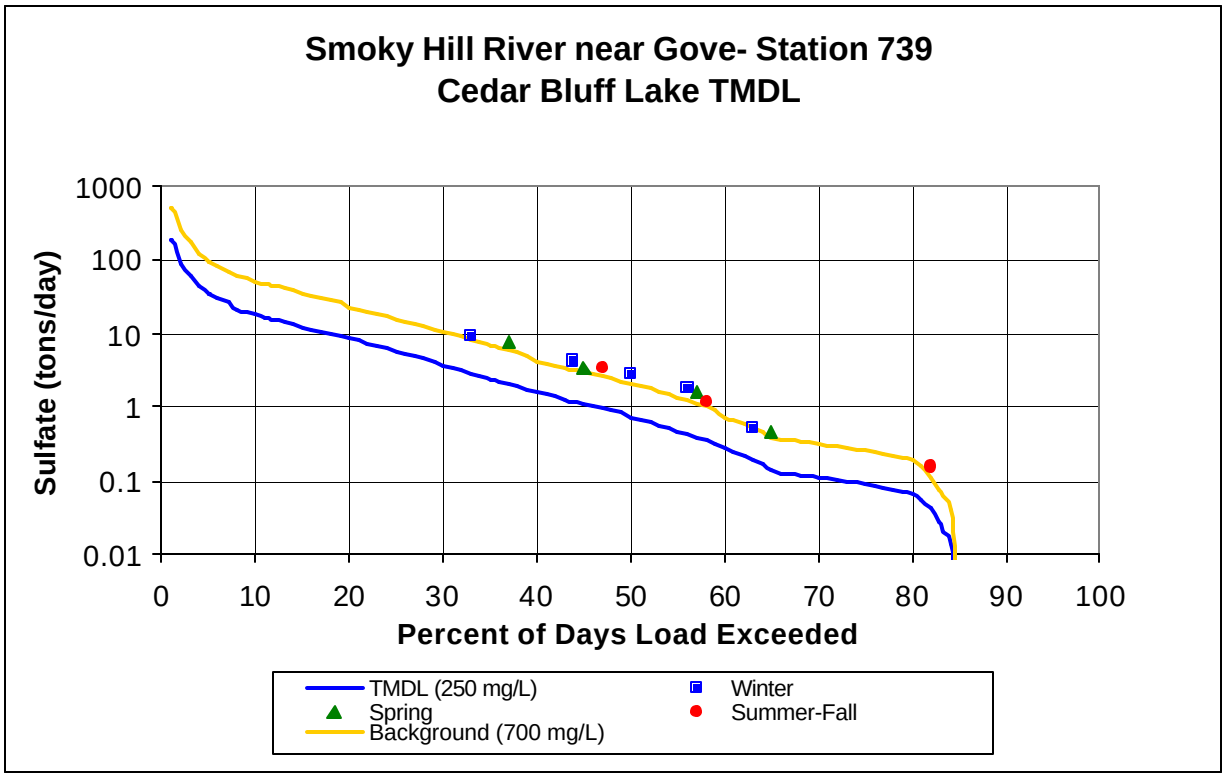


Station 550: Excursions were seen in each of the three defined seasons and are outlined below. Eighty-eight percent of Spring samples and 100% of Summer-Fall samples were over the domestic supply criterion. Ninety-four percent of Winter samples were over the criterion. Overall, 93% of the samples were 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.
Station 550 near Trego (Smoky Hill River)	Spring	5	7	5	3	1	0	21/24 = 88%
	Summer	2	4	5	1	1	0	13/13 = 100%
	Winter	2	4	8	2	0	0	16/17 = 94%

Figure 9



Station 739: Excursions were seen in each of the three defined seasons and are outlined below. One hundred percent of Spring samples and 100% of Summer-Fall samples were over the domestic supply criterion. One hundred percent of Winter samples were over the criterion. Overall, 100% 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.
Station 739 near Gove (Smoky Hill River)	Spring	0	0	2	2	0	0	4/4 = 100%
	Summer	0	0	1	1	1	0	3/3 = 100%
	Winter	0	0	3	2	0	0	5/5 = 100%

Interim Endpoints of Water Quality (Implied Load Capacity) at Cedar Bluff Lake and Stations 224, 550, and 739 over 2008 - 2012:

Current Condition and Reductions for Cedar Bluff Lake

Parameter	Current Condition (1994 - 2000)	TMDL	Percent Reduction
Sulfate (mg/L)	452	452	0 %

The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards fully supporting Domestic Water Supply. This TMDL will, however, be phased. The current standard of 250 mg/L of sulfate was used to establish the TMDL. However, the Cedar Bluff Lake basin is affected by the weathering of Niobrara Chalk and Pierre Shale bedrock. The reduction of fresh groundwater discharged from the Ogallala-High Plains Aquifer indirectly contributes to the sulfate impairment, as well. As such, Cedar Bluff Lake has highly elevated sulfate levels because of natural sources and the lack of dilution with fresh water. During low flow periods, the elevation beyond natural sulfate levels can be attributed to long term consumptive use of water by irrigation. Even with considering this effect of irrigation, the natural source of sulfate makes achievement of the 250 mg/l criterion problematic across varied flow conditions at Stations 224, 550, and 739. At Stations 224, 550, and 739, since the Standard is not achievable because of natural contributions to the sulfate load and lack of dilution with fresh water, 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 Procedures also allow for alternate calculations if concentrations are not proportional to flow. Exceedances on the Smoky Hill River are seen across the flow duration curve from 10- 70% at Elkader and 10-85% at Trego and Gove. Therefore, the samples taken below median flow do not represent the complete loading situation. 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 224, 550, and 739. The average sulfate concentration at those stations for the samples collected at flows less than the median flow are as follows:

Background Concentrations in Cedar Bluff Lake Watershed

Station	Median Flow (cfs)	Background (mg/L)
Station 224 near Elkader (Smoky Hill River)	0.5	700
Station 739 near Gove (Smoky Hill River)	1.1	700
Station 550 near Trego (Smoky Hill River)	1.1*	500

* The stream segments above Elkader, except Ladder Creek, all had median flows below 1 cfs and thus by SB 204 were unclassified and not subject to numeric criteria. North Branch of Hackberry is classified because Oakley discharges into it.

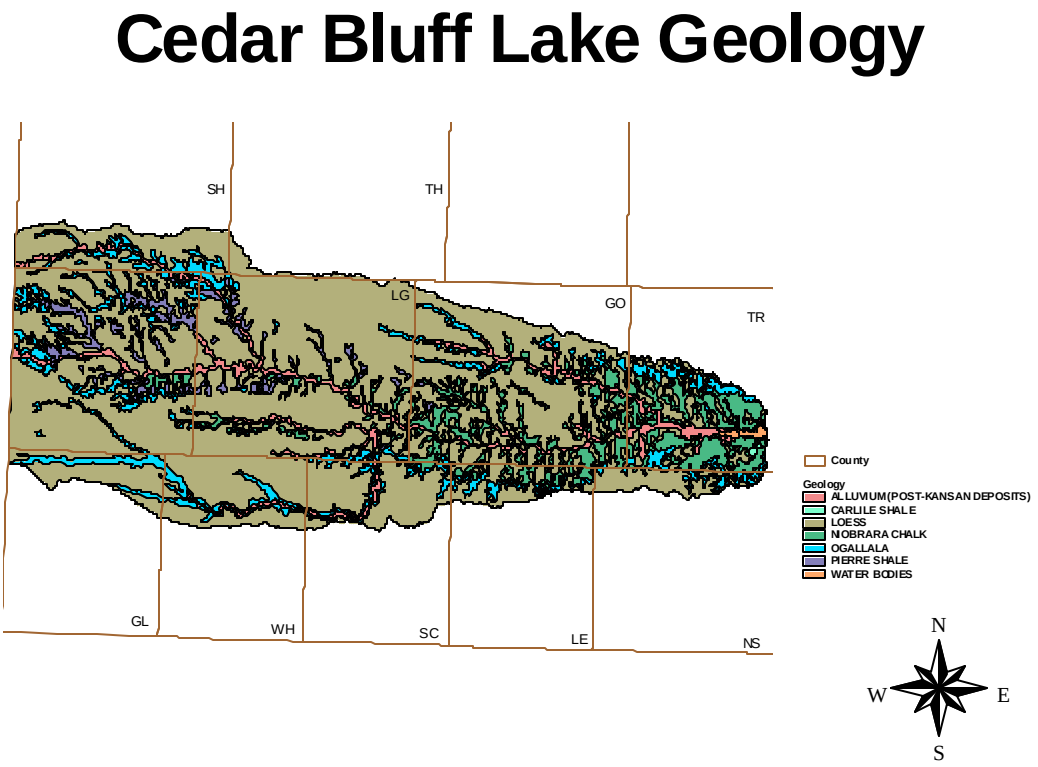
The Phase Two TMDL will be based on the future standard applied to these flows within the contributing portions of the Cedar Bluff Lake Basin watershed to Stations 224, 550, and 739.

Seasonal variation has been incorporated in this TMDL through the documentation of the seasonal consistency of elevated sulfate levels. Achievement of the endpoints indicates 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

Background: The Niobrara Chalk is the bedrock that outcrops and subcrops under unconsolidated sediments in most of the drainage area of the Smoky Hill River above Cedar Bluff Lake, except in the uppermost part of the subbasin where the Pierre Shale outcrops and subcrops under unconsolidated sediments (Figure 10). The Pierre Shale on the Upper Smoky Hill River above Elkader is likely a primary source of sulfate at the higher flows. The Smoky Hill Member of the Niobrara Chalk in the drainage area of the reservoir contains thin veins of gypsum (hydrous calcium sulfate) in some locations, and the Pierre Shale contains selenite (a crystalline form of gypsum). The source of the sulfate in the surface water entering the reservoir can be attributed to the gypsum in the

Figure 10



bedrock. However, evapotranspiration consumption of water in the drainage basin substantially increases the sulfate concentration of the river water during low flow periods. The large fluctuation in the amount of rainfall that can runoff to the river causes variations in the sulfate content of the river water. Substantial runoff is fresher than most of the baseflow of the Smoky Hill River and dilutes the sulfate concentration of the river water after flushing salts accumulated on soil surfaces and in dry stream sediments. Small amounts of runoff may not be fresh because they can dissolve the accumulated salts in soils and near surface sediments.

The flow in the Smoky Hill River above Cedar Bluff Lake generally decreased from the 1940s and 1950s to 1992, increased in 1993-1998, and is now back to rates less than the 1950s and 1960s (Figure 11). Part of the general decrease in flow is due to conservation practices such as terracing that retain water (some of which can then be consumed by evapotranspiration) and part to increased water consumption of ground water from the alluvial and High Plains aquifers that provide baseflow to the Smoky Hill River. Some of the flow trend could also be due to climatic changes. Any change that causes a long-term decrease in the amount of runoff to the river will generally cause an increase in the sulfate concentration in the river water. Climatic changes that lead to long-term hotter and drier conditions will also cause an increase in the sulfate content of the river water by increasing the evapotranspiration loss, leaving the remaining sulfate mass dissolved in a smaller amount of water. The record of sulfate concentration on the Smoky Hill River above Cedar Bluff Lake began in the latter part of the 1960s based on USGS and KDHE data records for the river near Arnold, which is

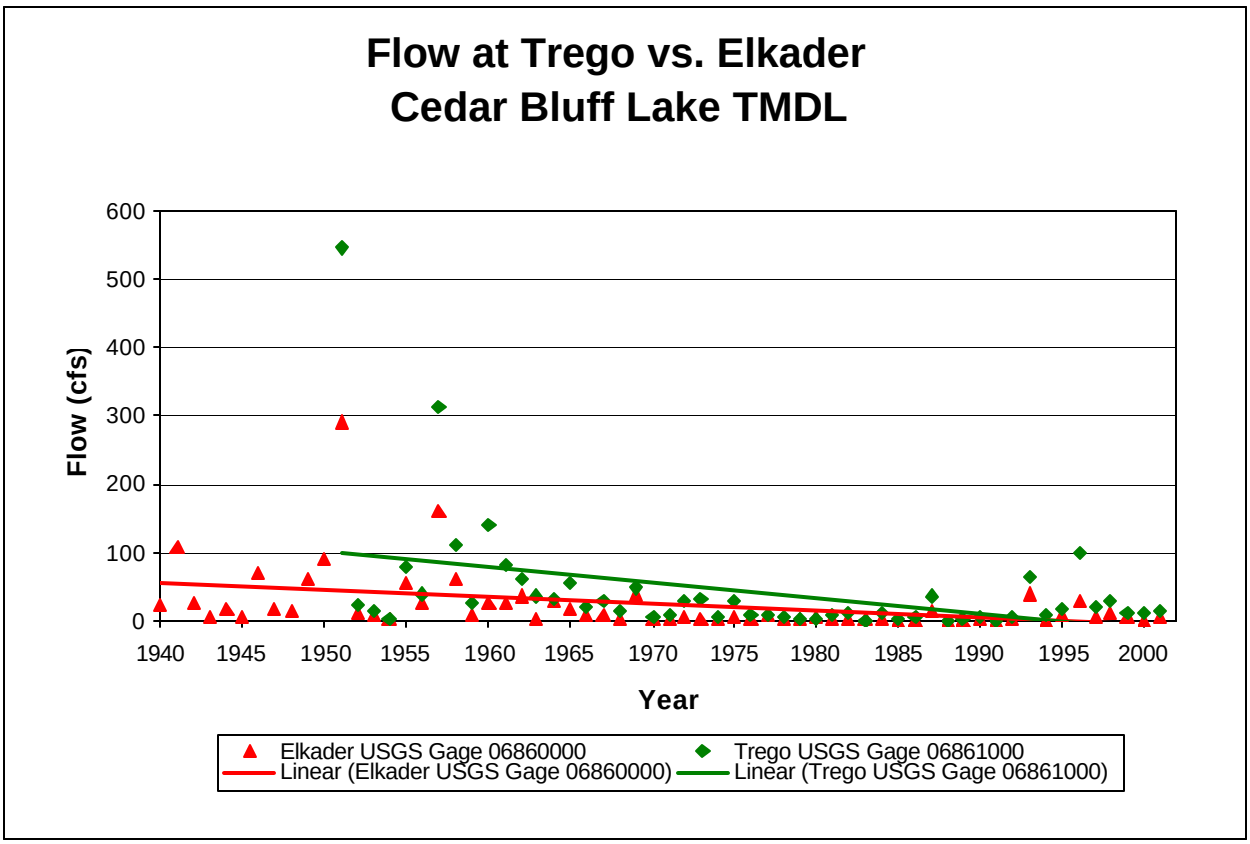


Figure 11

several miles upstream of the current KDHE station 550 south of Trego Center (Figure 12). The combined record near Arnold and Trego Center is not long enough to span the period of the 1940s and 1950s to the present during which the flow substantially decreased. Thus, the sulfate concentration during the higher flow preceding the mid-1960s is unknown.

Figure 12 does not show any apparent trend in sulfate concentration during the late 1960s to 2002. Figure 13 displays the sulfate content for the Smoky Hill River south of Trego Center for KDHE site 550; there is also no significant change in sulfate concentration with time for the period of record. However, the record for site 224 farther upstream at Elkader does show a statistically significant increase in sulfate content during 1987-2002. The increase in chloride concentration at site 224 for the same period is also statistically significant. The increase in sulfate concentration with time in the river at Elkader might be at least partly associated with an increasing frequency of very low flows during the sampling dates. The median flow for the river at Elkader for the site 224 sampling record is 0.50 cfs in comparison with the larger median flow near Trego (1.10 cfs). Thus, small decreases in flow in the river at Elkader (greater frequency of low flow values in Figure 11) may be a large enough percentage to affect the sulfate at that site but could be too small to affect the flow and, thus, the sulfate content farther downstream near Arnold and Trego Center. Linear regression for the sulfate versus flow in Figure 14 gives nearly horizontal lines.

Figure 12 - Sulfate concentration in the Smoky Hill River near Arnold and Trego Center based on USGS and KDHE data.

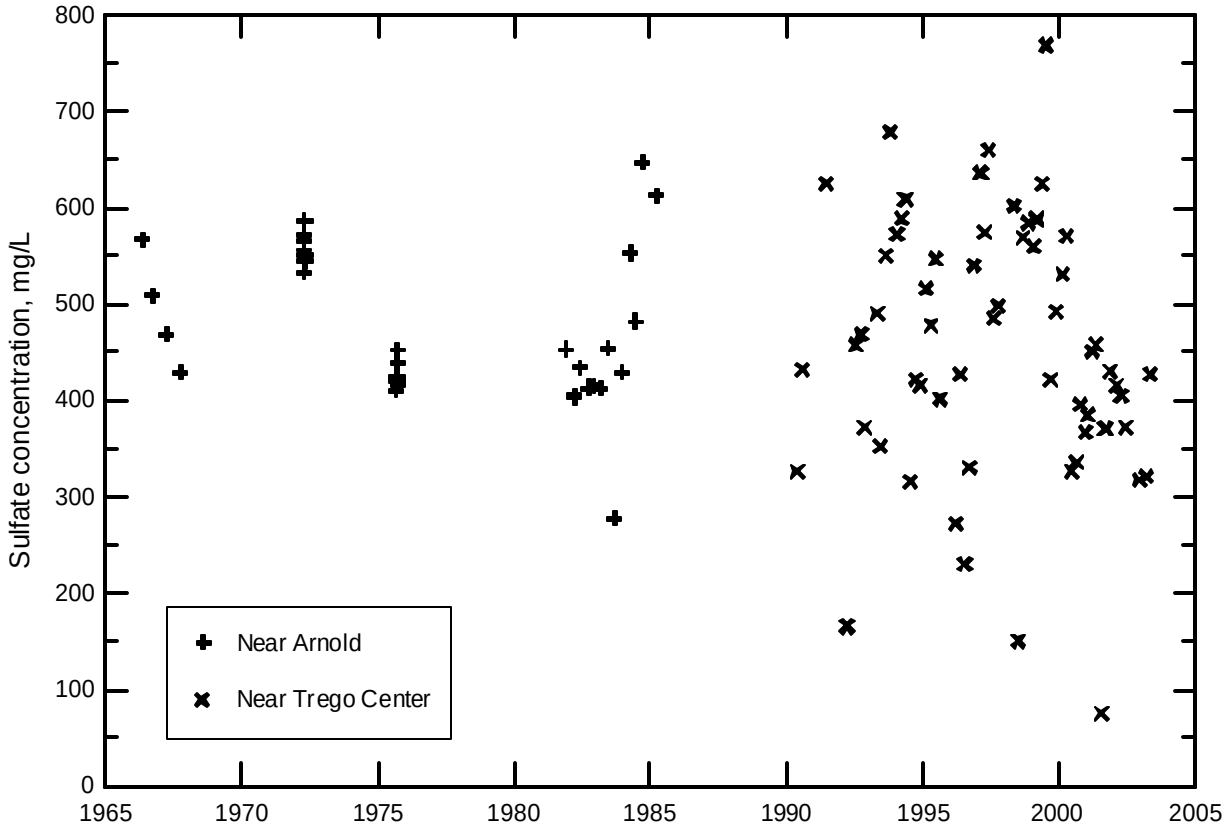
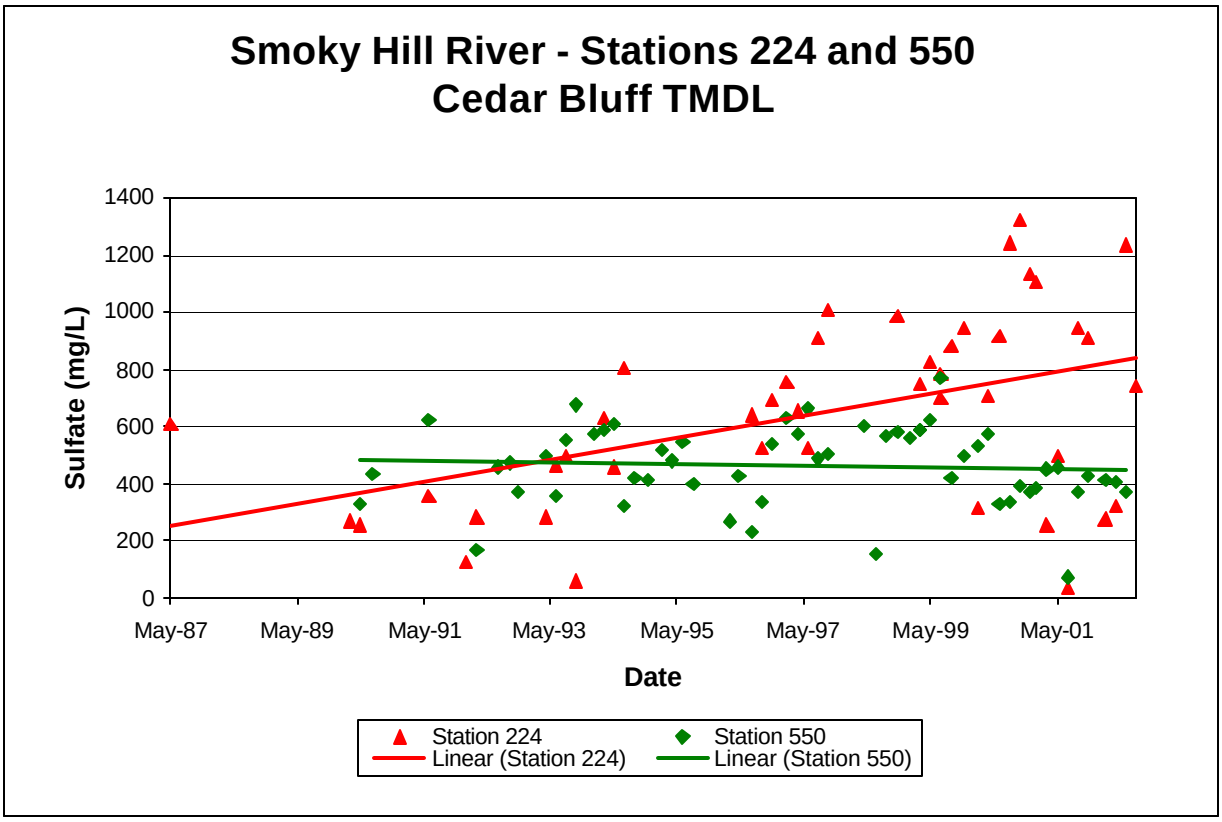


Figure 13



Irrigation Return Flows: Although there are surface water rights in the Smoky Hill River upstream of Cedar Bluff Reservoir (Figure 15), there is usually not enough water in the river to be used under these rights for irrigation. Irrigation reports from 2003 show the following:

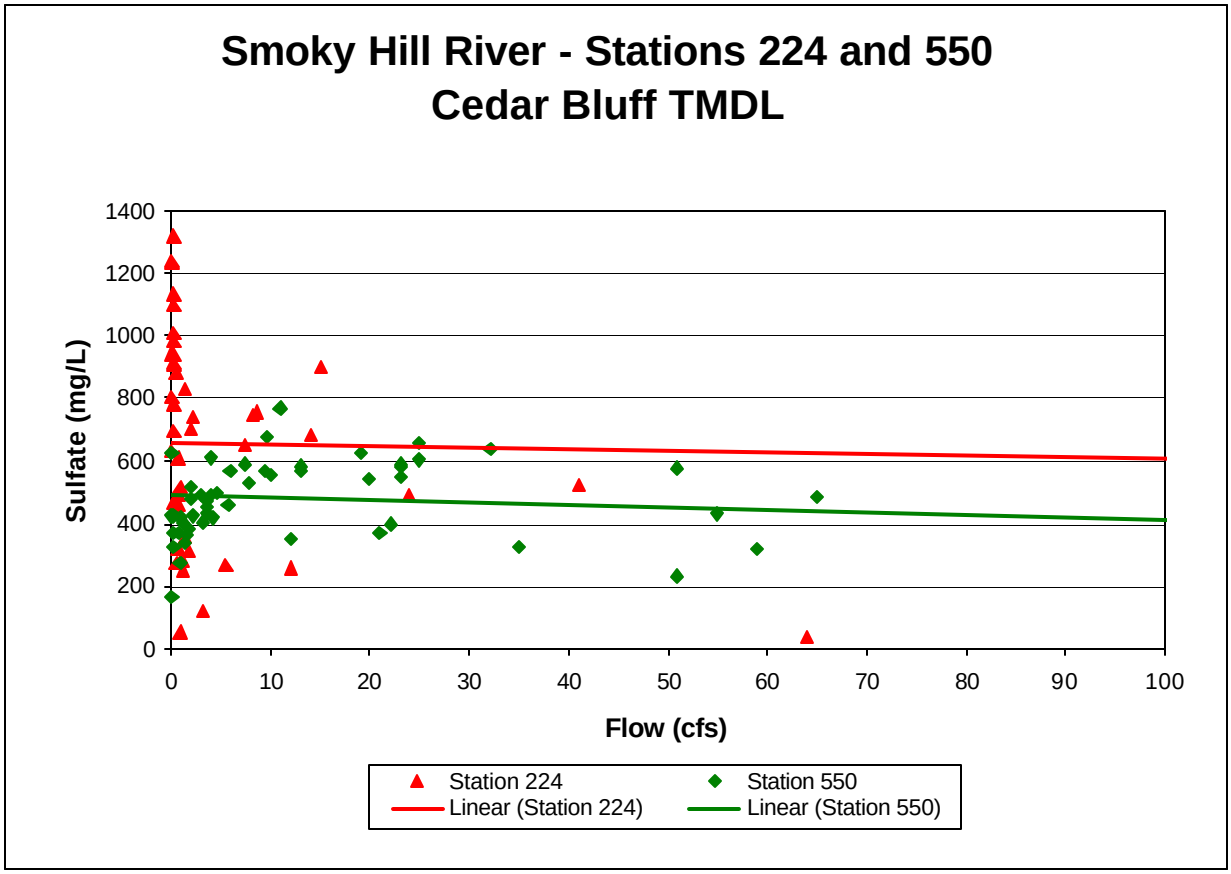
Water Use Statistics for Each Monitoring Site

Monitoring Sites	Surface Water		Groundwater	
	Area (acres)	Volume (acre-feet)	Area (acres)	Volume (acre-feet)
Station 224 near Elkader (Smoky Hill River)	0	0	145,124	147,706
Station 739 near Gove (Smoky Hill River)	0	0	7,968	10,023
Station 550 near Trego (Smoky Hill River)	105	60	47,234	47,158

There is no known irrigation return flow that enters via canals or other constructed surface drainage into the Smoky Hill River upstream of Cedar Bluff Lake. There are many wells in the alluvial aquifer of the Smoky Hill River upstream of the reservoir from which water is pumped for irrigation. Seepage of irrigation water from beneath the irrigated fields can slowly flow in the alluvial aquifer to the Smoky Hill River, particularly during wetter periods. The subsurface irrigation return flow has a higher concentration of dissolved solids (and sulfate) than the water pumped for irrigation because evapotranspiration consumes water while leaving behind the dissolved salts in the smaller water volume. Over the long-term, the sulfate mass discharged from the alluvial aquifer to the river and, thus, into the reservoir, is expected to be approximately the same with and without irrigation. However, the sulfate mass after the impact of irrigation is dissolved in a smaller volume of water, resulting in a greater sulfate concentration of the river and

reservoir water than without irrigation. These effects assume that there is no significant long-term change in climate that produces substantially drier or wetter conditions.

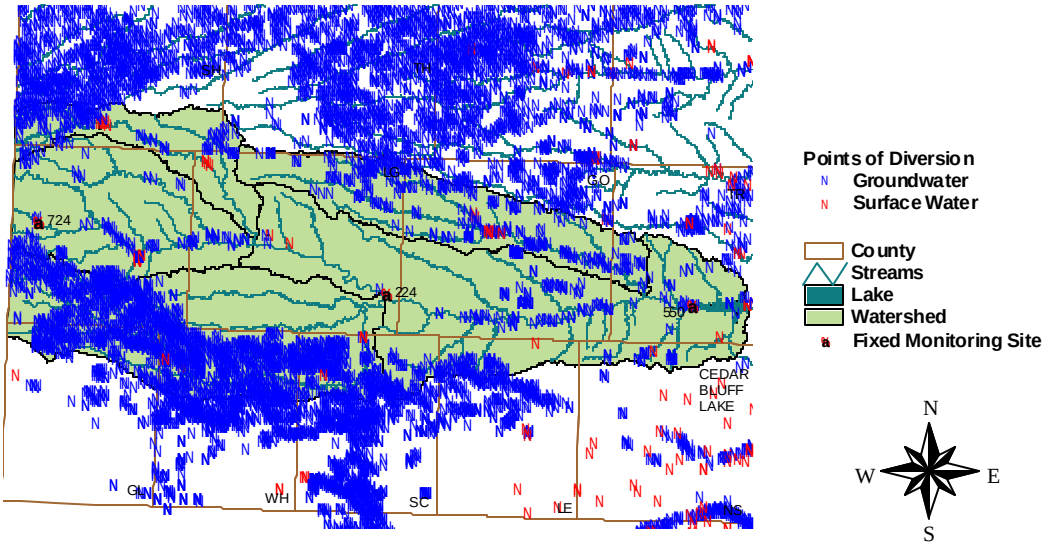
Figure 14



Oil Field Brine: Oil-field brine is high in chloride but often very low in sulfate concentration. When the sulfate content is substantial, it is still so much lower than the chloride content that the sulfate/chloride ratio is very low. Thus, if there is any significant impact from oil brine, it will be observable in the chloride content of a surface or ground water but not in the sulfate content. The sulfate/chloride ratio is typically much greater in natural, bedrock and soil sources of salinity and also in salinity generated or exacerbated by evapotranspiration consumption of water (leaving behind residual salts) than in oil brine.

Figure 15

Cedar Bluff Lake Points of Diversion



NPDES: Four permitted waste treatment facilities are located within the watershed (Figure 16). Three are non-overflowing lagoons that are prohibited from discharging. The Oakley MWTP discharges approximately 0.2 MGD based on monitoring data from last year. Any anthropogenic sulfate sources or hydrologic modifications increasing the sulfate concentration would be minor in comparison with the natural sulfate source in the watershed.

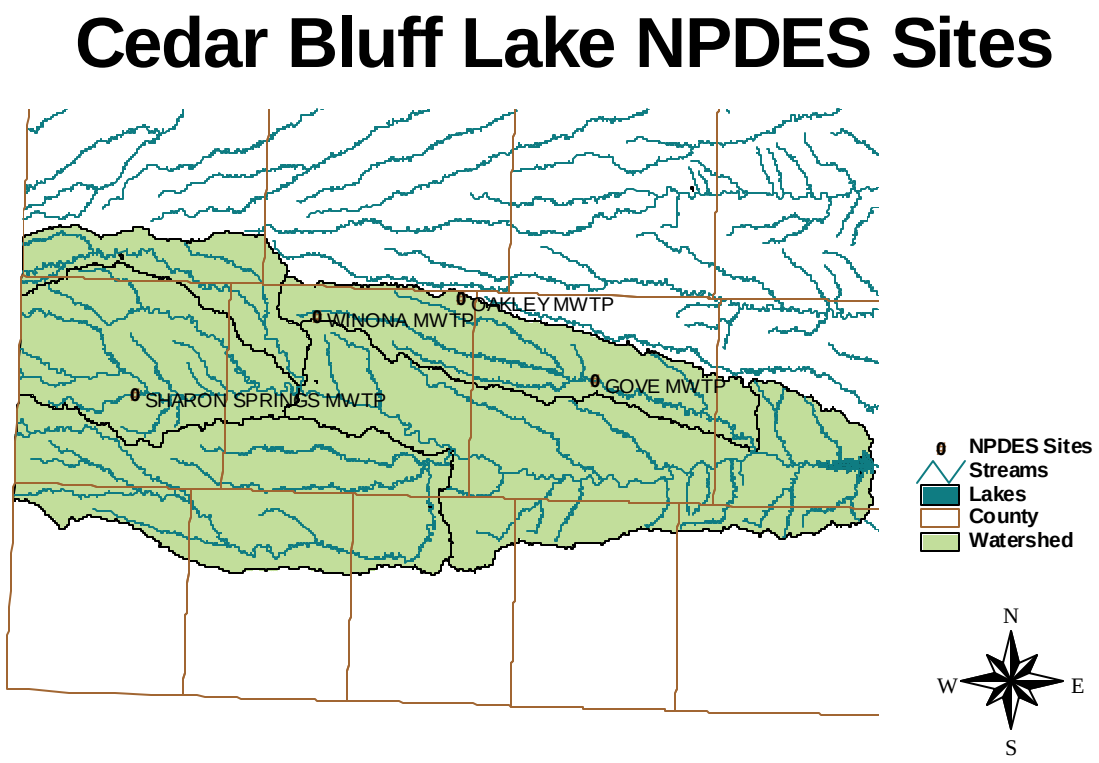
Waste Treatment Plants in the Cedar Bluff Lake Watershed

Kansas Permit Number	**Name**	**Type**	**Design Capacity (MGD)**	**SO_4 Wasteload Allocation**
M-SH11-NO01	Gove MWTP	Two-cell Lagoon	Non-overflowing	0 lbs/day
M-SH29-OO01	Oakley MWTP	Trickling Filter	0.4	334 lbs/day*
M-SH35-NO01	Sharon Springs MWTP	Two-cell Lagoon	Non-overflowing	0 lbs/day
M-SH41-NO01	Winona MWTP	Three-cell Lagoon	Non-overflowing	0 lbs/day

* Allows for up to 100 mg/L of Sulfate in the effluent at design flow.

Since Oakley MWTP is not currently required to monitor for sulfate in its effluent, the average sulfate concentration for this municipal source was estimated based on the sulfate in its influent, 69.4 mg/L. For this mechanical plant, a one to one ratio was used to estimate the sulfate in effluent from the city in the watershed's finished water.

Figure 16



Contributing Runoff: The watershed's average soil permeability is 1.7 inches/hour according to NRCS STATSGO database. About 77.9% 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 5.3% 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 and the lack of dilution with fresh water are overwhelmingly responsible for the excursions seen at the monitoring stations located within the Cedar Bluff Lake basin.

Point and Non-Point Sources: In the below table, under Phase One, the Wasteload and Load Allocations are given for all the stations included in this TMDL. The total Wasteload Allocation entering Cedar Bluff Lake is 334 pounds per day. Under Phase Two, Wasteload and Load Allocations were calculated from the background concentrations designated in the endpoint.

Allocations for Cedar Bluff Lake Watershed

Phase One: 250 mg/L Endpoint			
Station	224	739	550
Load Capacity (lbs/day)	675	1485	1485
Wasteload Allocation (lbs/day)*	0	0	334
Load Allocation (lbs/day)	675	1485	1151
Phase Two: Background			
Station	224	739	550
Background Concentration (mg/L)	700	700	500
Median Flow (cfs)	0.5	1.1	1.1
Load Capacity (lbs/day)	1890	4158	2970
Wasteload Allocation (lbs/day)*	0	0	334
Load Allocation (lbs/day)	1890	4158	2636

* 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.

Defined Margin of Safety: The Margin of Safety provides some hedge against the uncertainty of loading and the sulfate endpoints for the Cedar Bluff Lake Watershed. Since there are no sulfate adding processes present in the municipality discharging to the Smoky Hill River, the sulfate loads added by that facility reflect the sulfate content of its source water. The resulting wasteloads reflect concentrations and volumes which will not alter the background levels established at the stream station above Cedar Bluff Lake. In most cases, the effluent concentrations are below background levels, creating some dilution impact.

There are varying degrees of impact on sulfate levels from historic irrigation within the drainage of Cedar Bluff Lake. In the long term, the Load Allocations established by this TMDL reflect either the existing water quality standard or the background concentrations. 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 reduction of fresh groundwater discharged from the Ogallala-High Plains Aquifer indirectly contributes to the sulfate impairment in Cedar Bluff Lake and the sulfate impairment is primarily from natural geologic sources, this TMDL will be a Low Priority for implementation.

Unified Watershed Assessment Priority Ranking: Cedar Bluff Lake lies within the Smoky Hill Headwaters (HUC 8: 10260001) with a priority ranking of 70 (Low Priority for restoration), North Fork Smoky Hill (HUC 8: 10260002) within Category IV, Upper Smoky Hill (HUC 8: 10260003) with a priority ranking of 66 (Low Priority for restoration), Ladder (HUC 8: 10260004) with a priority ranking of 65 (Low Priority for restoration), and Hackberry (HUC 8: 10260005) with a priority ranking of 68 (Low Priority for restoration).

Priority HUC 11s: The majority of the bedrock outcropping is in HUC 11 (10260005020, 10260003020, 10260003030, 10260003040, and 10260003050), and thus the Upper Smoky Hill and Hackberry subwatersheds should take priority.

5. IMPLEMENTATION

Desired Implementation Activities

1. Monitor any anthropogenic contributions of sulfate loading to the lake and rivers.
2. Establish an alternative background criterion.
3. Assess likelihood of the lake and rivers being used for domestic uses.
4. Evaluate irrigation management practices for reducing salt leaching.

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.

b. Evaluate impact of irrigation return flows on sulfate loading to streams.

Water Quality Standards and Assessment - KDHE

a. Establish background levels of sulfate for the rivers, tributaries, and lake.

Use Attainability Analysis - KDHE

a. Consult with Division of Water Resources on locating existing or future domestic points of diversion from Cedar Bluff Lake for drinking water purposes.

Subbasin Management - DWR

a. Evaluate Best Management Practices for irrigation which decrease salt loading to streams.

Time Frame for Implementation: Development of a background level-based water quality standard should be accomplished with the 2006 water quality standards revision.

Targeted Participants: Primary participants for implementation will be KDHE and DWR.

Milestone for 2008: The year 2008 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, additional monitoring data from Cedar Bluff Lake will be reexamined to confirm the impaired status of the lake and the suggested background concentration. 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 and the Division of Water Resources.

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 and should not receive funding.

Effectiveness: Minimal control can be exerted on the amount of natural background.

6. MONITORING

KDHE will continue to collect samples from Cedar Bluff Lake and at Stations 224, 550, and 739. Based on that sampling, the priority status will be evaluated in 2007 including application of a 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.

Monitoring of sulfate levels in effluent will be a condition of NPDES and state permits for facilities. This monitoring will continually assess the functionality of the systems in reducing sulfate levels in the effluent released to the streams upstream of Cedar Bluff 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.

Milestone Evaluation: In 2008, evaluation will be made as to the degree of implementation which has occurred within the watershed and current condition of Cedar Bluff 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.

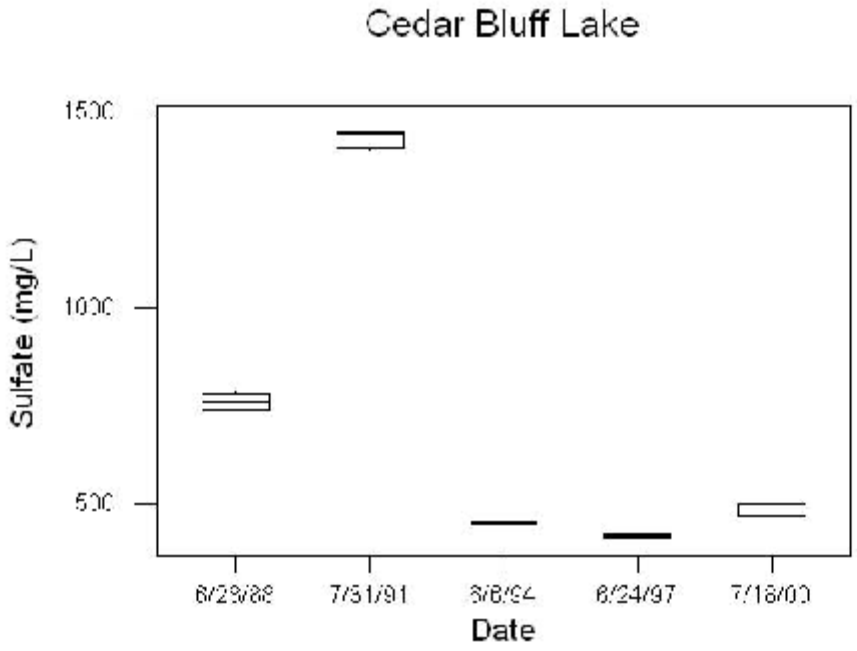
Bibliography

Liscek, Bonnie C. Methodology Used in Kansas Lake TMDLs [web page] Jul. 2001; http://www.kdhe.state.ks.us/tmdl/eutro.htm [Accessed 17 May 2002].

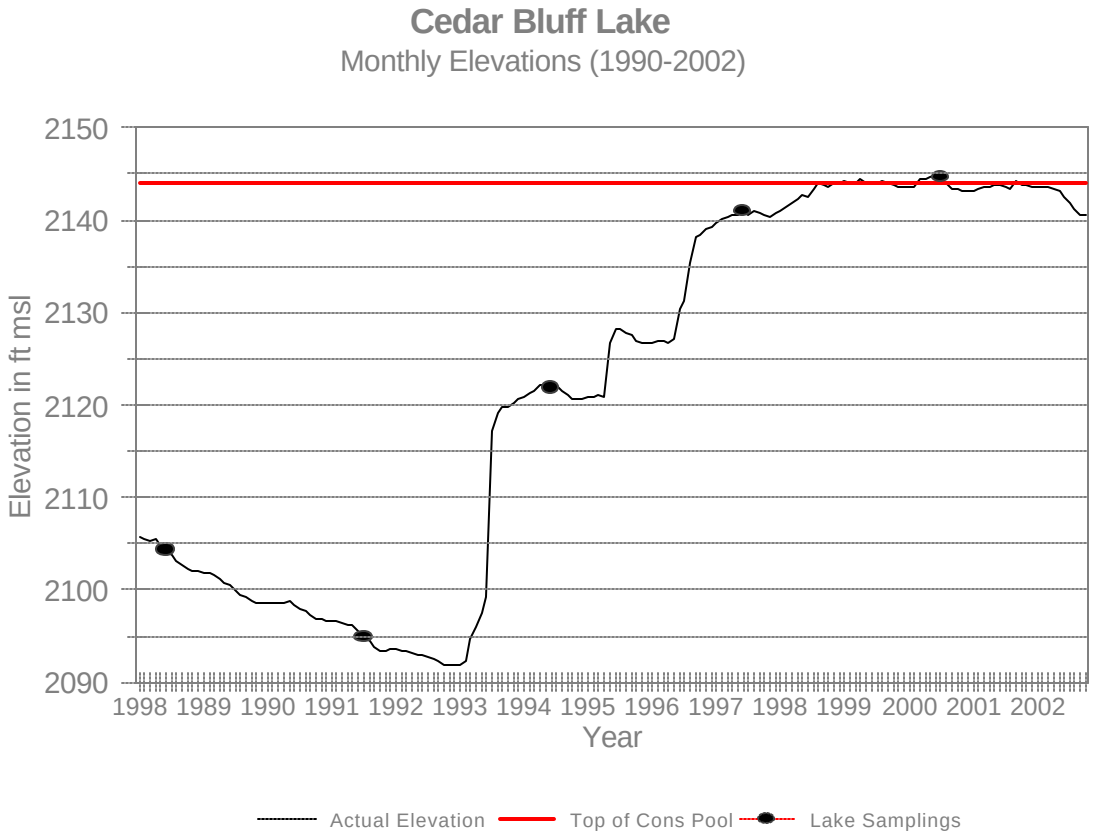
Whittemore, D. (7 Oct 2003). Re: Revision of information for use in the sulfate TMDL for the Smoky Hill River above Cedar Bluff Reservoir.

Whittemore, D. (21 Jan 2003). Re: Information for use in the sulfate TMDL for Cedar Bluff Reservoir.

Appendix A - Boxplots



Appendix B - Monthly Elevations



Approved March 3, 2004