

SMOKY HILL/SALINE RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body/Assessment Unit: Upper Kansas River, Lower Smoky Hill River, Lower Saline River, including Wolf Creek, Bullfoot Creek, Elkhorn Creek, Gypsum Creek, Holland Creek, Mud Creek, Turkey Creek, Chapman Creek and Carry Creek
Water Quality Impairment: Sulfate

1. INTRODUCTION AND PROBLEM IDENTIFICATION

- Subbasins:** Upper Kansas, Lower Smoky Hill & Lower Saline
- Counties:** Geary, Dickinson, Saline, Ottawa, Lincoln, Russell, McPherson, Clay & Ellsworth
- HUC 8:** 10260008, 10260010 & 10270101
- Ecoregion:** Central Great Plains, Smoky Hills (27a)
Flint Hills (28)
- Drainage Area:** Approximately 3,436 square miles from Kanopolis and Wilson Dams to Ft. Riley/Ogden.

Water Quality Limited Segment on Upper Kansas River: 7

Water Quality Limited Segments on Lower Smoky Hill River: 1, 2, 6, 9, 10, 11, 12, 13, 14 & 15

Water Quality Limited Segments on Lower Saline River: 1, 2, 3, 4, 5, 9 & 13

All Stream Segments within Listed Impaired Tributary Watersheds

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

HUC 8 10270101 – Upper Kansas

Watershed: **Upper Kansas River above Ogden**

Station 518 Kansas River (7) Three Mile Creek (15)

HUC8 10260008 – Lower Smoky Hill

Watershed: **Smoky Hill River (Junction City)**

Station 264 Smoky Hill R (1)
Smoky Hill R (2)

Watershed: **Lyon Creek**

Station 516 Lyon Cr (31) Otter Cr (42)
Unnamed Stream (638)
W.Branch Lyon Creek (34) Unnamed Stream (515)
Lime Cr (51) Unnamed Stream (618)
Lyon Cr (540) Unnamed Stream (542)

Watershed: **Carry Creek**
Station 708 Carry Cr (35)

Unnamed Stream (32)

Watershed: **Chapman Creek**
Station 515 Chapman Cr

Basket Cr (40)
West Chapman Cr (5)

Chapman Cr

Watershed: **Smoky Hill River (Enterprise)**

Station 265 Smoky Hill R (6)
Smoky Hill R (9)
Smoky Hill R (10)
Smoky Hill R (11)
Smoky Hill R (12)

Lone Tree Cr (41)

Watershed: **Turkey Creek (Abilene)**

Station 644 Turkey Cr (28)
Turkey Cr (30)

W. Branch Turkey Cr (29)
E. Turkey Cr (50)
Middle Branch (58)

Watershed: **Mud Creek (Abilene)**

Station 643 Mud Cr (8)

Watershed: **Holland Creek**

Station 642 Holland Cr (25)

E. Holland Cr (27)
W. Holland Cr (26)

Watershed: **Gypsum Creek**

Station 641 Gypsum Cr (18)

Gypsum Cr (20)
Gypsum Cr (21)
Gypsum Cr (22)

W. Branch Gypsum Cr (44)
Spring Cr (45)
McAllister Cr (49)
Hobbs Cr (48)
Stag Cr (19)
S. Gypsum Cr (24)
Battle Cr (23)
N. Gypsum Cr (57)

Watershed: **Smoky Hill River (Salina/Mentor)**

Stations: 268, 514 Smoky Hill R (13)

Smoky Hill R (14)

Smoky Hill R (15)

E. Dry Cr (43)
Dry Cr (36)
Pewee Cr (56)
Kentucky Cr (17)
Paint Cr (52)
Sharps Cr (16)
Wiley Cr (47)

W. Kentucky Cr (54)

HUC 8 10260010 – Lower Saline

Watershed: **Saline River (New Cambria)**

Station 267 Saline R (1)
Saline R (2) Shaw Cr (41)
Saline R (3 – lower) Owl Cr (18)

Watershed: **Mulberry Creek (Salina)**

Station 640 Mulberry Cr (19) Dry Cr (29)
Mulberry Cr (20) Spring Cr (24) W. Spring Cr (25)
Spring Cr (26) Ralston Cr (28)
Spring Cr (27)
Mulberry Cr (21) Eff Cr (23)
Mulberry Cr (22) Table Rock Cr (40)

Watershed: **Saline River (Beverly)**

Station 513 Saline R (3 – upper) Twelvemile Cr (36)
Saline R (4)
Saline R (5) Yauger Cr (35)
Lost Cr (34)
Saline R (9) West Twin Cr (37)
Saline R (13)

Watershed: **Elkhorn Creek**

Station 671 Elkhorn Cr (17) W. Elkhorn Cr (38)

Watershed: **Bullfoot Creek**

Station 672 Bullfoot Cr (14) Spring Cr (16)
Bullfoot Cr (15)

Watershed: **Spillman Creek**

Station 673 Spillman Cr (6) Trail Cr (32)
Bacon Cr (7)
N. Br. Spillman Cr (8)

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: Upper Kansas River: Primary B Recreation; Special Aquatic Life Support, Domestic Water Supply; Food Procurement; Groundwater Recharge, Industrial Water Supply, Irrigation; Livestock Watering. Smoky Hill River, Saline River and Chapman Creek same, except Primary C Recreation and Expected Aquatic Life Support. Gypsum Creek same except Secondary b Recreation.

Special Aquatic Life Support, Secondary b Recreation and Food Procurement on Carry Creek

Expected Aquatic Life Support, Secondary b Recreation and Food Procurement on Wolf Creek, Elkhorn Creek, Mud Creek, Holland Creek, Turkey Creek. Bullfoot Creek same except Primary C Recreation.

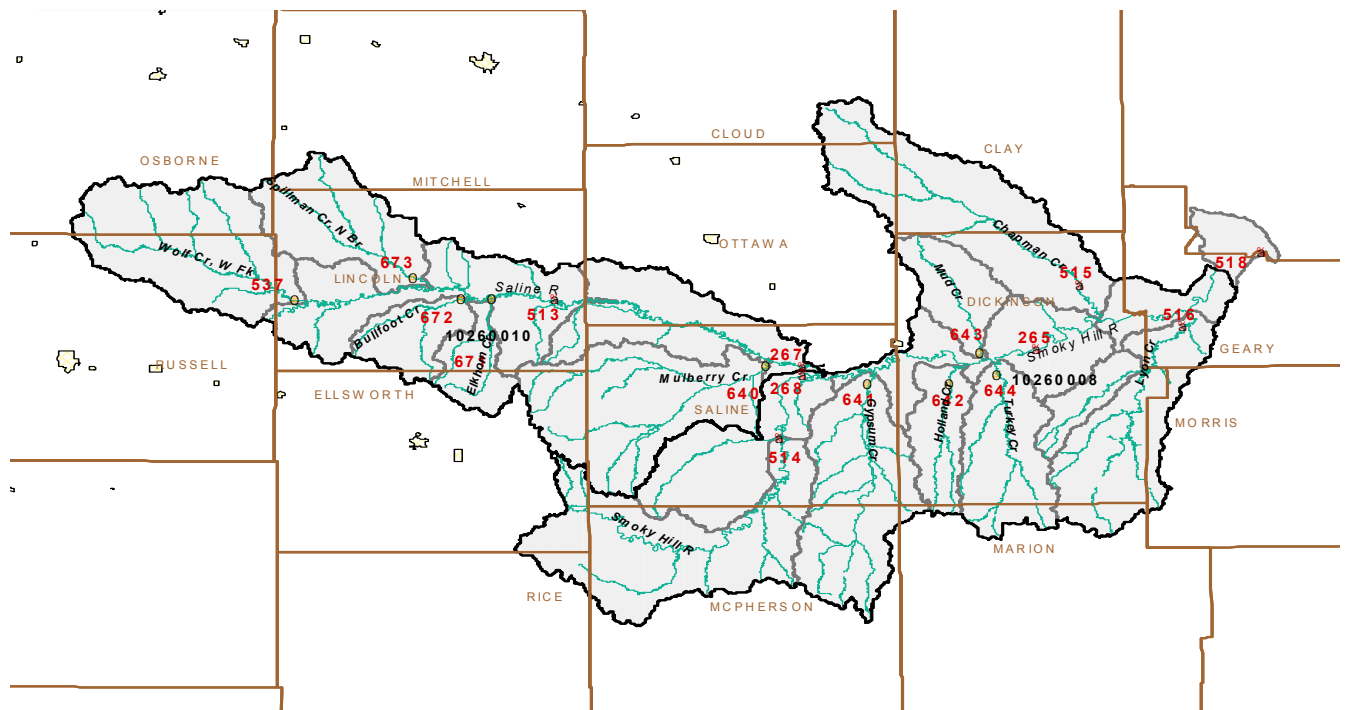
2002 303(d) Listing: Smoky Hill/Saline River Basin Streams

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 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. Base Map of TMDL Area – Upper Kansas, Lower Smoky Hill & Lower Saline



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

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

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. The entire drainage was assessed for excessive sulfate including the impaired streams of the Kansas River at Ogden, the Smoky Hill River from Junction City to New Cambria, the Smoky Hill River from New Cambria to Kanopolis Dam, the Saline River from New Cambria to Wilson Dam and Wolf Creek from Sylvan Grove to its headwaters. The major tributaries to the Smoky Hill and Saline Rivers were also monitored, albeit on a rotational basis for the most part. Those stations had three to four years of data available with sample sizes of 15 to 23. Gaging stations are located evenly throughout the watershed and flow estimates were made from USGS extrapolation studies. A number of the gaging stations had sulfate data collected before 1990 as part of USGS mineral intrusion studies on the Saline and Smoky Hill Rivers (Gillespie and Hargadine, 1981, 1986).

Current Condition: Starting on the Kansas River at Ogden, sulfate concentrations have a generally inverse relation with flow (Figure 2). There is tremendous scatter in the sample data, weakening any linear relationship with streamflow. Nonetheless, sulfate exceedances over 250 mg/l cease once flows reach 30 percent exceedance levels. Sulfate levels at lower flows show a number of samples below 250 mg/l and sulfate concentrations are rarely above 300 mg/l.

Two principal streams comprise the flow at Ogden; the Republican River as released from Milford Dam above Junction City and the Smoky Hill River arriving from the west of Junction City. The sulfate loads are principally carried by the Smoky Hill River. Comparison of sulfate levels at Junction City and Ogden indicates a general pattern of dilution between Ogden and Junction City (Figure 3). The Republican River is the main dilution base and releases from Milford Reservoir serve to support downstream flows along the Kansas River. The pattern of dilution strengthens when comparing Ogden and Junction City sulfate levels with those on the Smoky Hill River at Enterprise (Figures 4 & 5).

Between Ogden and Enterprise, Lyon Creek and Chapman Creek join the Smoky Hill River. Lyon Creek is consistently low in sulfate (Figure 6), while one of its tributaries, Carry Creek, has sulfate levels above 250 mg/l except at high flows. Chapman Creek has a strong presence of sulfate throughout most of its hydrologic regime (Figure 7). While there is an inverse relationship between flow and sulfate on Chapman Creek as was seen at Ogden, the overall concentrations of sulfate are higher on Chapman Creek. Only flows exceeded 10 percent of the time or less have low sulfate levels. Moderate flows typically range from 250 – 350 mg/l in sulfate. Flows exceeded 80 percent of the time or more can see sulfate elevate to over 450 mg/l.

Sulfate is pervasive along the Smoky Hill at Enterprise (Figure 8) over flows exceeded 15 percent of the time or more. Sulfate tends to be below 350 mg/l most of the time, except at lower flows when concentrations can reach 400 mg/l. The Solomon River at Niles has sulfate concentrations between 250 and 300 mg/l for a majority of the time (Figure 9). Occasional levels above 300 mg/l can be seen at lower flows exceeded 80 percent of the time or more.

Table 1. Stream Gages and Monitoring Stations on the Lower Smoky Hill and Saline Rivers

Station	Stream	Type	Record	Med Q (cfs)	Avg SO4 (mg/l)	Max SO4 (mg/l)	# of Samples	# >250 mg/l	# > 1000 mg/l
Ogden/Ft. Riley (518)	Kansas River	Q/WQ	1990-2003	1220	199	342	144	33	0
Junction City (264)	Smoky Hill R.	WQ	1996-8, 2003	ND	234	341	83	43	0
Enterprise (265)	Smoky Hill R.	Q/WQ	1990-2003	727	259	422	84	53	0
Lyon Crk (516)	SH R. Trib	WQ	1990-2003	40	127	235	79	0	0
Carry Crk (708)	Lyon C Trib	WQ	1994, 98, 2002	14	283	495	16	11	0
Chapman Crk (515)	SH R. Trib	Q/WQ	1990-2003	24	293	469	80	62	0
Turkey Crk (644)	SH R. Trib	WQ	1991, 95, 99, 2003	31	1003	1436	20	20	13
Mud Crk (643)	SH R. Trib	WQ	1991, 95, 99, 2003	2.3	351	543	21	15	0
Holland Crk (642)	SH R. Trib	WQ	1991, 95, 99, 2003	4.8	1074	1380	22	22	14
Gypsum Crk (641)	SH R. Trib	WQ	1991, 95, 99, 2003	6.3	254	402	20	12	0
Niles (266)	Solomon R.	Q/WQ	1990-2003	223	226	361	80	25	0
New Cambria	Smoky Hill R.	Q	1990-2003	400	ND	ND	ND	ND	ND
Salina (268)	Smoky Hill R.	WQ	1990-2003	ND	157	293	80	1	0
Mentor (514)	Smoky Hill R.	Q/WQ	1990-2003	74	157	360	79	3	0
New Cambria (267)	Saline R.	WQ	1990-2003	ND	277	425	79	52	0
Mulberry Crk (640)	Sal R. Trib	WQ	1991, 95, 99, 2003	19	143	278	22	1	0
Tescott/Beverly (513)	Saline R.	Q/WQ	1990-2003	70	334	487	80	68	0
Elkhorn Crk (671)	Sal R. Trib	WQ	1993, 97, 2001	3.9	377	509	15	13	0
Bullfoot Crk (672)	Sal R. Trib	WQ	1993, 97, 2001	3.6	242	321	16	10	0
Spillman Crk (673)	Sal R. Trib	WQ	1993, 97, 2001	4.7	169	295	15	2	0
Wolf Crk (537)	Sal R. Trib	WQ	1990, 94, 98, 2002	5.6	383	530	21	20	0
Wilson Dam	Saline R.	Q	1990-2003	20	ND	ND	ND	ND	ND

The tributaries to the Smoky Hill River in the vicinity of Abilene show varying levels of sulfate (Figure 10). On the north side of the valley, Mud Creek averages 350 mg/l, but is below 250 mg/l at the lowest flows. Meanwhile, Holland Creek and Turkey Creek on the south side are consistently above 1000 mg/l and maintain high sulfate concentrations throughout the range of hydrologic conditions. There is some dilution at the higher flows, but concentrations do not fall below 700 mg/l. Gypsum Creek to the west shows greater sulfate levels at higher flows. Concentrations are below 250 mg/l for flows exceeded 70 percent of the time or more, but are over the criterion at flows exceeded 60 percent of the time or less. The highest concentrations are seen at the highest flows, leveling off at 400 mg/l.

The Saline River joins the Smoky Hill River in the vicinity of New Cambria, east of Salina. The sulfate content of the two rivers above their confluence is markedly different (Figures 11 & 12). The Saline River as measured in the Beverly/Tescott and New Cambria areas is consistently high in sulfate, concentrations below 250 mg/l are rarely seen at Beverly over all flow conditions, but there is some dilution seen between Beverly and New Cambria. The Smoky Hill River at Salina and Mentor is low in sulfate, with only 1-3 samples exceeding 250 mg/l.

Along the Saline River, different tributaries contribute varied amounts of sulfate (Figure 13). Elkhorn Creek tends toward the highest sulfate concentrations, averaging 377 mg/l. Bullfoot Creek hovers about 250 mg/l over all flow conditions, averaging 242 mg/l. Spillman Creek and Mulberry Creek are low in sulfate, averaging 169 and 143 mg/l, respectively, and rarely exceeding 250 mg/l. Wolf Creek near Sylvan Grove, the uppermost tributary to the Saline River below Wilson Dam, is also high in sulfate, averaging 383 mg/l. (Figure 14).

Examination of sulfate data collected by USGS prior to 1990 indicates high concentrations historically at the Saline River near Tescott and Smoky Hill River at Enterprise. Table 2 indicates average sulfate levels seen at the USGS gaging stations at Tescott and Enterprise in the 1960's are significantly different (lower) in average concentration than the contemporary (since 1990) KDHE stations at Beverly and Enterprise. However, the sulfate concentrations are not different on average on the Kansas River at Ft. Riley nor the more current data at Ogden. The difference in sulfate at Tescott/Beverly and Enterprise is a marked departure in the relationships seen among these stations for sodium, chloride and conductivity. The lack of significant differences among those constituents was evidence of no irrigation impacts on stream chloride concentrations. However, the differences in sulfate at the stations extends to high flow conditions (Figures 15 & 16). Evaluation continues as to why there are differences in these data.

Figure 2. Kansas River at Ogden Sulfate-Flow Relationship

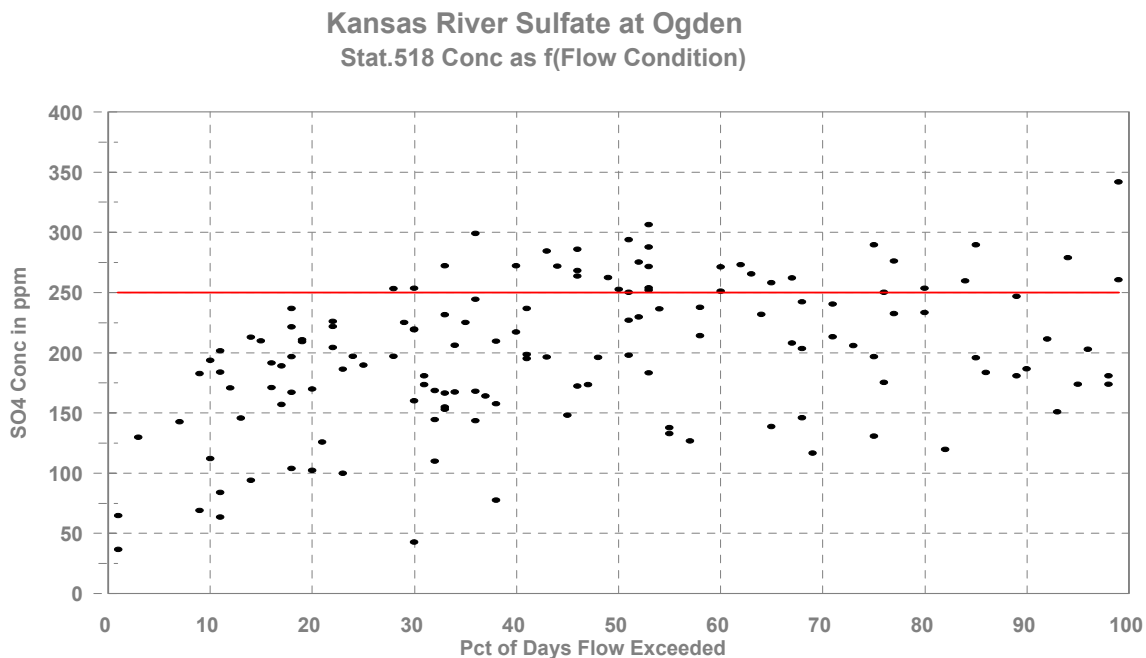


Figure 3. Sulfate Relationship between Junction City and Ogden

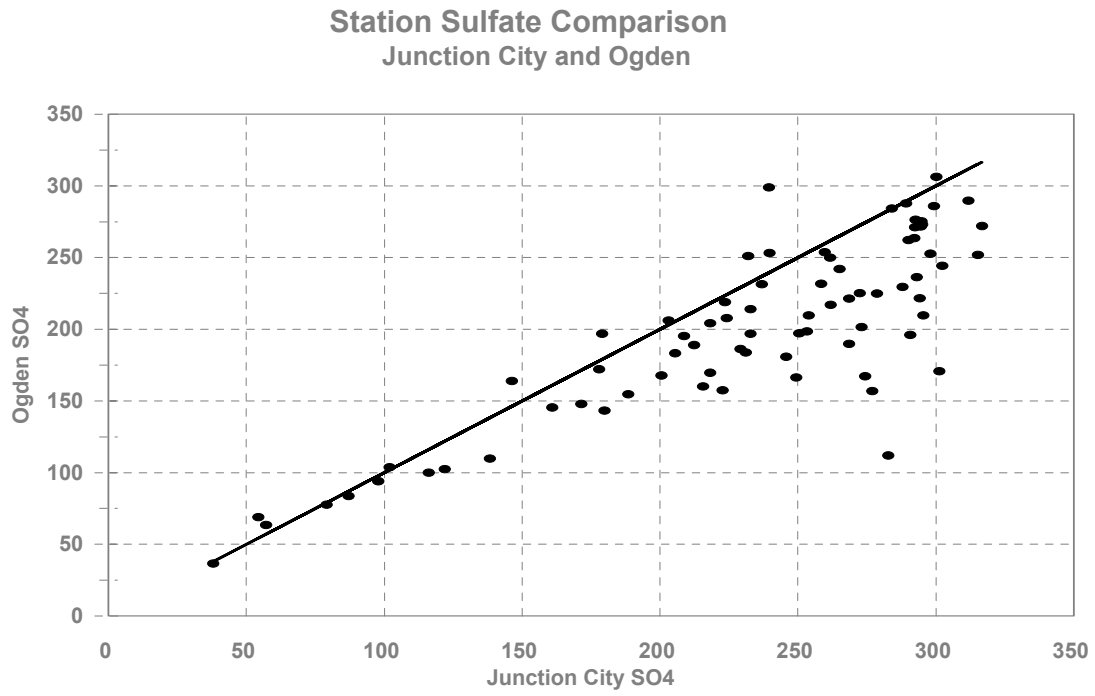


Figure 4. Sulfate Relationship between Enterprise and Ogden

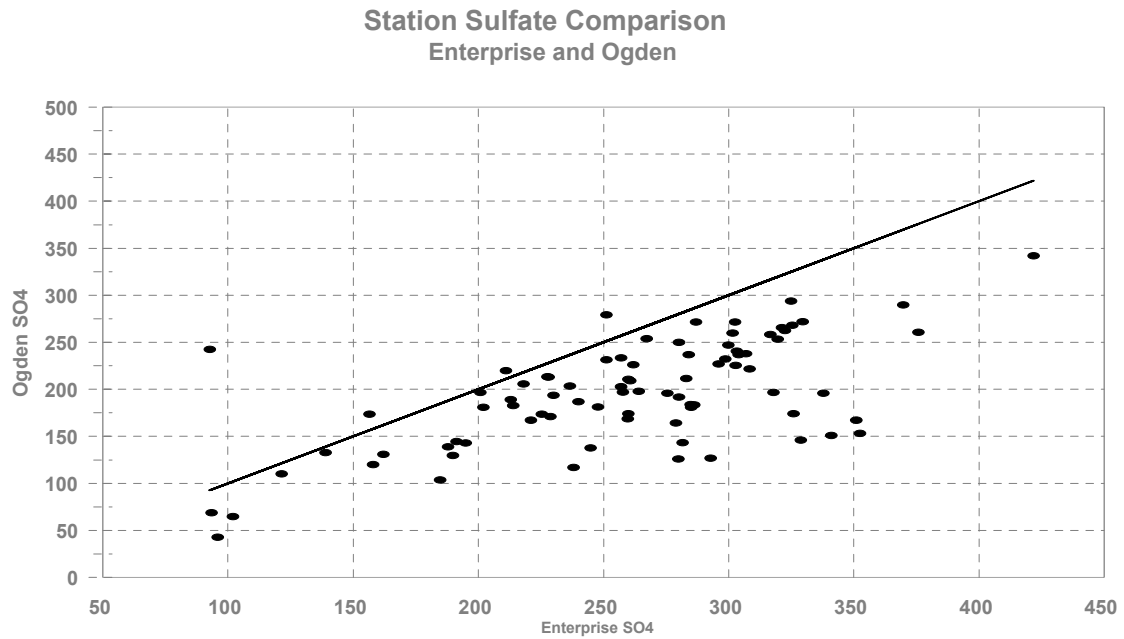


Figure 5. Sulfate Relationship between Enterprise and Junction City

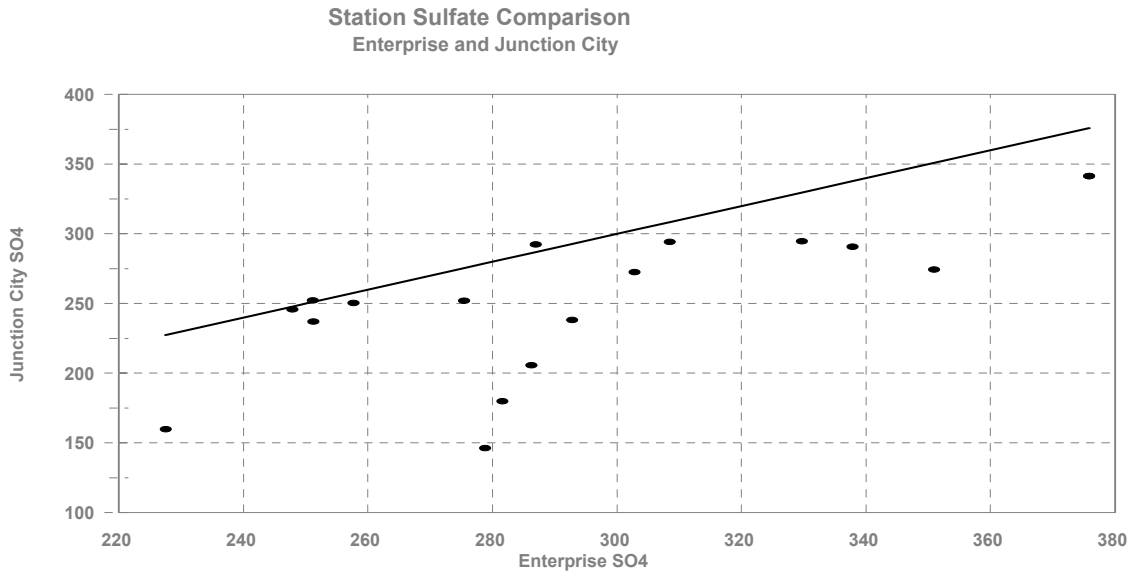


Figure 6. Lyon and Carry Creeks Sulfate – Flow Relationship

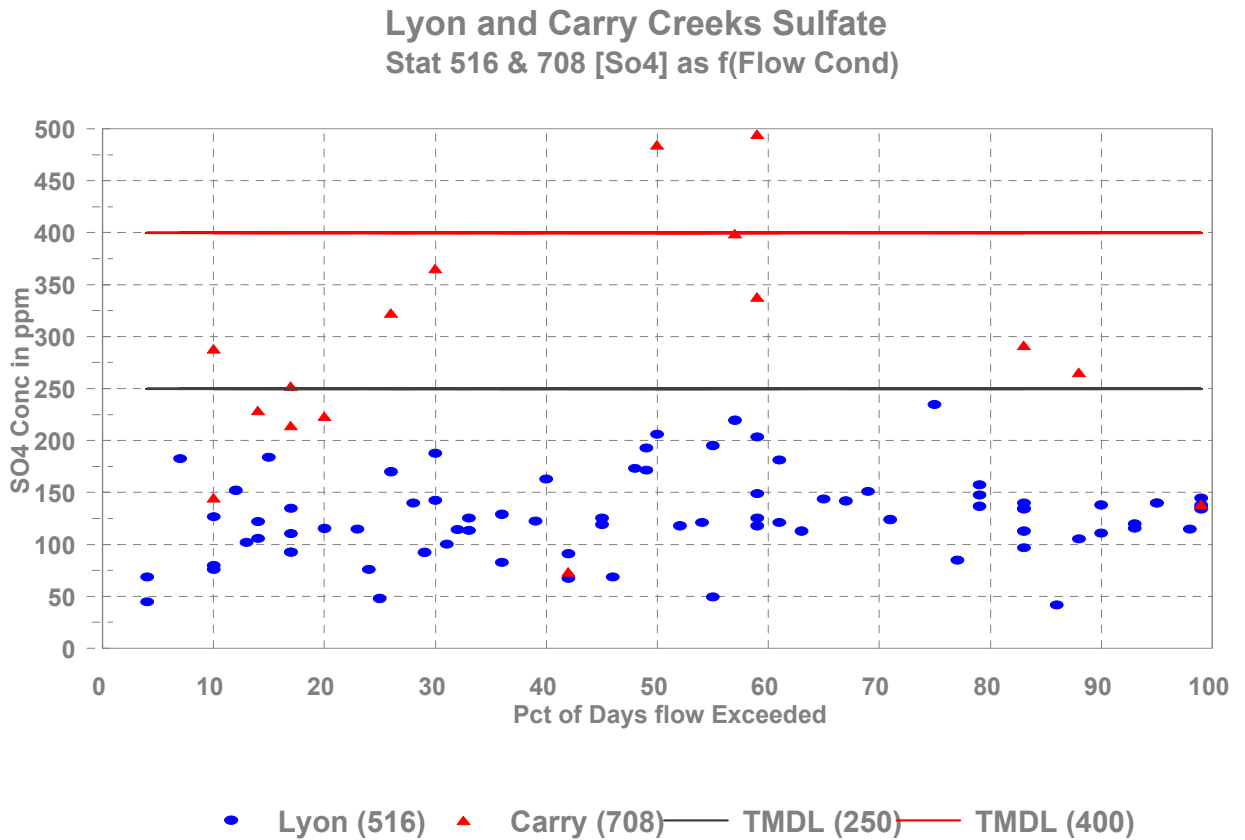


Figure 7. Chapman Creek Sulfate – Flow Relationship

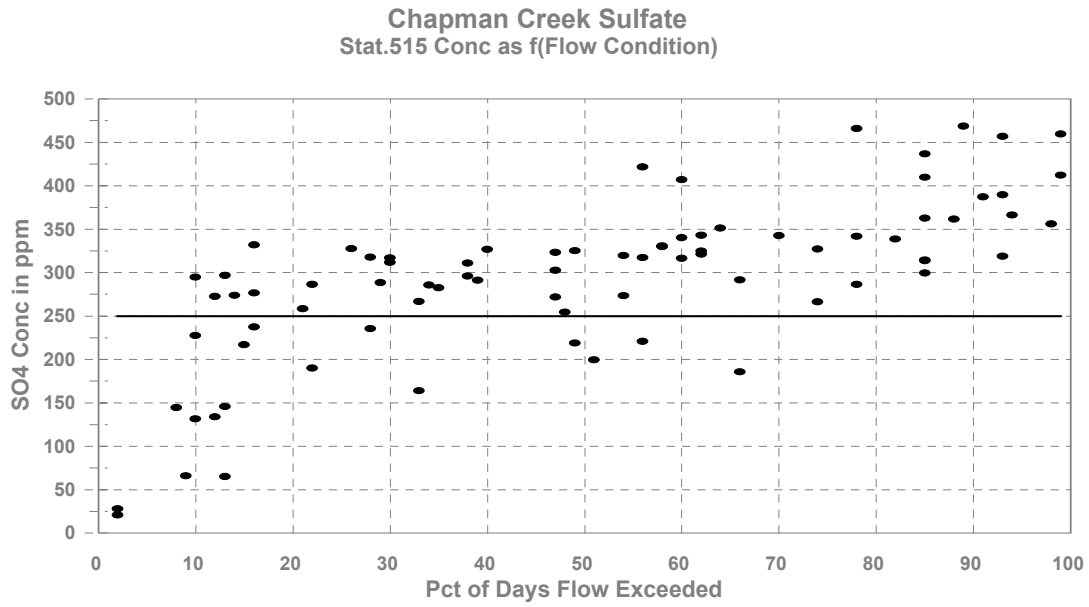


Figure 8. Smoky Hill River at Enterprise Sulfate – Flow Relationship

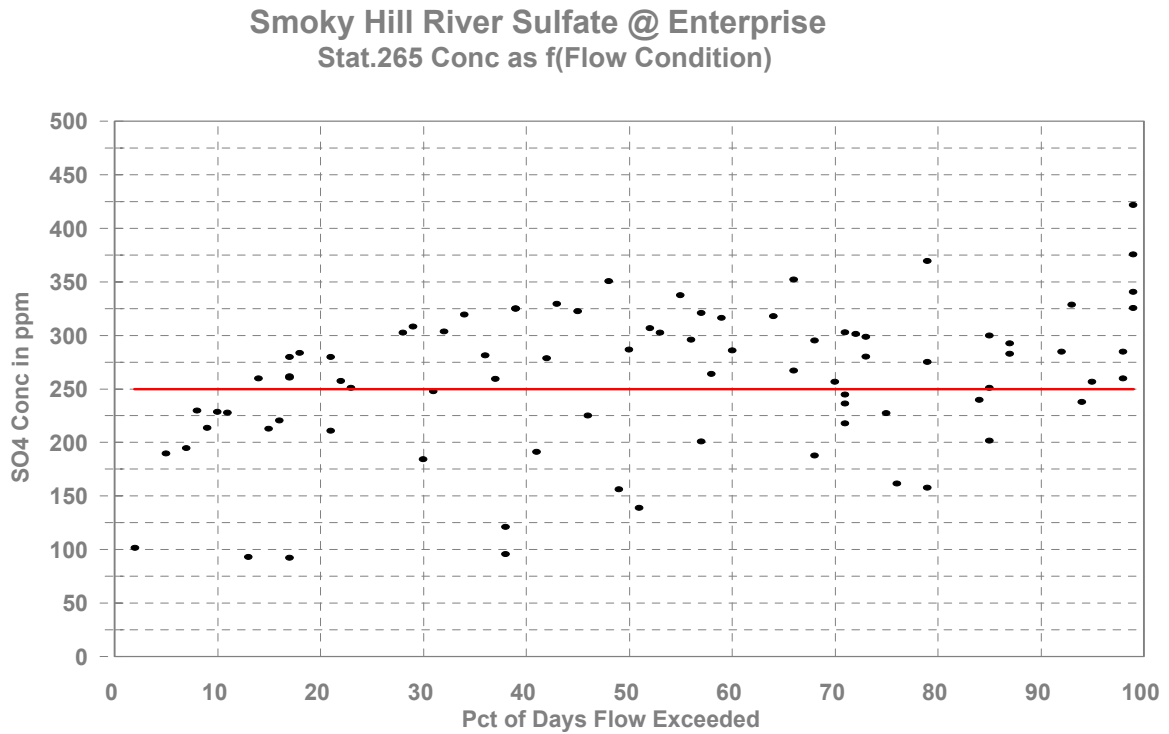


Figure 9. Solomon River near Niles Sulfate – Flow Relationship

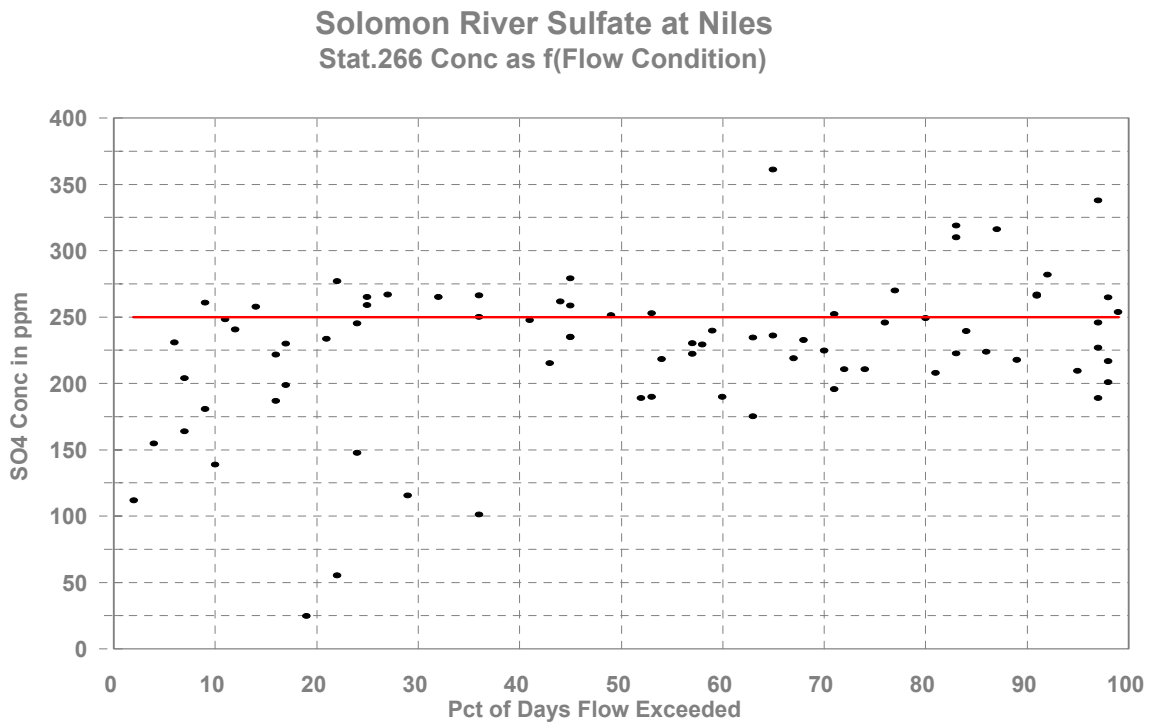


Figure 10. Smoky Hill River Tributaries Sulfate – Flow Relationship

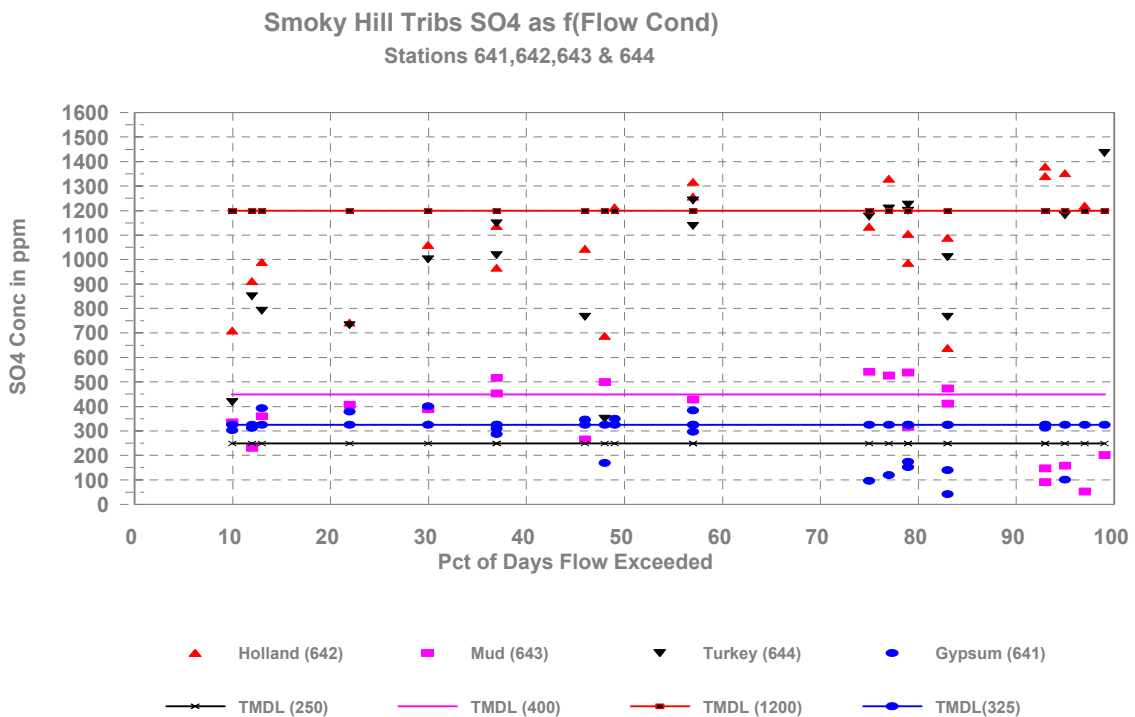


Figure 11. Saline River at Beverly and New Cambria Sulfate – Flow Relationship

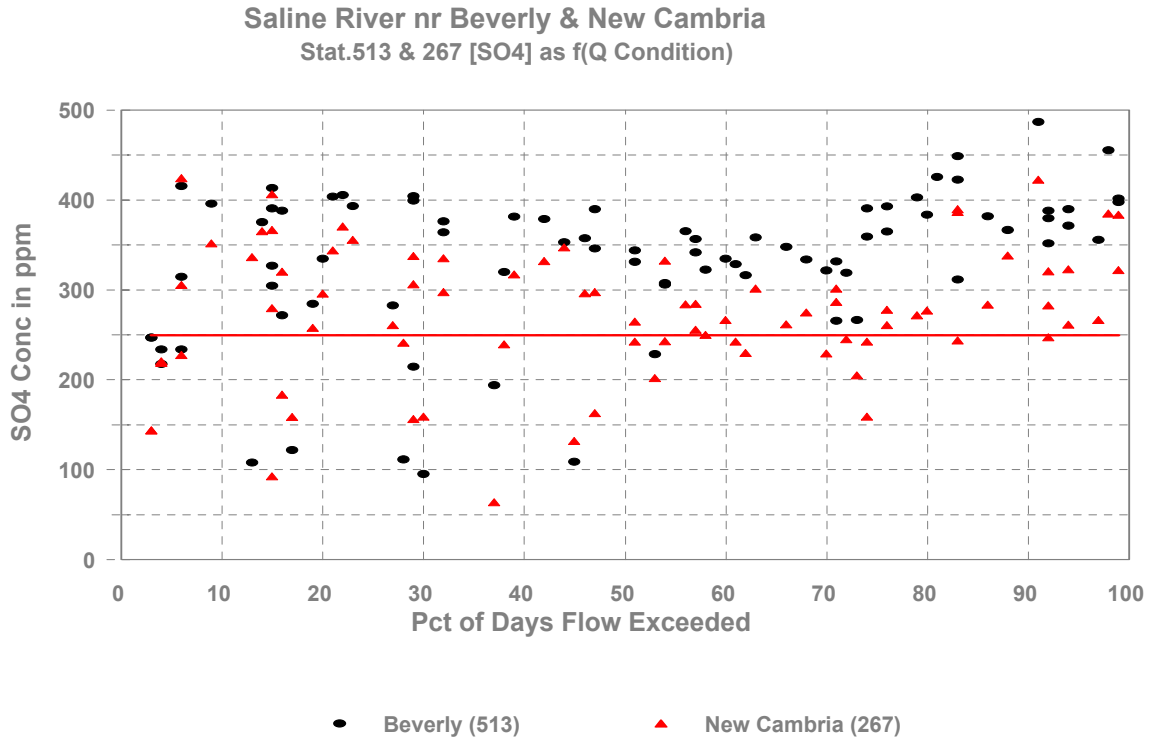


Figure 12. Smoky Hill River near Mentor Sulfate – Flow Relationship

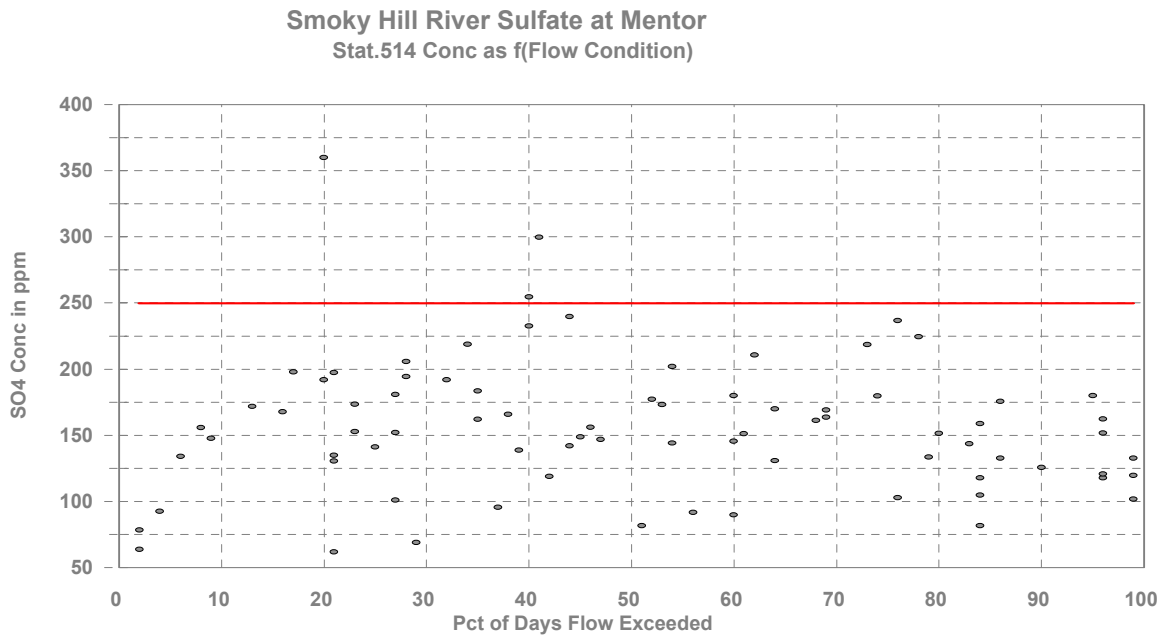


Figure 13. Saline River Tributaries Sulfate – Flow Relationship

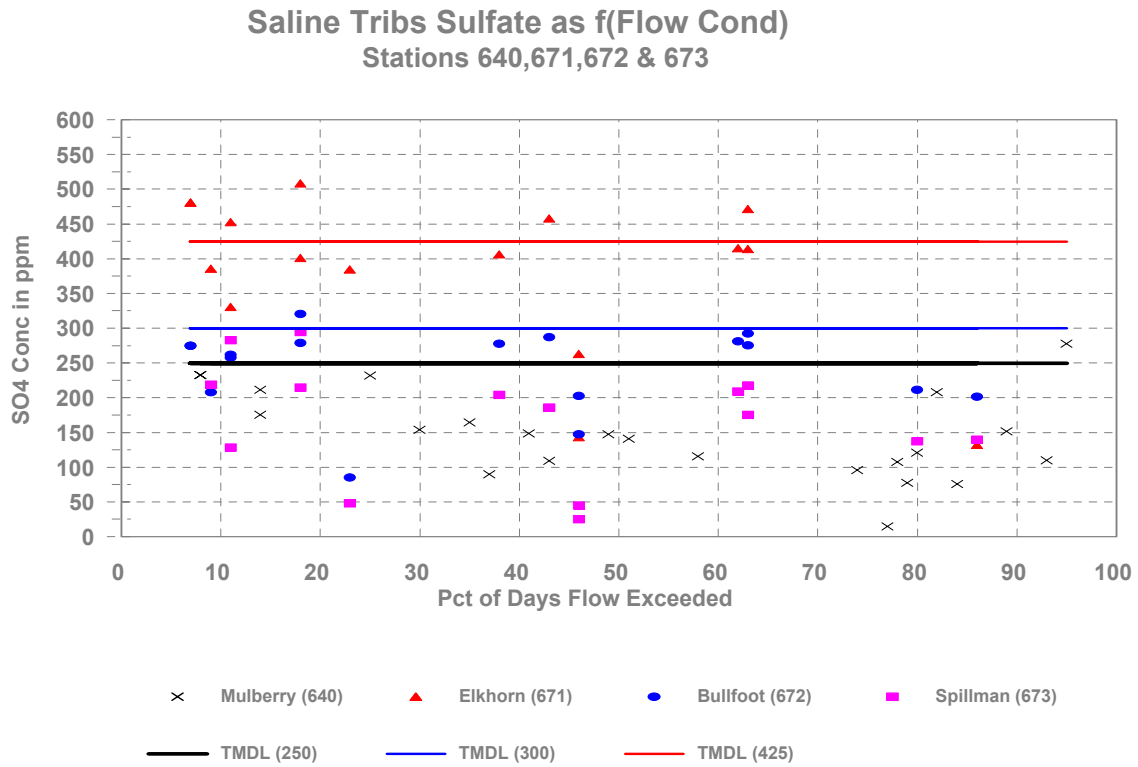


Figure 14. Wolf Creek Sulfate – Flow Relationship

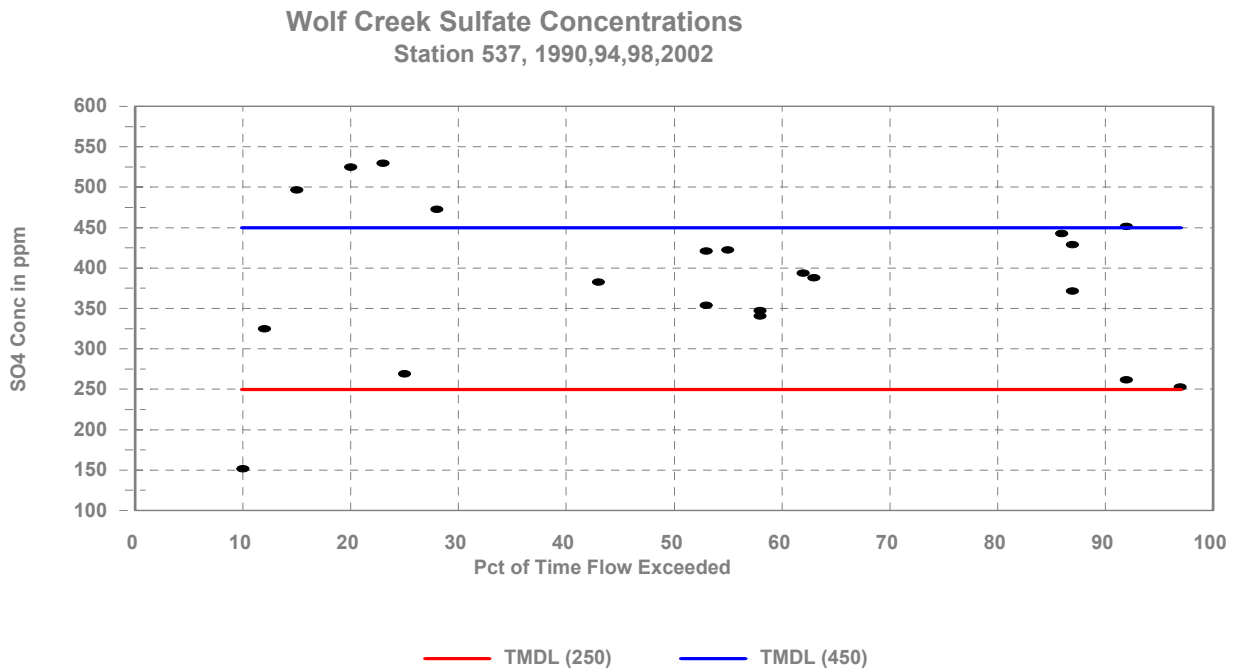


Table 2. Average Sulfate Concentrations at USGS and KDHE stations in the Smoky Hill Basin

USGS Station	Average Sulfate	KDHE Station	Average Sulfate
Kansas R. - Ft.Riley	183 mg/l	Kansas R. - Ogden	199 mg/l
Pre-90 Smoky Hill R. - Enterprise	203 mg/l	Present Day Smoky Hill R. - Enterprise	259 mg/l
Saline R. - Tescott	243 mg/l	Saline R. - Beverly	334 mg/l

Figure 15. Sulfate Conditions on the Saline River; 1950-1975 vs 1990-2003

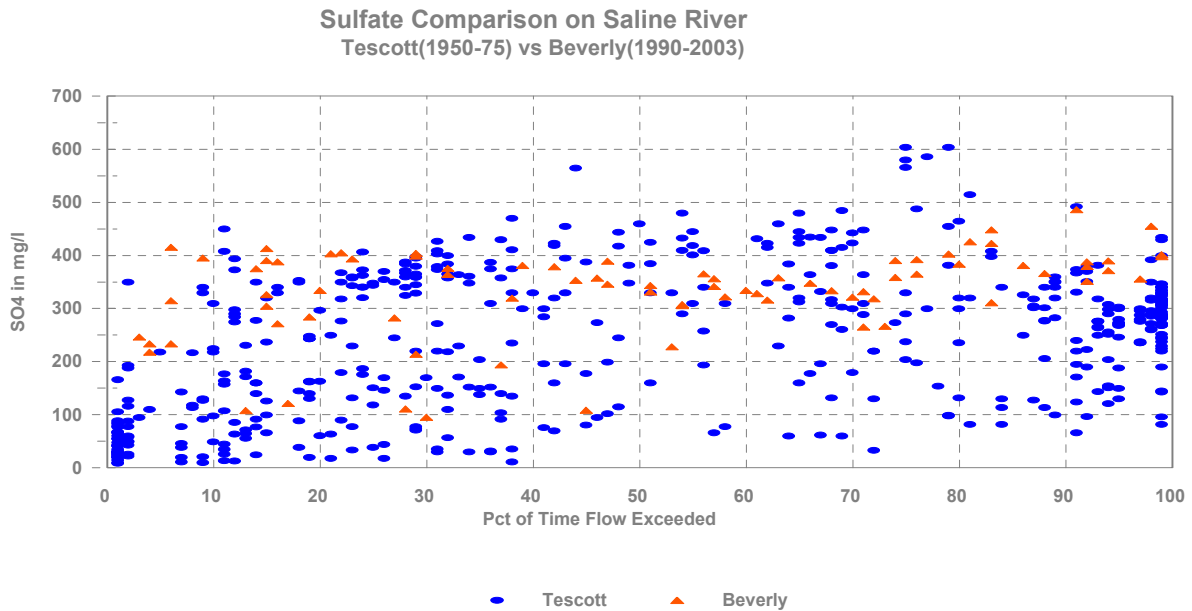
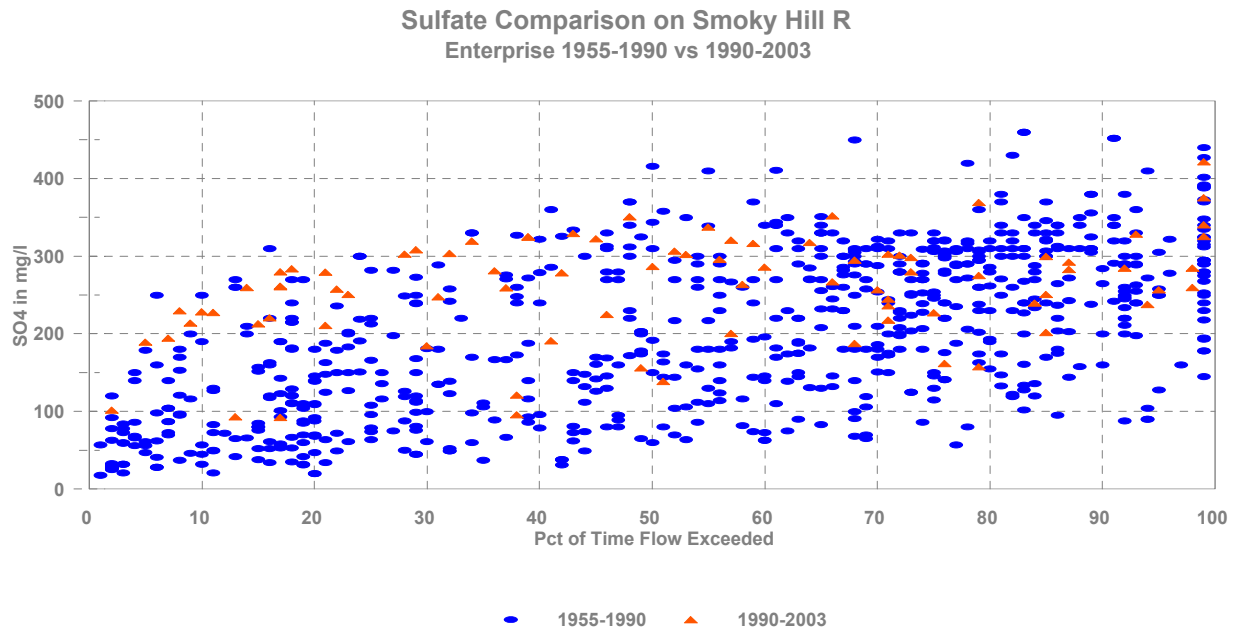


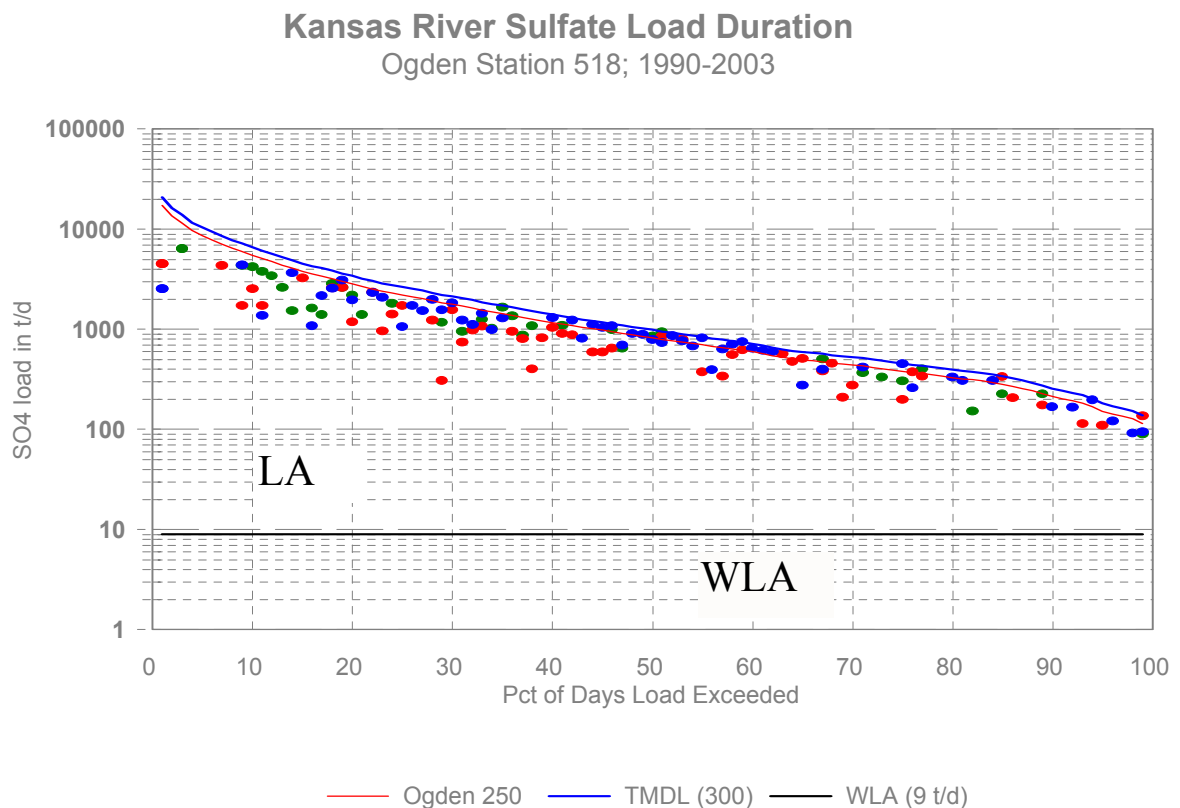
Figure 16. Sulfate Conditions on the Smoky Hill River at Enterprise; 1955-1990 vs 1990-2003



Uniform endpoints were applied to the streams because of the pervasive excursions over the 250 mg/l water quality criterion across varied flow conditions. While point source influences are most dramatic at low flows, the historic sampling record indicates concentrations of similar or greater magnitude occur at flows that far exceed the design flows of the point sources in this basin. Therefore, the causes of the excursions are likely to be natural in origin. Emphasis was placed on the Kansas River at Ogden because the Kansas River below the confluence with the Big Blue River has existing uses for Domestic Water Supply. A Load Duration Curve was used to express the TMDL for sulfate at Ogden (Figure 17).

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 in Figure 17: Spring (Apr-Jun; green), Summer-Fall (Jul-Oct; red) and Winter (Nov-Mar; blue). Generally, exceedances were seen during the lower flows of Summer, Fall and Winter. 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. 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. More excursions are seen in Winter when runoff and reservoir releases are lowest.

Figure 17. The TMDL Load Duration Curve for Sulfate on the Kansas River near Ogden.



Interim Endpoints of Water Quality (Implied Load Capacity) on the Upper Kansas River, Lower Smoky Hill River, Lower Saline River and Tributaries.

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 and Wellington Formations and washover of water interacting with gypsum beds, outcrops and enriched soils. As such, the watershed’s main stems and Wolf Creek have elevated sulfate levels from this natural source. In localized cases, some elevation beyond natural sulfate levels can be attributed to oil-field brine and long term consumptive use of water by irrigation. However, analysis of historic USGS chloride data and KGS chloride-bromide analysis suggest these anthropogenic impacts are minor and indiscernible against the climatic variability of the sulfate levels in the streams. The natural background of sulfate, consistently above 250 mg/L at low and high flows, makes achievement of the Standard unlikely on these streams. The existing criterion of 250 mg/l can be and is achieved on Lyon Creek, the Solomon River, the Smoky Hill River from Kanopolis to Salina, Mulberry Creek and Spillman Creek.

Since the existing criterion is not achievable on the Saline River, the Smoky Hill River below Salina, the Upper Kansas River above Ogden and the tributaries to these main stem reaches, because of natural contributions of the sulfate load, an alternative endpoint is needed. The need for an alternative endpoint is also justified by the inapplicability of the existing water quality standard for water supply since there are no points of diversion for domestic water supply between Salina and Ogden.

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. Because the excursions are occurring under almost all flow conditions, the Implementation Procedures do not apply well, therefore, the initial endpoints are established on the Kansas River at Ogden and applicable upstream reach segments by examining the concentration that most samples do not exceed across all flow ranges. Table 3 lists the proposed alternative background concentrations.

Phase Two of the TMDL will be based on the future standard under these flow conditions within the watersheds draining to these KDHE Stations. The Phase One endpoint of 250 mg/l will be established at any points of diversion constructed for water supply along the streams of the watershed above Ogden.

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.

Table 3. Background Concentration Endpoints for Applicable Stations in the Smoky Hill-Saline River System

Stream	Kansas R.	Carry Crk	Chapman Crk	Smoky Hill R.	Holland Crk	Mud Crk	Turkey Crk	Gypsum Crk	Saline R.	Saline R.	Elkhorn Crk	Bullfoot Crk.	Wolf Crk
Location	Ogden	Lyona	Sutphen	Enterprise	Abilene	Abilene	Abilene	Solomon	New Cambria	Beverly	Lincoln	Lincoln	Sylvan Grove
Station	518	708	515	265	642	643	644	641	267	513	671	672	537
Background	300 mg/l	400 mg/l	370 mg/l	325 mg/l	1200 mg/l	400 mg/l	1200 mg/l	325 mg/l	375 mg/l	390 mg/l	425 mg/l	300 mg/l	450 mg/l

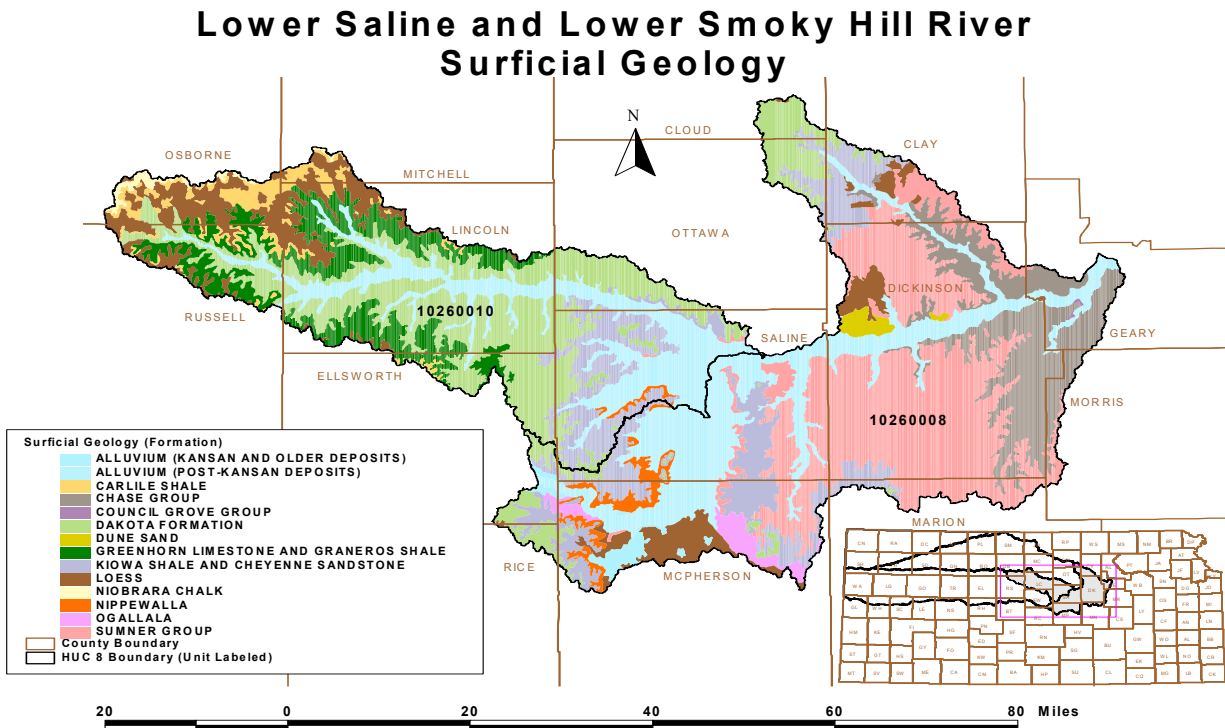
3. SOURCE INVENTORY AND ASSESSMENT

Geology: The main contribution of sulfate to the Lower Smoky Hill and Upper Kansas Rivers is the natural dissolution of gypsum and anhydrite in bedrock from the Permian Wellington Formation in outcrops and underlying Saline, Dickinson and southern Clay counties. Sulfate enters via ground water from the alluvial aquifers of the two rivers or tributary inflow from the surrounding creeks. Water within the Wellington Formation underlying the Smoky Hill River near the confluence of the Solomon River usually has sulfates in the range of 4000-8000 mg/l. Runoff and baseflow dissolving gypsum deposits is the chief contributor to sulfates in the tributaries in the Abilene – Chapman – Herrington vicinity.

Naturally saline ground water from the Dakota Formation in Russell County discharges into the alluvium of the Lower Saline River and Wolf Creek and contributes sulfate to those streams. Gypsum dissolution is responsible for the sulfate levels along the Saline and its tributaries. The gypsum is contained within shales of the upper Cretaceous bedrock underlying the drainage basin. Runoff from the uplands interacts with gypsum deposits exposed at the surface and loads up on sulfate as water moves through the soils and shallow geologic deposits. Some weathering of pyrite located within shale members of the Greenhorn Limestone, Carlile Shale and Dakota Formation also produces sulfate through oxidation. Generally, ground water loading is responsible for sulfate loadings at low flows and runoff-gypsum mixtures place sulfate in solution at high flows.

Evapo-transpiration and consumptive use of water in the basin can increase sulfate levels in the streams, but this is likely to be insignificant factors in the face of the geologic influences at all flow levels (Figure 18).

Figure 18. Surface Geology of TMDL Area



NPDES: There are fifteen permitted wastewater treatment facilities discharging to the Smoky Hill, Saline or Kansas Rivers (Appendix A-1). These fifteen point sources are listed in Appendix A-2 and typically discharge minor amounts of sulfate to the rivers. Three of the facilities have monitored for sulfate: Chapman averages 185 mg/l; Salina averages 243 mg/l; and Junction City-Southwest averages 82 mg/l. Similar effluent concentrations are expected for the other dischargers, depending on the sulfate content of their source water.

There are also four additional dischargers to the Smoky Hill River above the Mentor monitoring station (Appendix A-3). Since the river is not impaired by sulfate between Kanopolis Dam and Salina, these point sources are accounted by the ambient monitoring at Mentor and will not be assigned wasteload allocations under this TMDL. Similarly, there are eight dischargers on tributaries to the Smoky Hill and Saline Rivers that are accounted by monitoring stations located near the outlet of the tributary watersheds (Appendix A-4). Finally, there are eight quarries with NPDES permits located with the TMDL area (Appendix A-5). Six of the quarries handle limestone, one is a clay mining operation and the last site quarries shale. Review of the discharge records for the quarries indicates all but one does not discharge except for quarry or mine pit dewatering or during stormwater runoff. The one quarry located in Geary County does discharge regularly, but only has a sulfate level of 32 mg/l.

There are also twenty-eight non-discharging municipal, commercial and industrial facilities within the TMDL area (Appendix B). These facilities retain all wastewater and will be given a wasteload allocation of zero to reflect their lack of discharge and impact to the streams of the Lower Smoky Hill, Lower Saline and Upper Kansas sub-basins.

Irrigation: Use of surface and ground water for irrigation does occur throughout the sub-basins, but in moderate volumes. Table 4 displays the 2001 reported Irrigation Water Use and estimates of potential stream depletion and return flows for the monitored watersheds in the three sub-basins. Potential depletion was estimated by assuming the total irrigation use, from both surface water and ground water, was supplied by the streams in each watershed over the course of an 120-day growing season. Return flows were estimated by assuming that 85% of the diversion was consumed through evapotranspiration and deep percolation would return the remaining water to the stream as seepage over an 180-day period. By these calculations, ten percent of the diverted water would be returned to the stream.

As can be seen in Table 4 and Figure 19, most of the irrigation is located within the alluvial valley of the Smoky Hill River between Kanopolis Dam and Salina. Additional irrigation pressure is seen along the Smoky Hill and Kansas Rivers between Enterprise and Ogden. These two irrigation areas coincide with areas with the freshest water supply. Within the saline influenced drainages of the Saline River from Wilson Dam to Salina and the Smoky Hill River from Salina to Enterprise, irrigation is spottier because of the poor quality water, particularly in the area influenced by the briny Wellington formation.

Irrigation along the tributaries is very small, because of the lower availability of water and the diminished suitability of the soils and landscape for irrigation.

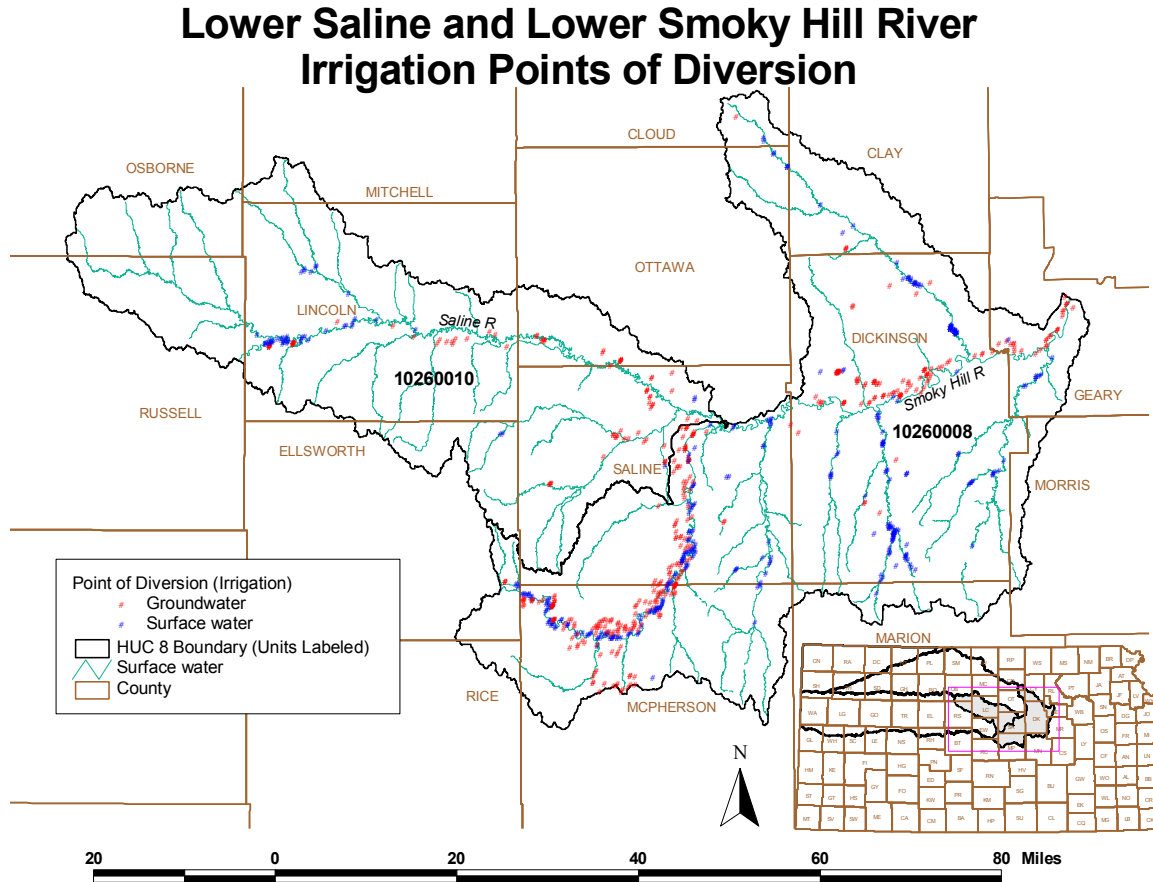
Table 4. 2001 Irrigation Use in Sub-basins of the Lower Smoky Hill – Saline River System

Monitoring Site	Site #	SW af	GW af	Total af	Pot. Depletion	Pot. Return Flows
Saline-Beverly	513	206.4	529.5	735.9	3.1 cfs	0.31 cfs
Saline-New Cambria	267	0	305.6	305.6	1.3 cfs	0.13 cfs
Wolf Creek	537	0	0	0	0	0
Bullfoot Creek	671	0	0	0	0	0
Elkhorn Creek	672	0	0	0	0	0
Spillman Creek	673	0	0	0	0	0
Mulberry Creek	640	1.0	299.3	299.3	1.3 cfs	0.13 cfs
Smoky Hill – Mentor	514	2552.3	6147.4	8699.7	36.6 cfs	3.7 cfs
Smoky Hill – Salina	268	64.6	1386.8	1451.4	6.1 cfs	0.6 cfs
Smoky Hill –Enterprise	265	0	919.8	919.8	3.9 cfs	0.39 cfs
Gypsum Creek	641	63.2	18.8	82.0	0.34 cfs	0.03 cfs
Holland Creek	642	0	0	0	0	0
Mud Creek	643	0	432.8	432.8	1.82 cfs	0.18 cfs
Turkey Creek	644	188.1	9.2	197.3	0.83 cfs	0.08 cfs
Kansas – Ogden	518	0	2471.4	2741.4	10.4 cfs	1.0 cfs
Lyon Creek	516	84.7	0	84.7	0.36 cfs	0.04 cfs
Chapman Creek	515	537.5	32.3	569.8	2.4 cfs	0.24 cfs

Irrigation along the Smoky Hill River from Kanopolis Dam to Salina is seasonally intense with loss of flow between the Langley gage to the Mentor gage. Any loss of flow is reversed once growing season ceases. The depletion impact is mitigated, to a degree, by releases from Kanopolis and, despite, the heaviest irrigation pressure, there are no sulfate impairments at the Mentor or Salina monitoring sites. Given the strong environmental constraint of the saline water supplies, irrigation does not exert much influence on the sulfate levels seen in the TMDL area. Irrigation is either non-existent, of small volume in terms of depletion and return flows, or mitigated by reservoir releases, particularly from Kanopolis and Milford Reservoir on the Republican above Junction City. The incidence of high sulfate excursions at high flows when irrigation has ceased or any return flows or depletions are overwhelmed by the amount of streamflow indicates that sulfate is more influenced by geology and climate than anthropogenic factors.

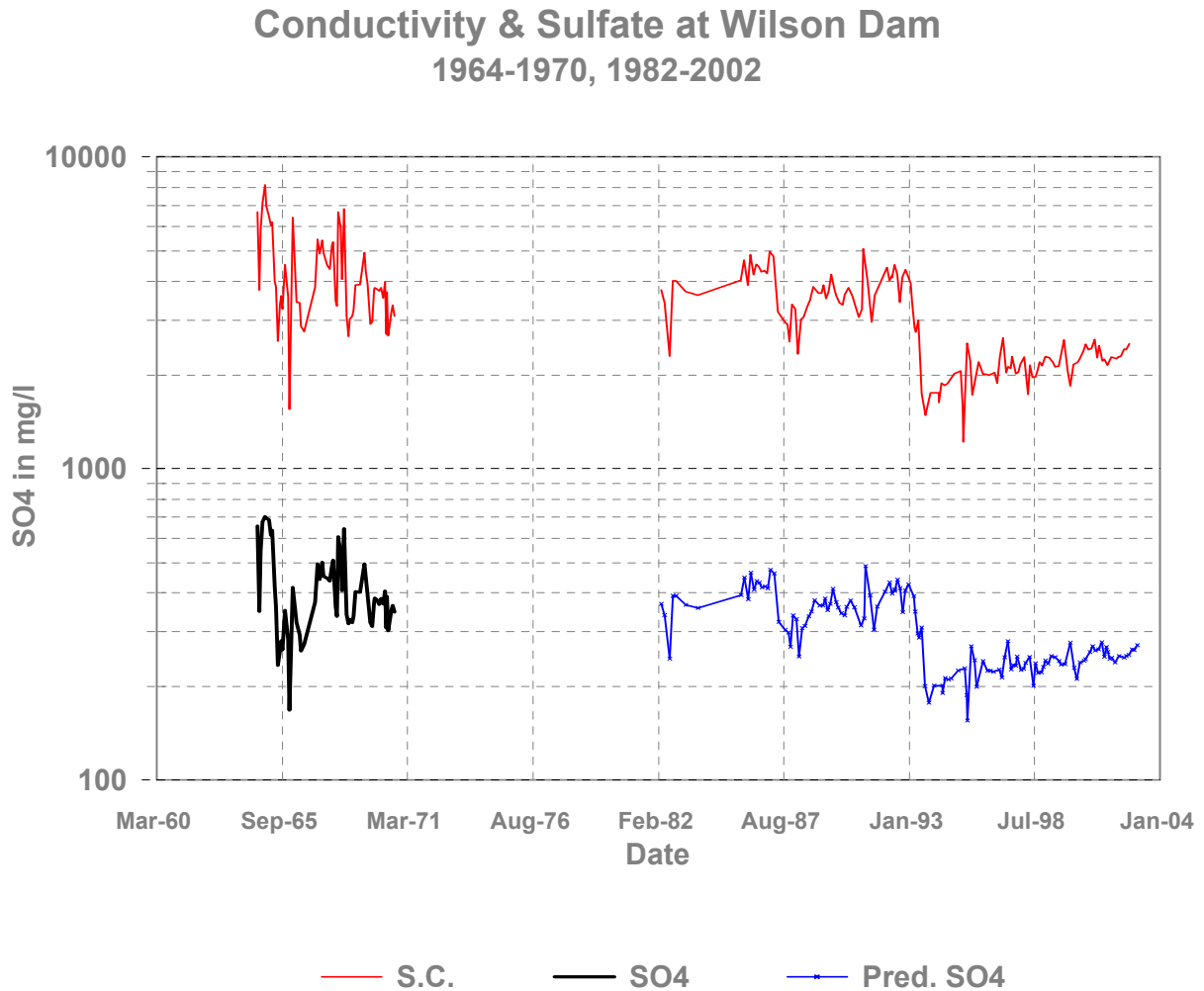
Brine from Oil and Gas Operations: While there are some historic oil and gas operations within the TMDL area (see www.kgs.ku.edu/PRS/petro/interactive.html), examination of the chemistry of the water in Wolf Creek, Saline River and Smoky Hill River indicates that any loading from brine disposal, past or present, is insignificant in the face of the climatic and geologic driven variability of sulfate levels seen in the streams (Whittemore, 2004).

Figure 19. Irrigation Points of Diversion in Lower Saline and Smoky Hill Subbasins



Wilson Dam Releases: Sulfate samples were taken by USGS at the gaging station below Wilson Dam from 1964 to 1970 and specific conductivity measurements were taken from 1964 to 2002. There is a strong correlation between conductivity and sulfate ($SO_4 = 48.5 + 0.0854 \cdot SC$; $R^2 = 0.90$). Figure 20 shows the variability of conductivity and predicted sulfate over time. There was a data gap between 1970 and 1982. The highest sulfates were present within Wilson Lake in 1964-1965, when the lake was filling and minimal releases of water were made. As the pool filled, usually by sporadic fresh water runoff, sulfate levels declined in 1970. Resumption of sampling in 1982 saw sulfate levels elevated slightly from 1970, likely an aftermath of the 1980-81 drought conditions. A major filling event in 1987 depressed sulfate levels and the 1993 flood significantly diluted the lake concentrations. Since 1993, the lake drainage has been getting dryer over time and sulfates are trending upward. Average of actual sulfate concentrations in 1964-1970 was 410 mg/l. Average predicted sulfate from 1982 to 2002 was 297 mg/l. Releases from Wilson Lake reflecting capture of Dakota mineralized intrusion into the Saline River have a significant influence on downstream sulfate concentrations.

Figure 20. Actual and Estimated Sulfate Concentration of Wilson Dam Releases



4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

Point and Non-point Sources: Because of the data showing low to moderate levels of sulfate from those few facilities with monitored effluent, the point sources will be assigned an allocation based on their design flows and the current water quality criterion of 250 mg/l. These allocations will be influenced by the source water of the municipalities, which should be below background levels. Non-point source allocations will reflect the heightened background concentrations seen at all flow conditions. Since the majority of the sulfate load is generated by the movement of runoff over gypsum laden geology and soils, the background concentrations are the most likely endpoint to be achieved under this TMDL. The allocations will need to be reviewed if a water supply point of diversion is established on any of the streams.

Table 5 displays the wasteloads, load allocations and Margin of Safety under wet, normal and dry flow conditions on the streams of the three TMDL subbasins.

Table 5. Wasteloads, Loads Allocations and Margin of Safety (tons/day) at Different Flow Conditions for Smoky Hill – Saline River System

Stream	Station	LOAD ALLOCATIONS (MOS)			WLA
		25%Q	50%Q	75%Q	
Kansas R. – Ogden	518	2377 (264)	889 (99)	410 (46)	9.00
Lyon Creek	516	46 (5)	23 (3)	11 (1)	0.95
Carry Creek	708	29 (3)	14 (1)	5 (1)	0.0
Chapman Creek	515	52 (6)	25 (3)	13 (1)	0.05
Smoky Hill R. – Enterprise	265	1398 (155)	574 (64)	252 (28)	9.00
Turkey Creek	644	202 (22)	90 (10)	32 (4)	0.0
Mud Creek	643	23 (2)	8 (1)	2.2 (.3)	0.72
Holland Creek	642	96 (11)	41 (4)	14 (2)	0.0
Gypsum Creek	641	44 (5)	18 (2)	5 (0.5)	0.04
Smoky Hill R. – Salina/Mentor	268/514	209 (23)	96 (11)	45 (5)	0.57
Smoky Hill R. – Kanopolis Dam	N/A	122 (14)	60 (7)	31 (3)	0.0
Saline R. – New Cambria	267	254 (28)	75 (8)	36 (4)	0.11
Saline R. – Beverly	513	225 (25)	67 (7)	32 (4)	0.20
Mulberry Creek	640	31 (3)	12 (1)	3.6 (0.4)	0.01
Elkhorn Creek	671	9 (1)	4 (0.5)	0.9 (0.1)	0.0
Bullfoot Creek	672	7 (1)	2.7 (0.3)	0.5 (0.1)	0.0
Spillman Creek	673	8 (1)	2.9 (0.3)	0.8 (0.1)	0.0
Wolf Creek	537	17 (2)	6 (1)	2.7 (0.3)	0.09
Saline River – Wilson Dam	N/A	107 (12)	22 (2)	14 (1)	0.0

Wasteload Allocations are fixed by the design flow for each of the facilities located within the TMDL area and the 250 mg/l sulfate criterion. Specific wasteload allocations were not assigned to the quarries in the drainage because of their inconsistent and uncommon discharge patterns. Monitoring data from one of the quarries showed low sulfate levels in its discharge (32 mg/l). Should a future need arise to assign a wasteload allocation to persistently discharging quarries, that allocation may be made through reallocation of existing wasteload allocations for the same stream segment, or a reallocation of the pertinent flow weighted load allocation might be made. Figures 21-31 display the TMDLs and their allocations across flow conditions for the streams in this drainage.

Margin of Safety: The Margin of Safety is explicitly set at 10% of the Load Allocation at the three flow conditions. Wasteload allocations are at existing concentrations which are below the 250 mg/l criterion. The impairments are generated from non-point sources and it is proper to establish the Margin of Safety on these major pollutant sources.

State Water Plan Implementation Priority: Because the sulfate along the Lower Saline and Smoky Hill Rivers is primarily due to natural geologic sources, this TMDL will be a Low Priority for implementation.

Figure 21. Kansas River at Ogden Sulfate TMDL

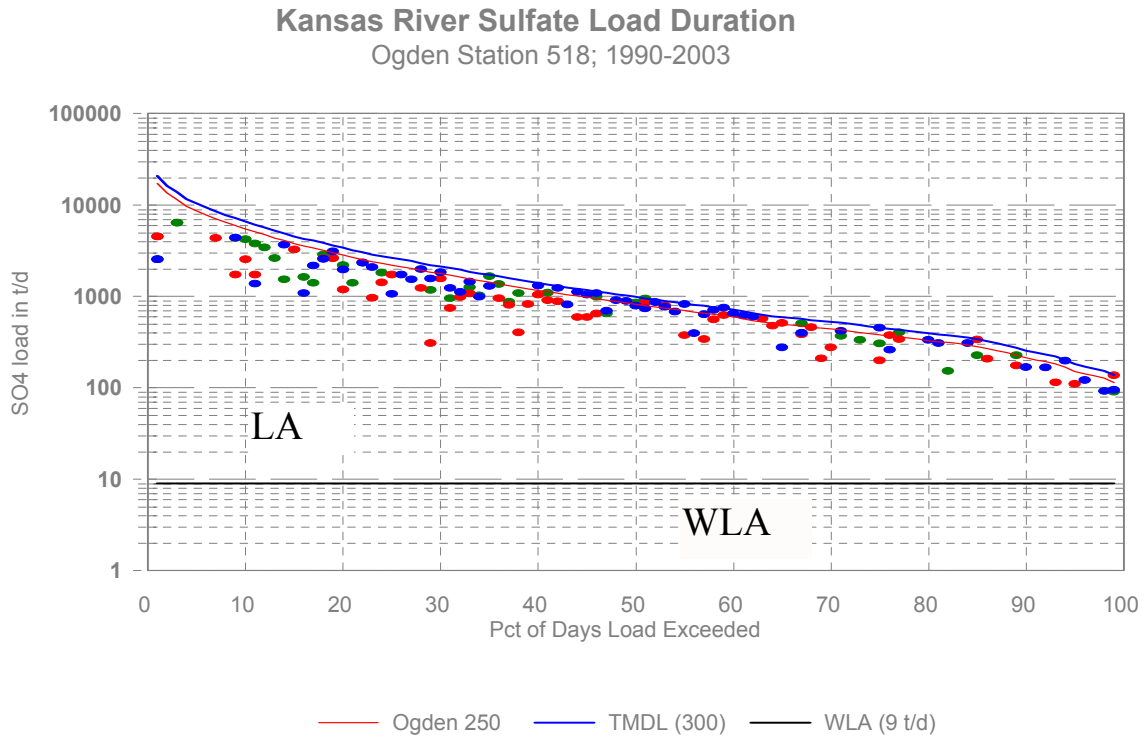


Figure 22. Smoky Hill River at Enterprise Sulfate TMDL

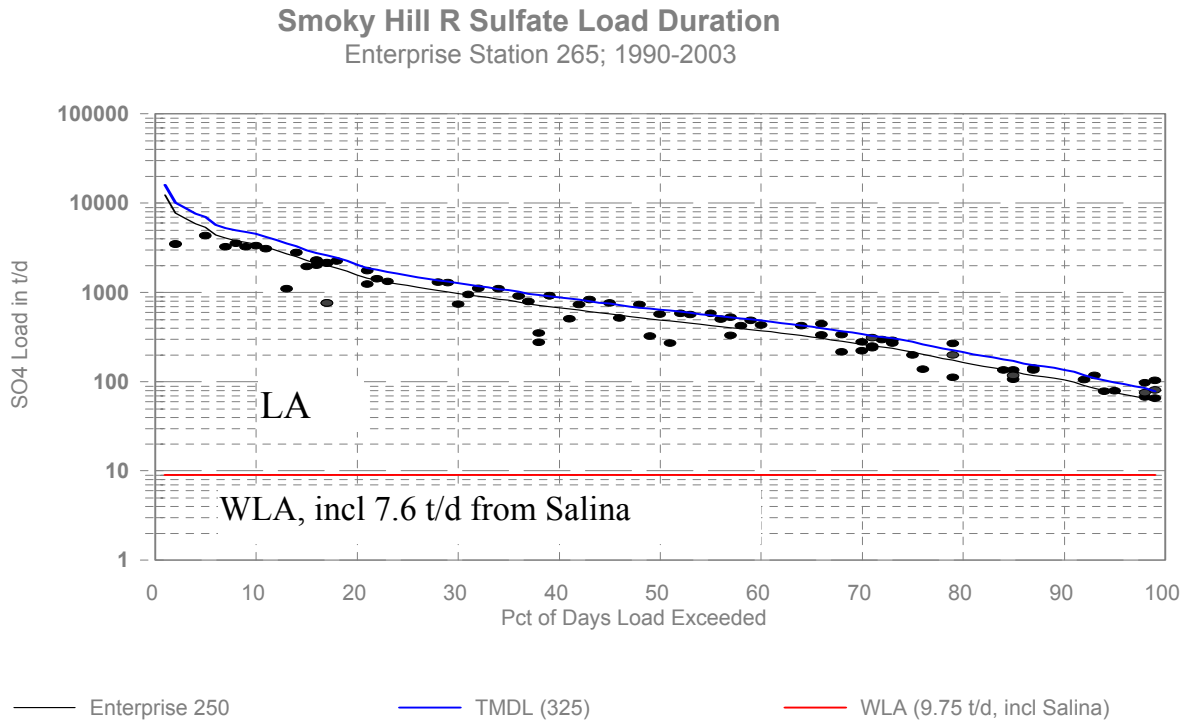


Figure 24. Chapman Creek at Sutphen Sulfate TMDL

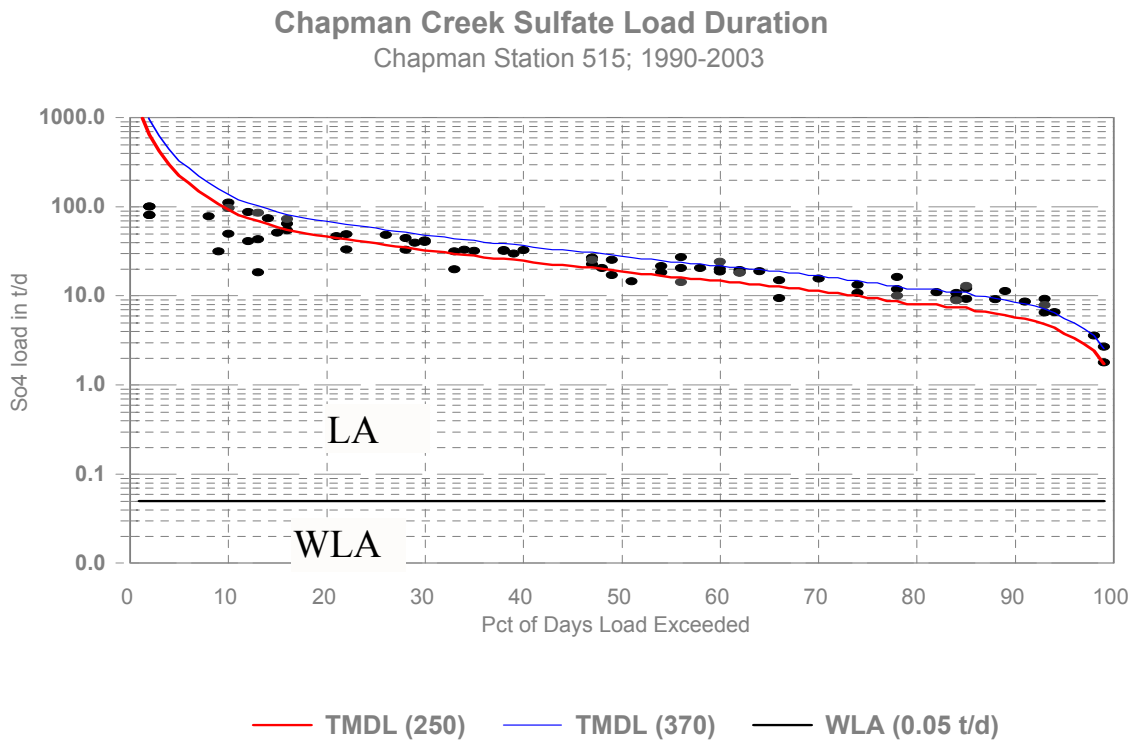


Figure 25. Lyon and Carry Creek Sulfate TMDL

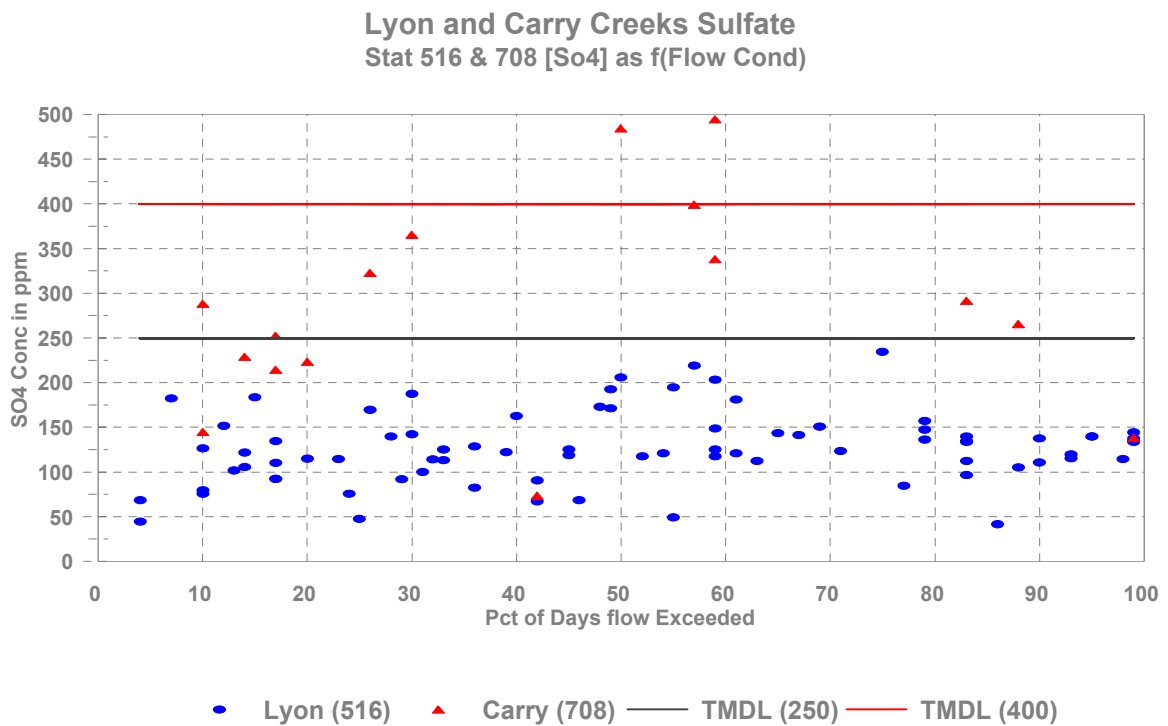


Figure 26. Abilene Vicinity Streams Sulfate TMDL

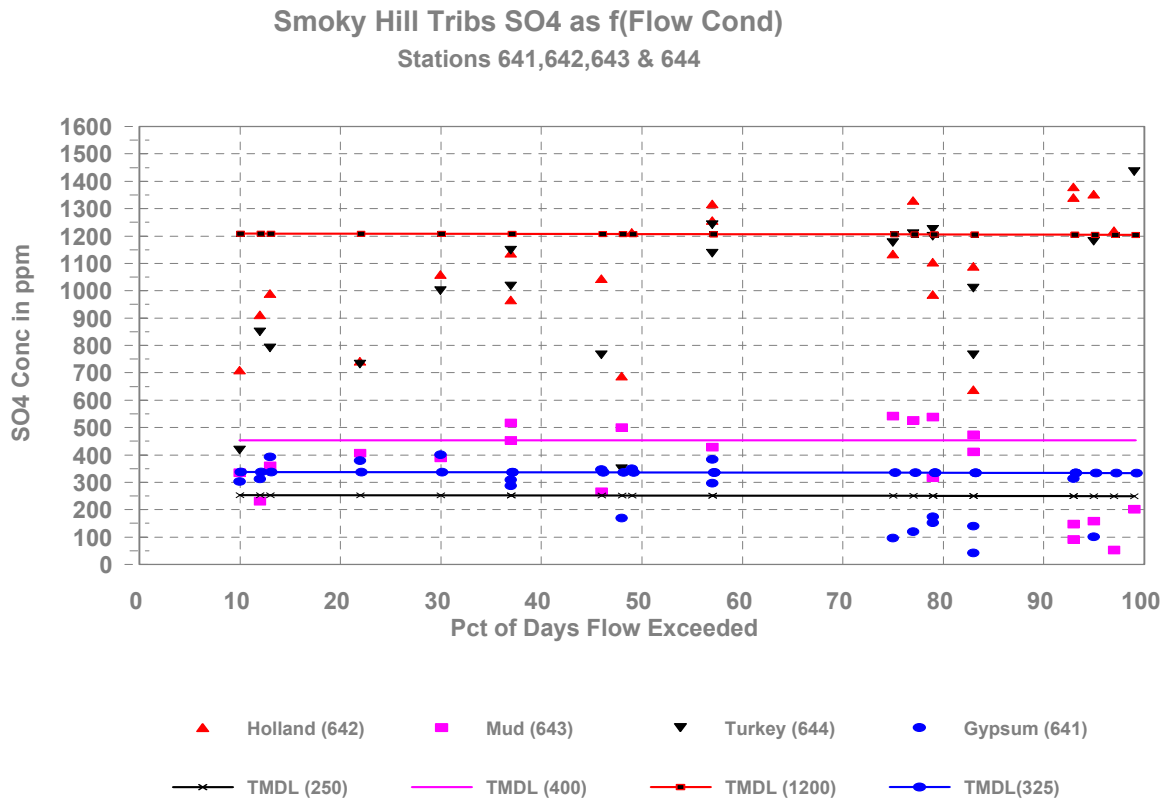


Figure 27. Smoky Hill River at Mentor Sulfate TMDL

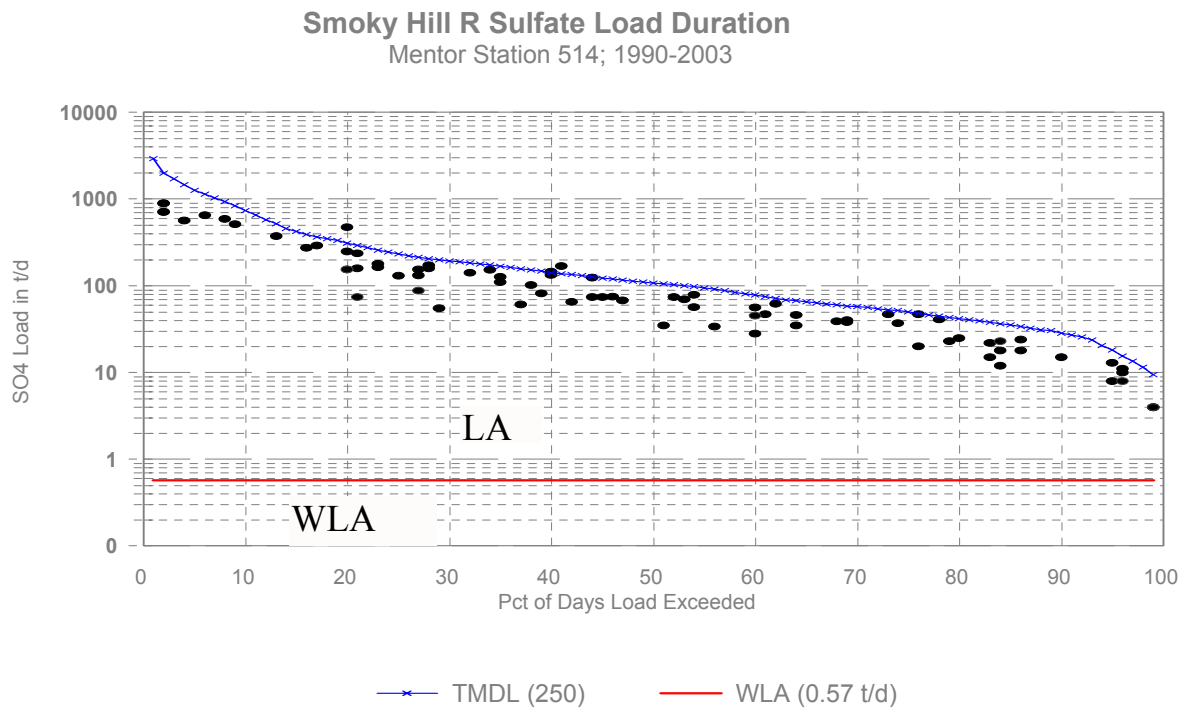


Figure 28. Saline River at New Cambria Sulfate TMDL

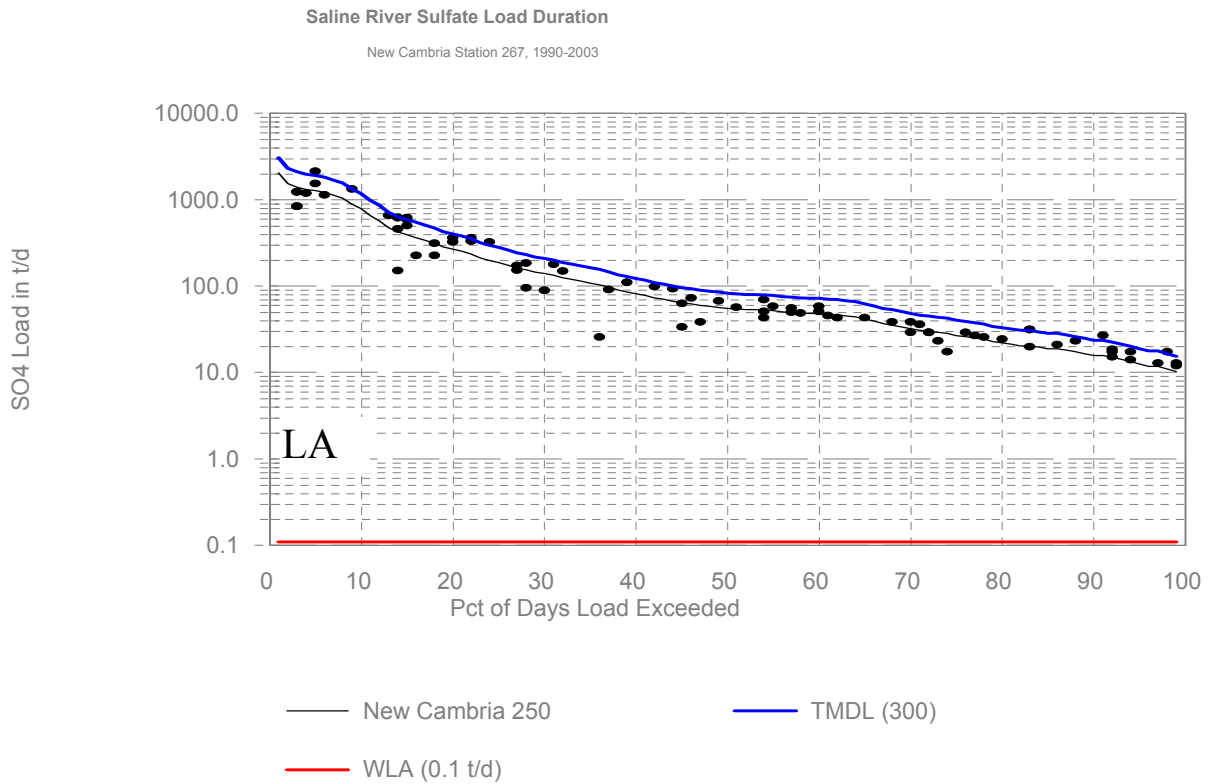


Figure 29. Saline River at Beverly Sulfate TMDL

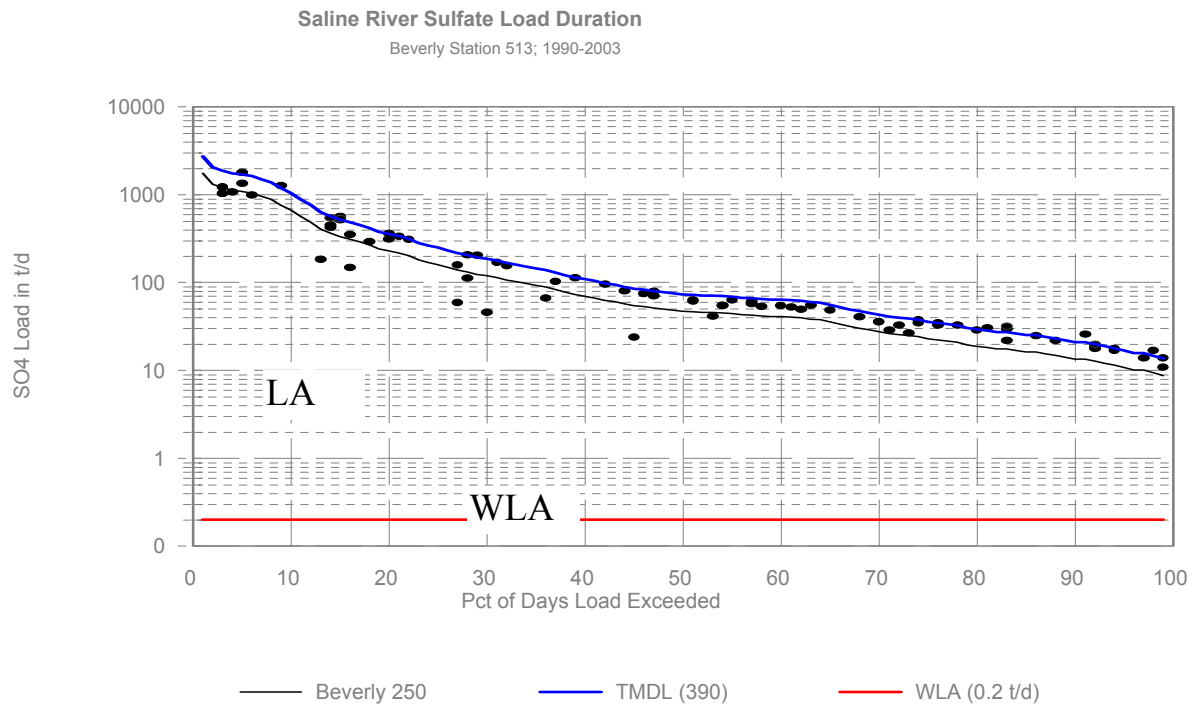


Figure 30. Saline River Tributaries Sulfate TMDL

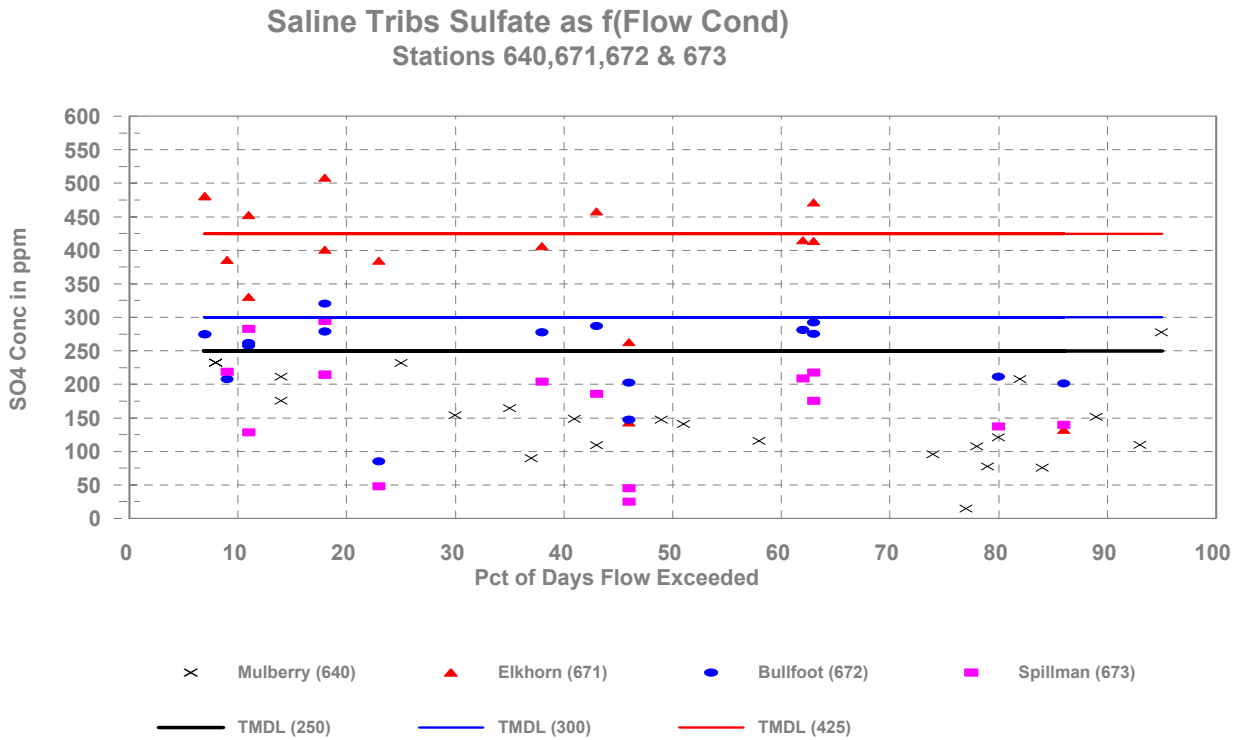
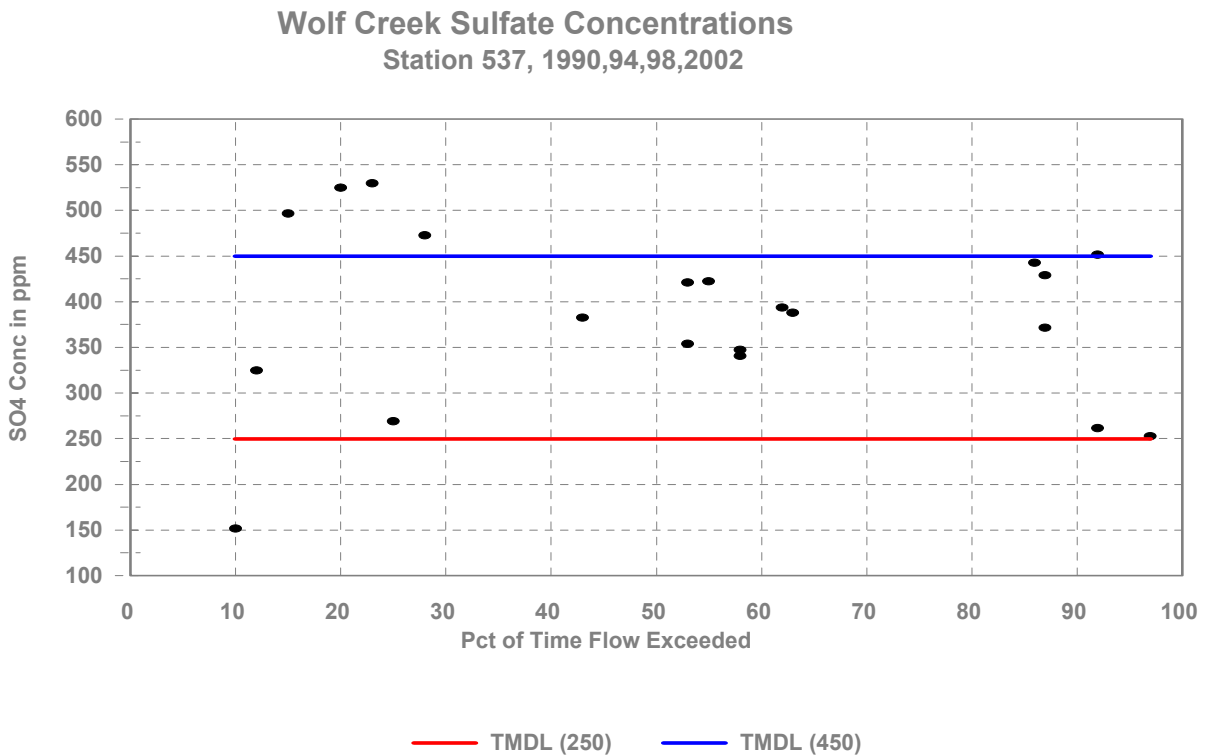


Figure 31. Wolf Creek Sulfate TMDL



Unified Watershed Assessment Priority Ranking: This TMDL addresses streams within three Subbasins: the Lower Smoky Hill (HUC 8: 10260008) with a ranking of 35 (Medium Priority for restoration), the Lower Saline (HUC 8: 10260010) with a ranking of 33 (Medium Priority for restoration) and the Upper Kansas (HUC 8: 10260101) with a priority ranking of 22 (Medium Priority for restoration).

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

5. IMPLEMENTATION

Desired Implementation Activities

1. Monitor any anthropogenic contributions of sulfate loading to the river system.
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.

Non-Point Source Pollution Technical Assistance - KDHE

- a. Evaluate any potential anthropogenic activities which might contribute sulfate to the streams 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 2004 water quality standards revision.

Targeted Participants: Primary participants for implementation will be KDHE.

Milestone for 2009: The year 2009 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 sulfate levels in the streams, particularly at lower 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, particularly at higher flows. Some runoff and erosion control practices might lower sulfate loading to stream reaches

6. MONITORING

KDHE will continue to collect bimonthly samples from permanent and rotational stations between Kanopolis and Wilson Dams and the Kansas River at Ogden. Based on that sampling, the priority status will be evaluated in 2009 including application of numeric criterion based on background concentrations.

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

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 2009, evaluation will be made as to the degree of implementation which has occurred within the watershed and current condition of the streams of the Lower Smoky Hill, Lower Saline and Upper Kansas Sub-basins. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

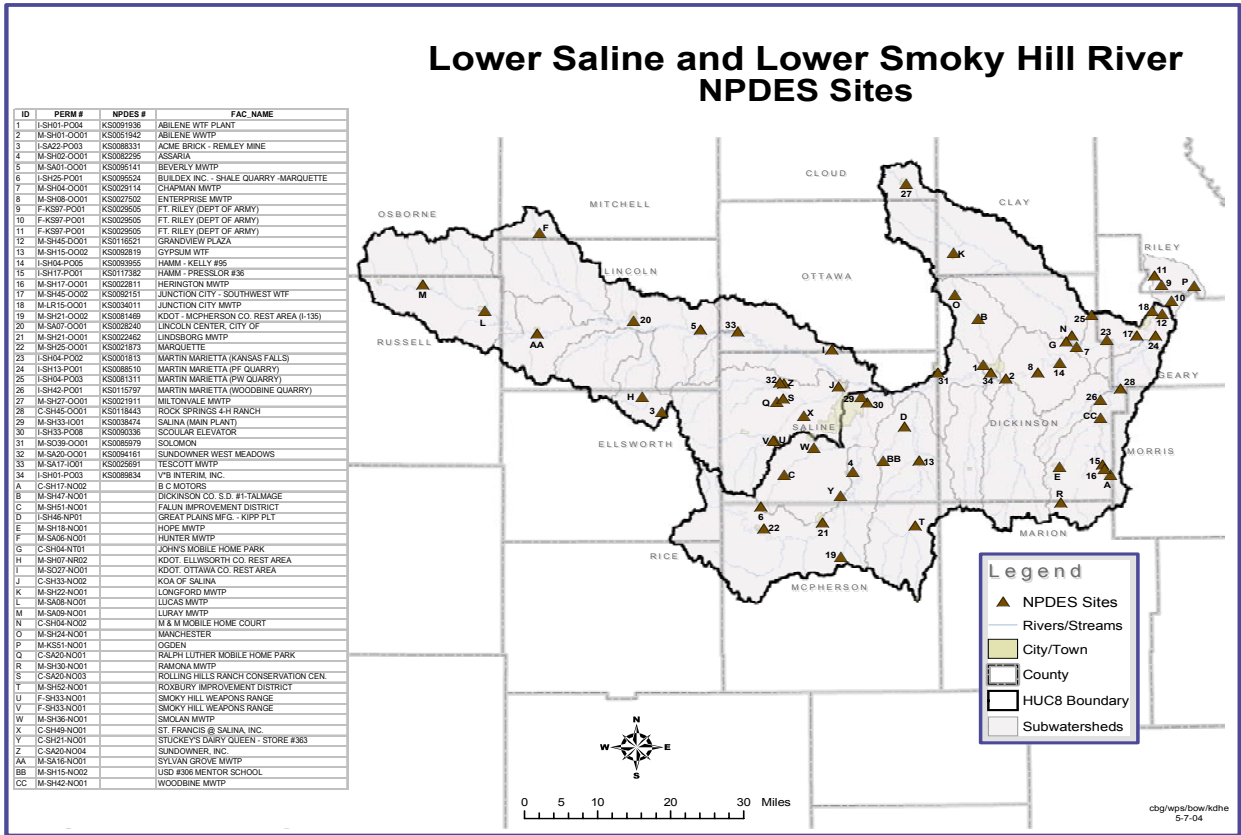
Consideration for 303(d) Delisting: The streams will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2008-2012. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable 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; March 12 & 15, 2004 Memos on Salt Source assessment and analysis for the sulfate TMDL for the lower Saline River basin and the lower Smoky Hill basin.**

Appendix A-1 NPDES Sites in Smoky Hill TMDL Area



APPENDIX A-2: DISCHARGERS OF SULFATE INTO SMOKY HILL, SALINE AND KANSAS RIVERS

PERMIT #	NPDES #	FACILITY NAME	RECEIVING STREAM	DSGN Q (MGD)	AVG SO4 (mg/l)
F-KS97-PO01	KS0029505	FT. RILEY (CUSTER HILL)	KANSAS RIVER VIA THREE MILE CREEK	1.330	
F-KS97-PO01	KS0029505	FT. RILEY (MAIN POST)	KANSAS RIVER	1.100	
F-KS97-PO01	KS0029505	FT. RILEY (CAMP FORSYTH)	KANSAS RIVER VIA REPUBLICAN RIVER	0.630	
M-LR15-OO01	KS0034011	JUNCTION CITY MWTP	KANSAS RIVER VIA REPUBLICAN RIVER	2.500	
M-SH45-DO01	KS0116521	GRANDVIEW PLAZA	SMOKY HILL RIVER	0.190	
M-SH45-OO02	KS0092151	JUNCTION CITY - SOUTHWEST WTF	SMOKY HILL RIVER	2.500	82
M-SH04-OO01	KS0029114	CHAPMAN MWTP	SMOKY HILL RIVER	0.250	185
M-SH08-OO01	KS0027502	ENTERPRISE MWTP	SMOKY HILL RIVER	0.090	
M-SH01-OO01	KS0051942	ABILENE WWTP	SMOKY HILL RIVER	1.206	
M-SO39-OO01	KS0085979	SOLOMON MWTP	SMOKY HILL RIVER VIA SOLOMON RIVER	0.110	
M-SH33-IO01	KS0038474	SALINA (MAIN PLANT)	SMOKY HILL RIVER	7.250	243
I-SH33-PO08	KS0090336	SCOULAR ELEVATOR	SMOKY HILL RIVER VIA EAST DRY CREEK	0.036	300*
M-SA01-OO01	KS0095141	BEVERLY MWTP	SALINE RIVER	0.014	400*
M-SA17-IO01	KS0025691	TESCOTT MWTP	SALINE RIVER	0.048	
M-SA07-OO01	KS0028240	LINCOLN MWTP	SALINE RIVER	0.220	

APPENDIX A-3: DISCHARGERS TO THE SMOKY HILL RIVER ABOVE THE MENTOR STATION

PERMIT #	NPDES #	FACILITY NAME	RECEIVING STREAM	DES Q (MGD)
M-SH02-OO01	KS0082295	ASSARIA	SMOKY HILL RIVER	0.0600
M-SH21-OO01	KS0022462	LINDSBORG MWTP	SMOKY HILL RIVER	0.4180
M-SH21-OO02	KS0081469	KDOT - MCPHERSON CO. REST AREA (I-135)	SMOKY HILL RIVER VIA W. KENTUCKY CREEK	0.0076
M-SH25-OO01	KS0021873	MARQUETTE	SMOKY HILL RIVER	0.0670

APPENDIX A-4: DISCHARGERS TO MONITORED TRIBUTARIES TO THE SMOKY HILL AND SALINE RIVERS

PERMIT #	NPDES #	FACILITY NAME	RECEIVING STREAM	DES Q (MGD)
M-SH17-OO01	KS0022811	HERINGTON MWTP	SMOKY HILL R VIA LIME CR	0.9000
C-SH45-OO01	KS0118443	ROCK SPRINGS 4-H RANCH	SMOKY HILL R VIA LYON CRK	0.0125
I-SH01-PO03	KS0089834	V*B INTERIM, INC.	SMOKY HILL RIVER VIA MUD CREEK	0.4000
I-SH01-PO04	KS0091936	ABILENE WTF PLANT	SMOKY HILL RIVER VIA MUD CREEK	0.2880
M-SH27-OO01	KS0021911	MILTONVALE MWTP	CHAPMAN CR	0.0490
M-SH15-OO02	KS0092819	GYPSUM WTF	GYPSUM CREEK	0.0410
M-SA20-OO01	KS0094161	SUNDOWNER WEST MEADOWS	MULBERRY CREEK	0.0110
M-SA08-OO02	KS0095222	LUCAS MWTP	WOLF CREEK	0.0850

APPENDIX A-5: QUARRY DISCHARGERS IN LOWER SMOKY HILL/SALINE BASIN

PERMIT #	NPDES #	FACILITY NAME	RECEIVING STREAM	TYPE	ACT Q?
I-SH04-PO02	KS0001813	MARTIN MARIETTA (KANSAS FALLS)	SMOKY HILL RIVER/OLD RIVER OXBOW	LIMESTN	YES – 32 mg/l SO4
I-SH04-PO05	KS0093955	HAMM - KELLY #95	SMOKY HILL RIVER/TERRAPIN LAKE	LIMESTN	NO
I-SH17-PO01	KS0117382	HAMM - PRESSLOR #36	SMOKY HILL RIVER	LIMESTN	NO
I-SH42-PO01	KS0115797	MARTIN MARIETTA (WOODBINE QUARRY)	LWR SMOKY HILL R VIA LYON CR	LIMESTN	NO
I-SH13-PO01	KS0088510	MARTIN MARIETTA (PF QUARRY)	SMOKY HILL RIVER/UNNAMED TRIB.	LIMESTN	NO
I-SH04-PO03	KS0081311	MARTIN MARIETTA (PW QUARRY)	LOWER SMOKY HILL RIVER	LIMESTN	NO
I-SA22-PO03	KS0088331	ACME BRICK - REMLEY MINE	SALINE RIVER/EAST ELKHORN CREEK	CLAY	NO
I-SH25-PO01	KS0095524	BUILDEX INC. - SHALE QUARRY -MARQUETTE	SMOKY HILL RIVER VIA WEST DRY CREEK	SHALE	NO

APPENDIX B-1: NON-DISCHARGING FACILITIES IN LOWER SMOKY HILL/SALINE BASIN

PERMIT #	FACILITY	DRAINAGE
C-SA20-NO01	RALPH LUTHER MOBILE HOME PARK	SALINE RIVER
C-SA20-NO03	ROLLING HILLS RANCH CONSERVATION CEN.	SALINE RIVER
C-SA20-NO04	SUNDOWNER, INC.	SALINE RIVER
C-SH04-NO02	M & M MOBILE HOME COURT	LWR. SMOKY HILL RIVER
C-SH04-NT01	JOHN'S MOBILE HOME PARK	LOWER SMOKY HILL RIVER
C-SH17-NO02	B C MOTORS	SMOKY HILL
C-SH21-NO01	STUCKEY'S DAIRY QUEEN - STORE #363	SMOKY HILL RIVER
C-SH33-NO02	KOA OF SALINA	SALINE RIVER
C-SH49-NO01	ST. FRANCIS @ SALINA, INC.	SMOKY HILL RIVER
F-SH33-NO01	SMOKY HILL WEAPONS RANGE	SMOKY HILL RIVER
F-SH33-NO01	SMOKY HILL WEAPONS RANGE	SMOKY HILL RIVER
I-SH46-NP01	GREAT PLAINS MFG. - KIPP PLT	LWR. SALINE RIVER
M-KS51-NO01	OGDEN	KANSAS RIVER
M-SA06-NO01	HUNTER MWTP	LWR. SALINE RIVER
M-SA09-NO01	LURAY MWTP	LWR SALINE R VIA WOLF CR
M-SA16-NO01	SYLVAN GROVE MWTP	LWR SALINE R
M-SH07-NR02	KDOT. ELLWSORTH CO. REST AREA	U. SMOKY HILL R
M-SH15-NO02	USD #306 MENTOR SCHOOL	LWR SMOKY HILL R/GYPSUM CCR
M-SH18-NO01	HOPE MWTP	LWR SMOKY HILL R VIA WEST BR. LYON CR
M-SH22-NO01	LONGFORD MWTP	CHAPMAN CR
M-SH24-NO01	MANCHESTER	SMOKY HILL RIVER
M-SH30-NO01	RAMONA MWTP	LWR SMOKY HILL R
M-SH36-NO01	SMOLAN MWTP	LWR SMOKY HILL R
M-SH42-NO01	WOODBINE MWTP	LWR SMOKY HILL R VIA LYON CR
M-SH47-NO01	DICKINSON CO. S.D. #1-TALMAGE	SMOKY HILL RIVER
M-SH51-NO01	FALUN IMPROVEMENT DISTRICT	SMOKY HILL R/UNNAMED TRIB & DRY CR
M-SH52-NO01	ROXBURY IMPROVEMENT DISTRICT	SMOKY HILL RIVER
M-SO27-NO01	KDOT. OTTAWA CO. REST AREA	SALINE RIVER