

Smoky Hill River

Main Stem Segment: WQLS: 5, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, &18 (Smoky Hill River)
starting at Kanopolis Lake and traveling upstream to station 539 near Schoenchen.

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

HUC8: 10260005

Kanopolis Lake (Station 016001)

Thompson Cr (37)

Smoky Hill R (5) - part

Clear Cr (42)

Skunk Cr (48)

Ash Cr (1190)

Mud Cr (47)

Oxide Cr (45)

HUC8: 10260005

Smoky Hill River (Ellsworth) (Station 269)

Smoky Hill R (5) - part

Turkey Cr (46)

Buffalo Cr (6)

Smoky Hill R (7)

Loss Cr (44)

Wolf Cr (36)

Smoky Hill R (8)

Cow Cr (38)

HUC8: 10260006

Smoky Hill River (Wilson) (Station 723)

Smoky Hill R (9)

Blood Cr (35)

Spring Cr (41)

Wilson Cr (40)

Coal Cr (34)

Smoky Hill R (10)

Beaver Cr (33) (**Station 734**)

Smoky Hill R (11)

Goose Cr (39) (**Station 735**)

Sellens Cr (32) (**Station 736**)

HUC8: 10260006

Fossil Creek (Station 713)

Fossil Cr (13)

HUC8: 10260006

Landon Creek (Station 714)

Landon Cr (31)

HUC8: 10260006

Smoky Hill (Russell) (Station 7)

Smoky Hill R (12)

Smoky Hill R (14)

Smoky Hill R (15)

10260007 Big Cr (1)

Walker Cr (2)

Big Cr (3)

Smoky Hill R (16)

Eagle Creek (30)

Smoky Hill R (17)

Buck Creek (29)

Smoky Hill R (18)

Shelter Creek (43)

Big Timber Cr (24)

Unnamed Stream (28)

Big Timber Cr (25)

Timber Creek (26)

Big Timber Cr (27)

HUC8: 10260007

N. Fk. Big Creek (Station 715)

N. Fk. Big Cr (4)

Mud Cr (9)

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

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

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

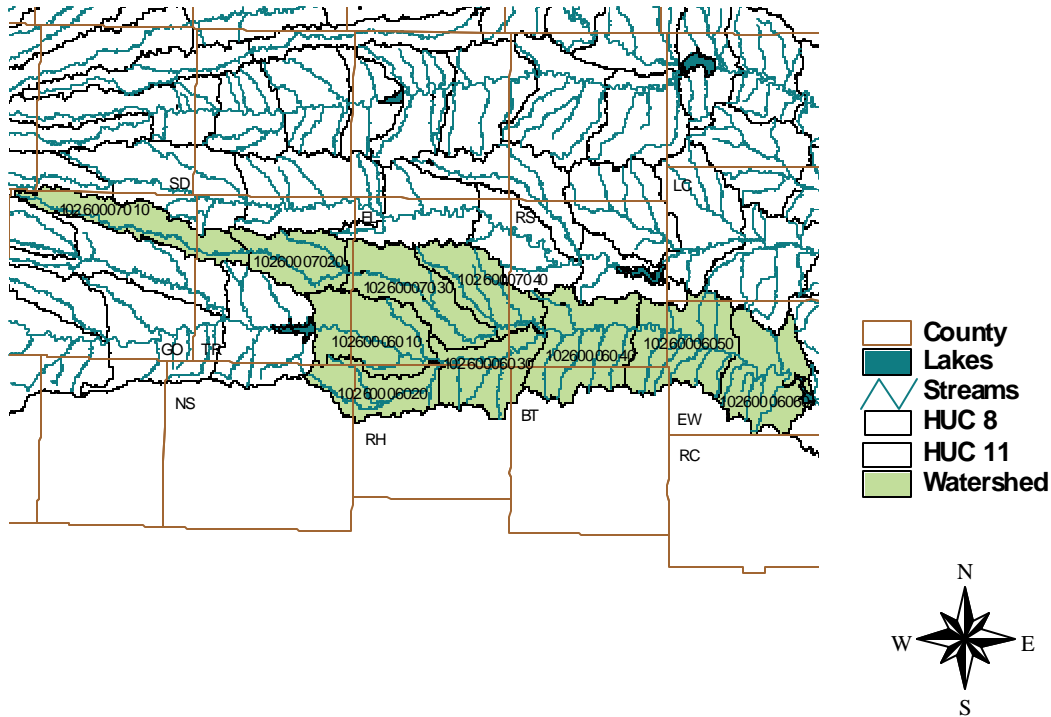
Impaired Use: Domestic Water Supply

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

In stream segments where background concentrations of naturally occurring substances, including chlorides and sulfates, exceed the domestic water supply criteria listed in table 1a in subsection (d), at ambient flow, due to intrusion of mineralized groundwater, the existing water quality shall be maintained, and the newly established numeric criteria for domestic water supply shall be the background concentration, as defined in K.A.R. 28-16-28b(e). Background concentrations shall be established using the methods outlined in the “Kansas implementation procedures: surface water quality standards,” as defined in K.A.R. 28-16-28b(ee), available upon request from the department. (K.A.R. 28-16-28e(c) (3)(B))

Figure 1

Kanopolis Lake HUC 11s



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

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

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

Period of Record Used: Six surveys during 1988 - 2003

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

Stream Chemistry Monitoring Sites:

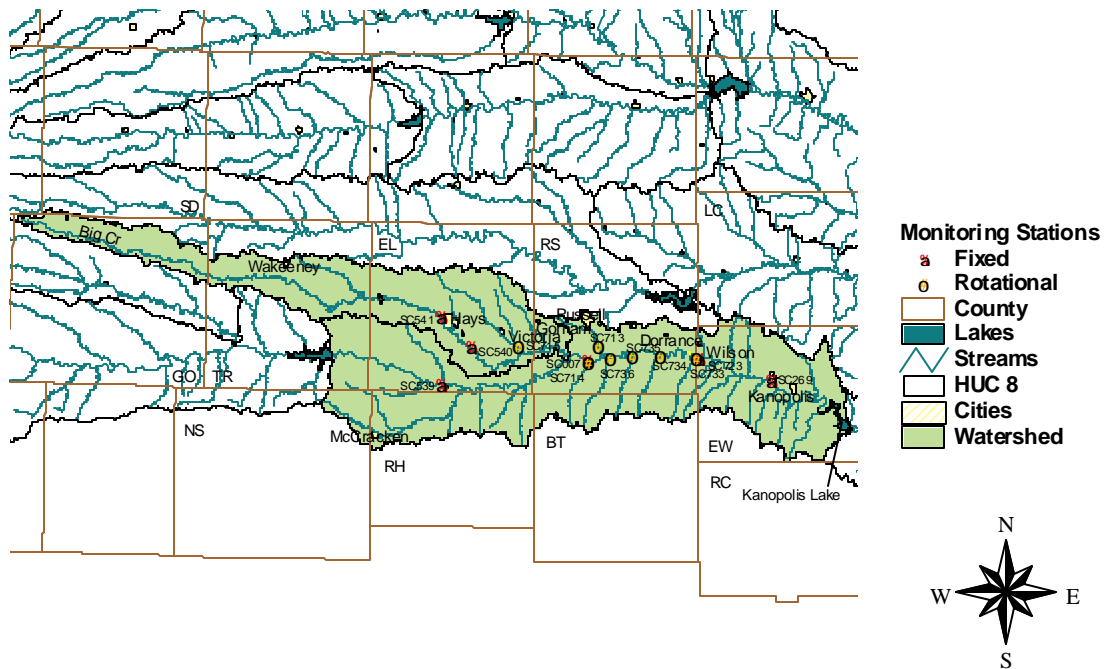
Monitoring and Flow Record Information for the Kanopolis Lake Basin

Monitoring Sites	Period of Record Used	Flow Record (USGS Gage)	Median Flows (cfs)	Avg [Cl] (ppm)
Station 007 near Russell (Smoky Hill River)	1985 - 2003	Smoky Hill River near Bunker Hill (USGS Gage 06864050)	35.4 cfs	530 mg/l
Station 269 at Ellsworth (Smoky Hill River)	1985 - 2003	Smoky Hill River at Ellsworth (USGS Gage 06864500)	64.5 cfs	370 mg/l

Station 713 near Russell (Fossil Creek)	1994, 1998, 2002	Estimated by USGS Scientific Investigations Report 2004-5033	0.51 cfs	530 mg/l
Station 714 near Russell (Landon Creek)	1994, 1998, 2002	Estimated by USGS Scientific Investigations Report 2004-5033	0.32 cfs	290 mg/l
Station 715 near Walker (NF Big Creek)	1995, 1999, 2003	Estimated by USGS Scientific Investigations Report 2004-5033	0.56 cfs	250 mg/l
Station 723 near Wilson (Smoky Hill River)	2000 - 2003	Smoky Hill River at Ellsworth (USGS Gage 06864500)	50.0 cfs	420 mg/l
Station 734 near Dorrance (Beaver Creek)	2002	Estimated by USGS Scientific Investigations Report 2004-5033	0.94 cfs	305 mg/l
Station 735 near Bunker Hill (Goose Creek)	2002	Estimated by USGS Scientific Investigations Report 2004-5033	0.37 cfs	430 mg/l
Station 736 near Russell (Sellens Creek)	2002	Estimated by USGS Scientific Investigations Report 2004-5033	0.47 cfs	390 mg/l

Figure 2

Kanopolis Lake TMDL Reference Map



Current Condition:

Over the period of record, the chloride concentration in Kanopolis Lake has averaged 231 mg/L (Appendix A). The exceedences above the domestic water quality standard occurred in 1988 and 1994. At that time, the average chloride concentrations were 357 mg/L and 277 mg/L, respectively. Since 1994, the water quality in Kanopolis Lake has significantly improved averaging 191 mg/L of chloride.

Average Chloride Concentrations in Kanopolis Lake

Date	Chloride (mg/L)	Average Annual Flow at Smoky Hill Rv. at Ellsworth (cfs)
6/27/1988	357	36
8/14/1991	175	52
6/7/1994	277	107
6/23/1997	208	125
7/17/2000	181	138
7/21/2003	185	68

The concentration of chloride in the Smoky Hill River gets diluted as the water flows toward Kanopolis Lake. The mean concentration drops further to 601 mg/L at station 007 then to 414 mg/L at station 723 and finally to 365 mg/L at station 269 (Figures 3, 4, 5, & 6). The differences between stations 007 and 269 and stations 007 and 723 are statistically significant. Because of their proximity, stations 269 and 723 are more similar.

Figure 3

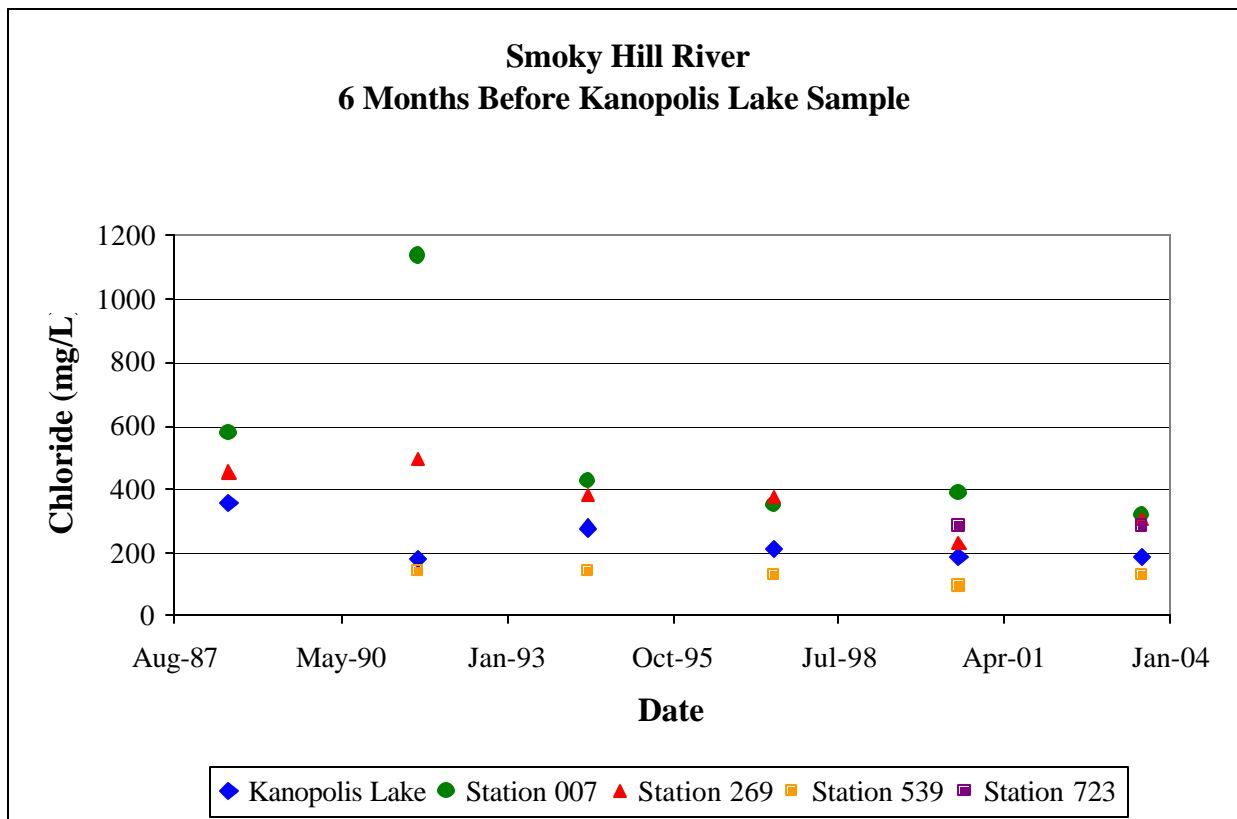


Figure 4

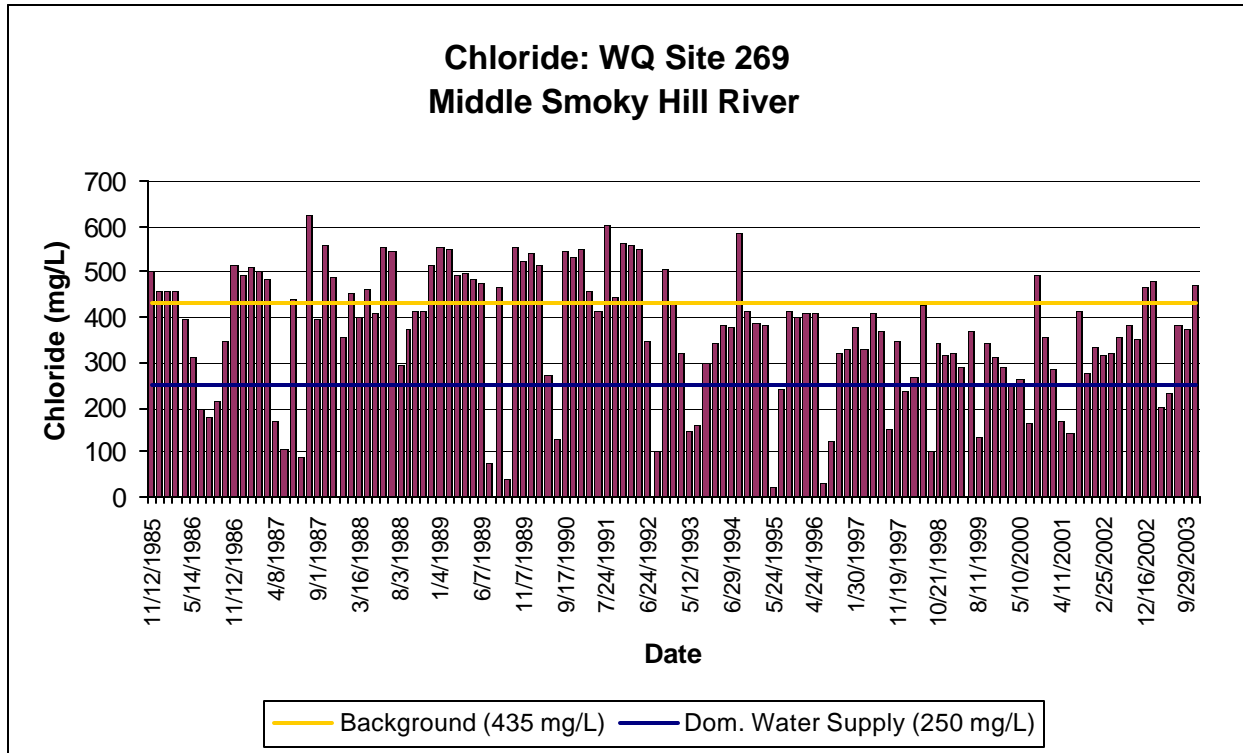


Figure 5

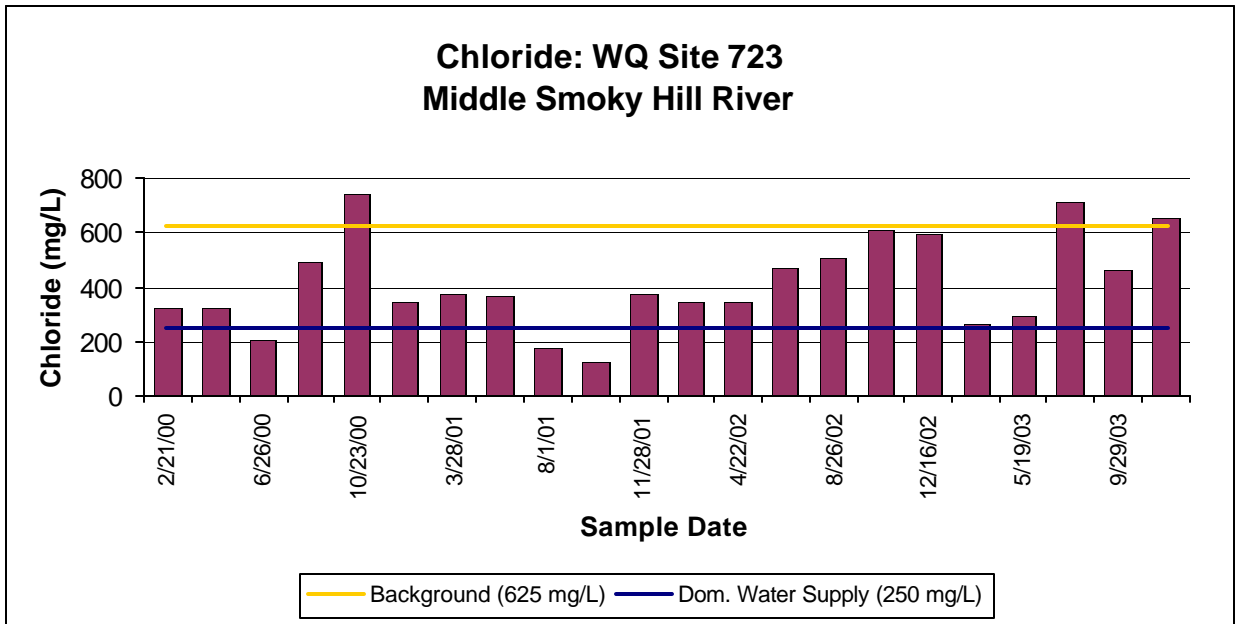
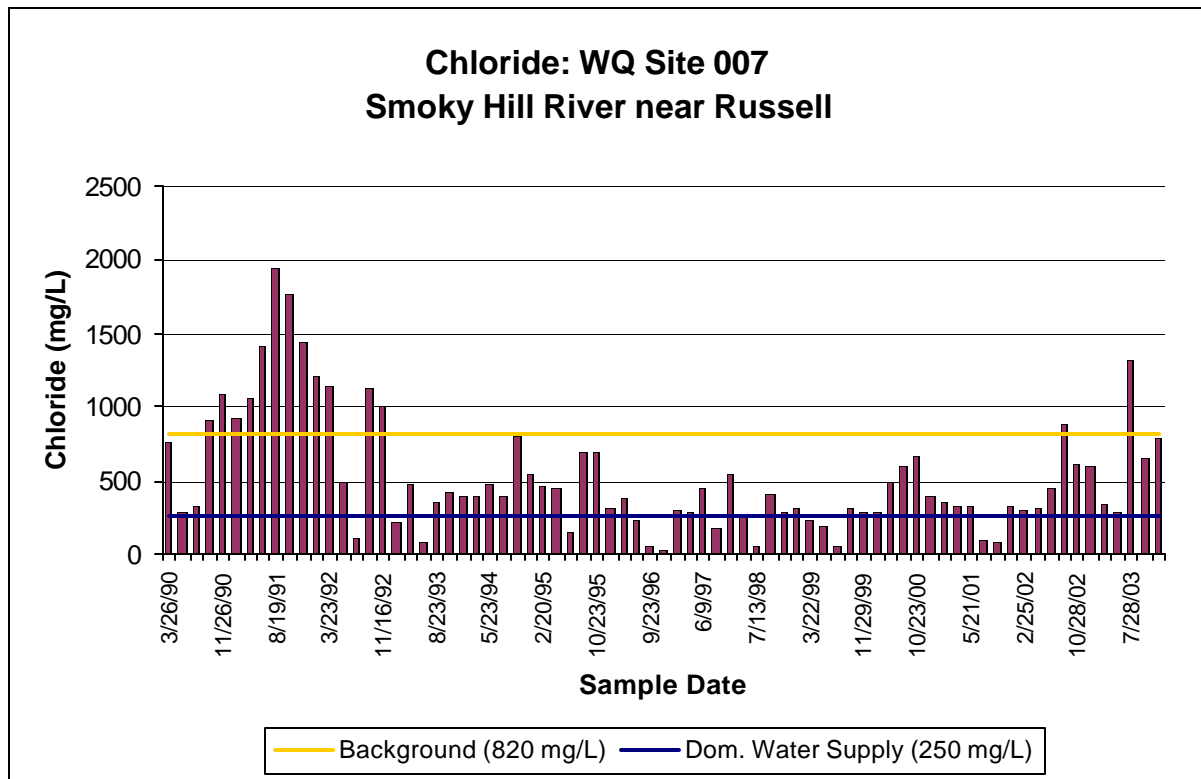


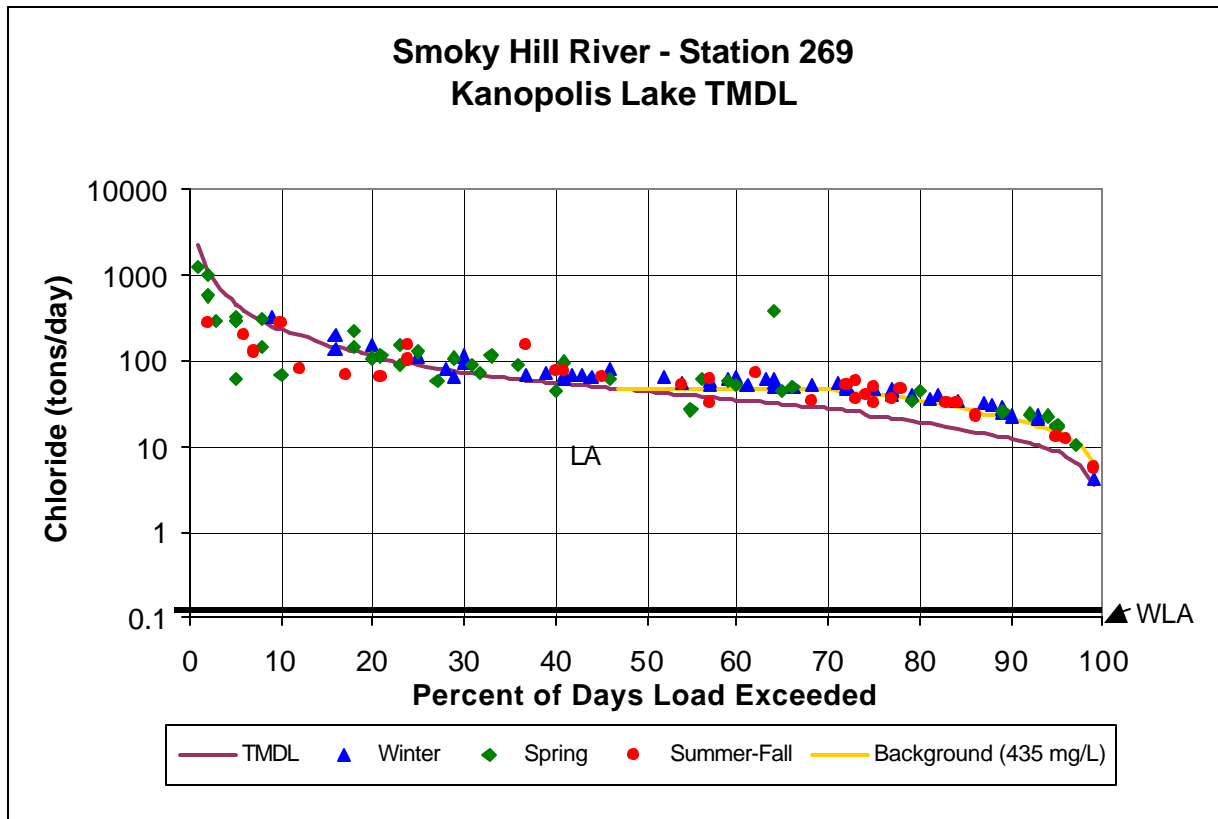
Figure 6



Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. Sample data for the sampling sites were categorized for each of the three defined seasons: Spring (Apr-Jul), Summer-Fall (Aug-Oct) and Winter (Nov-Mar). High flows and runoff equate to lower flow durations; baseflow and point source influences generally occur in the 75-99% range. A Load curve was established for the Domestic Water Supply criterion by multiplying the flow values along the curve by the applicable water quality criterion and converting the units to derive a load duration curve of tons of chloride per day. This load curves represent the TMDL since any point along the curve represents water quality for the standard at that flow. Historic excursions from the water quality standard are seen as plotted points above the load curve. Water quality standards are met for those points plotting below the load duration curve (Figures 7, 8, and 9).

Data on the six tributaries covered under this TMDL were too few in number to develop reasonable estimates of background endpoints or load duration curves. Rudimentary graphs showing chloride concentrations over time and initial load duration curves are presented in Appendices B and C for the tributaries to the Middle Smoky Hill River.

Figure 7

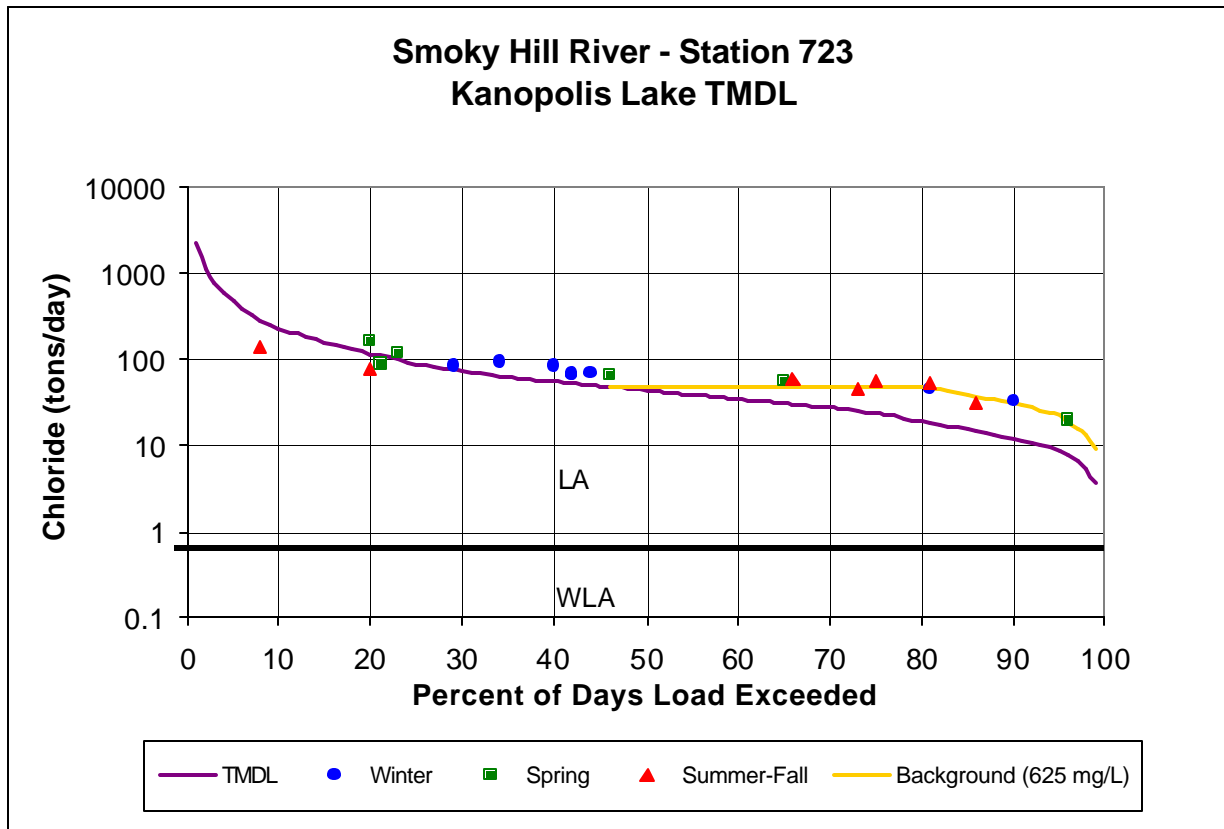


Station 269: Excursions were seen in each of the three defined seasons and are outlined below. Sixty-four percent of Spring samples and 78% of Summer-Fall samples were over the domestic supply criterion. Ninety-six percent of Winter samples were over the criterion. Overall, 80% of the samples were over 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 CHLORIDE STANDARD OF 250 mg/L BY FLOW AND SEASON

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Smoky Hill River at Ellsworth (269)	Spring	1	5	7	6	3	5	27/42 = 64%
	Summer	1	2	4	10	5	3	25/32 = 78%
	Winter	1	3	10	16	11	3	44/46 = 96%

Figure 8

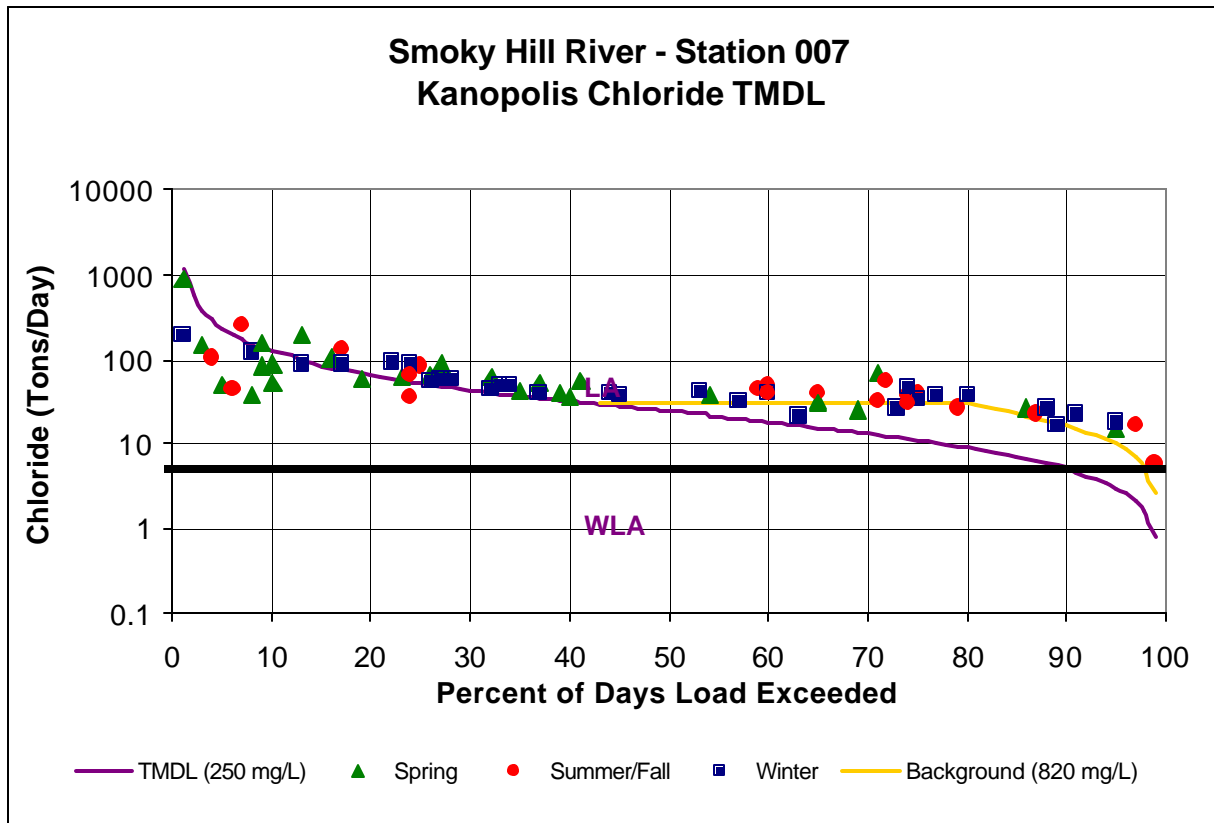


Station 723: Excursions were seen in each of the three defined seasons and are outlined below. Eighty-three percent of Spring samples and 71% of Summer-Fall samples were over the domestic supply criterion. One hundred percent of Winter samples were over the criterion. Overall, 86% of the samples were over the criteria. This would represent a baseline condition of non-support of the impaired designated use, if a point of diversion for water supply was present along the river.

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

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Smoky Hill River near Wilson (723)	Spring	0	2	1	1	0	1	5/6 = 83%
	Summer	0	0	0	3	2	0	5/7 = 71%
	Winter	0	0	6	0	2	0	8/8 = 100%

Figure 9



Station 007: Excursions were seen in each of the three defined seasons and are outlined below. Sixty-nine percent of Spring samples and 85% of Summer-Fall samples were over the domestic supply criterion. Eighty-nine percent of Winter samples were over the criterion. Overall, 81% of the samples were over the criteria. This would represent a baseline condition of non-support of the impaired designated use.

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

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Smoky Hill River near Russell (007)	Spring	1	3	8	4	1	1	18/26 = 69%
	Summer	1	3	0	9	2	2	17/20 = 85%
	Winter	0	3	9	7	4	2	25/28 = 89%

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

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

Current Condition and Reductions for Kanopolis Lake

Parameter	Current Condition	TMDL	Percent Reduction
Chloride (mg/L)	231	< 250	0 %

The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards fully supporting Drinking Water Use. This TMDL will, however, be phased. The current standard of 250 mg/L of chloride was used to establish the TMDL. However, the Smoky Hill River system is affected by the discharge of saline groundwater from the Dakota aquifer. As such, the watershed's main stem and many of its tributaries have elevated chloride levels from this natural source. In some cases, the elevation beyond natural chloride levels can be attributed to oil-field brine. The elevated background of chloride, consistently above 250 mg/L, makes achievement of the Standard unlikely at lower flow conditions at Stations 007, 269, and 723. Since the Standard is not achievable because of natural contributions of the chloride load at lower flows, an alternative endpoint is needed at that flow range.

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 there is a notable decline in chloride concentrations at flows exceeding the 70th percentile flows and since there is a significant influence by brine discharge in Russell County, the background concentration endpoints were established with those factors accounted.

Starting at Station 007 near Russell on the Smoky Hill River, the average concentration of chloride occurring under flow conditions exceeded 70-99 percent of the time was found to be 1028 mg/l. Based on KGS analysis of the influence of brine, an estimated 20 percent of the concentration was presumed to come from historic brine disposal. Therefore, the background endpoint was calculated to be 820 mg/l.

Low flow condition samples taken concurrently at Russell and Ellsworth in 2002-2003 were used to calculate the potential dilution to the river below Russell. The average chloride concentration at Russell was 760 mg/l in 14 cfs, the corresponding concentration at Station 269 at Ellsworth was 490 mg/l in 29 cfs. The resulting intervening dilution is 15 cfs of 77 mg/l water. Therefore, the corresponding long term background concentration at Ellsworth based on the background concentration of 820 mg/l at Russell is 435 mg/l.

Background concentrations at Station 723 near Wilson, lying between Russell and Ellsworth was taken as the average between the endpoints at those two stations. This relationship tended to be verified based on concurrent sampling over 2000-2003. The resulting background concentration at Wilson is 625 mg/l.

In order to reflect the pattern of chloride concentrations seen at higher flows between Russell and Ellsworth and to remain consistent with the Kanopolis Lake endpoint of 250 mg/l, the Phase One endpoint of 250 mg/l was maintained at the three river stations for flows exceeding median flow. A transition zone of constant loading was established between flow conditions of 70-80 percent exceedance and 40-50 percent exceedance. The 250 mg/l endpoint was applied for the higher flows. This approach supports the Kanopolis Lake endpoint because these higher flows are chiefly responsible for refilling the lake and their associated lower chloride content will be reflected in the concentrations in the lake.

Tentative Endpoints for Stations 007, 269, and 723

Station	Phase Two Low Flow Background (mg/L)
Station 269 at Ellsworth (Smoky Hill River)	435
Station 723 near Wilson (Smoky Hill River)	625
Station 007 near Russell (Smoky Hill River)	820

The Phase Two TMDL will be based on the future standard applied to the lower flows within the contributing portions of the Smoky Hill River watershed to Stations 007, 269, and 723. Figures 7-9 display the desired loads throughout the hydrologic spectrum along the Smoky Hill River.

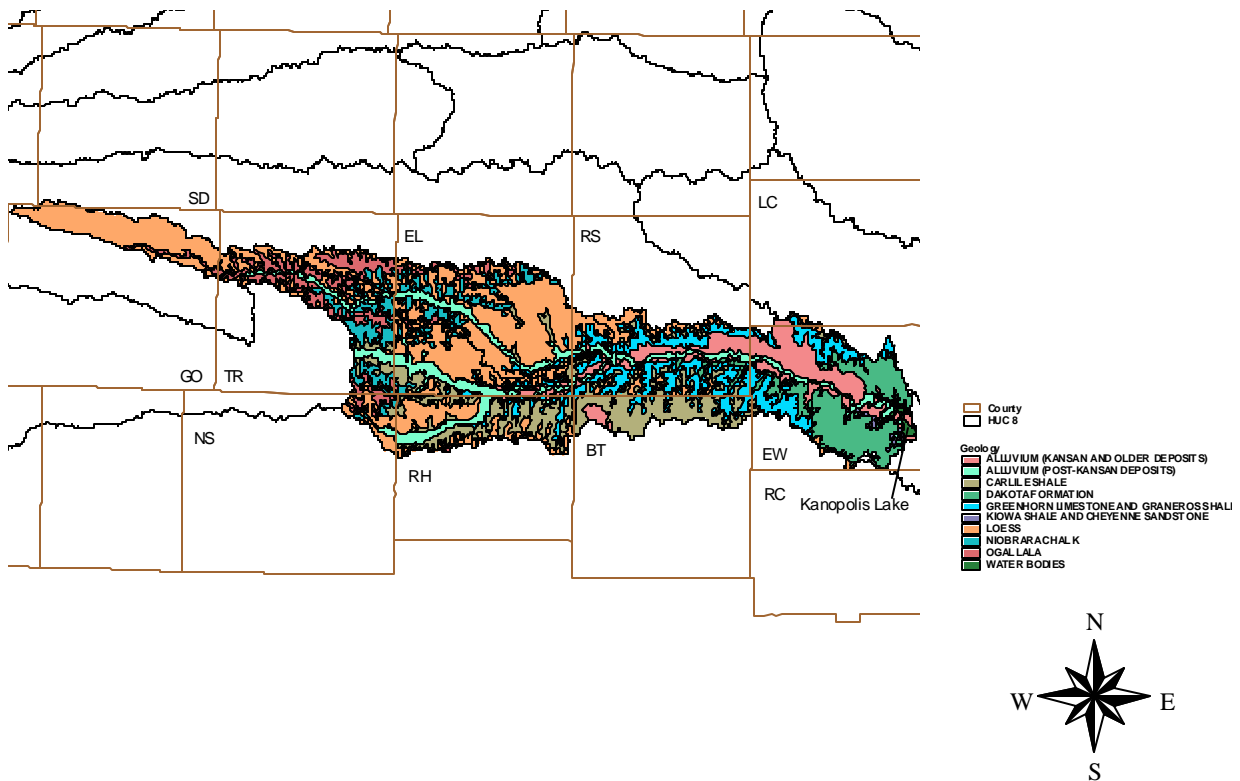
The chemical and hydrologic data on the tributaries are generally limited in sample size to adequately reflect the seasonal and hydrologic variability inherent in chloride concentrations. Therefore, the Phase One endpoint of 250 mg/l will remain in place until sufficient sample sizes are available to assess the need for alternative background concentrations. Initially, at this point of time, Station 713 on Fossil Creek, Station 735 on Goose Creek and Station 736 on Sellens Creek may required alternative criteria. The Phase One endpoint may be appropriate for Stations 714 (Landon Creek), 715 (NF Big Creek) and 734 (Beaver Creek).

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

3. SOURCE INVENTORY AND ASSESSMENT

Figure 12

Kanopolis Lake Geology



Chloride background: The main source of chloride in Kanopolis Lake is the discharge of naturally saline groundwater from the Dakota aquifer into the alluvial aquifer of the Smoky Hill River and then into the river in Russell County. The saline groundwater originates from upward intrusion of saltwater from the Cedar Hills Sandstone of Permian age, which underlies the Dakota aquifer in parts of central and north-central Kansas. The chloride content of saltwater in the Cedar Hills Sandstone in Russell and Ellis counties averages about 26,000 mg/L based on available data. The saltwater is derived from the dissolution of halite (rock salt). Other natural sources are small amounts of chloride in the minerals and traces of seawater trapped in the marine bedrock of the drainage basin that are released during weathering of the rock. Evapotranspiration consumption of water in the drainage basin and evaporation from the surface of streams and the reservoir increase the chloride concentration of the surface water.

Natural factors controlling variations in chloride: The record of water quality for Kanopolis Lake indicates that the chloride concentration is highly variable. Large fluctuations in the amount of rainfall that runs off into the streams can cause variations in the dissolved solids content of the Smoky Hill River and the lake water (Figure 13). The runoff following substantial rainstorms is appreciably fresher than most of the baseflow of streams and can dilute the dissolved solids concentration of water as it fills the lake (Figure 14). However, the relationship of flow within the drainage basin of the Smoky Hill River to the chloride content of Kanopolis Lake water is not simple because it depends on which part of the watershed receives more rainfall and thus contributes greater flow to the lake inflow. Groundwater discharge to the Smoky Hill River in Russell County introduces a much greater chloride load than runoff and groundwater discharge in other portions of the basin. Factors affecting stream-alluvial aquifer relationships of the Smoky Hill River in Russell County substantially influence the amount of saline groundwater discharge to the river.

Figure 13

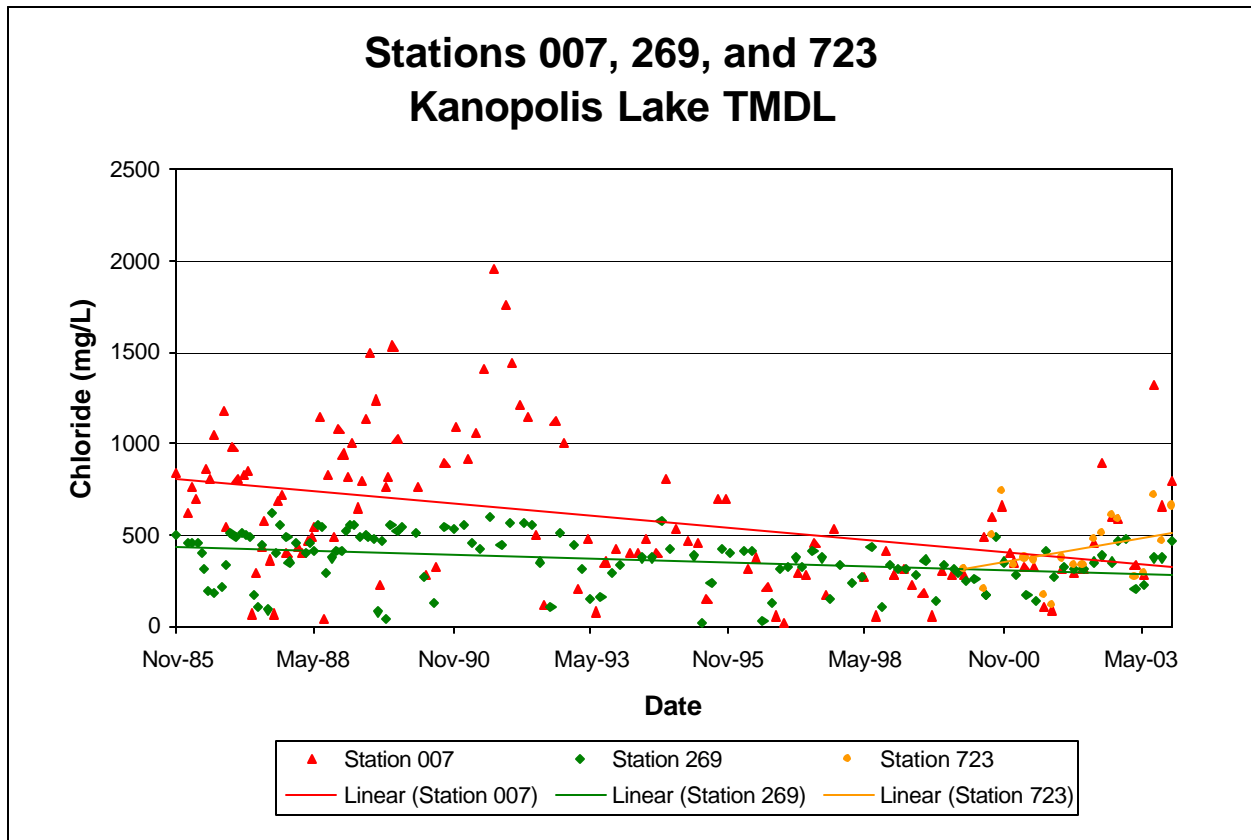
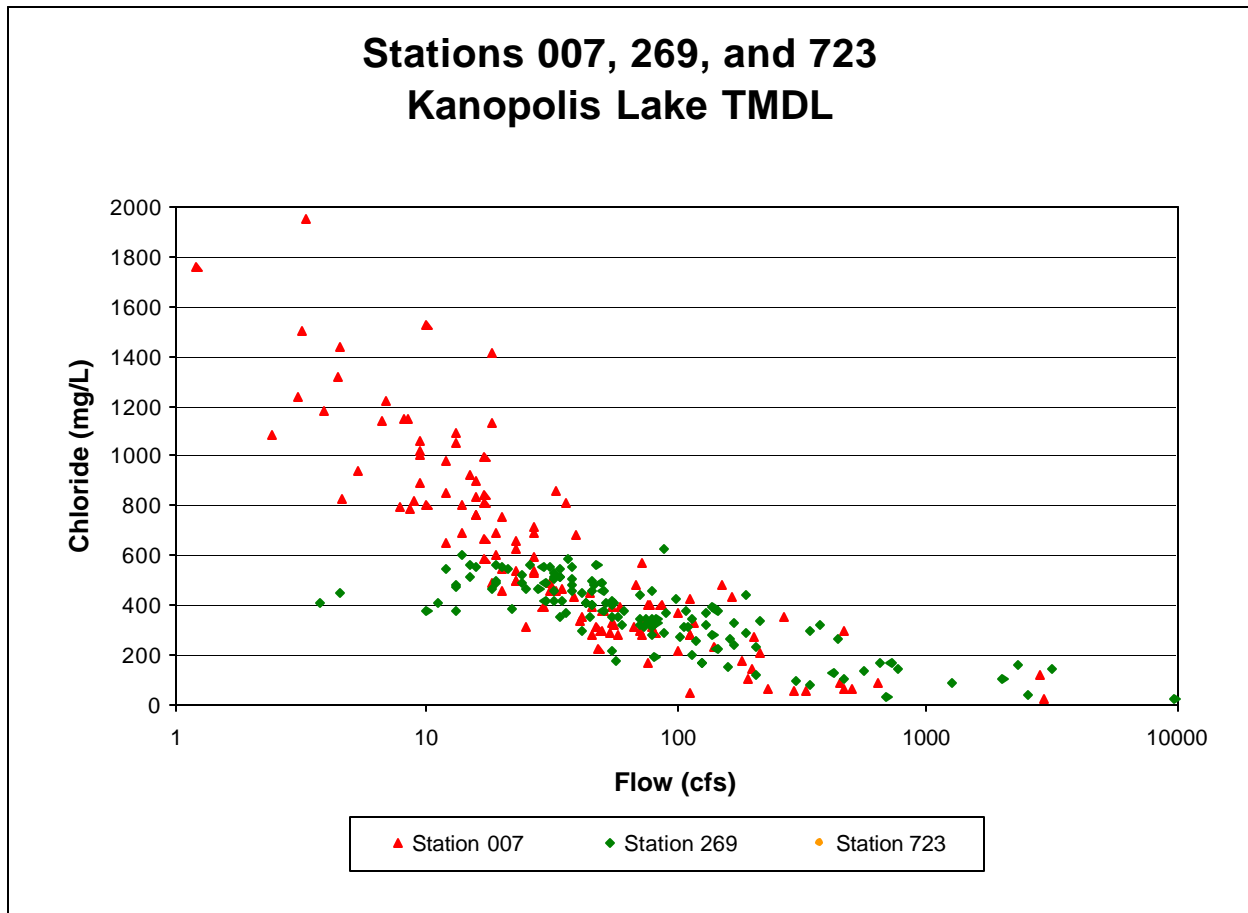


Figure 14



Irrigation Return Flows: Land use and water use are expected to have caused a small long-term increase in the chloride concentrations (in comparison to conditions without these impacts) by increasing evapotranspiration. Residual dissolved solids are left in a smaller volume of water because of reduced discharge of fresh ground water from consumptive use. Most of these changes in use are related to irrigation (Figures 15-17). However, most of the irrigation is on land along Big Creek or the Smoky Hill River above Schoenchen (Figure 17). The stations monitoring those two stream segments show no impairment by chloride. As in the case of the Saline River, the chloride impairments start at the Ellis-Russell county line. Similar to the Saline, irrigation in Russell County drops off considerably with the coincidental rise in chloride intrusion. No irrigation use has been seen along the Smoky Hill River below Russell, once again an indictment on the high chloride load carried by the stream, eliminating its potential use for irrigation. The tributaries to the Smoky Hill River in Russell County show no irrigation use. Three of the tribs centered near Russell (Fossil, Goose and Sellens) show high chloride similar to that seen on the main stem near Russell.

Irrigation reports from 2003 show the following:

Water Use Statistics for Each Monitoring Site

Monitoring Sites	Surface Water		Groundwater		1990-2003
	Area (acres)	Volume (acre-feet)	Area (acres)	Volume (acre-feet)	Chloride Conc. (mg/l)
Smoky Hill River Valley from Cedar Bluff to Schoenchen (Station 539)	310	246	666	545	125
Big Creek above Munjor (Station 540)	168	100	9883	8323	140
Smoky Hill River Valley below Schoenchen to Russell (Station 007)	25	48	238	322	530
Smoky Hill River Valley from Russell to Wilson (Station 723)	0	0	0	0	419*
Smoky Hill River Valley from Wilson to Ellsworth (Station 269)	0	0	0	0	340

* 2000-2003

Figure 15

Kanopolis Lake TMDL Points of Diversion near Station 007

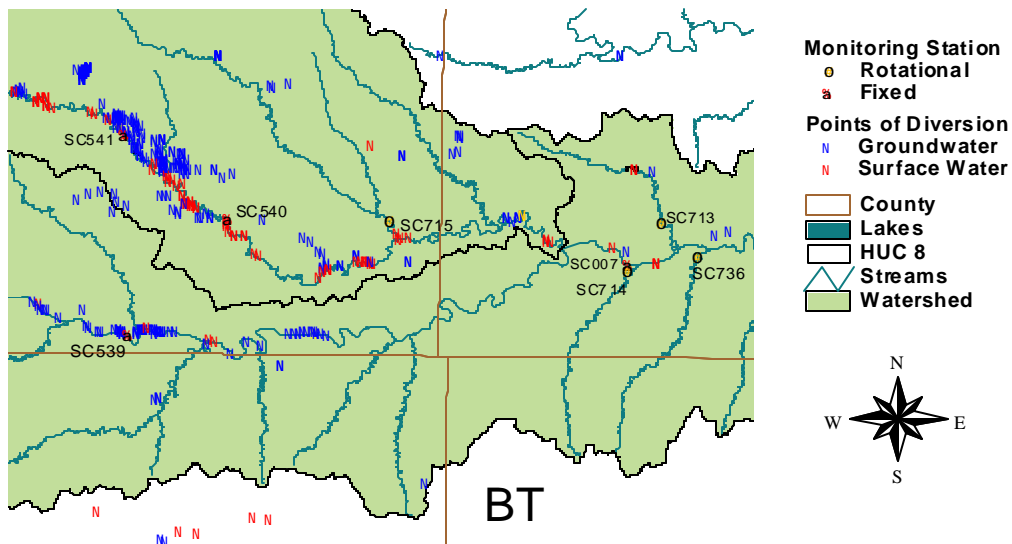


Figure 16

Kanopolis Lake TMDL Points of Diversion near Station 269

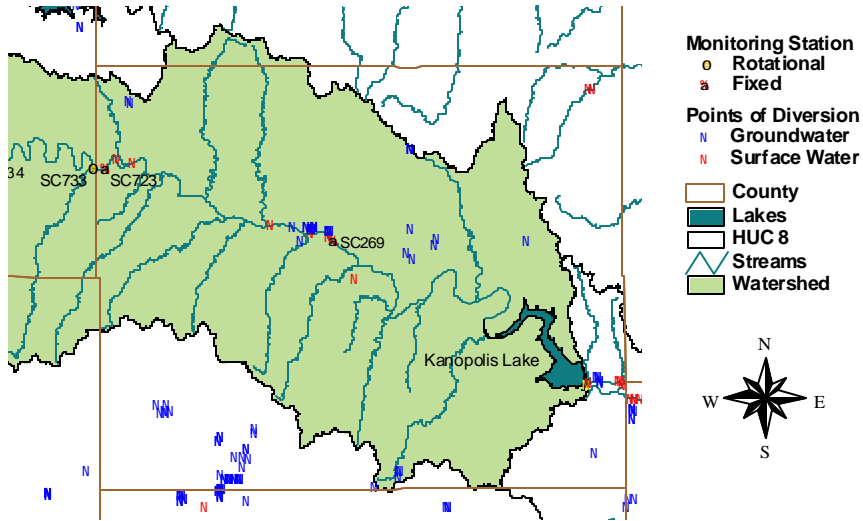
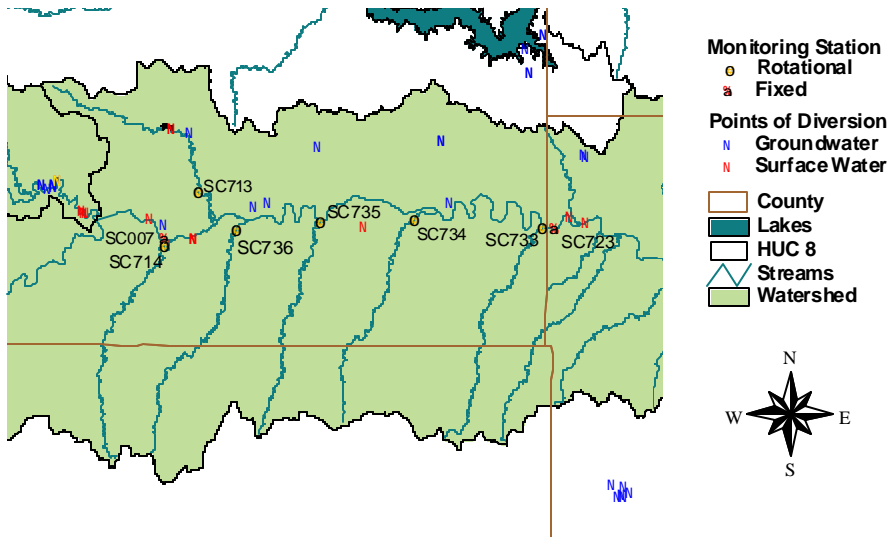


Figure 17

Kanopolis Lake TMDL Points of Diversion near Station 723



NPDES: Twenty-seven permitted waste treatment facilities are located within the watershed (Figure 18). Nineteen are non-overflowing lagoons that are prohibited from discharging, seven are discharging municipal waste treatment plants, and one is a discharging industrial facility. The non-overflowing lagoons may contribute to the load under extreme precipitation events (flow durations exceeded under 5 percent of the time). Such events would not occur at a frequency or for a duration sufficient to cause an impairment in the watershed. Any anthropogenic chloride sources or hydrologic modifications increasing the chloride concentration would be minor in comparison with the chloride coming from natural sources.

Non-overflowing Facilities in the Kanopolis Watershed

Kansas Permit Number	Facility Name	Type	Cl Wasteload Allocation
C-SA03-NO01	BEAR HOUSE CAFE & TRUCK STOP	2-cell Lagoon	0 lb/day
C-SA21-NO01	SERVICE OIL COMPANY-INTERSTATE HOUSE	2-cell Lagoon	0 lb/day
C-SA21-NO02	WATERING HOLE	1-cell Lagoon	0 lb/day
C-SH07-NO01	STUCKEY'S DAIRY QUEEN - ELLSWORTH	2-cell Lagoon	0 lb/day
I-SH16-NP04	ELLIS CO. HIGHWAY DEPT.	3-cell Containment Basin	0 lb/day
M-SH05-NO01	DORRANCE MWTP	2-cell Lagoon	0 lb/day
M-SH12-NO02	USD #292 GRAINFIELD-WHEATLAND SCHOOL	2-cell Lagoon	0 lb/day
M-SH12-NR02	KDOT. GOVE CO. REST AREA I-70	2-cell Lagoon	0 lb/day
M-SH14-NO01	GRINNELL MWTP	2-cell Lagoon	0 lb/day
M-SH19-NO01	KANOPOLIS MWTP	2-cell Lagoon	0 lb/day
M-SH19-NO02	KDWP - KANOPOLIS (EAST)	2-cell Lagoon	0 lb/day
M-SH19-NO03	KDWP - KANOPOLIS (SOUTH SHORE)	2-cell Lagoon	0 lb/day
M-SH20-NO01	LIEBENTHAL MWTP	4-cell Lagoon	0 lb/day
M-SH31-NR02	KDOT. RUSSELL CO. REST AREA	2-cell Lagoon	0 lb/day
M-SH37-NO01	VICTORIA MWTP	3-cell Lagoon	0 lb/day
M-SH38-NR02	KDOT. TREGO CO. REST AREA	2-cell Lagoon	0 lb/day
M-SH50-NO01	MUNJOR IMPROVEMENT DISTRICT	3-cell Lagoon	0 lb/day
M-SH34-NO01	SCHOENCHEN MWTP	3-cell Lagoon	0 lb/day
M-SH10-NO01	GORHAM MWTP	3-cell Lagoon	0 lb/day

Since none of the municipal NPDES sites in the watershed are currently required to monitor for chloride in their effluent, average chloride concentrations for municipal sources were estimated based on the chloride in their influent (Appendix D).

Waste Treatment Plants in the Kanopolis Lake Watershed

Kansas Permit Number	Facility	Design Flow (MGD)	Type	Receiving Stream
M-SH38-OO01	WAKEENEY MWTP	0.43	Trickling Filter	Big Creek
M-SH06-OO02	ELLIS WWTF	0.30	Activated Sludge	Big Creek
M-SH16-OO02	HAYS WWTF	2.80	Activated Sludge	Big Creek
M-SH26-OO02	McCRACKEN MWTP	0.04	3-cell Lagoon	Big Timber Creek
M-SH31-OO02	RUSSELL WWTP	1.40	4-cell Lagoon	Fossil Creek
M-SH40-OO01	WILSON MWTP	0.09/0.15	Trickling Filter, 3-cell Lagoon in construction	Smoky Hill River
M-SH07-OO01	ELLSWORTH WWTF	0.50	3-cell Lagoon	Smoky Hill River
I-SH19-PO07	INDEPENDENT SALT COMPANY	0.0072	Groundwater Seepage from Salt Mine Shafts	Smoky Hill River

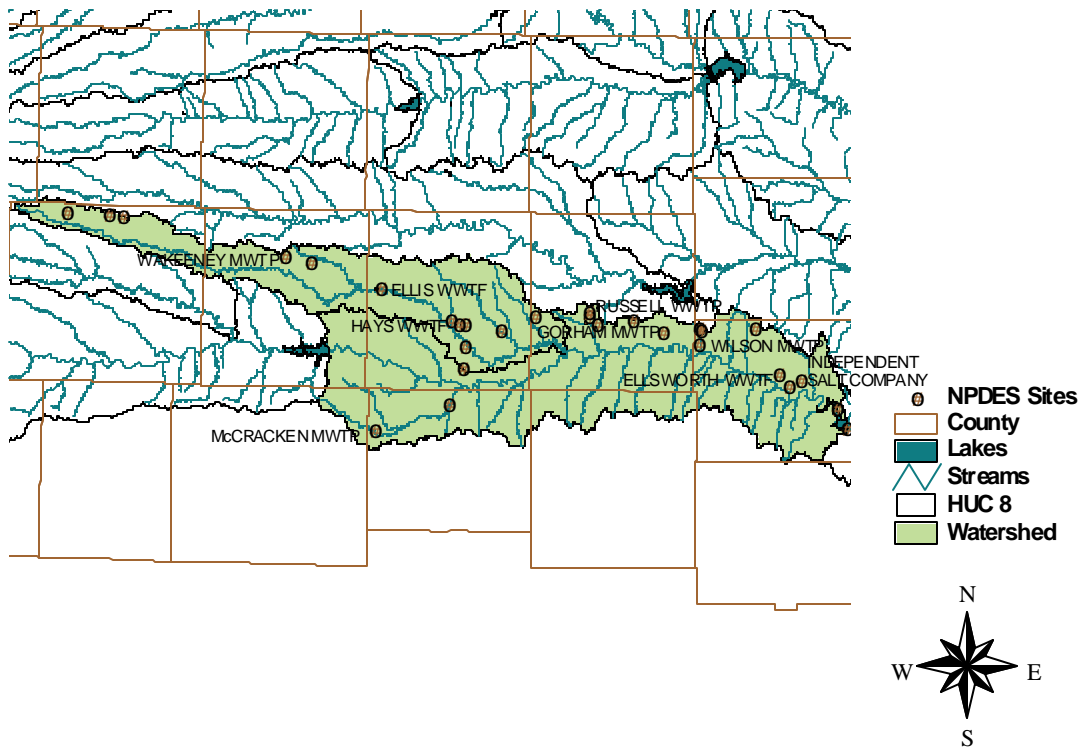
The Independent Salt Company is permitted to discharge seepage water with chloride concentrations up to 1,600 mg/L. Since the permit's effective date of May 2003, the median flow was 0.0066 MGD, and the median chloride concentration was 1,280 mg/L. While this chloride concentration is very high, the wasteload from the facility is minuscule because the design flow is very low. Under design flow conditions, the maximum contribution from the Independent Salt Company is 0.05 tons/day. This wasteload increases the ambient concentration in the Smoky Hill River by 2-3 mg/l and is offset by upstream wasteloads with concentrations below 250 mg/l.

Impact of Independent Salt Company Wasteload on Low Flow Conditions of Smoky Hill River

7Q10 Flow Arriving from Ellsworth	Ambient Upstream Chloride (mg/l)	Design Mine Discharge	Maximum Chloride Concentration from Mine	Mine Wasteload	Downstream Chloride (mg/l)
4.7 cfs	460 mg/l	0.0072 MGD (0.01114 cfs)	1600 mg/l	0.05 t/d	462.7 mg/l

Figure 18

Kanopolis Lake NPDES Sites



Oil-Field Brine: The load of chloride derived from past oil-brine disposal is small in comparison with that from natural sources but is significant. There are historically large oil fields in Russell County that lie across the Smoky Hill River valley. Substantial amounts of oil were discovered in Russell County in the 1920s and the oil fields expanded appreciably through the 1930s and 1940s. During the early period of the oil fields, the saltwater produced with the oil from subsurface formations was disposed in surface ponds and in shallow wells drilled into the Cretaceous sandstones (Dakota Formation and Cheyenne Sandstone). Some of the disposal was conducted under pressure injection. Later regulations required disposal into deeper subsurface formations. The surface disposal contaminated portions of the alluvial aquifer of the Smoky Hill River valley. Saltwater in portions of the shallow Cretaceous rocks in hydraulic communication with the alluvium can slowly flow to the alluvial aquifer if the hydraulic head in the sandstone units is high enough. The saltwater contamination from the alluvial aquifer has been slowly discharging to the river.

An investigation conducted as part of the Dakota Aquifer Program in 1991 and 1992 identified the presence of an oil-brine source of chloride mixed with the natural saltwater source in Smoky Hill River water in Russell County. Natural saltwater from the Dakota aquifer begins to enter the Smoky Hill River near the Ellis-Russell county line. Oil-brine starts to enter the river in Big Creek and in groundwater discharge just downstream of the confluence with Big Creek. About 30% of the total chloride dissolved in the river water was interpreted as from an oil-brine source in the river water south of Bunker Hill to Dorrance during very low flow in October 1991. In January 1992, oil brine chloride contributed over 20% of the total chloride in low flow in the same river stretch. The flow in the Smoky Hill River in the Bunker Hill to Dorrance area was in the range 2-3 cfs during the October 1991 sampling and 12-15 cfs during the January sampling.

The percentage of the chloride from the oil-brine source is expected to be much smaller during high river flows. Interpretation of bromide/chloride versus chloride mixing curves based on data for Lake Kanopolis (available only for 1997 and 2000 surveys) and the Smoky Hill River indicates that an oil-brine source contributes as much as 10-20% of the total chloride content in the lake water. The percentage depends on what proportion of the flow entering the lake is derived from the groundwater discharge to the Smoky Hill River in Russell County in comparison to flow from farther upstream in the river and the watershed of the river and lake downstream of Russell County. The oil-field brine contribution to the river chloride could possibly continue for a substantial period of time. After much of the brine contamination derived from the surface disposal ponds is flushed from the system, brine injected into shallow subsurface Cretaceous sandstones could continue to slowly bleed out of the disposal zones if the hydraulic head is higher than in the river and there is a hydraulic connection with the alluvial aquifer.

In order to account for the anthropogenic impact of historic brine disposal, the low flow background concentrations were reduced by 20 percent to discount the presence of brine in the samples.

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

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

The source assessment has ascertained that natural chloride loading within the watershed is the primary factor for the excursions seen at the monitoring stations located within the Kanopolis Lake/Smoky Hill River watershed. Oil-field brine is a secondary contributing factor.

Point Sources: The total wasteload allocation entering Kanopolis Lake is currently 4.16 tons per day, with an additional 1.12 tons per day allowable, while keeping the Lake under 250 mg/l. The following table lists the initial allocations by facility and watershed location.

Facility	Effluent Discharge	Effluent Chloride	Wasteload Allocation
Wakeeney	0.43 MGD	100 mg/l	0.18 tons/day
Ellis	0.30 MGD	250 mg/l	0.31 tons/day
Hays	2.80 MGD	150 mg/l	1.75 tons/day
McCracken	0.04 MGD	250 mg/l	0.04 tons/day
WLA at Station 007	3.57 MGD	153 mg/l	2.28 tons/day
Russell	1.40 MGD	250 mg/l	1.46 tons/day
WLA at Station 723	4.97 MGD	180 mg/l	3.74 tons/day
Wilson	0.15 MGD	100 mg/l	0.06 tons/day
Ellsworth	0.50 MGD	150 mg/l	0.31 tons/day
WLA at Station 269	5.62 MGD	175 mg/l	4.11 tons/day
Independent Salt	0.0072 MGD	1600 mg/l	0.05 tons/day
Total WLA into Kanopolis	5.6272 MGD	177 mg/l	4.16 tons/day
Future Capacity	----	225 mg/l	1.12 tons/day
WLA Margin of Safety	----	250 mg/l	0.59 tons/day
Total Watershed WLA	----	250 mg/l	5.87 tons/day

Non-point Sources: The primary factor influencing chloride concentrations in the streams above Kanopolis Lake is the natural geology with its brackish ground water. Because there are different endpoints at low and normal flow, allocations will differ. The Phase 1 endpoint of 250 mg/l will always apply to normal flow conditions. Because the lake refills with high flow events which will have a designated endpoint of 250 mg/l, the lake's endpoint of 250 mg/l will be assured. The following table displays the allocations for three locations on the Smoky Hill River and the accumulated loadings entering Kanopolis Lake under a low and a normal flow condition.

Wasteload and Load Allocations (tons per day) of Chloride in Kanopolis Lake Watershed

Chloride TMDL				
	SC007 Russell	SC723 Wilson	SC269 Ellsworth	Accumulated Lake Inflow
Low Flow (90% excd) - cfs	7.5	11.5	18	
Median Flow (50% excd) - cfs	35.4	50.0	64.5	
Wasteload Allocations	2.28	1.46	0.37	5.28*
Phase One Load Allocation - Low Q	4.56	6.99 **	10.94	10.94
Phase One Margin of Safety - Low Q	0.51 ***	0.78	1.22	1.81 ****
Phase One TMDL - Low Q	7.34	11.50 *****	16.26	18.03
Phase Two Load Allocation - Low Q	14.94	17.47	19.03	19.03
Phase Two Margin of Safety - Low Q	1.66	1.94	2.11	2.70
Phase Two TMDL - Low Q	18.88	23.14	25.25	27.01
Phase Two Load Allocation - Normal	21.51	30.38	39.18	39.18
Phase Two Margin of Safety - Normal	2.39	3.37	4.35	4.94
Phase Two TMDL - Normal	26.18	37.49	47.65	49.40
Phase Two Concentrations	820 mg/l	625 mg/l	435 mg/l	250 mg/l

* represents all existing point sources above lake plus available future allocation

** cumulative load allocation from entire upstream watershed

*** margin of safety is an explicit 10% off the load allocation

****represents 10% margin of safety from load allocation plus 0.59 t/d margin of safety from wasteloads

***** represents accumulated load allocations and wasteload allocations from upstream watershed

Tributaries Point and Non-Point Sources: Only one of the tributaries, Fossil Creek, has a NPDES facility discharging into its channel. That facility is the Russell Wastewater Treatment Plant, which discharges about 250 mg/l. The Wasteload Allocation for Russell is contained within the analysis of load allocations above the Wilson monitoring station (Station 723). The allocations for the individual tributary reaches is given by the following table, representing normal, median flow conditions. The endpoints will be set at 250 mg/l until additional data confirm the need to establish alternative chloride criteria on certain streams.

Stream	Median Q	Wasteload Allocations	Load Allocations	Margin of Safety	TMDL
Fossil Creek	0.51 cfs	1.46 tons/day	0.21 tons/day	0.02 tons/day	1.69 tons/day
Landon Creek	0.32 cfs	0.0 tons/day	0.19 tons/day	0.02 tons/day	0.21 tons/day
NF Big Creek	0.56 cfs	0.0 tons/day	0.34 tons/day	0.04 tons/day	0.38 tons/day
Beaver Creek	0.94 cfs	0.0 tons/day	0.57 tons/day	0.06 tons/day	0.63 tons/day
Goose Creek	0.37 cfs	0.0 tons/day	0.22 tons/day	0.03 tons/day	0.25 tons/day
Sellens Creek	0.47 cfs	0.0 tons/day	0.29 tons/day	0.03 tons/day	0.32 tons/day

Defined Margin of Safety: Since the majority of contribution of chloride to the Smoky Hill River comes from natural mineralized ground water intrusion, the Margin of Safety is explicitly 10% of calculated Load Allocations using either the original water quality criterion or the proposed background concentrations. Additionally, a Margin of Safety of 10% of the potentially allowable Wasteload Allocation (0.59 tons/day) is applied to ensure the Wasteload Allocations result in loadings that will cause the chloride content in the Smoky Hill River and Kanopolis Lake to remain below the intended endpoints. The Margin of Safety on the tributaries is explicitly 10% of the Load Allocation. No Margin of Safety was applied to Russell's discharge to Fossil Creek, since it was below the ambient concentration seen in the stream and acts as a dilution base.

State Water Plan Implementation Priority: Because the chloride impairment in Kanopolis Lake is primarily due to natural geologic sources, this TMDL will be a Low Priority for implementation.

Unified Watershed Assessment Priority Ranking: Kanopolis Lake watershed lies within the Middle Smoky Hill (HUC 8: 10260006) with a priority ranking of 51 (Low Priority for restoration) and the Big (HUC 8: 10260007) with a priority ranking of 56 (Low Priority for restoration).

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

5. IMPLEMENTATION

Desired Implementation Activities

1. Monitor any anthropogenic contributions of chloride loading to the lake and river.
2. Establish alternative background criterion.

Implementation Programs Guidance

NPDES and State Permits - KDHE

- a. Municipal permits for facilities in the watershed will be renewed after 2004 with annual chloride monitoring and any excessive chloride loading to the lake will have appropriate permit limits which does not increase the ambient background levels of chloride.

Non-Point Source Pollution Technical Assistance - KDHE

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

Water Quality Standards and Assessment - KDHE

- a. Establish background levels of chloride for the river and tributaries.

Total Maximum Daily Load Program - KDHE

- a. Reevaluate possible background concentrations on tributaries to Smoky Hill River in Russell County and adjust load allocations.

Oil and Gas Remediation Program - State Corporation Commission

- a. Target cleanup efforts to brine fields in proximity to Smoky Hill River below the Ellis-Russell county line.

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

Targeted Participants: Primary participants for implementation will be KDHE.

Milestone for 2008: The year 2010 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, sampled data from Kanopolis Lake should indicate evidence of no increase in chloride levels in the conservation pool elevations relative to the conditions seen over the period of record. Should the case of impairment remain, source assessment, allocation and implementation activities will ensue.

Delivery Agents: The primary delivery agents for program participation will be the Kansas Department of Health and Environment.

Reasonable Assurances:

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollutants.

1. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.
2. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.
3. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.

4. K.S.A. 82a-901, et seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

5. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan*.

6. The *Kansas Water Plan* and the Smoky Hill/Saline Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund annually generates \$16-18 million and is the primary funding mechanism for implementing water quality protection and pollutant reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are a Low Priority consideration.

Effectiveness: Minimal control can be exerted on natural contributions to loading.

6. MONITORING

KDHE will continue to collect bimonthly samples from permanent stations 269, 723, and 007. Further sampling and evaluation of Kanopolis Lake should occur twice before 2010. Based on that sampling, the priority status will be evaluated in 2010 including application of background concentrations. Sampling on the tributary stations should occur twice within the 2005-2010 period. Based on those samples, alternative background concentrations might be established.

Should impaired status remain in 2010, the desired endpoints under this TMDL will be refined and more intensive sampling will need to be conducted under specified seasonal flow conditions over the period 2010-2014

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

7. FEEDBACK

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

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

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

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

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

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

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

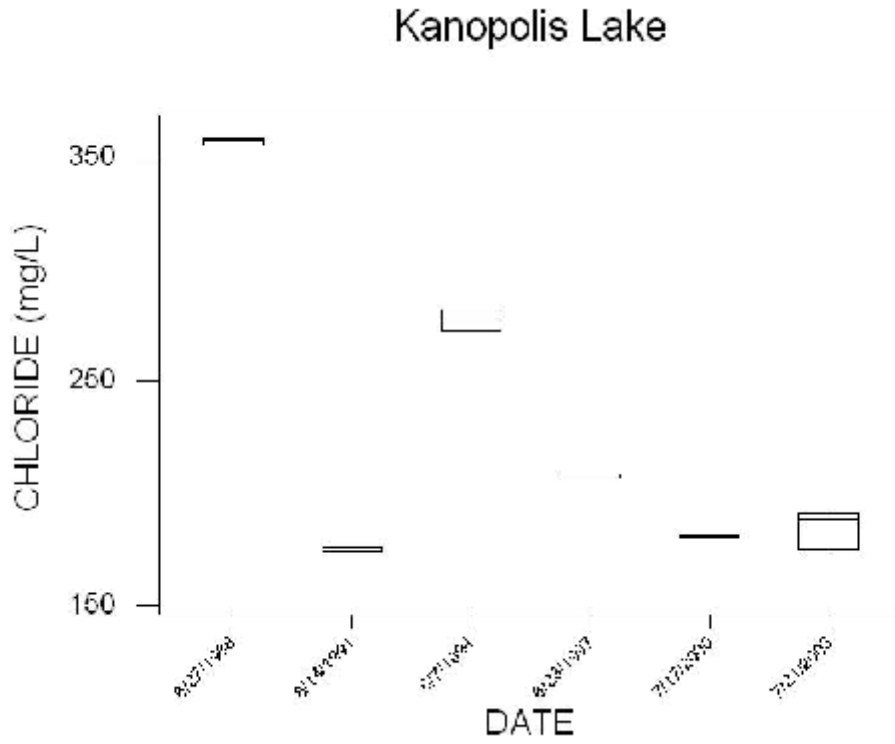
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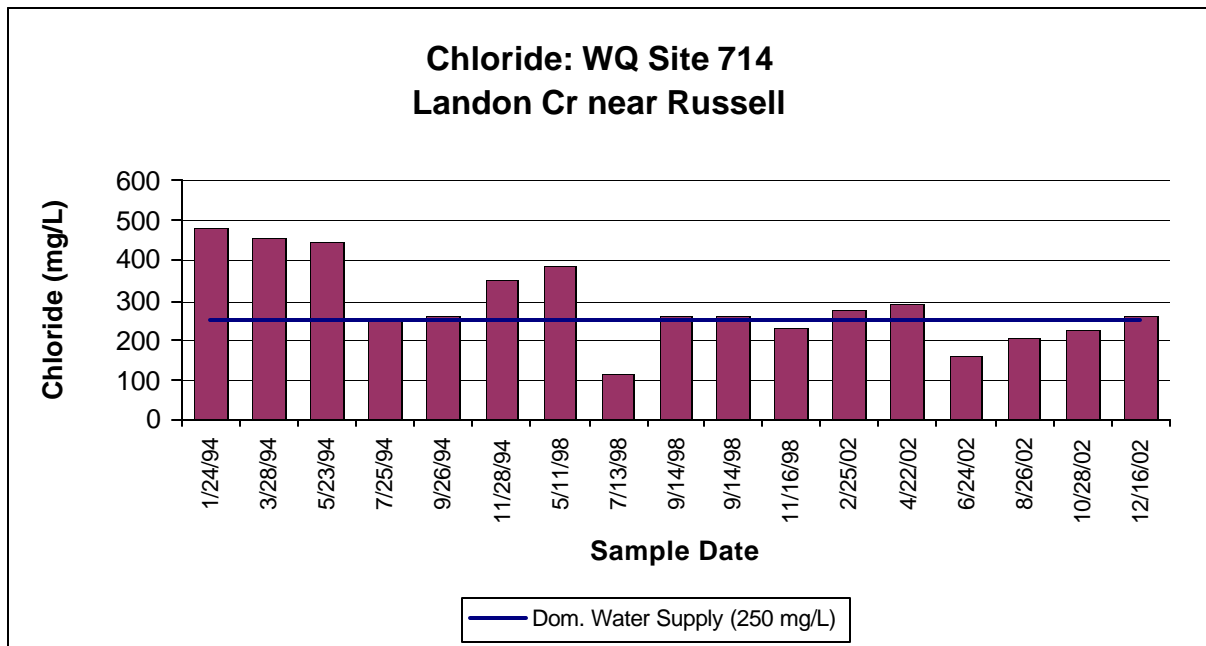
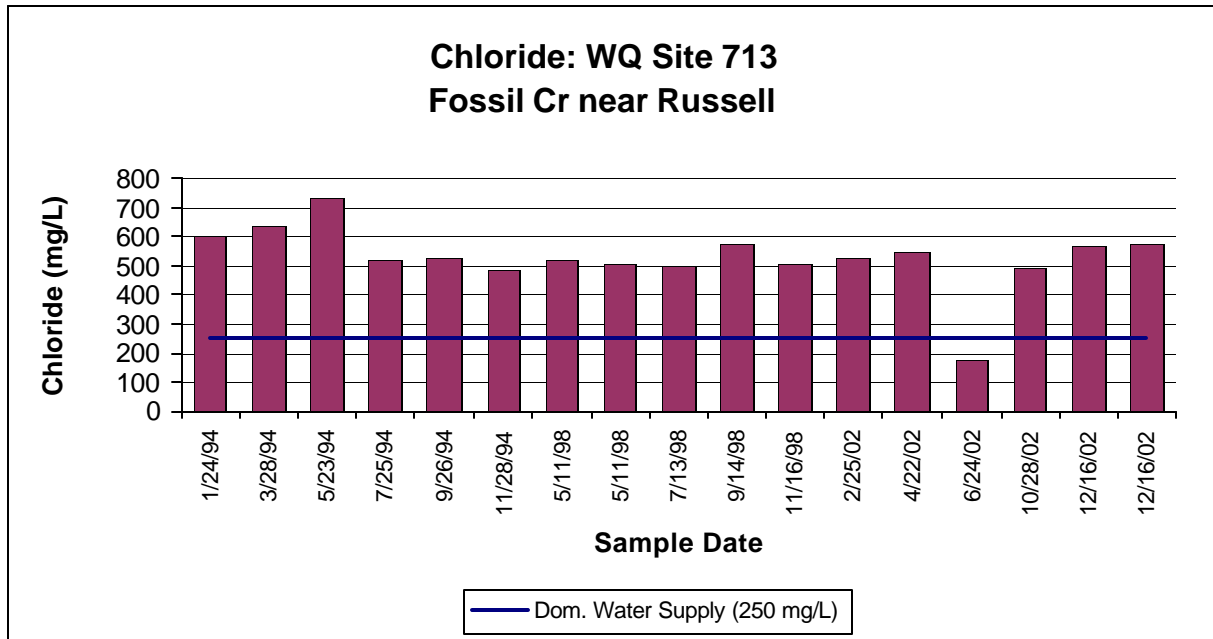
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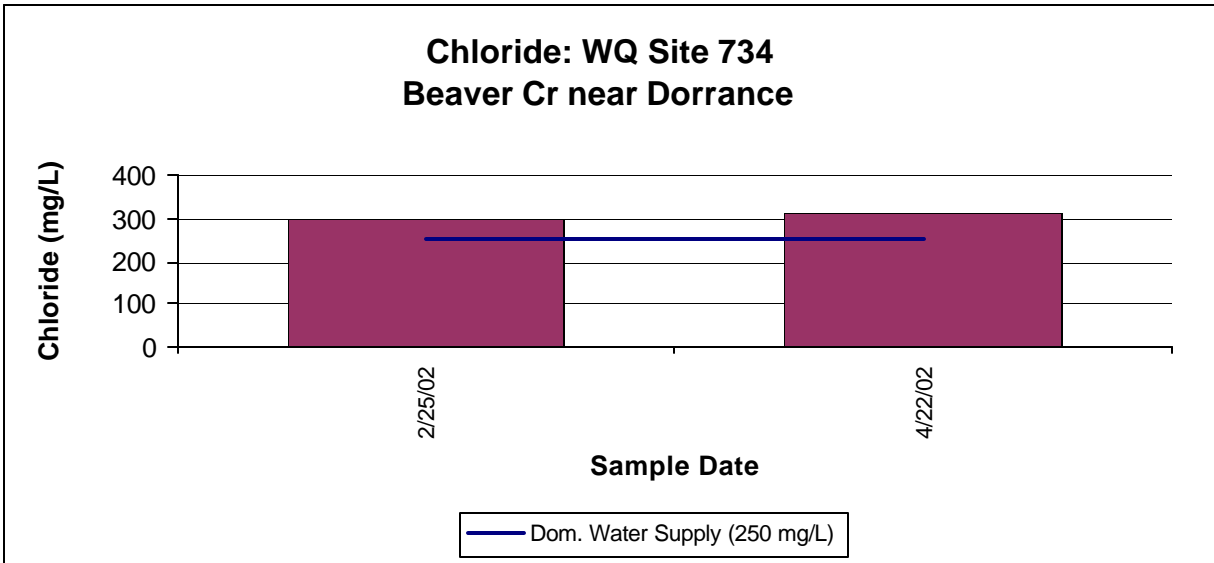
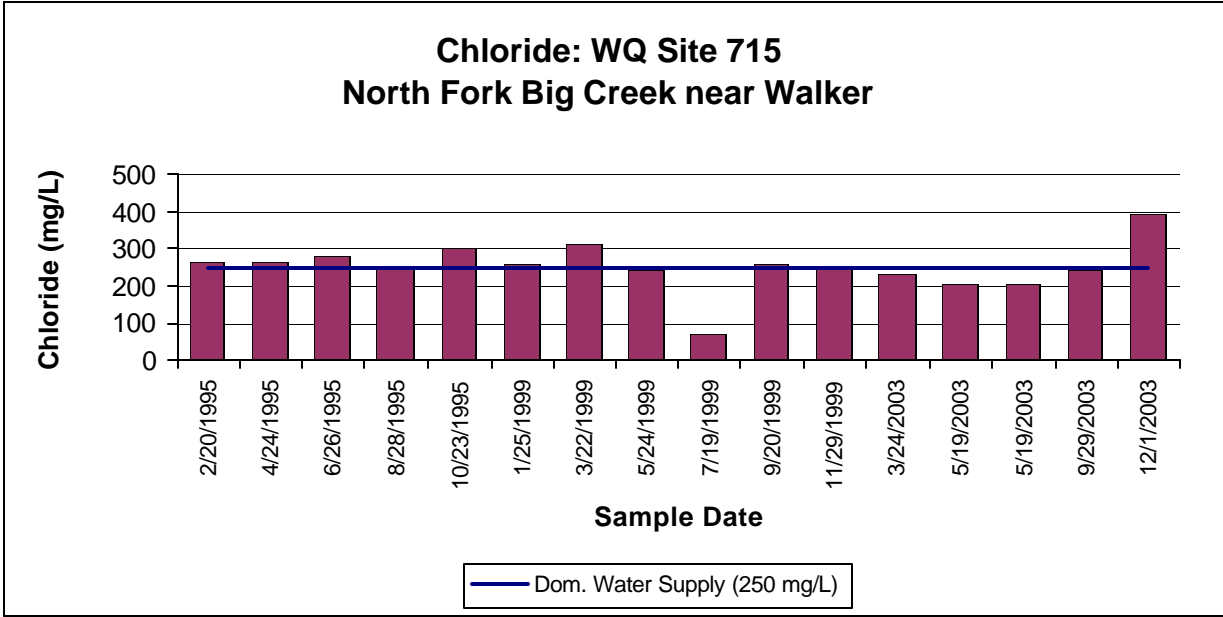
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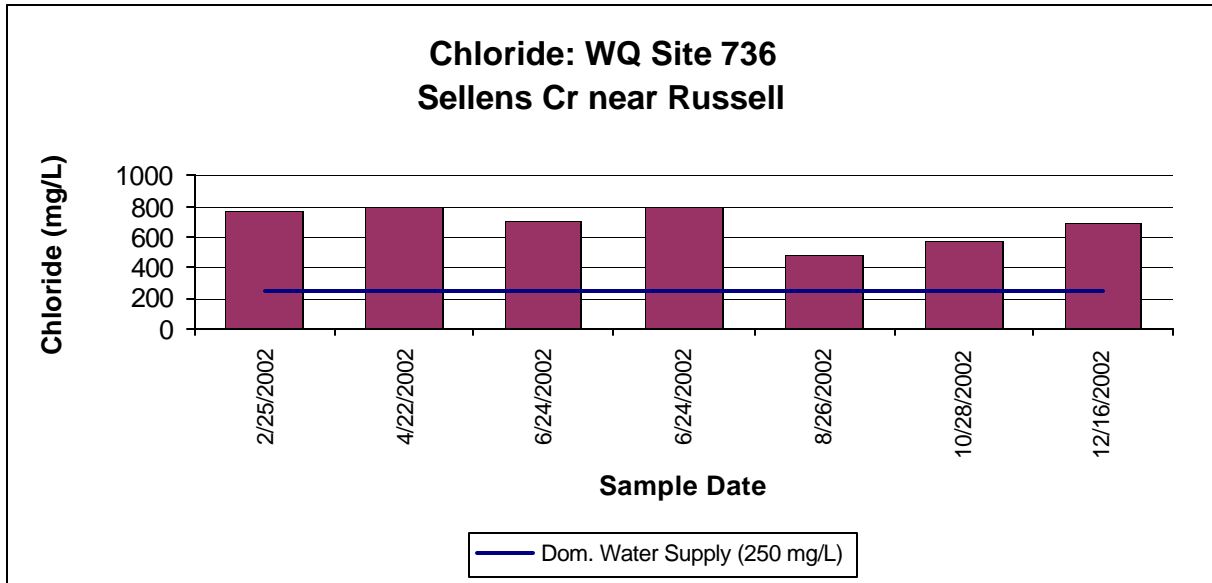
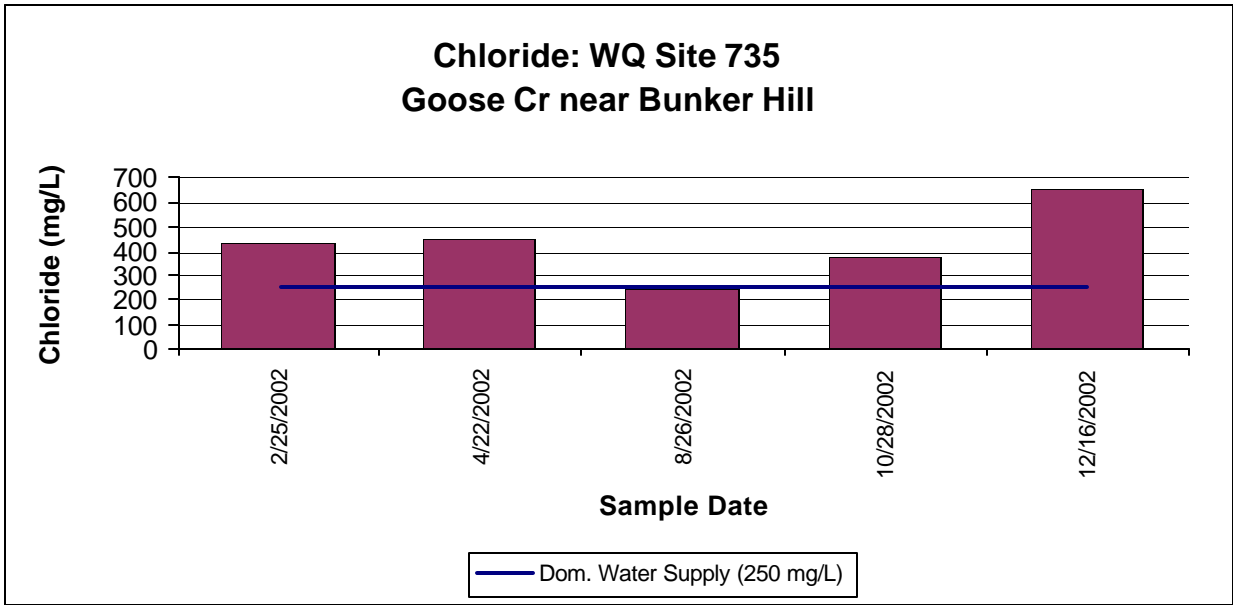
Appendix A - Boxplot



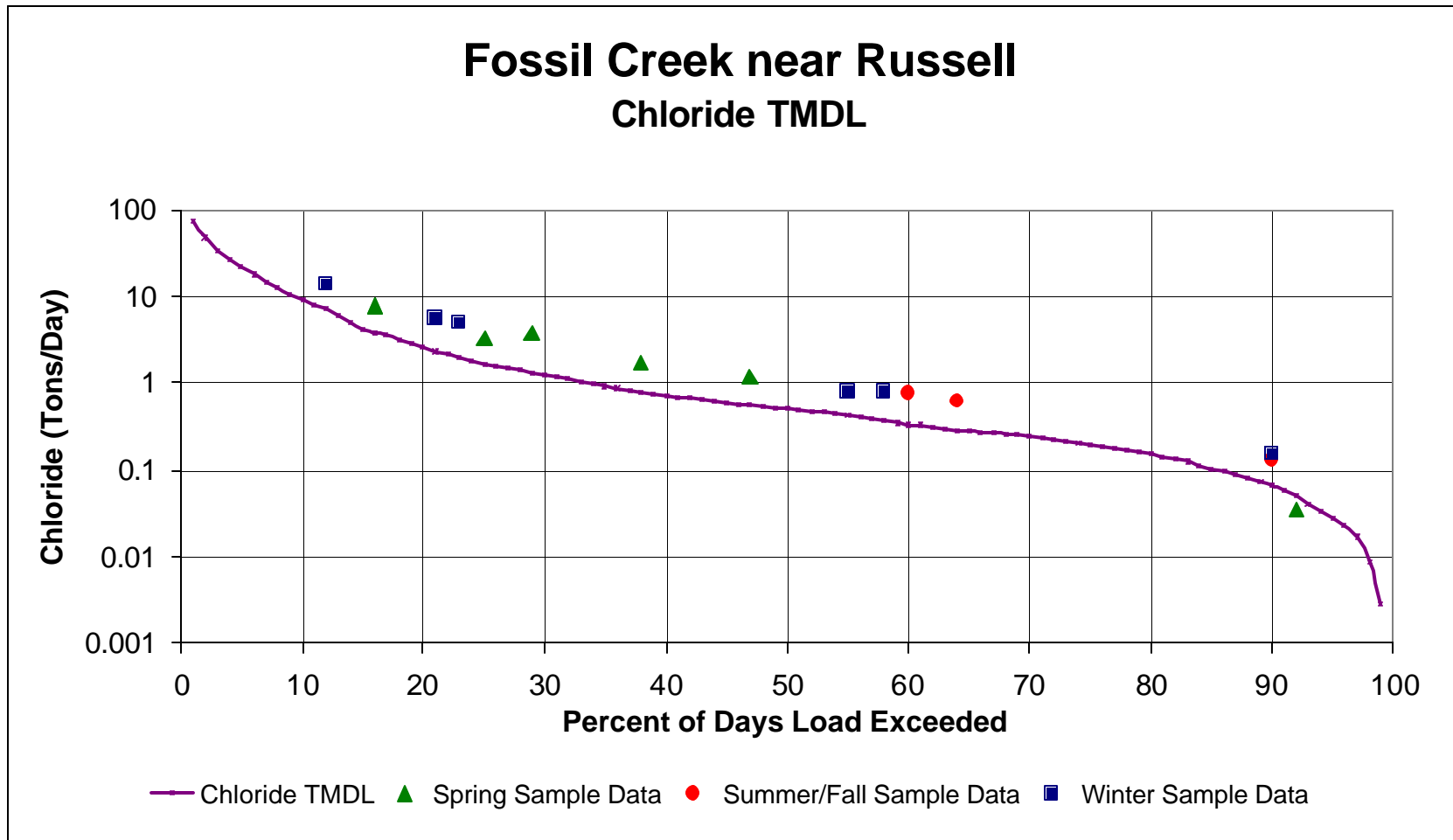
Appendix B - Concentration Graphs for Tributaries

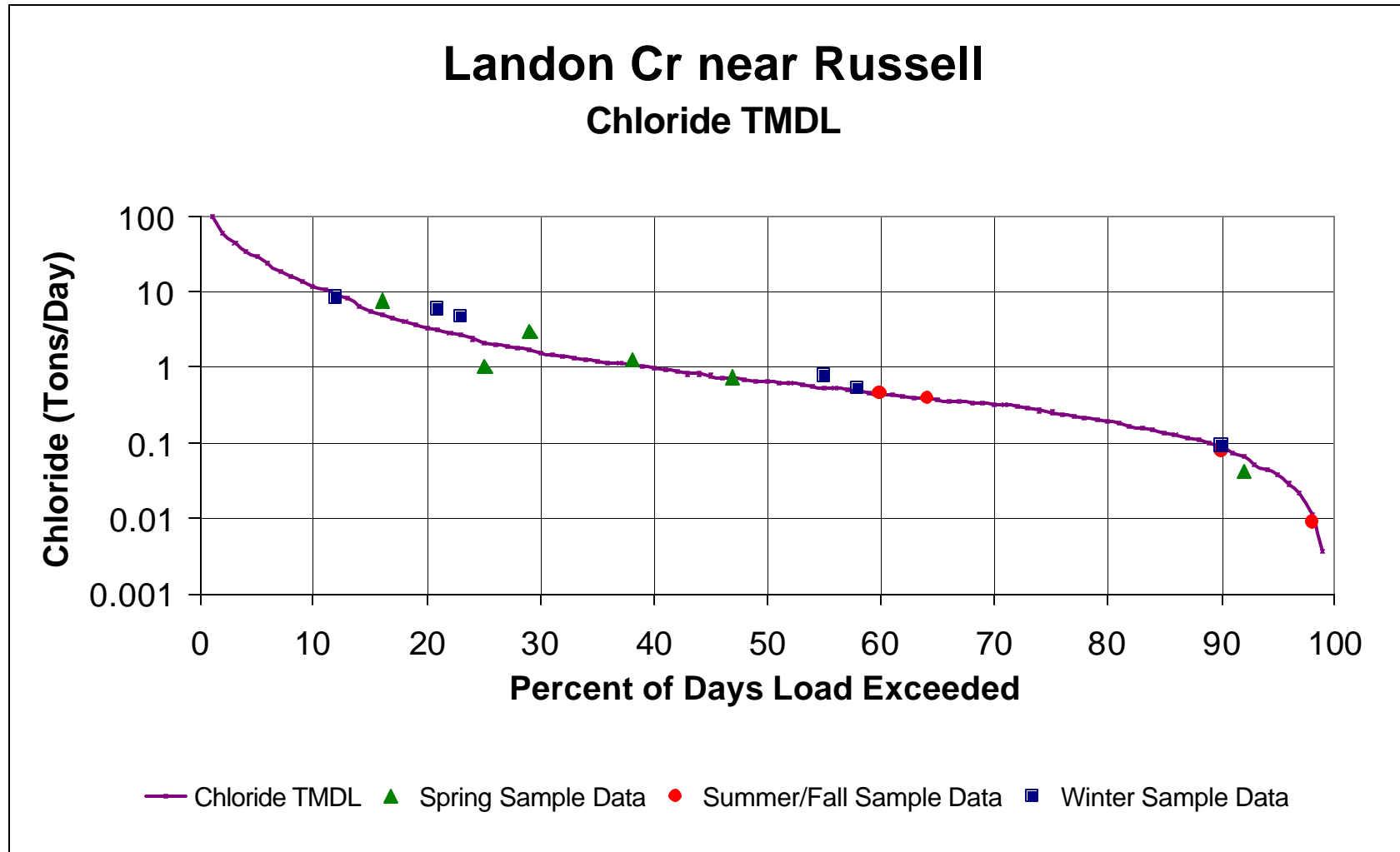


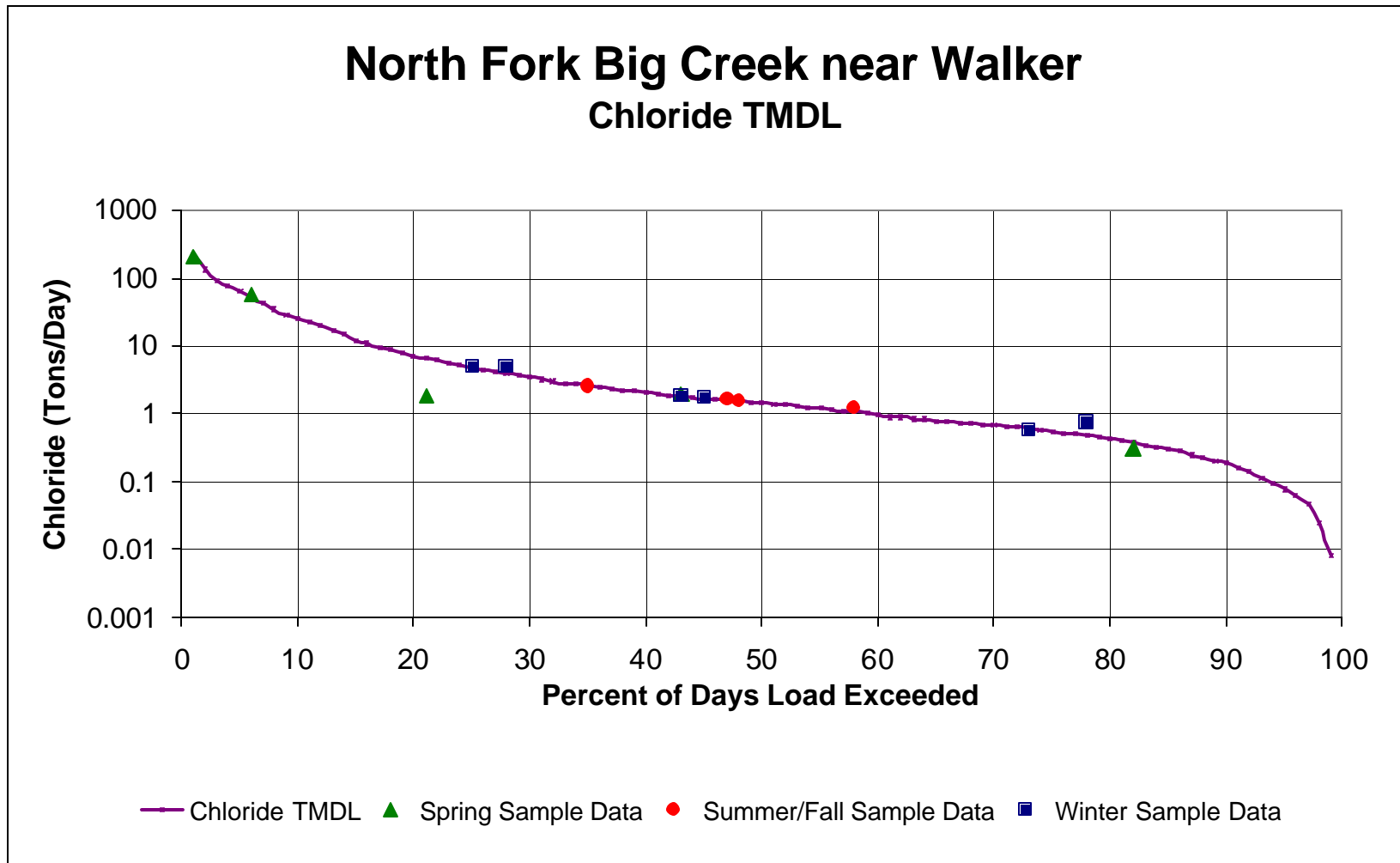




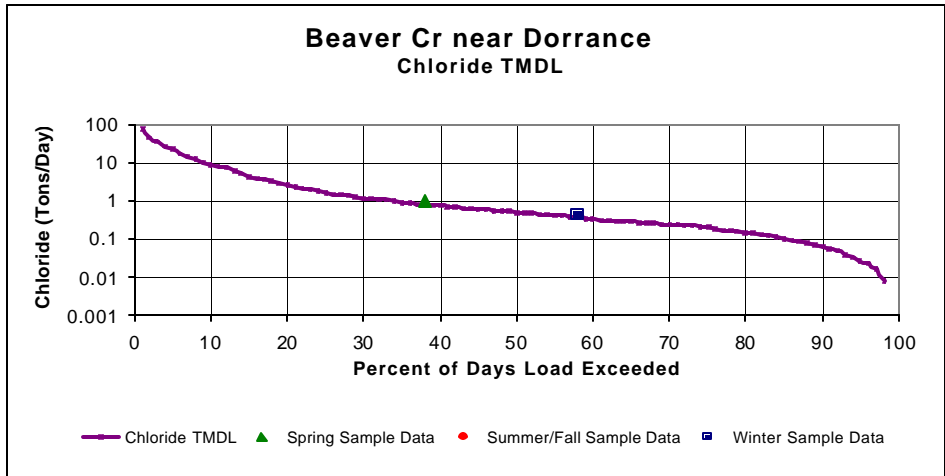
Appendix C - Load Duration Curves for Tributaries
Station 713



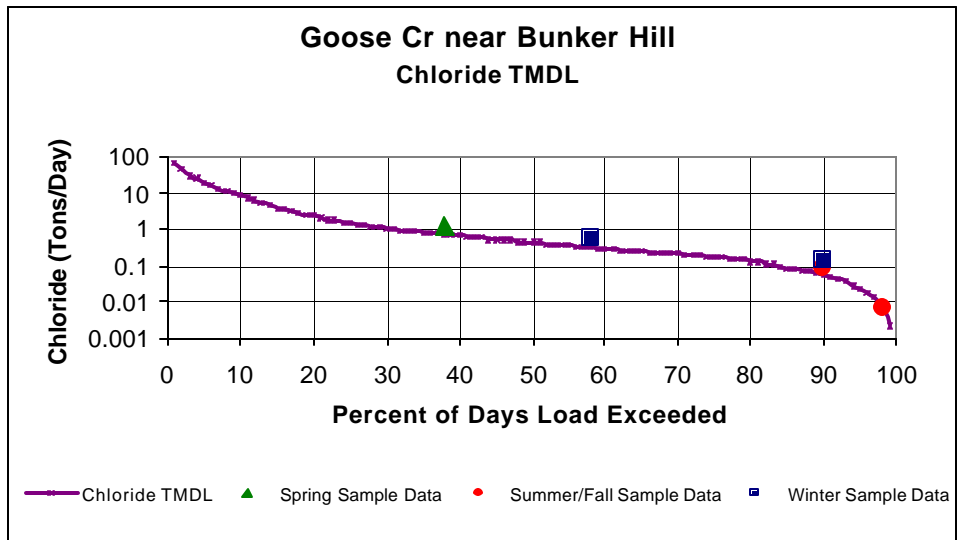


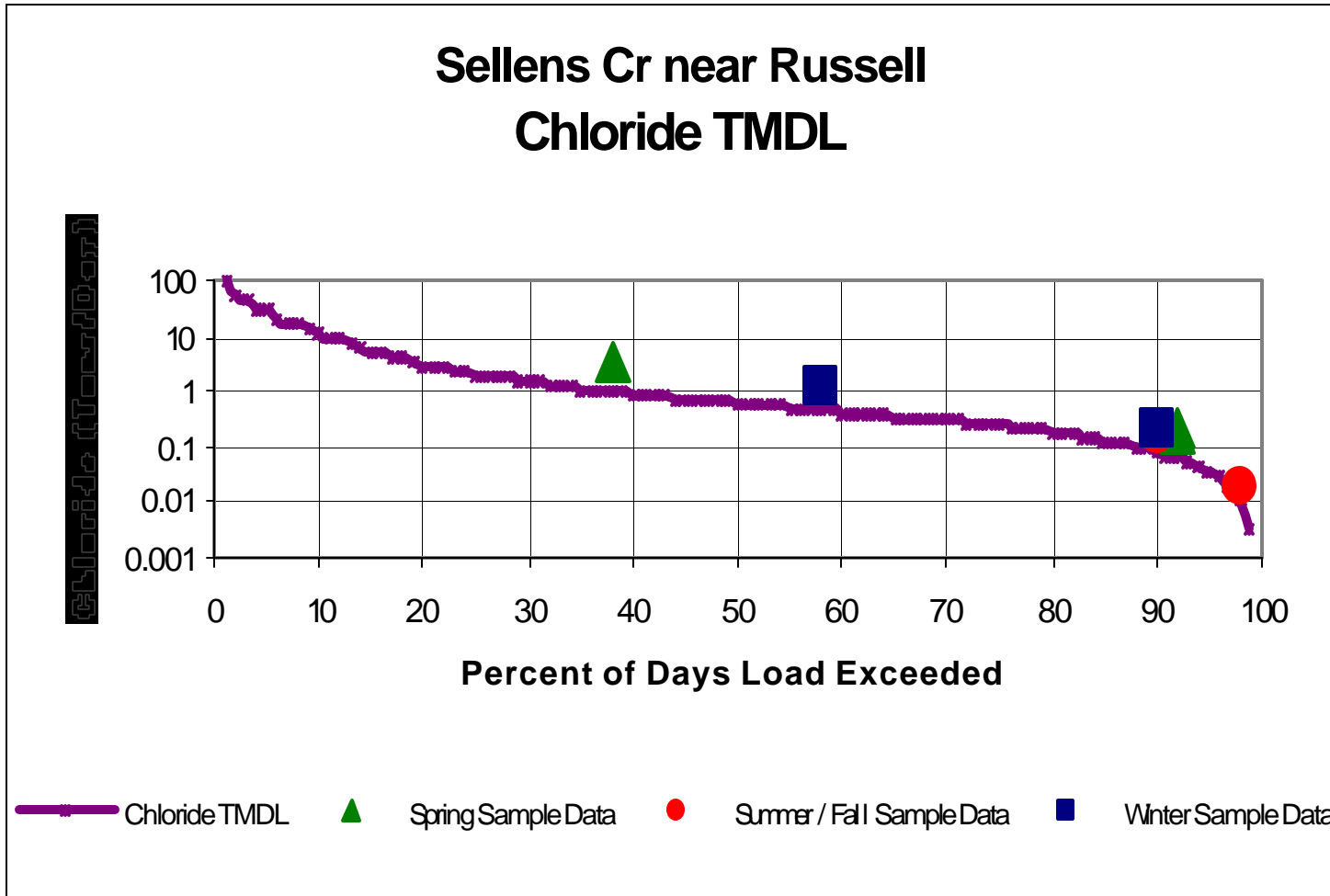


Station 734



Station 735





Appendix D - Wasteload Allocations Calculations

Permit Number	Facility	Public Water Supply Used to Calculate Effluent	Design Flow (MGD)	Type	Chloride in Influent (mg/L)	Chloride in Effluent (mg/L)	Chloride Load (tons/day)
Upstream of Station 007							
M-SH26-OO02	McCRACKEN MWTP	City of McCracken	0.04	3-cell Lagoon	165.55	250	0.04
M-SH16-OO02	HAYS WWTF	City of Hays	2.80	Trickling Filters	140.98	150	1.75
M-SH38-OO01	WAKEENEY MWTP	City of Wakeeney	0.43	Trickling Filter	32.30	100	0.18
M-SH06-OO02	ELLIS WWTF	City of Ellis	0.30	UV Disinfection	229.22	250	0.31
							2.28
Between Station 007 and 723							
M-SH31-OO02	RUSSELL WWTP	City of Russell	1.40	4-cell Lagoon	173.84	250	1.46
							1.46
Between Station 723 and 269							
M-SH07-OO01	ELLSWORTH WWTF	City of Ellsworth	0.50	disinfection, 3 cell Lagoon	99.96	150	0.31
M-SH40-OO01	WILSON MWTP	City of Wilson	0.15	Trickling Filter, Lagoon in construction	10.00	100	0.06
							0.37
Between Station 269 and Kanopolis Lake							
I-SH19-PO07	INDEPENDENT SALT COMPANY	N/A	0.0072	Mechanical Mining of Underground Salt		1600.0	0.05
						Total	4.16

9/21/2004