LOWER ARKANSAS RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Cow Creek and Little Cow Creek (above Willowbrook)
Water Quality Impairment: Chloride (Cl)

1. INTRODUCATION AND PROBLEM IDENTIFICATION

Sub-basin: Cow

Counties: Barton, Ellsworth, Rice, and Reno

HUC 8: 11030011 **HUC** 11 (14): **010** (010,020,030, 040, 050, 060, and 070)
020 (010, 020, 030, 040, 050, and 060)
030 (010, 020, 030, 040, 050, 060, and 070)

Ecoregion: Central Great Plains, Rolling Plains and Breaks (27b)
Central Great Plains, Great Bend Sand Prairie (27c)

Drainage Area: Approximately 886 square miles

Main Stem Segments: WQLS: 1, 2, 3, 5, 6; starting at Water Quality Monitoring Site 522 and traveling upstream to northeastern Barton County and southwestern Ellsworth County (**Figure 1**).

Main Stem Segment with Tributaries by HUC 8 and Watershed/Station Number:
HUC 8: 11030011
Watershed: **Cow Creek (Willowbrook)**
Station 522 **Cow Cr (1)** Dry Cr (22)
Jarvis Cr (19)
Owl Cr (18)

HUC 8: 11030011
Watershed: **Little Cow Creek**
Station 656 **Little Cow Cr (2)** Salt Cr (21)

HUC 8: 11030011
Watershed: **Cow Creek (Lyons)**
Station 657 **Cow Cr (3)** Spring Cr (20)
Lost Cr (17)
Plum Cr (4)

Cow Cr (5) Little Cheyenne Cr (7)

Cow Cr(6)

Designated Uses: For Main Stem Segments (1, 2, 3, 5, 6,): General Purpose Waters; Expected Aquatic Life Support; Domestic Water Supply (except segment 2); Groundwater Recharge;

For Stem Segment (7): Exceptional State Waters; Special Aquatic Life Support; Groundwater Recharge

For Stem Segments (4, 17, 18, 19, 20, 21, 22): General Purpose Waters; Expected Aquatic Life Support; Groundwater Recharge for segment 4 only

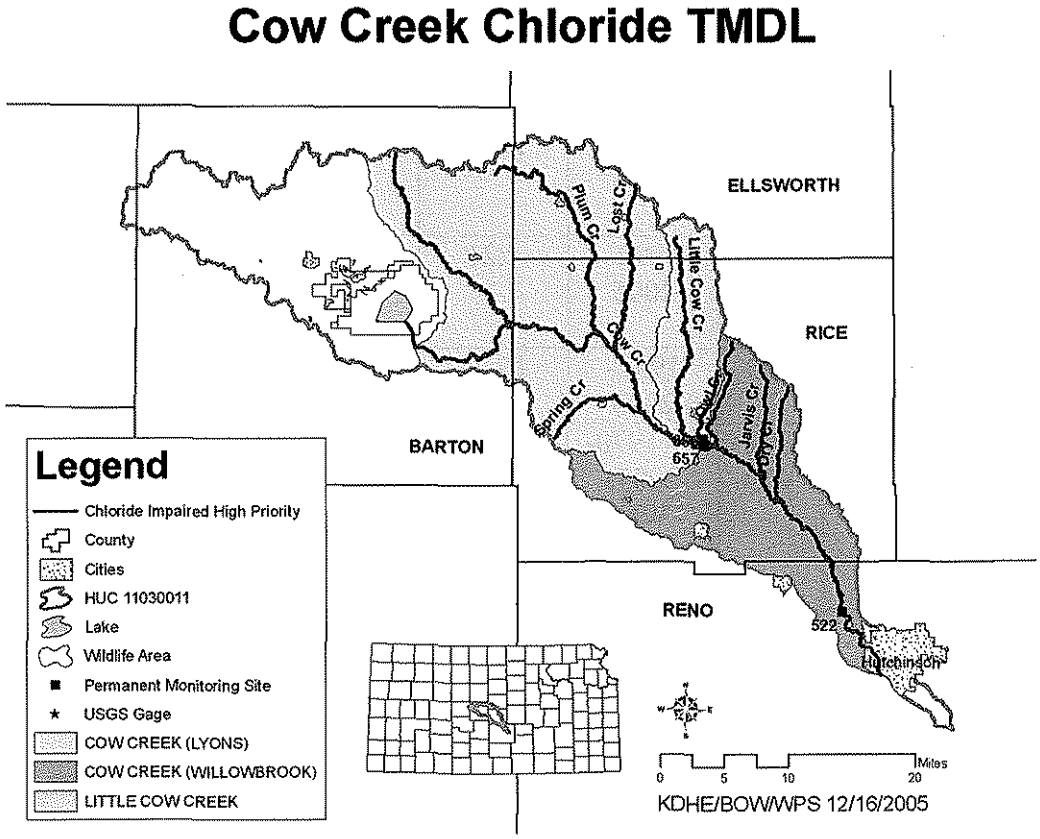
2002 & 2004 303(d) Listing: Lower Arkansas Basin Streams: Cow Creek (Willowbrook) (Segment 1); Little Cow Creek (Segment 2); Cow Creek (Lyons)(Segment 3, 5, and 6)

Impaired Use: Attainable Domestic Water Supply

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

In stream segments where background concentrations of naturally occurring substances, including chlorides and sulfates, exceed the domestic water supply criteria listed in table 1a in subsection (d), at ambient flow, due to intrusion of mineralized groundwater, the existing water quality shall be maintained, and the newly established numeric criteria for domestic water supply shall be the background concentration, as defined in K.A.R. 28-16-28b(e). Background concentrations shall be established using the methods outlined in the "Kansas implementation procedures: surface water quality standards," as defined in K.A.R. 28-16-28b(gg), available upon request from the department. (K.A.R. 28-16-28e (b) (9) & K.A.R. 28-16-28e (c) (3) (B))

Figure 1. Cow Creek (HUC 11030011) Chloride TMDL base map.



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 2004 303(d): Not Supporting Domestic Water Supply

Streamflow and Water Quality Monitoring Sites: Table 1 indicates the USGS Stream Gaging Station and KDHE Ambient Stream Water Quality Monitoring Stations used in this TMDL. Flow estimates were made from USGS extrapolation studies.

Table 1. Stream Chemistry Monitoring Sites: Monitoring and Flow Record Information for the Cow Creek Sub-basin.

Station	Stream	Type	Period of Record Used	Med Q	Avg Cl (mg/L)	Max Cl (mg/L)	# Of Samples	# > 250 mg/L
Station 522 (near Willowbrook)	Cow Cr	WQ	1990-2005	19.65	242	470	94	50
Station 656 (Little Cow Cr)	Little Cow Cr	WQ	1992-2005	1.21	275	473	81	53
Station 657 (near Lyons)	Cow Cr	WQ	1992-2005	10.75	375	669	81	68
USGS Station 07143300	Cow Cr	Q & WQ	Q (1970-2005) WQ (1961-1976)	12	647	2440	115	93
North American Salt Data	Cow Cr above Owl Cr	WQ	1990-2000	NA	336	832	3178	2199

Long Term Flow Conditions: Median Flow = 12 cfs; 7Q10 = 1

Current Conditions: Over the period of record, chloride concentration averages were established for KDHE ambient stream monitoring stations 522, 656, and 657. The chloride averages for the sampling stations are illustrated in Table 1. Each site had a number of samples that exceeded the established water quality standards. There is significant scatter in the sample data. Chloride exceedances over 250 mg/l cease once flows reach 10 percent exceedance levels for stations 657 and 522 and 20 percent exceedance levels for station 656 (**Figures 2, 3, and 4**). Station 657 rarely had any chloride samples below 250 mg/l for flows above the 10 percent exceedance levels.

Figure 2.

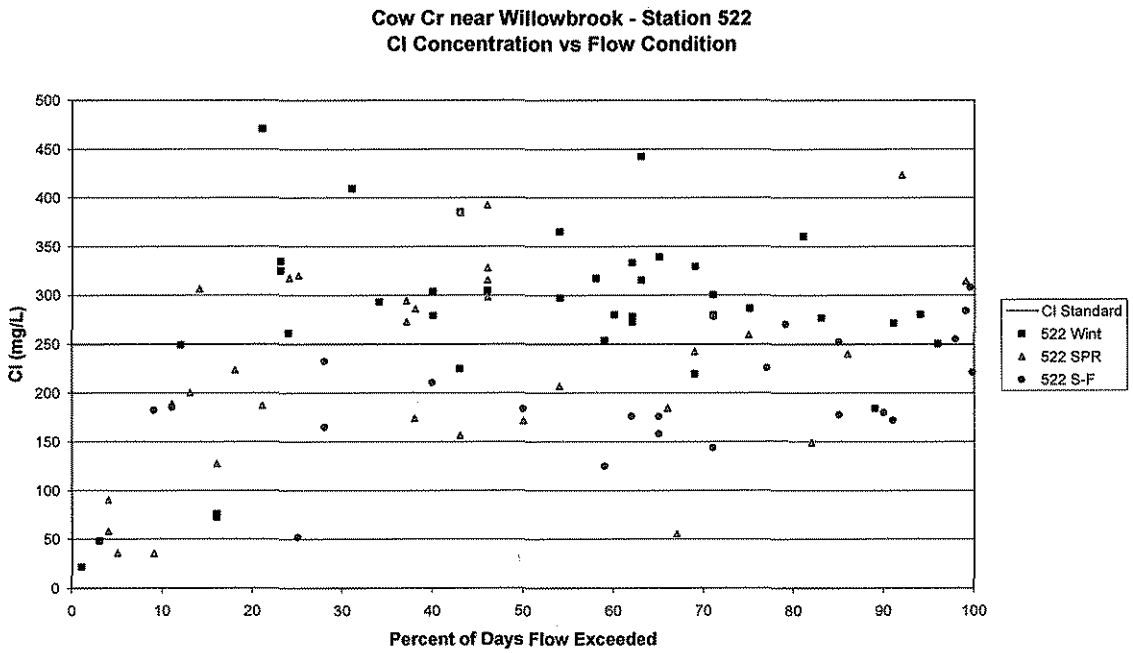


Figure 3.

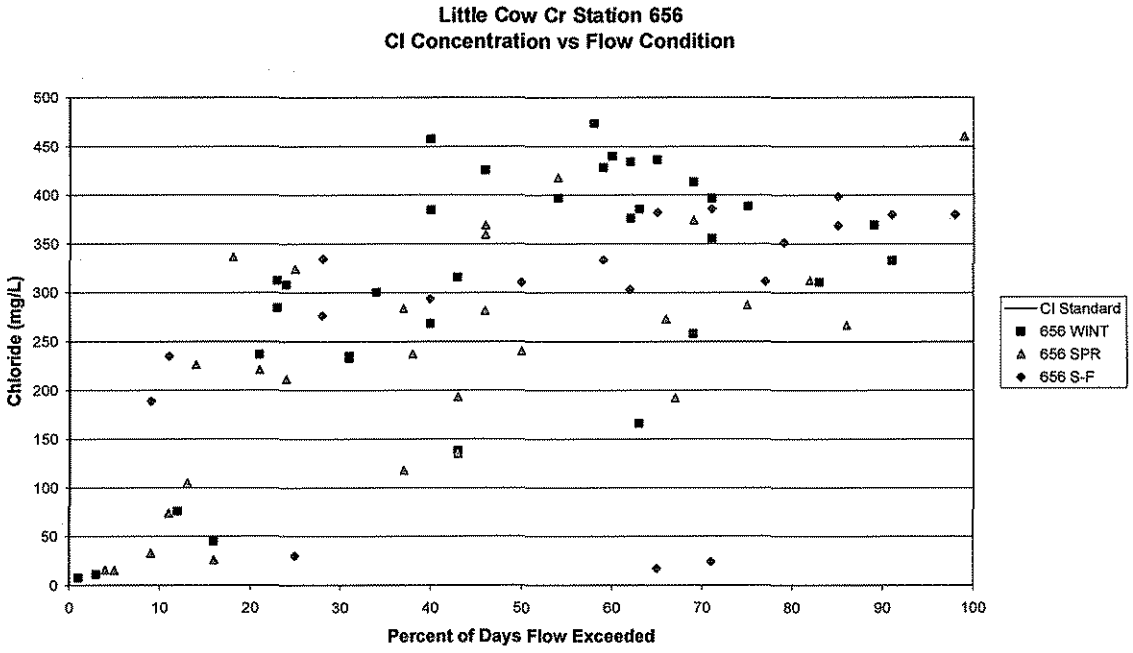
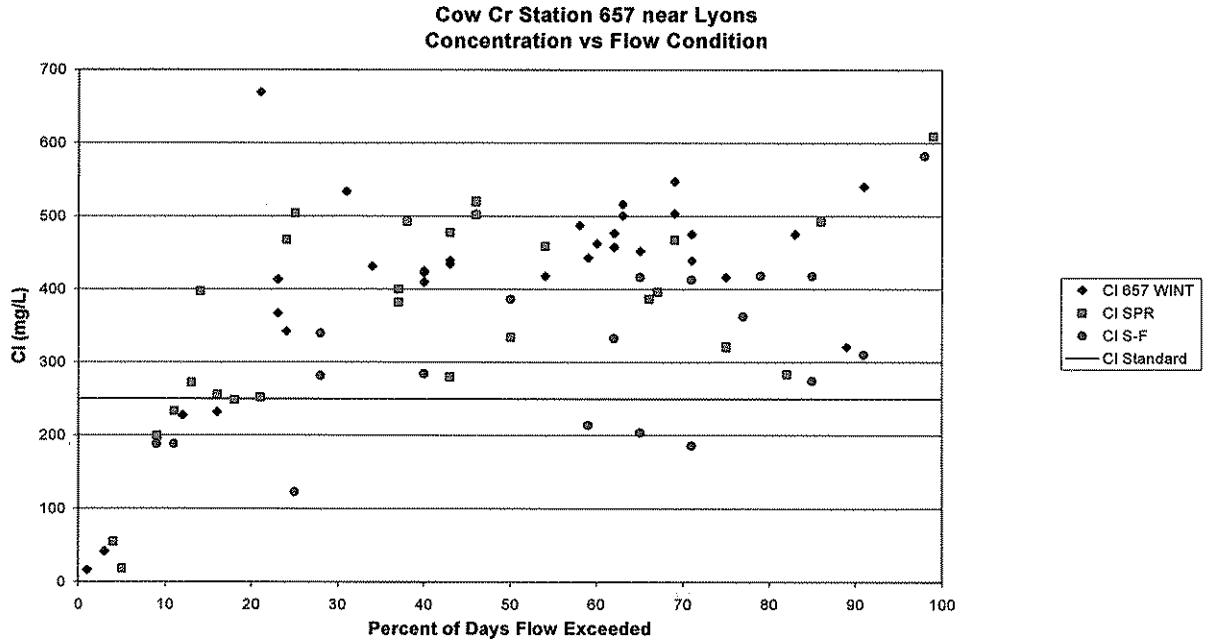


Figure 4.



In general, the concentration of chloride in Cow Creek is diluted as waters flow towards Willowbrook, KS. During low flow conditions, chloride concentrations are diluted from both Little Cow Creek (station 656) and Cow Creek near Lyons (station 657) downstream to Cow Creek above Willowbrook (station 522. Station 522, above Willowbrook, is approximately 32 stream miles downstream from stations 656 and 657, which are fairly close geographically) **(Figure 1)**. Flows from station 656 and 657 converge about a ½ mile downstream just above the USGS 07143300 (Cow Creek near Lyons) gaging station. During high flow conditions the chloride concentrations are higher at station 657 and are diluted at station 522, but station 656 and 522 show similar chloride concentrations (**Figure 5**). This may be due to the low levels of chloride in runoff contributed from Little Cow Creek at station 656 in comparison to runoff on upper Cow Creek at station 657, which may drain historic brine fields, as well as outflows from Cheyenne Bottoms.

The droughts of 1990-1992 appear to be the only period were critical low flows were observed. There were only four samples collected at station 522 during the critical low flow period; these averaged 282 mg/l of chloride. There were numerous samples evaluated for the critical low flow period on Cow Creek above Owl Creek, which were collected by the North American Salt Company. Critical low flow chloride concentrations averaged 265 mg/l at this location.

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. Generally, chloride concentration averages are higher in the winter months under all flow conditions for monitoring stations 657, 656, and 522. 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 pounds of chloride 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 applicable load duration curves.

Figure 5.

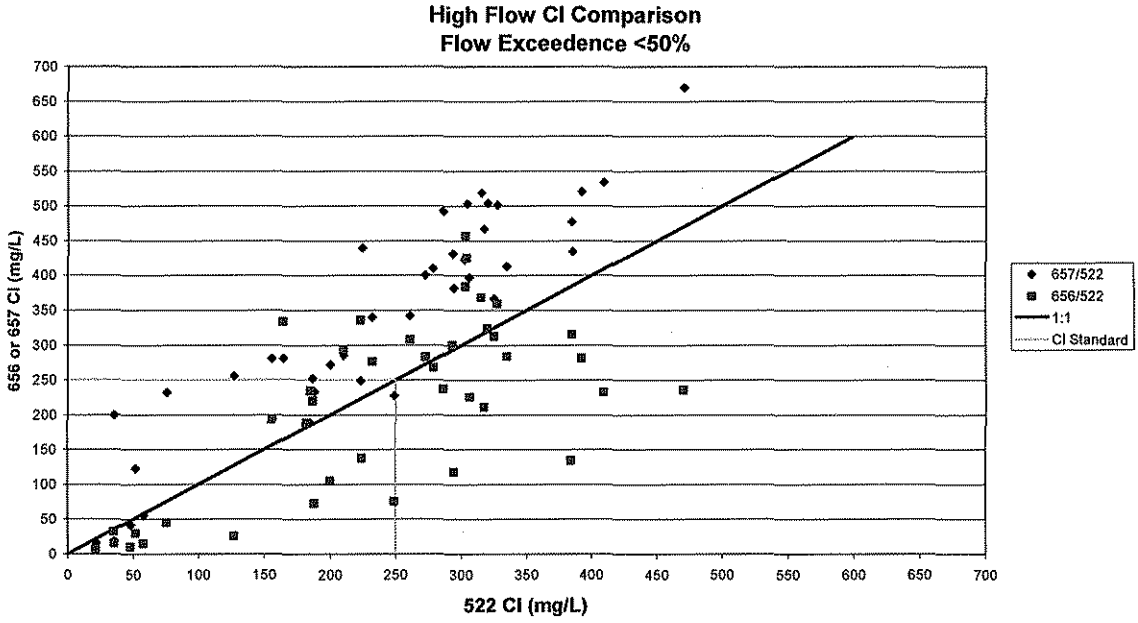
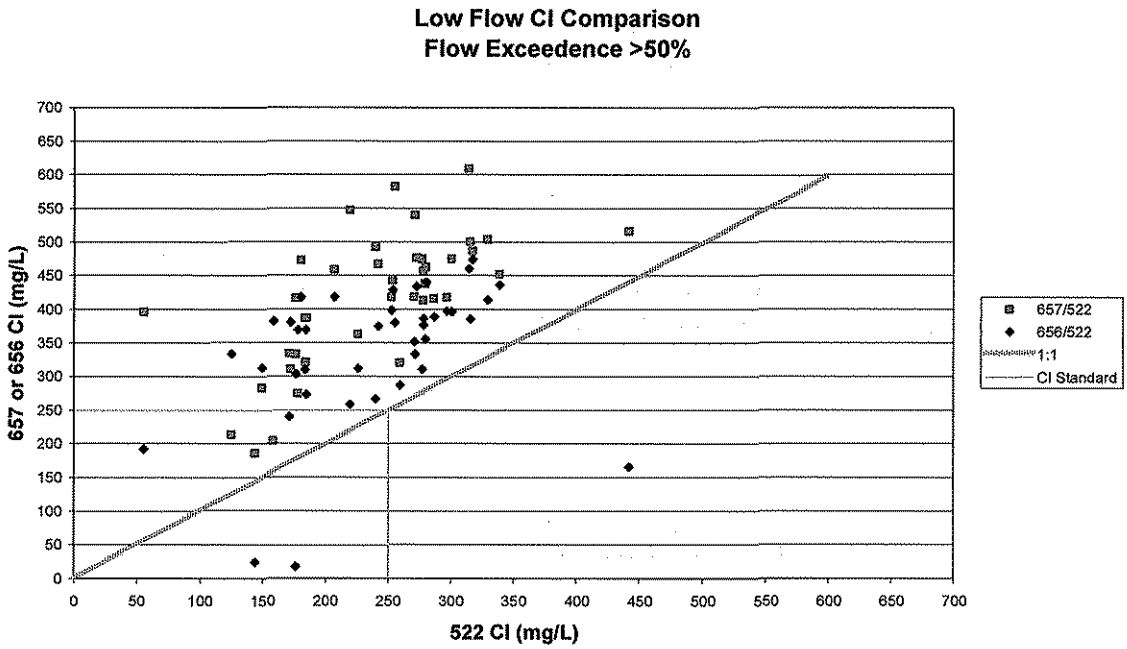


Figure 6.

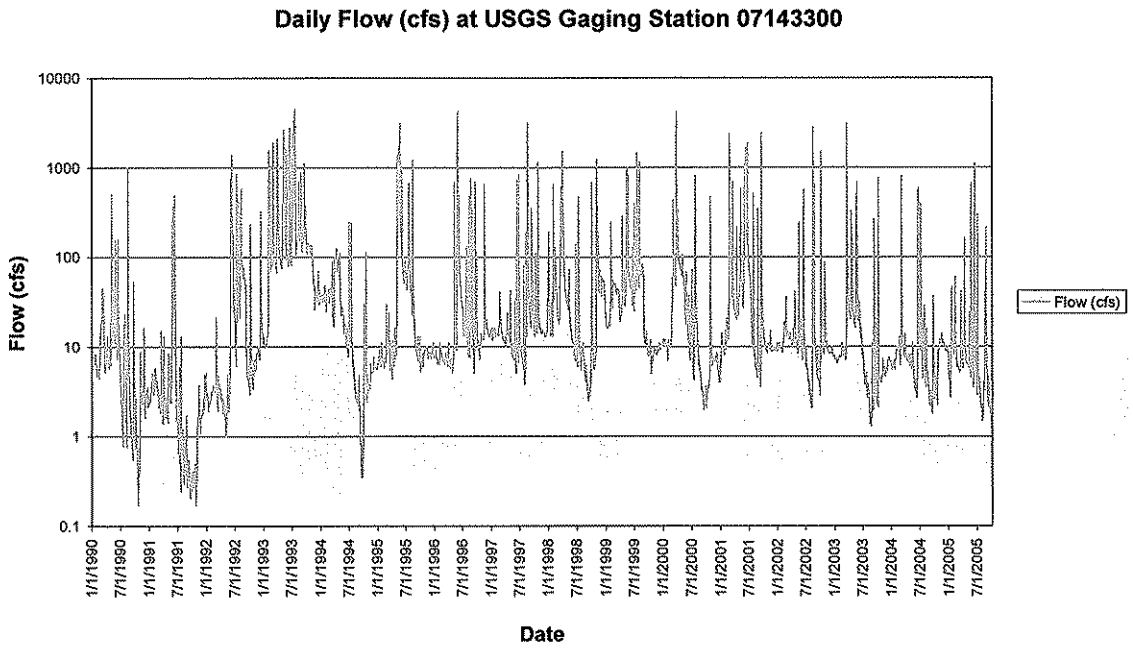


Flow duration data was established by examining the data from the USGS Lyons Gaging Station 07143300 from 1970 to 2005. This is the only USGS gaging station on Cow Creek. Flow values for KDHE monitoring stations 656 and 657 were calculated by multiplying the respective flow values from the USGS gaging station by the drainage area for the specified KDHE monitoring station (656 or 657), and dividing that value by the total drainage area for the USGS gaging station. Based on these calculations, flows from 657 accounted for approximately 89% and flows from 656 accounted for approximately 11% of the total flow values at the USGS gaging station near Lyons. Flow values were calculated for KDHE monitoring station 522 utilizing data from the USGS Scientific Investigations Report 2004-5033 and available data from the flow values at the USGS gaging station near Lyons.

Table 2. Selected Hydrology for the Cow Creek TMDL.

			Percent of Time Flow Exceeded		
Stream (Station)	Drainage Area	Mean Flow	90 %	75%	50%
Cow Cr near Lyons (657)	630	49.4	2.69	5.29	9.86
Little Cow Cr (656)	72.4	5.63	.31	.61	1.13
Cow Cr at USGS Station 07143300	703	80.65	3	5.9	11
Cow Cr above Willowbrook (522)	886	68	5.52	10.25	18.15

Figure 7.



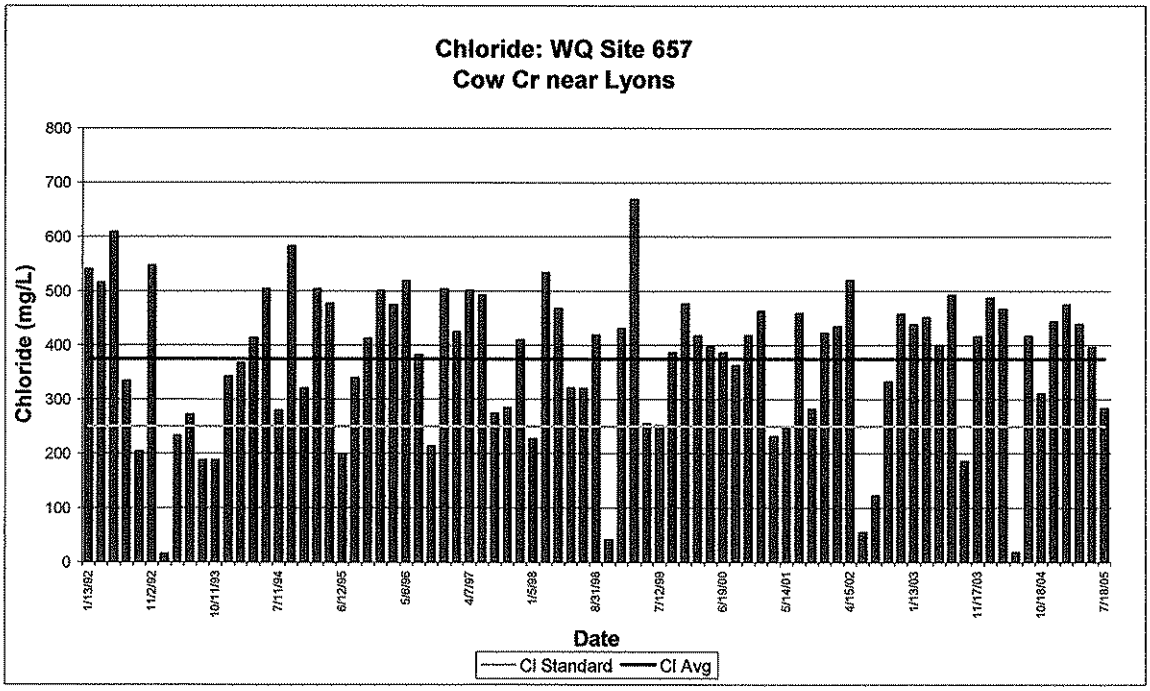
Station 657 (Cow Cr near Lyons):

Excursions were seen in each of the three defined seasons as indicated in **Table 3** and **Figure 8**. Samples were over the domestic water supply criterion in 83% of the Spring samples, 75% of the Summer-Fall samples, and 88% of the Winter samples. Overall, 84% of the samples were over the criterion. This would represent a baseline condition of non-support of the designated use.

Table 3. Number of Samples Over Chloride Standard of 250mg/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.
Cow Cr near Lyons (657)	Spring	0	5	9	5	4	1	24/29=83%
	Summer	0	1	3	4	4	3	15/20=75%
	Winter	0	4	8	13	3	1	29/33=88%

Figure 8.



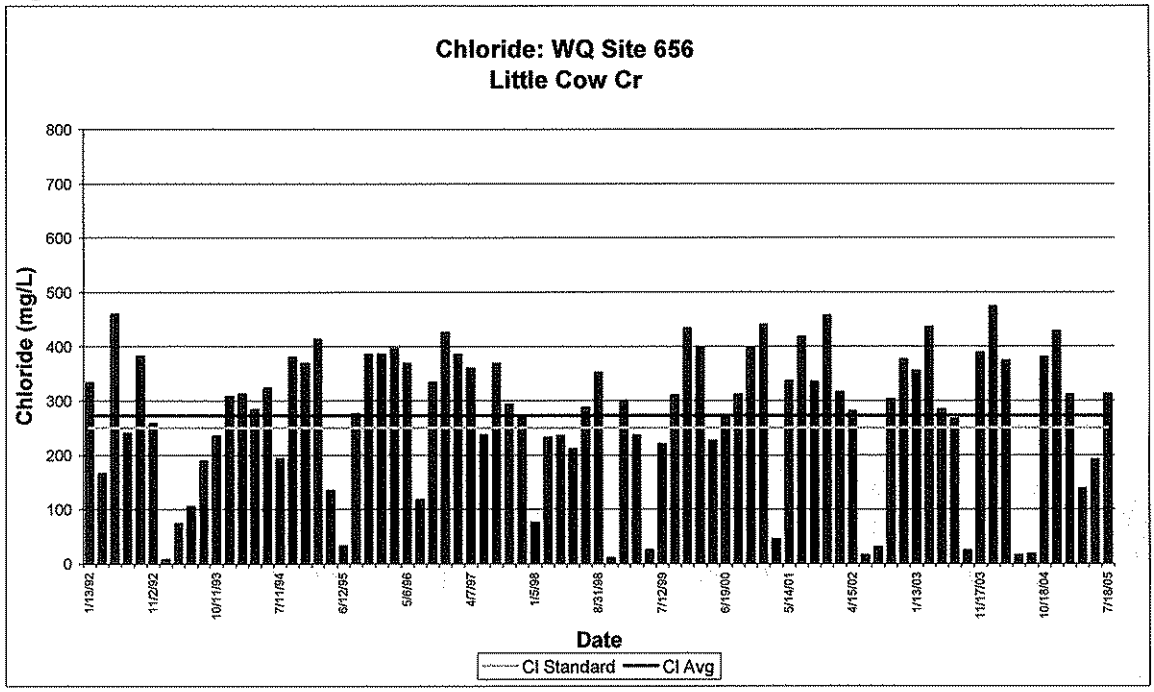
Station 656 (Little Cow Cr):

Elevated chlorides were seen in each of the three defined seasons as indicated in **Table 4** and **Figure 9** at station 656. Samples were over 250 mg/L in 46% of the Spring samples, 75% of the Summer-Fall samples, and 73% of the Winter samples. Overall, 65% of the samples were over 250 mg/L.

Table 4. Number of Samples Over Chloride Standard of 250mg/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.
Little Cow Cr (656)	Spring	0	1	5	3	3	1	13/28=46%
	Summer	0	0	3	5	4	3	15/20=75%
	Winter	0	3	6	12	3	1	25/34=73%

Figure 9.



Station 522:

Excursions were seen in each of the three defined seasons as indicated in **Table 5** and **Figure 10** at station 522. Samples were over the domestic water supply criterion in 42% of the Spring samples, 26% of the Summer-Fall samples, and 77% of the Winter samples. Overall, 53% of the samples were over the criterion. This would represent a baseline condition of non-support of the designated use.

Table 5. Number of Samples Over Chloride Standard of 250mg/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.
Cow Cr near Willowbrook (522)	Spring	0	2	9	0	1	2	14/33=42%
	Summer	0	0	0	1	2	3	6/23=26%
	Winter	0	4	7	14	3	2	30/39=77%

Figure 10.

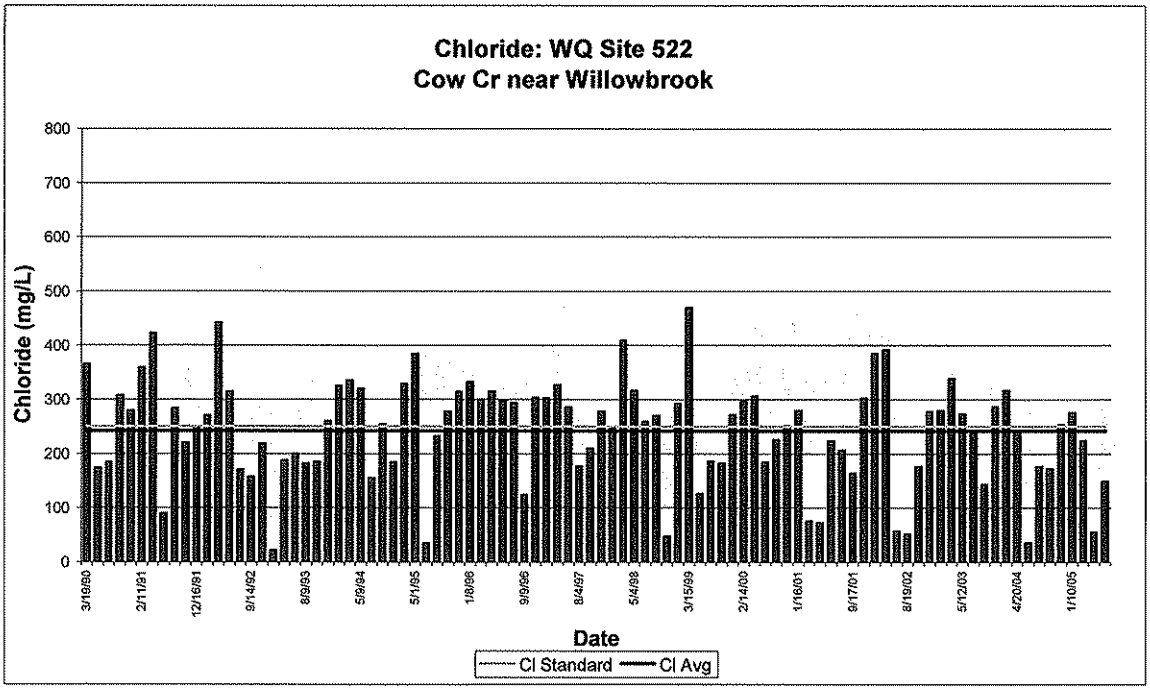


Table 6. Chloride Concentration mg/L Seasonal Averages.

Station	Wint All Flow Avg	Wint Low Flow Avg	Spr All Flow Avg	Spr Low Flow Avg	S-F All Flow Avg	S-F Low Flow Avg	All Seasons All Flow Avg	All Season Low Flow Avg
Cow Cr near Lyons 657	419	466	363	407	312	348	375	413
Little Cow Cr 656	306	375	228	314	286	301	275	337
Cow Cr near Willowbrook 522	280	297	225	221	200	211	242	251
Cow Cr above Owl Cr (NASC)	396	443	324	437	262	320	336	402

Interim Endpoints of Water Quality (Implied Load Capacity) at Sites 656, 657, and 522 over 2010-2015:

The desired endpoint of this TMDL is to protect the domestic water supply by maintaining an average chloride concentration below 250 mg/L in Cow Creek. The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards fully supporting Drinking Water Use. However, this TMDL will be staged. The current criterion of 250 mg/L of chloride was used to establish the TMDL and its Wasteload Allocations. The Cow Creek sub-basin is affected by the discharge of saline groundwater, which increases the natural chloride concentrations of the sub-basin. Additionally, runoff from brine fields may contribute chlorides. This is evident in the data as chloride concentrations are frequently greater than 250 mg/l during relatively high flow conditions. Chloride concentrations have generally been stable over time and there has not been an obvious increase of chloride over time. Therefore, the elevated background concentration of chloride makes the achievement of the Standard unlikely at most flow conditions. Since the existing criterion is not achievable on Cow Creek, because of natural contributions of the chloride load, an alternative endpoint is needed.

Cheyenne Bottoms adds a unique characteristic for the natural progression of the chloride load downstream. Water often pools here during dryer conditions and chloride levels increase through evapotranspiration, increasing the concentration of dissolved solids. During wetter conditions, Cheyenne Bottoms could contribute significant chloride loads as the water enters the Little Cheyenne tributary. Thus Cheyenne Bottoms has the potential for contributing higher chloride loads during moderately high flows.

Based on a Kansas Geological Survey report on the Chloride impairment in the Cow Sub-basin, it is estimated up to 80% of the chloride content is from natural sources during low flow conditions in Cow Creek near Lyons. Oil-field brine accounts for approximately 10-20% of the chloride load south of Lyons and accounts for the largest anthropogenic chloride source (Whittemore). The flushing and recharge of groundwater are slowly diluting the saline waters produced from the historical practice of discarding brine pollution on the surface. (Whittemore)

Kansas Implementation Procedures for Surface Water allow for a numerical criterion based on natural background to be established from winter samples taken at flows less than the median flow in the creek. The specific stream criteria to supplant the general standard will be developed concurrent with Stage One of this TMDL following the appropriate administrative and technical Water Quality Standards processes. Meanwhile, a Stage Two endpoint has been developed for the creek based on currently available information for each of the KDHE monitoring stations.

The background concentrations for stations 657, 656, and 522 have been adjusted based on calibrating the current point source discharge flows, loads, and concentrations with low flow data sets from 1992. Based on these calculations, the background chloride concentrations and flow values for the natural seepage at each of the respective stations was established (**Table 7**). The Stage Two TMDL will be based on the future criterion.

Table 7. Tentative Background concentrations for Stations 657, 656, and 522.

Station	Stage Two Background (mg/L)
Station 657 Cow Cr near Lyons	460
Station 656 Little Cow Cr	300*
Station 522 Cow Cr near Willowbrook	300

* Adjusted for City of Lyons discharge.

The background chloride concentration at the USGS gaging station 07143300 is approximately 450 mg/L based on flow contributions from station 657 and station 656. During typical flow conditions (25-75% flow duration interval) chloride concentrations decline approximately 32% from Cow Creek above Owl Creek (near the USGS 07143300 station) to station 522 above Willowbrook as calculated from data collected from North American Salt Company (above Owl Creek) and KDHE data (station 522) during concurrent time periods.

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

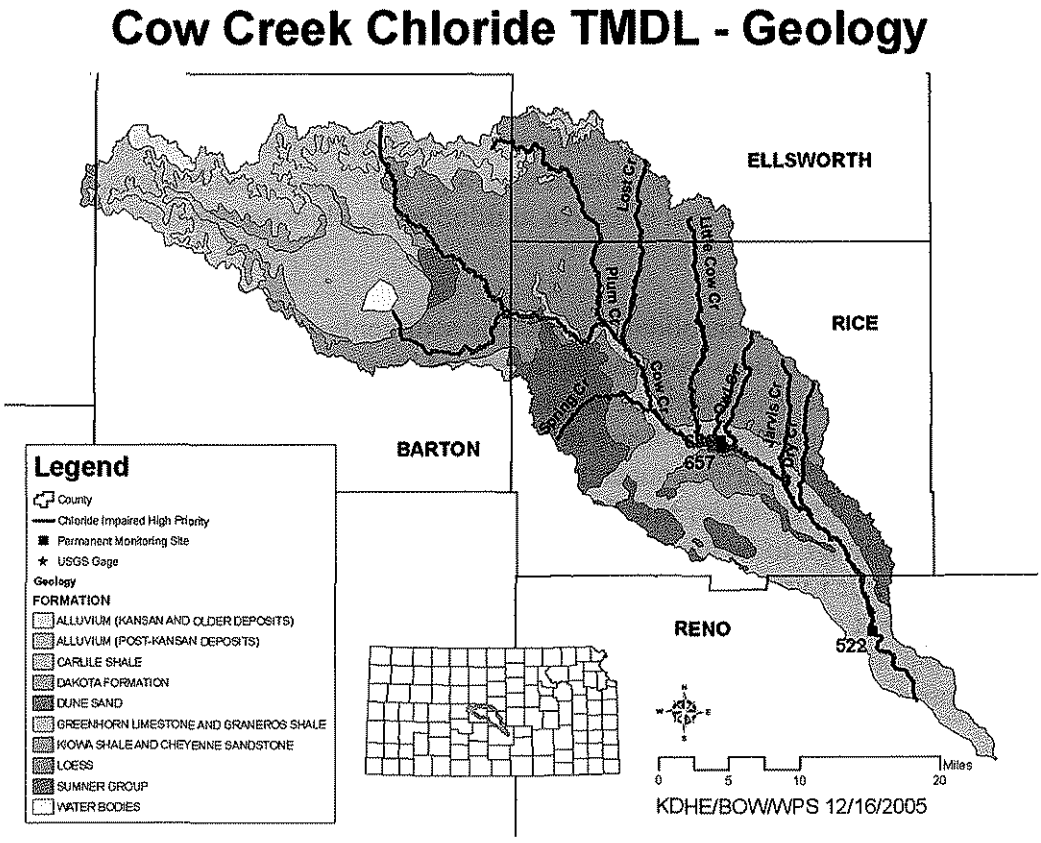
General Geology: The primary geologic material underlying the Cow Creek sub-basin is the High Plains aquifer and local alluvial aquifers that interact with stream flow. Cretaceous bedrock consisting of the Dakota Formation, Graneros Shale, Greenhorn Limestone, and Carlile Shale occur at or near the surface of parts of this basin, especially in the Cheyenne Bottoms watershed (see Geology Map of Cow Creek Basin, **Figure 11**). A small amount of water discharges from these geologic units to the stream in the basin. The Dakota Formation underlies part of the High Plains aquifer. Permian bedrock consisting primarily of siltstones and sandstones underlies the High Plains aquifer in the eastern part of the basin.

The following information was summarized from the Kansas Geological Survey Bulletin No. 88, written by Bruce F. Latta, which details the movement of groundwater in Barton County. The groundwater table underneath the Cow Creek drainage basin is irregular. Based on KGS contouring of the water table in this area, it is apparent that water table troughs have been created because the channels of Cow Creek and Little Cheyenne Creek are actually below the water table in some locations. The natural flow of groundwater is towards and into Cow Creek and Little Cheyenne Creek when the water table is above the stream channels, as is the case in the lower part of Cow Creek and Little Cheyenne Creek in southeast Barton County. KGS also noted in Bulletin No. 88 that underlying Cheyenne Bottoms a broad trough has formed on the water table, resembling the Cretaceous bedrock underlying the water table. Groundwater enters the Cheyenne Bottoms area from all directions other than the southeast area where it leaves the Bottoms. Here the groundwater is discharged into Little Cheyenne Creek or flows into the groundwater beneath Little Cheyenne Creek. Precipitation reaches the water table at Cheyenne Bottoms from natural runoff or from water entering from the creeks entering the Bottoms,

Deception Creek or Blood Creek. Precipitation that is not lost through the evapotranspiration process at Cheyenne Bottoms will mix with the underground reservoir since essentially all runoff in the immediate area feeds directly to Cheyenne Bottoms (Latta). Cheyenne Bottoms helps reduce the flow peaks in Cow Creek during rainfall events covering the upper part of the watershed since the runoff flows towards the Bottoms and is captured at Cheyenne Bottoms much like a reservoir (Whittemore).

The Cow Sub-basin average annual rainfall ranges from 23 to 27 inches. Rainfall recharges the local area of the High Plains aquifer and Cretaceous aquifer units sufficiently enough that the aquifers contribute groundwater discharge to Cow Creek, which helps sustain flows.

Figure 11.



Site 656 and 657

Chloride Background: The discharging of saline groundwater influences Chloride concentrations in the upper Cow basin leading to station 657. According to USGS, natural chloride in streams is attributed from dissolved marine salt from the sedimentary rock formations (Pope et al.). The primary contributor to the chloride impairment in the upper half of Cow Creek is natural in source. Low to moderate levels of chlorides is present in groundwaters in the Cretaceous bedrock at or near the surface of the sub-basin. The Dakota aquifer generally contains freshwater in the general area, but portions of some of the aquifer contain saline water in the subsurface underlying the northernmost parts of the Cow Creek sub-basin in Barton County (**Figure 11**). The Dakota aquifer and the overlying Upper Cretaceous rocks in this area are capable of discharging small amounts of saline water to Cow creek and it's tributaries that may potentially increase chloride concentrations under low flow conditions in these tributaries.

The chloride content of water in the pools of Cheyenne Bottoms can be extremely high (>2,000 mg/L), especially during drier conditions. Inflowing water in the Bottoms is mainly attributed to runoff from the westernmost part of the Cow Creek basin and from direct precipitation. However, Cheyenne Bottoms is also supplemented by water diverted from the Arkansas River and Walnut Creek. The high chloride concentration in the Bottoms water is mainly derived from the evapotranspiration concentration of a mixture of saline groundwater discharge, freshwater runoff, and imported water. Seepage from the pools at the Bottoms enters the outlet drainage canal that joins Little Cheyenne Creek. The condition of low flow seepage in the drainage at the end of the outlet canal will contain the highest chloride concentrations. Since the standing pools in the Bottoms may contain very high chloride concentrations, heavy rain events draining the pools may be less effective in diluting the chloride concentrations as the water enters the outlet canal.

Groundwater in the unconsolidated Cenozoic sediments downgradient of Cheyenne Bottoms is affected by the inflow from the Bottoms and by evapotranspiration concentration, due to the shallow depth of the water table in this area. The saline groundwater discharges to Little Cheyenne Creek, resulting in greater flows downstream in relation to the flows near the end of the Bottoms outlet canal. Chloride concentrations are diluted as the groundwater discharges near the confluence of Cow Creek under low flow conditions. The saline low flow from Little Cheyenne Creek is enough to be the major source of chloride at water quality Monitoring Site 657 on Cow Creek near Lyons. Water in the High Plains aquifer between the confluence of Little Cheyenne Creek and Site 657 is generally fresh. Therefore, the discharge of unpolluted groundwater along the main Cow Creek stem segments (segments 3 and 5) tends to dilute the chloride concentration under low flow conditions in Cow Creek.

Little Cheyenne Creek contains significantly higher chloride concentrations than in Cow Creek just above the convergence of the streams during low flow conditions. As observed in KGS samples collected in 1999, the chloride values of Little Cheyenne Creek upstream of the confluence of Cow Creek was 678 mg/L; 261 mg/L in Cow Creek above the confluence with Little Cheyenne Creek; and 2,573 mg/L near the outfall of Cheyenne Bottoms in Little Cheyenne Creek (Whittemore). Increasing outlet flows from Cheyenne Bottoms could affect the chloride content and load of Cow Creek. The data is indicative of a constant saline groundwater intrusion

from Little Cheyenne Creek regardless of flow, where higher flows are related to higher groundwater discharge events, thus potentially contributing greater chloride loads. The data suggests, "chloride loads increase greatly with flow in Cow Creek near Lyons" (Whittemore).

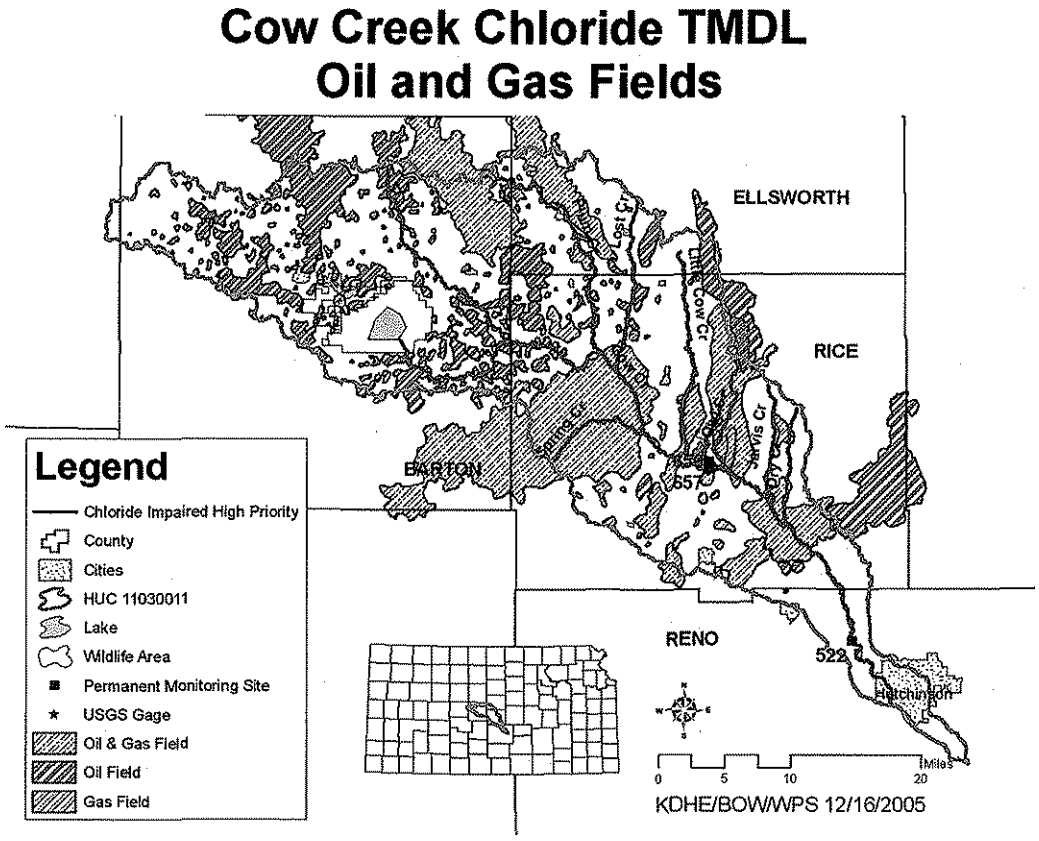
Downstream of the confluence with Little Cheyenne Creek but upstream of Plum Creek, Cow Creek had a chloride content of 536 mg/L. Plum Creek water upstream of the confluence with Cow Creek contained 215 mg/L of chloride. Spring Creek was sampled upstream of the confluence with Cow Creek and contained 554 mg/L of chloride. Cow Creek contained 530 mg/L of chloride upstream of Spring Creek. The chloride content of water upstream of the Little Cow Creek near Lyons was 411 mg/L. All of these samples were collected in the fall of 1999, though not necessarily the same day, and reported by KGS (Whittemore). The KGS samples suggest that Plum Creek acts to dilute the chloride concentration of Cow Creek prior to reaching station 657. The KGS also collected samples from Little Cow Creek in the fall of 1999. The chloride concentration from this sample was 433 mg/L.

Oil-field Brine: There are several old oil fields in the watershed of Cow Creek (see Oil and Gas Field Map of the Cow Creek basin, **Figure 12**) above Monitoring Site 657. The early practice of disposing oil brines in surface ponds in these old oil fields resulted in pollution of the unconsolidated sediments, including the High Plains aquifer, in the area of these ponds. The disposed oil brines contained from several tens of thousands to over a hundred thousand mg/L chlorides. The polluted groundwater is slowly being naturally diluted via natural recharge and is flushed to tributaries and the main stem of Cow Creek by groundwater discharge.

There is a substantial area of known oil brine contamination in the Cow Creek drainage basin near Chase, KS where the Chase-Silica Field is located. Kansas Geological Survey Bulletin 85 describes the oil-brine contamination of groundwater in Rice County. The Bulletin indicates that oil brine disposal extended from the mid 1930's through at least 1946 and probably a little later for an area about 3 miles southeast of Chase and about 1.5 miles southwest of Cow Creek. In 1950, a Salt-processing plant in Lyons was allowed to discharge brine into a surface ditch between the plant and the brine recovery wells. While this process occurred, white saline deposits were visible along the edges of the ditch and in Owl Creek east of the ditch during dry periods. Groundwater flows east in this area and several farm wells east of the ditch became unusable due to saline contamination. In 1946, a test hole water sample near the base of the alluvial materials, 0.8 miles east of the salt-processing plant's ditch, contained 21,800 parts per million of chloride (Fent, KGS Bulletin 85). Groundwater contamination was also probably attributed to oil fields that started in the 1930's and early 1940's in the Cow Creek drainage upstream of the Chase and Lyons areas. Possible sources of early chloride contamination of Cow Creek in the 1930's could have included locations where some oil brine was released into ditches or escaped during breaks in berms around surface disposal ponds. The maximum discharge of chloride into Cow Creek from groundwater contamination probably occurred during the late 1940's to early 1950's. The soils and shallow aquifers, such as the alluvium of the streams, was where the groundwater predominately discharged the majority of the contamination during the earlier periods. Today, the discharge of chloride contamination takes a longer time to flush and most of the oil-field brine chloride input to Cow Creek is probably from deeper contaminated groundwater by dense brines that penetrated into the subsurface aquifer.

Irrigation Return Flow: The amount of irrigation in the watershed above Monitoring Site 656 and 657 is smaller than other areas of the High Plains aquifer due to smaller saturated thickness of the aquifer and the salinity in the vicinity of Cheyenne Bottoms. Irrigation return flow is not expected to contribute any significant amount of chloride to Cow Creek at Site 657 or to Little Cow Creek at site 656

Figure 12.



NPDES: There are seven permitted waste treatment facilities located upstream of station 657. Two of these are non-overflowing lagoons that are prohibited from discharging and five are discharging municipal waste treatment plants. There are three permitted waste treatment facilities located upstream of station 656. One of these is a non-overflowing lagoon that is prohibited from discharging, one is a municipal waste treatment plant, and one is an industrial discharging facility.

Table 8. Non-Overflowing Facilities above Stations 656 and 657.

Kansas Permit Number	Facility Name	Type	Cl Wasteload Allocation - Station
M-AR87-NO01	City of Susank	2-cell Lagoon	0 lb/day, 657
I-AR45-NO02	Superior Essex Communications	Lined Pond	0 lb/day, 657
M-AR55-NO01	City of Lorraine	3-cell Lagoon	0 lb/day, 656

The non-overflowing lagoons may contribute to the load under extreme precipitation events, however these events would not occur at a frequency or for a sufficient duration to cause impairment in the watershed.

Table 9. Discharging Waste Treatment Facilities above Stations 656 and 657.

Kansas Permit Number	Facility	Design Flow (MGD)	Type	Receiving Stream – Station
M-AR15-OO01	City of Bushton	.07	Trickling Filter	Plum Cr, 657
M-AR19-OO01	City of Chase	.086	3-cell Lagoon	Spring Cr, 657
M-AR45-OO01	City of Hoisington	.5314	3-cell Lagoon	Blood Cr, 657
M-AR21-OO01	City of Claflin	.075	Trickling Filter	Cow Cr, 657
M-AR46-OO01	City of Holyrood	.052	3-cell Lagoon	Plum Cr, 657
M-AR56-OO01	City of Lyons	.55	Activated Sludge	Little Cow Cr, 656
I-AR56-PR01	Mid America Redi-Mix	.00003	Lagoon	Little Cow Cr, 656

Population projections for Chase, Claflin, and Holyrood indicate slight to moderate declines (Kansas Water Office (KWO)). Projections of future water use and resulting wastewater appear to be within design flows for these current system's treatment capacities. Population projections for Bushton indicate a stable population with minimal population fluctuations. Population projections for Hoisington and Lyons indicate slight to moderate increases (KWO). Projection of future water use and resulting wastewater are within design flows for Hoisington and Lyons based on these projections assuming each person accounts for utilizing 100 gallons per/day.

The municipal NPDES permit for the City of Chase and Holyrood requires quarterly chloride sampling. However, the current permit for the city of Holyrood has only been in effect since January of 2005 and the previous permit did not require chloride sampling. The Cities of Claflin and Lyons are required to sample monthly for chlorides as a condition of their permits. All samples must be "Grab" samples for these municipalities. The discharge from these municipalities will contain chlorides in their wastewater, due to the dissolution of water softener used by their respective residents and customers (Whittemore).

Table 10. Discharging facilities required to sample for Chloride.

Facility	Period of Record	Flow Avg. (MGD)	Cl Average (mg/L)	Cl Max (mg/L)
City of Chase	2003-2005	ND	NR	NR
City of Claflin	2001-2005	0.0512	317	472
City of Holyrood	2005	NR	297	308
City of Lyons	2001-2005	0.371	416	570

NR= Not Reported
ND= No Discharge

Site 522

Chloride Background: The primary cause of the chloride impairment in the lower half of Cow Creek is natural in source. These natural sources are similar to those at Site 657, although the concentrations are more dilute as a result of additions of freshwater to Cow Creek downstream of Lyons. The natural sources of chloride from Cheyenne Bottoms and Cretateous bedrock are still the main contributors to the chloride load at Site 522. In addition, low levels of chloride are derived from upward dispersion of saline water in Permian bedrock underlying the High Plains aquifer. Although the Permian bedrock contains saline water underlying parts of the watershed between Lyons and site 522, it only contributes substantial amounts of chloride to the High Plains aquifer in the deepest bedrock channels eroded into the Permian bedrock surface. The chloride eventually is dispersed into the shallower parts of the High Plains aquifer, however the effect is not as pronounced as that south of the Arkansas River in Reno County. The main increase in natural loads of low flows is from the additional natural groundwater discharge to Cow Creek.

Chloride concentration averages for station 522 samples are less than the upstream stations 656 and 657. Fresh water is being discharged into Cow Creek between Lyons and Willowbrook that helps homogenize and dilute the water chemistry above Willowbrook relative to samples obtained in Cow Creek near Lyons (Whittemore). Based on the KGS data, "there is additional flow with a lower chloride that dilutes Cow Creek water between Lyons and near Saxman" (Whittemore).

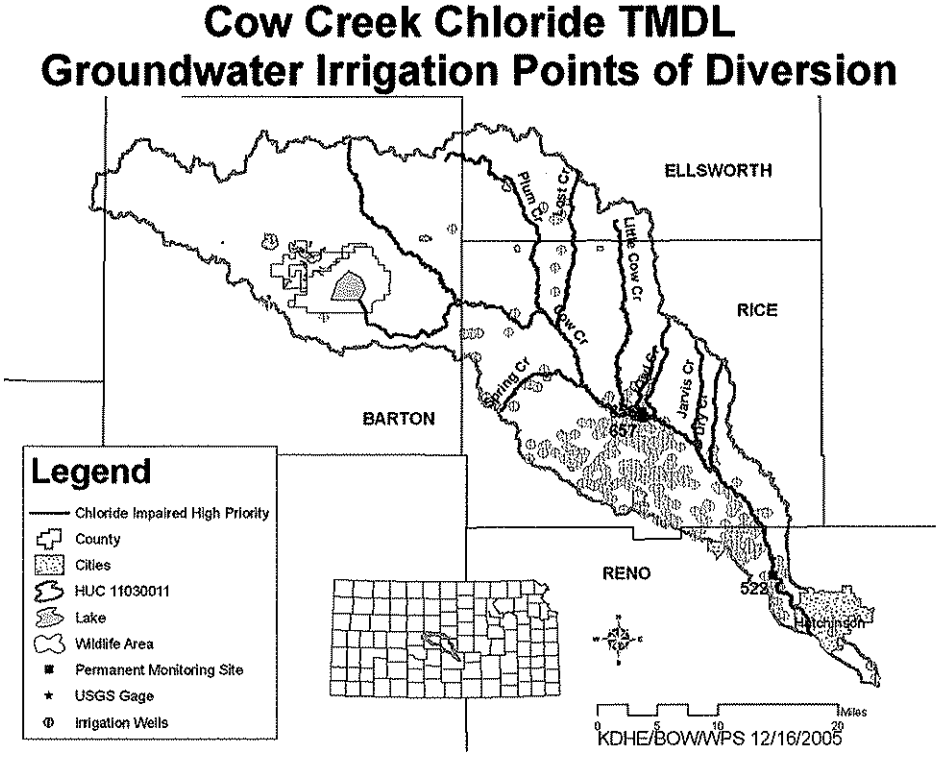
Oil-field Brine: There are a few old oil fields in the watershed between Lyons and Site 522 that are known to contribute chloride pollution to the watershed, however the chemistry of Cow Creek at Site 522 suggests that the oil-brine chloride source is greater at Site 657 than at Site 522. The data suggests that the main chloride contributions from oil-brine sources at Site 522 appears to be from diluted concentrations originating above Lyons at Site 657.

Irrigation Return Flow: Use of groundwater for irrigation does occur throughout the sub-basin (**Figure 13**). Utilizing calendar year 2004 WIMAS Water Right Information, the area above monitoring site 522 has approximately 19,800 Acre-Feet authorized for groundwater irrigation water use. Potential depletion is estimated to be 83 cfs by assuming the total groundwater irrigation use was supplied from the sub-basin over the course of a 120-day growing season. Return flows are estimated to be 8.3 cfs 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 a 180-day period. By these calculations, ten percent of the diverted water would be returned to the stream. However, these values are inflated because the majority of the irrigation wells are constructed in the deeper High Plains aquifer (Equus Beds and Big Bend Prairie Aquifers), and not under the alluvial influence of Cow Creek.

The background concentration of chloride in the shallower groundwaters can be expected to slowly increase with the long-term use of water for irrigation from the High Plains aquifer, and from the return of much of the residual salt content from the water pumped to the subsurface for consumptive use in the watershed between Lyons and Station 522. However, the effect of this on Cow Creek is likely to be minimal, because the residual salt is likely to be flushed from

the soil during wet periods into high creek flows. Much of the irrigation in this area is either center pivot or center pivot with drop nozzles, which greatly reduces the direct return flow to the aquifer from irrigation waters.

Figure 13.



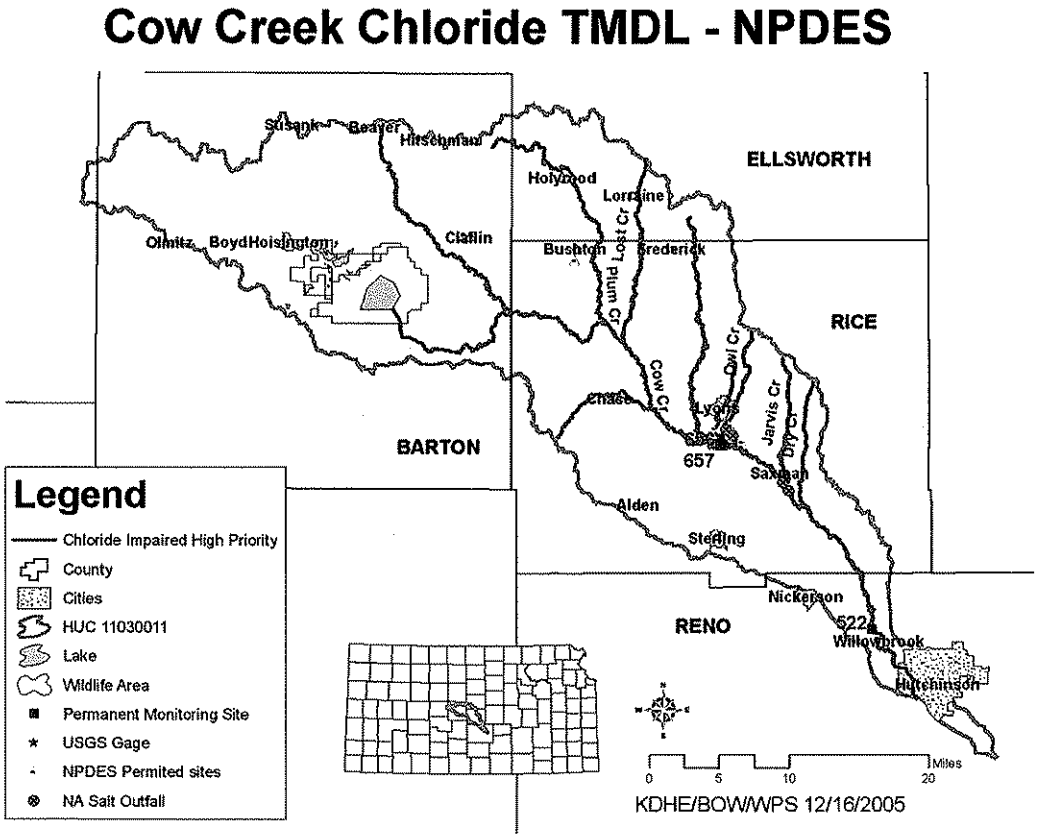
NPDES Sites: There are a total of three permitted waste treatment facilities located below sites 657 and 656 and above 522 (**Table 11**).

Table 11. Discharging Waste Treatment Facilities above Station 522

Kansas Permit Number	Facility	Design Flow (MGD)	Type	Receiving Stream - Station
I-AR85-CO01	Sterling Municipal Power Plant	Outfall 001 (a) = .0672 Outfall 001 (b) = .0672 Outfall 001 (c) = .1512		Bull Cr
I-AR56-PO01	North American Salt			Outfall 001 and 003 = Owl Cr Outfall 002 and 004 = Cow Cr
M-AR85-OO01	City of Sterling	.255	3-cell Lagoon	Bull Cr

The discharge from the City of Sterling and the Sterling Municipal Power Plant should not reach the main Cow Creek stem based on the length of travel to Cow Creek under low flow conditions. Neither of the permitted facilities in Sterling is required to sample for chlorides as a condition of their permits.

Figure 14.



The North American Salt Company operates three active groundwater remediation projects. These projects have been and continue to be managed by the KDHE Bureau of Environmental Remediation. The general purpose of these projects is to remediate chloride contaminated groundwater by withdrawing the water from the aquifer and either using it as industrial water supply for North American's operations or injecting it into Class I deep injection wells. A total of 16 groundwater withdrawal / interceptor wells are used for the three remediation projects. In general, the highly elevated chloride water is disposed into the Class I wells; the lesser-concentrated chloride water is discharged through North American's outfalls in accordance with its NPDES permit. The three remediation projects are described in greater detail below.

The "Cow Creek Aquifer Remediation Program" began in the mid-1980s. This program was required as a result of an Order between the KDHE and a predecessor owner of the North

American Salt Company facility. Historical salt manufacturing and material handling practices conventional to the salt industry at that time caused localized contamination of soil and groundwater in an area to the southeast of the City of Lyons. The North American Salt Company assumed responsibility for operation of the Cow Creek Aquifer Remediation Program upon acquisition of the facility in the late-1980s. The KDHE Bureau of Environmental Remediation has acknowledged that: the subject chloride plume is under containment and control, significant progress has been achieved in reduction of the plume, and that remediation continues to progress in accordance with the established plan and associated remediation model.

The "Old North Lyons Mine Plume Remediation Program" began in the late-1990s and contains two groundwater remediation projects: a "Southern Containment Project" and a "Northern Containment Project." Both projects were developed and implemented as a result of voluntary agreements between the KDHE and the North American Salt Company. A salt mine, separate from the present-day North American Salt Company facility, operated from the late-1800s until approximately 1950. Historical salt manufacturing and material handling practices conventional to the salt industry during that time caused localized contamination of soil and groundwater in an area to the northeast of the city of Lyons. A responsible party for this former salt mine site has not been identified. KDHE assumed responsibility for site closure and conducted such activities in the early 1990s. Legacy contamination in the form of chloride contaminated groundwater has migrated to the south from the former mine site. This localized plume has impacted the remediation performance of the Cow Creek Aquifer Remediation Program and has threatened the water quality of the domestic water supply wells of the City of Lyons. As a result, the KDHE installed the infrastructure for the remediation of the Old North Lyons Mine Plume. Under the voluntary agreements, the North American Salt Company facility is operating the Old North Lyons Mine Plume Remediation Program. The KDHE Bureau of Environmental Remediation is managing this program and is confident that: the subject chloride plume is under containment and control, significant progress will continue to be achieved in reduction of the plume, remediation should continue to progress in accordance with the established plan and associated remediation model, and the City of Lyons drinking water supply wells will be fully protected. The KDHE has approved and funded over $1.5 million associated with the "Southern" and "Northern" containment remediation projects.

The North American Salt Company has four discharge outlets associated with their NPDES permit. The discharges at outfalls 003 and 004 are necessary with the active remediation projects associated with the facility.

Outfall #001 is discharged into Owl Creek. As indicated on the NPDES permit, the flow average is 425 gpm and the discharge originates from non-contact cooling and steam condensate by utilizing groundwater from the Hollinger #1 and #2 water supply wells. Chlorides must be sampled daily and can not exceed a daily value of 400 mg/L for Outfall #001. In addition the flow weighted daily measured chloride concentration for this outfall and #003 shall not exceed 887 mg/L.

Outfall #002 is discharged into Cow Creek and averages 400 gpm. Discharge from this outlet originates from groundwater from the North American Salt Company's chloride remediation well (Interceptor Well I), which is located near Saxman, KS. The daily maximum

chloride value allowable for this outfall is 750 mg/L. The discharge from this outfall was discontinued on February 13, 2004. KDHE Bureau of Environmental Remediation approved the discontinued use of pumping Interceptor Well I and there are currently no plans to restart use of this well and outfall.

The average flow for outfall #003 is 320 gpm and it discharges into Owl Creek. Discharge from this outlet originates from groundwater from the East Water Well and a portion of the Brine Field Interceptor Well. The daily maximum chloride value allowable for this outfall is 900 mg/L and the flow weighted daily measure chloride concentration for outfalls 001 and 003 shall not exceed 887 mg/L, as previously mentioned.

Outfall #004 is discharged into Cow Creek and averages 250 gpm. Discharge originates from groundwater from another chloride remediation well, Interceptor Well H. The daily maximum chloride value allowable for this outfall is 400 mg/L and the daily average shall not exceed 300 mg/L. Discharge from this well was approved with the approval of a revised NPDES permit that became effective July 1, 2004. The discharging from this outfall is intended to be in lieu of discharging from outfall 002.

The chloride poundage effluent limitation for the permit states, "the sum of the chloride poundage reported from outfalls 001, 002, 003 and 004 shall be 5040 lbs/day or less". The North American Salt Company has been operating under this 5040 lbs/day effluent limitation for the past 14 years. The recorded average for all outfalls for data collected from 2001-2005 is 3717 lbs/day. The recorded flow weighted daily average of Chloride during this time frame for outfalls 001 and 003 is 395 mg/L, well below the permitted limits.

Independent chloride samples were collected by the North American Salt Company (formerly IMC Salt, Inc.) for several years from a location in Cow Creek upstream from the Owl Creek confluence and downstream from where Little Cow Creek joins the main segment of Cow Creek. This location is near the approximate location of the USGS gaging station near Lyons. The chloride concentration average for this sampling location for the period of record from calendar year 1990 through 2000 is 336 mg/L. North American Salt also sampled at a second location, downstream of the Owl Creek confluence, in Cow Creek from 1994 through 2000. The chloride average at this location was 338 mg/L.

Table 12. North American Salt Recorded Flow and Chloride Averages.

Outfall Number	Period of Record	Flow Avg. (MGD)	Wint Season Flow Avg. (MGD)	Cl Average of Monthly Avgs. (mg/L)	Cl Avg. of Wint Months (mg/L)	Cl Daily Load Avg. (lbs/day)
001	2001-2005	0.488	.509	113.7	117.6	464
002	2001-2004	0.537	.533	115	118	524.4
003	2001-2005	0.406	.419	737	758	2500
004	2004-2005	0.339	.367	266	265	753.3

The KGS collected a sample from Owl Creek that contained 101 mg/L, however the sampling location was above the North American Salt Company's outfalls. Another sample was collected in Cow Creek a few miles downstream of Owl Creek and contained 335 mg/L of chloride. The KGS samples were obtained in the fall of 1999. The KGS sample value is very

similar to the data provided by North American Salt Company, which indicated a chloride average of 338 mg/L in Cow Creek below Owl Creek

Fugitive Salt Dust: Fugitive Salt Dust has been reported as a potential non-point source of chloride in the area around the City of Lyons, which may contribute chloride concentrations during runoff events to both stations 656 and 522.

Contributing Runoff: The Cow Creek watershed's average soil permeability is 1.6 inches/hour according to the Natural Resource Conservation Service STATSGO database. About 88% of the watershed produces runoff even under relative low (1.71"/hr) potential runoff conditions. Under very low (1.14"/hr) potential conditions, this area is reduced to 62%. Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeability's. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than .57"/hr of rain will generate runoff from only 14.8% of this watershed. With the exception of the area around Cheyenne Bottoms, much of this contributing area is located in the lower half of the watershed.

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

Point and Non-Point Sources: The basic condition of the impaired condition is caused by natural background loadings, therefore point source controls are not emphasized greatly, with the exception of the City of Lyons and the North American Salt Company. The North American Salt Company will presumably meet several remediation goals in the near future based on recent groundwater remediation modeling. The model suggests that the chloride plume will reduce sufficiently enough for outfall 004 to be shut off in 2008. The North American Salt Company anticipates that two hundred gallons per day of discharge that is currently being routed to outfall 003 will be re-directed for deep well injection by approximately 2015. This will roughly leave eighty gallons per day to be discharged to outfall 003, which will most likely originate from the East Water Well. It is foreseeable that the water being discharged to outfall 003 at this future date will have a considerably lower chloride concentration. The remediation milestones provided by the North American Salt Company indicate the Brinefield Interceptor and East Water Wells could be shutdown by approximately 2016. As the chloride concentrations improve in Interceptor Well F, (another remediation well that is currently going to deep well injection) there is potential that this water may be re-routed to be discharged into Cow Creek via an outfall. Therefore, even though there may not be any discharge to outfall 003 by the year 2025, a conservative assumption will be made for this TMDL to assume that some flow will be entering the watershed as part of the conclusion of the remediation project, either from outfall 003 or another outfall relating to the remediation activities in 2025.

The goal for the City of Lyons is to achieve operational and source reduction capabilities to discharge chloride concentrations no greater than 300 mg/L. Since this may not be achievable in the immediate future, this TMDL does not account for this reduction until the year 2025.

Table 13 displays the total loads, wasteloads and load allocations for the Stage Two loads that will be in place currently and in year 2025 under this TMDL at the 50%, 75%, and ~90% flow exceedance frequencies. Under Stage One, the Wasteload Allocations are altered in order to comply with the existing water quality criterion of 250 mg/L. Brine will eventually dilute out over time, a load allocation was based on a brine dilution of 1% per year under this TMDL. Should a domestic water supply point of diversion become established within the TMDL area, the Stage One criterion and Wasteload Allocations influencing water quality in that segment of the stream would be applied to ensure the water supply use was protected.

The majority of the current loading at the 50% flow exceedance level is contributed by brine and natural background sources in Cow Creek. The largest point source contributions at Station 522 above Willowbrook are associated with the North American Salt Company and from the City of Lyons.

Low flow chloride values at station 656 directly correlate with chloride concentrations discharged from the City of Lyons (**Figure 15**). As flows increase in Little Cow Creek the discharge chloride concentrations from the City of Lyons become diluted at station 656. **Figures 16 and 17** illustrate how low flow periods in Little Cow Creek are almost entirely composed of flows from the discharge from the City of Lyons, which translates into the City of Lyons accounting for approximately the entire chloride load during these occurrences at station 656. The figures also show deviations in chlorides between Lyons and station 656 occurs during runoff events.

Table 13. Current Stage Two 2005 and Stage Two 2025 Loads and Allocations (lbs/day) for Cow Creek and Little Cow Creek at specific flow exceedance frequencies.

Stream Station	2005-50%	2025-50%	2005-75%	2025-75%	2005 ~90%	2025 ~90%
Cow Cr above Willowbrook 522	**33202**	**30629**	**19749**	**17203**	**12358**	**9288**
Wasteload Allocations 522	3726	1178	3726	1178	3710	1178
Tributary and Alluvial Load Allocations 522	2835	3348	1134	1674	729	729
Little Cow Cr 656	**2185**	**1840**	**1885**	**1540**	**1885**	**1540**
Wasteload Allocations 656	1723	1378	1723	1378	1723	1378
Tributary and Alluvial Load Allocations 656	462	462	162	162	162	162
Cow Cr near Lyons 657	**24456**	**24263**	**13004**	**12811**	**6034**	**5841**
Wasteload Allocations 657	744	744	744	744	744	744
Brine 657	1058	865	1058	865	1058	865
Tributary and Alluvial Load Allocations 657	22654	22654	11202	11202	4232	4232

Figure 15. Chloride concentration comparison at station 656 and from City of Lyons discharge

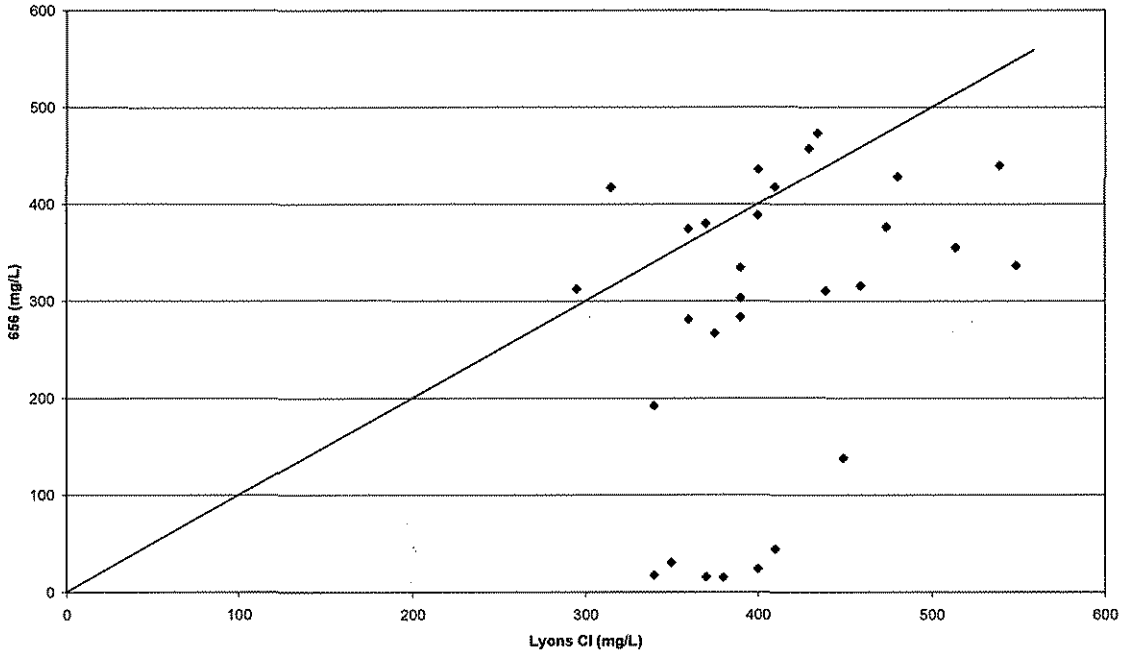


Figure 16. Flow comparison between station 656 and City of Lyons discharge.

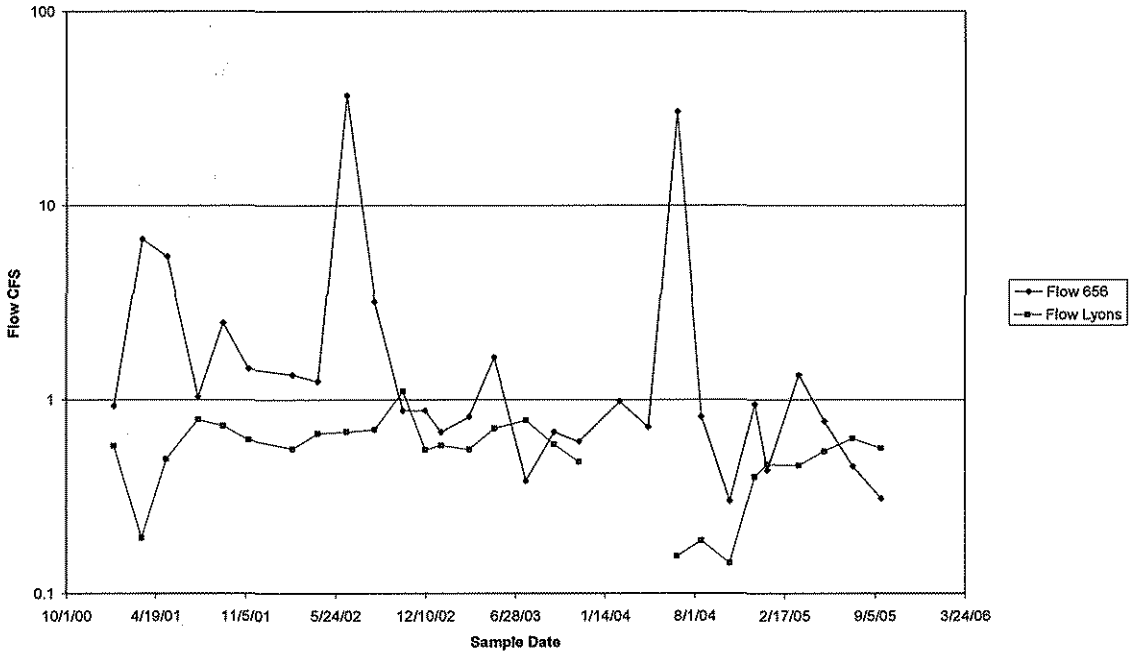
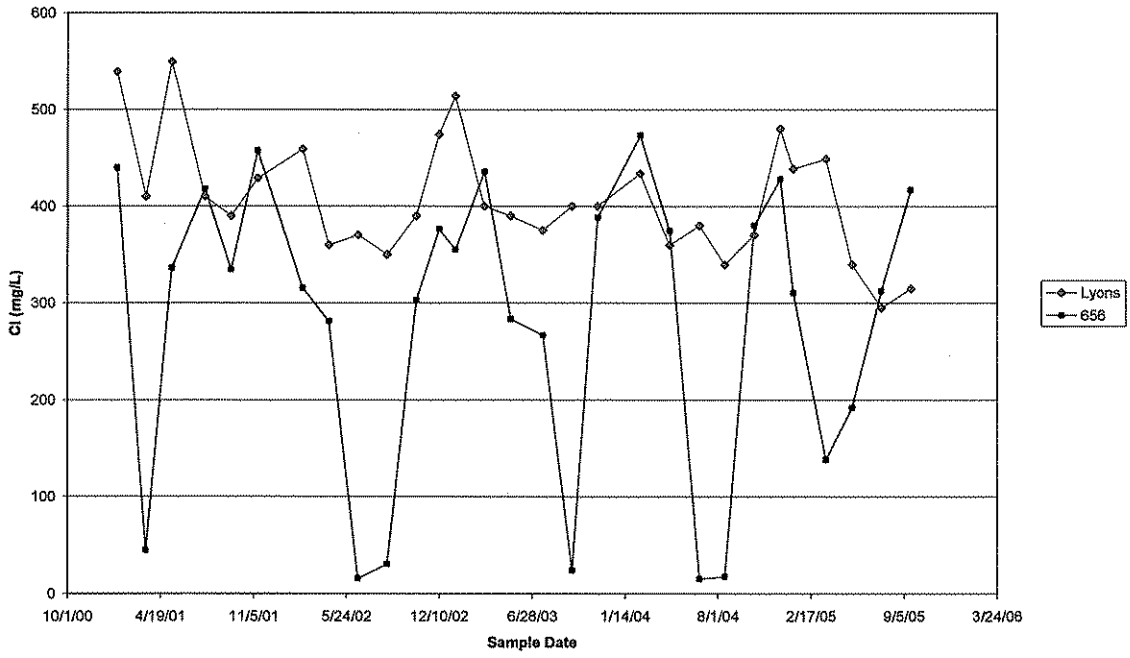


Figure 17. Chloride Concentrations at station 656 vs. City of Lyons discharge



A variety of scenarios involving the point source dischargers at similar low flow exceedence levels were examined in relation to chloride concentrations and loads for stations 657, 656, and 522. **Table 14** shows the resulting values for each of the scenarios. The first scenario reflects the baseline condition where wasteloads reflect the current condition and were derived from average flows and chloride concentrations utilizing data from the years 2001-2005 and outfall 002 from the North American Salt Company facility is not operating. Scenario One is the baseline condition calibrated with chloride concentration averages from selected data points sampled in early 1992 during a historical low flow period. The second scenario reflects the baseline condition of Scenario One without any point sources or brine, which represents the natural background concentrations. The third scenario reflects this same condition with the exception that brine is still present.

The fourth scenario reflects the baseline condition with all municipalities at maximum design flows. The fourth scenario reflects the current TMDL. The fifth scenario illustrates the projected future conditions for this TMDL in the year 2015, where the brine concentration has diluted at 1% per year and the North American Salt Company has significantly reduced flow to outfall 003. Scenario Six represents the future milestone for this TMDL by the year 2025. By the year 2025, the City of Lyons will be held to discharging a chloride concentration equivalent to or less than the background concentration of 300 mg/L, the brine concentration will be reduced to a diluted concentration at a rate of 1% per year, and the North American Salt

Company will maintain reduced flows from outfall 003. The milestone endpoint for 2025 is to maintain a chloride concentration of approximately 300 mg/L at Station 522.

Table 14. Resulting Chloride Concentrations and Loads from Various Point Source Loadings.

Scenario	1	2	3	4	5	6
Station	Current Baseline	No WLA or Brine	No WLA Brine Present	TMDL Stage Two 2005	TMDL Stage Two 2015 Projection	TMDL Stage Two Milestone 2025
522 Cl (mg/L)	343	301	332	344	317	302
522 Load (lbs/d)	11045	5123	6181	12358	9724	9289
656 Cl (mg/L)	360	300	300	367	367	300
656 load (lbs/d)	1030	162	162	1885	1885	1540
657 Cl (mg/L)	475	461	490	458	450	444
657 Load (lbs/d)	5577	4232	5290	6034	5932	5841

Current Wasteload Allocations have been established for each individual contributing point source facility under Stage One and Stage Two of this TMDL, as seen in Table 15. Stage One allocations will only be utilized if water supply points of diversion are established below the outfalls of these facilities.

Table 15. Current Chloride Wasteload Allocations (lbs/day) for Dischargers to Cow Creek Sub-basin.

Discharger	Bushton	Chase	Claflin	Holyrood	Lyons	NASC
Stage One	146	180	157	109	1149	2019
Stage Two	187	230	198	129	1723	3710

Table 16. Stage Two Chloride Wasteload Allocations for individual outfalls at the North American Salt Company for 2005 and 2015 (same for 2025).

North American Salt Company	Outfall 001 - 2005	Outfall 001 - 2015	Outfall 003 - 2005	Outfall 003 - 2015	Outfall 004 - 2005	Outfall 004 - 2015	**Total - 2005**	**Total - 2025**
Outfall Flow (cfs)	.76	.76	.63	.18	.52	0	**1.91**	**.94**
Load (lbs/day)	464	464	2493	715	753	0	**3710**	**1179**
Cl Avg. Conc. (mg/L)	113	113	735	735	266	0	**360**	**232**

Currently, outfall 001 at the North American Salt Company currently acts as a major source of dilution to the chloride load. The total flow discharged from all outfalls should not exceed an average chloride concentration of 360 mg/L as indicated in **Table 16**. As the remediation goals are met, the flow weighted chloride concentration average for all outfalls will be significantly reduced to a chloride concentration average of 232 mg/L.

Margin of Safety: The Margin of Safety is implicitly established by: holding point sources above station 657 to concentrations below background levels and by maintaining adequate load balance at the North American Salt Company. Since the elevated chloride levels seen in the streams are predominantly caused by the natural loadings of saline groundwater from underlying geologic formations, the only mitigating factor to those load allocations is the dilution provided by the point sources. By not allowing the wasteload allocations to be established by the background concentrations above station 657, by balancing the current wasteload allocation from the North American Salt Company and by conservatively estimating future wasteload allocations once the remediation goals are met at the North American Salt Company, the dilution base is secured and the Stage Two endpoints will be achieved by 2025.

State Water Plan Implementation Priority: Because the chloride impairment along Cow Creek is primarily due to natural geologic sources, this TMDL will be a Low Priority for implementation, though the State Water Plan indicates ongoing remediation efforts should be a high priority by KDHE and the Kansas Corporation Commission (KCC).

Unified Watershed Assessment Priority Ranking: This TMDL addresses streams within the Cow Creek sub-basin (HUC 8: 11030011) with a priority ranking of 27 (Medium Priority for restoration).

Priority HUC 11s: Because of the natural geologic contribution of this impairment, no priority sub-watersheds or stream segments will be identified, although brine field remediation should occur in the upper Cow Creek sub-watershed and remediation efforts by North American Salt will continue on and below Owl Creek.

Figure 18.

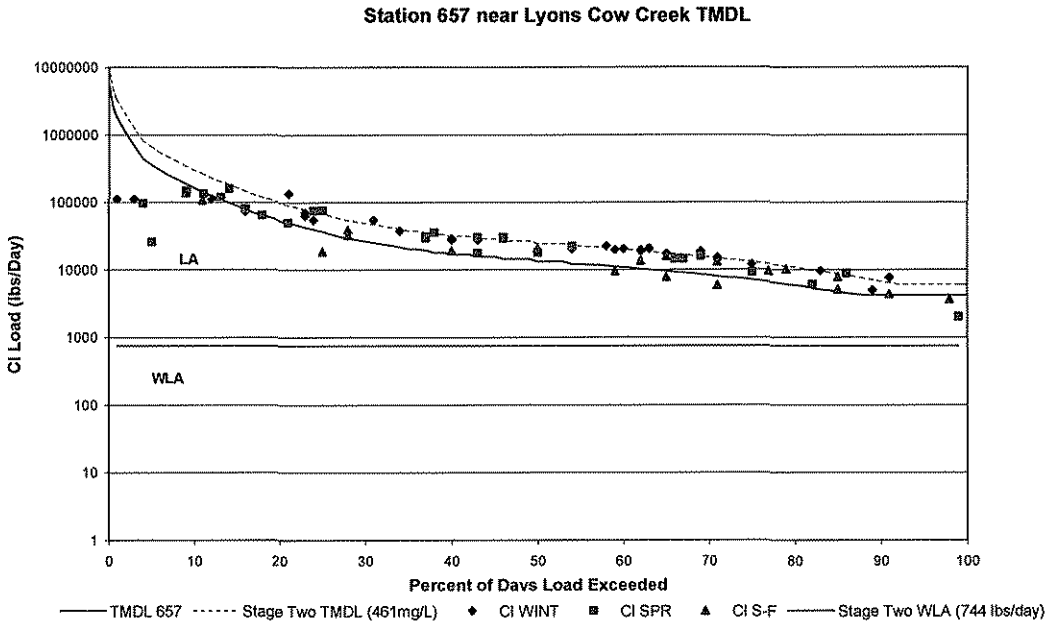


Figure 19.

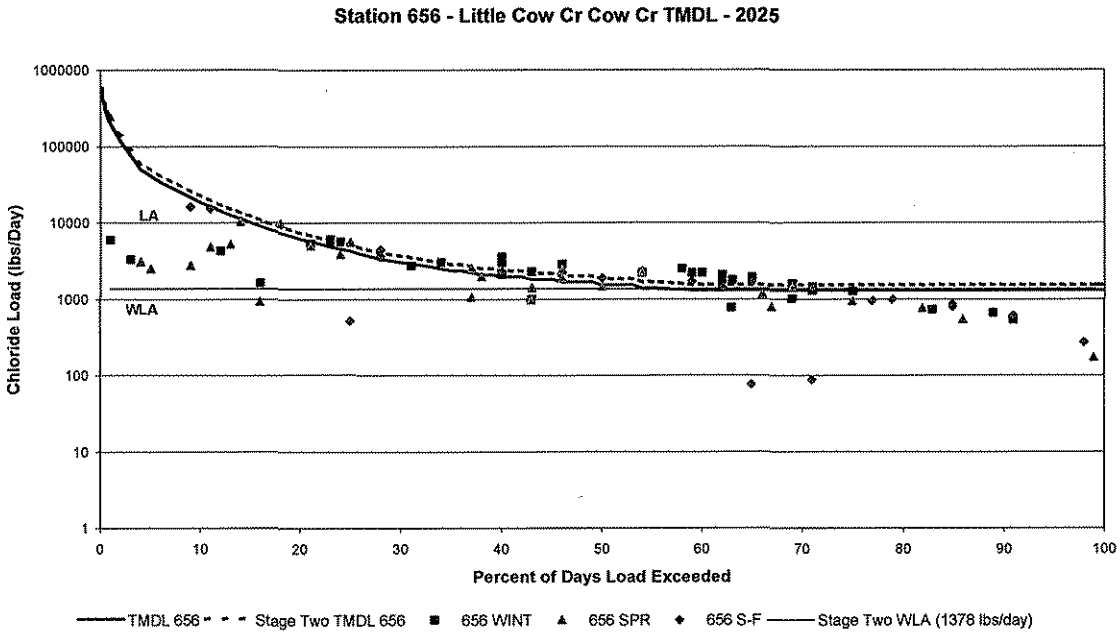


Figure 20.

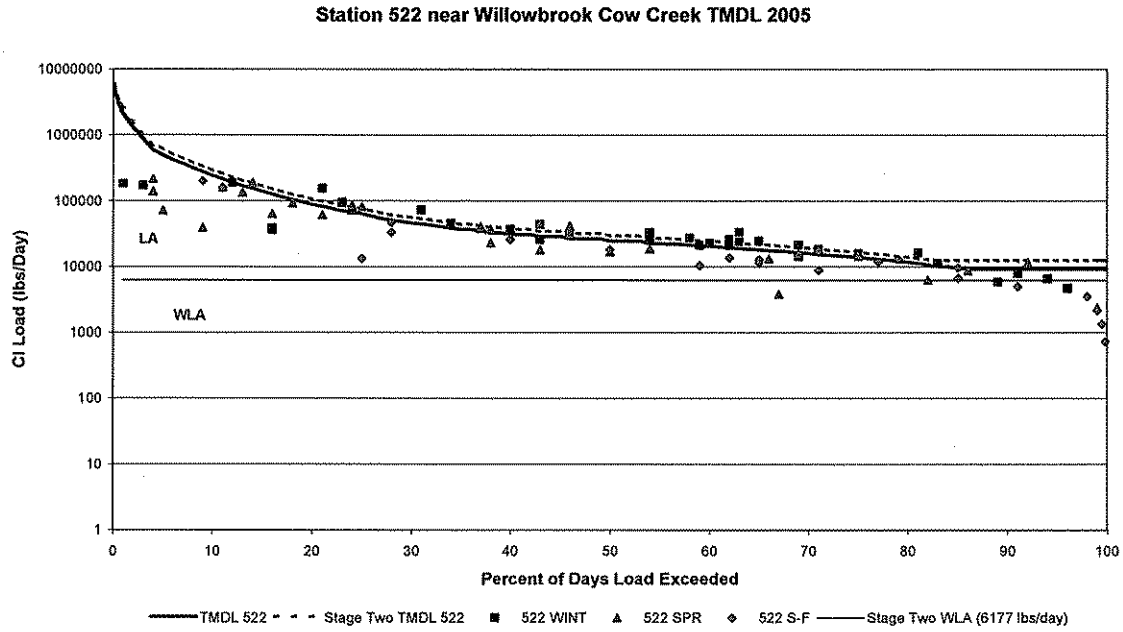


Figure 21.

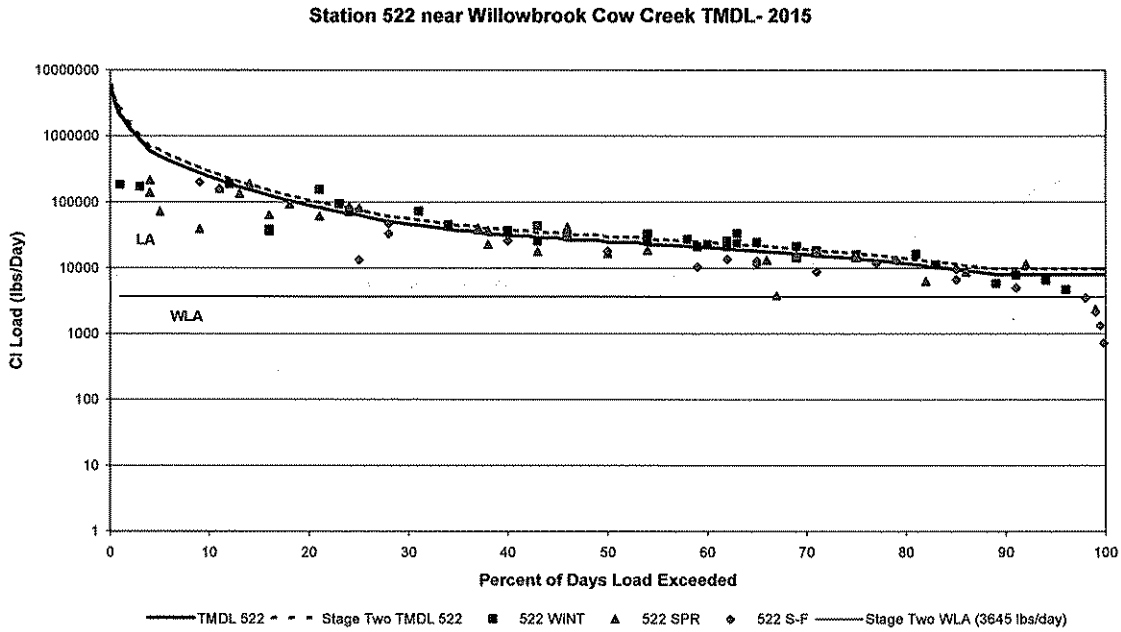
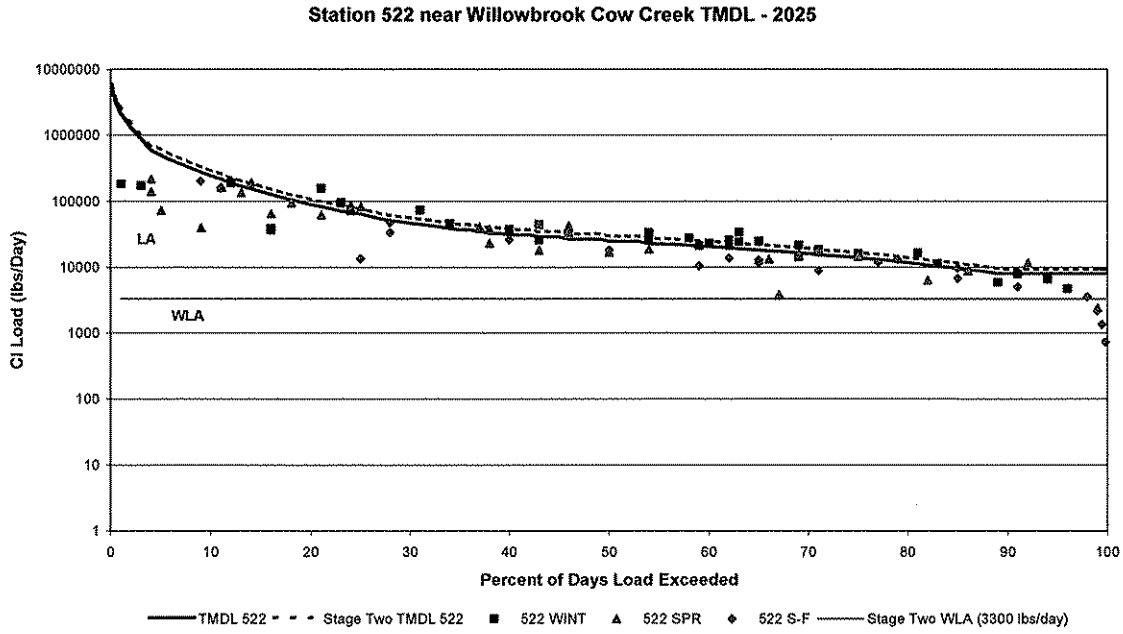


Figure 22.



5. IMPLEMENTATION

Desired Implementation Activities

1. Monitor any anthropogenic contributions of chloride loading to the river system.
2. Establish alternative background criterion.
3. Reduce any high chloride industrial or municipal waste streams through process modification and the achievement of established groundwater remediation goals.

Implementation Programs Guidance

NPDES and State Permits- KDHE

a. Municipal and industrial permits for facilities in the watershed will be renewed after 2007 with annual chloride monitoring and any facility with excessive chloride discharge will have appropriate permit limits, which maintain the ambient background levels of chloride. The permit limits for each outfall of the North American Salt Company will account for the wasteload allocations specified in this TMDL. Any new discharger with extremely high chloride will be limited to acute concentrations via permit limits.

Non-Point Source Pollution Technical Assistance – KDHE

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

b. The KDHE Bureau of Air and Radiation will evaluate potential sources and remedies for fugitive salt dust emissions in the Lyons area.

Water Quality Standards and Assessment – KDHE

a. Establish background levels of chloride for Cow Creek, Little Cow Creek and their tributaries.

Pollution Prevention Institute – Kansas State University

a. Work with the City of Lyons on process improvements to reduce the waste stream of high chloride water entering the municipal wastewater treatment system.

Conservation Program - Kansas Corporation Commission (KCC)

a. Initiate remediation of significant brine fields contributing chlorides to the upper Cow Creek sub-watershed.

Time Frame for Implementation: Development of a background level-based water quality standard should be accomplished with the 2007 water quality standards revision.

Targeted Participants: Primary participants for implementation will be KDHE, the City of Lyons and the North American Salt Company.

Future Milestones: The year 2011 marks the midpoint for 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 the average chloride levels in the streams, particularly at lower flows. By 2015, the North American Salt Company should reach some tentative remediation goals and account for a reduction in the contributing chloride load as indicated in this TMDL. The progress for meeting the remediation goals will be evaluated regularly to ensure the goals of this TMDL are achievable. By 2025, the City of Lyons and the North American Salt Company should accomplish chloride load and concentration reductions to ensure the goals of this TMDL are achieved. 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 empower 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 non-point 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 Lower Arkansas 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 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.

State Water Plan funding is available for point source remediation associated with contamination from orphan sites, one of which is contamination associated with the "Old North Lyons Mine Plume". The Kansas Department of Health and Environment has spent more than $1.5 million of State Water Plan funds since the mid 1990's in cooperation with the North American Salt Company with the ongoing remediation of the "Southern" and "Northern" containment projects in the Lyons area as part of the "Old North Lyons Mine Plume Remediation Program".

Effectiveness: Minimal control can be exerted on natural contributions to loading. Interception of the saline groundwater and subsequent deep injection may be effective in lowering chloride over the long term.

6. MONITORING

KDHE will continue to collect bimonthly samples from permanent stations along Cow Creek and Little Cow Creek near Lyons and in Cow Creek above Willowbrook. Based on that sampling,

the priority status will be evaluated in 2011 and thereafter, including application of numeric criterion based on background concentrations.

Quarterly monitoring of chloride levels in effluent discharge will be a condition of NPDES and state permits for facilities above station 657. Monthly monitoring of chloride levels in the effluent discharge will be required for the City of Lyons. Daily chloride monitoring of chloride levels in the effluent discharge will be required for the North American Salt Company. This monitoring will continually assess the contributions of chloride in the wastewater effluent released to the Cow Creek Sub-basin upstream of Willowbrook.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Lower Arkansas Basin were held on June 7, 2006 in Hutchinson. An active Internet site was established at http://www.kdheks.gov/tmdl/public.htm to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Lower Arkansas Basin.

Public Hearing: A Public Hearing on the TMDL of the Lower Arkansas Basin was held in Hutchinson, KS on June 7, 2006. The public record was held open until June 20, 2006. No comments were received by KDHE.

Basin Advisory: The Lower Arkansas Basin Advisory Committee met to discuss the TMDLs in the basin on June 7, 2006.

Discussion with Interest Groups: The Kansas Department of Health and Environment met to discuss the implications of this TMDL with representatives from the North American Salt Company on February 24th and April 28th, 2006. A meeting was held between staff from the Bureau of Water and from the Bureau of Environmental Remediation on April 28, 2006.

Milestone Evaluation: In 2011, evaluation will be made as to the degree of implementation and remediation, which has occurred within the watershed and current condition of the streams of the Cow Creek Sub-basin. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: Because of the long-term brine loadings, achievement of the Water Quality Standard will extend over fifteen to twenty years. The streams will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2007-2025. Therefore, the decision for delisting will come about in the preparation of the 2026, 303(d) list. Should modifications be made to the applicable water quality criteria during the initial ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities might 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 would come in 2006, 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 2007-2014.

Revised June 28, 2006

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Appendix A. Baseline and Stage Two Load Scenario Calculations.

Scenario One, Baseline

	Scenario #1 Baseline 1992 Data							
Low Flow Load	Current avg. flows and Concentrations for everyone							
Site	Municipal & Industrial Point Source	Flow cfs	Conc*	WLA	LA		TMDL lbs/Day	
Station 522 ~88.5% GPM								
338.82	NAS Outfall 001	0.754936	113	460.6619				
	NAS Outfall 002	0	0	0				
281.88	NAS Outfall 003	0.628082	735	2492.857				
235.37	NAS Outfall 004	0.524433	266	753.2956				
	Seepage	1.35	100		729			
	522 Totals	**5.957687**	**343.246**	**3706.815**	**729**		**11042.74**	
Cow USGS Gage		2.700236	453.1105	6606.928				
Station 656 ~82%								
	Seepage	0.1	300		162			
	Lyons WW .55	0.428519	375	867.751				
	656 Totals	**0.528519**	**360.8094**	**867.751**	**162**		**1029.751**	
Station 657	94% Load							
	Natural Seepage	1.7	461			4231.98		
	Brine	0.3	653		1057.86			
	Bushton	0.03094	320	53.46432				
	Chase	0	0	0				
	Claflin	0.078897	316	134.6298				
	Holyrood	0.06188	297	99.24314				
	657 Totals	**2.171717**	**475.5733**	**287.3373**	**1057.86**	**4231.98**	**5577.177**	

Scenario Four, 2005 TMDL

Phase Two Low Flow	**Scenario 4 TMDL 2005**						
	Small Towns at max						
Site	Municipal & Industrial Point Source	**Flow cfs**	**Conc***	**WLA**	**LA**		TMDL lbs/Day
Station 522	Load						
flow in gpn	Seepage						
341	NAS Outfall 001-max	0.76	113	463.752			
0	NAS Outfall 002-off	0	0	0			
282	NAS Outfall 003-	0.628082	735	2492.857			
235	NAS Outfall 004-max	0.524433	266	753.2956			
	Background seepage	1.35	100		729		
	522 Totals	**6.651166**	**344.0705**	**3709.905**	**729**		**12357.74**
	usgs gage at Lyons on Cow Creek	3.388651	432.7536	7918.834			
Little Cow Creek							
Station 656							
	Seepage	0.1	300		162		
382	Lyons WW .55	0.85085	375	1722.971			
	656 Totals	**0.95085**	**367.1123**	**1722.971**	**162**		**1884.971**
Upper Cow Creek							
Station 657							
	Nat Seepage	1.7	461			4231.98	
	Brine	0.3	653		1057.86		
49	Bushton	0.10829	320	187.1251			
60	Chase	0.133042	320	229.8966			
52	Claflin	0.116025	316	197.9851			
36	Holyrood	0.080444	297	129.0161			
	657 Totals	**2.437801**	**458.3565**	**744.0228**	**1057.86**	**4231.98**	**6033.863**

Scenario Five, 2015 TMDL

Phase Two Low Flow	**Scenario 5 TMDL Projected Future 2015**						
	Small Towns at max, Brine Dilution 10 years @ 1%/year						
Site	Municipal & Industrial Point Source	**Flow cfs**	**Conc***	**WLA**	**LA**		TMDL lbs/d
Station 522	Load						
flow in gpm	Seepage						
341	NAS Outfall 001-max	0.76	113	463.752			
0	NAS Outfall 002-off	0	0	0			
81	NAS Outfall 003-	0.18	735	714.42			
0	NAS Outfall 004-max	0	266	0			
	Background seepage	1.35	100		729		
	522 Totals	**5.678651**	**317.1054**	**1178.172**	**729**		**9723.946**
	usgs gage at Lyons on Cow Creek	3.388651	427.1761	7816.774			
Little Cow Creek							
Station 656							
	Seepage	0.1	300		162		
382	Lyons WW .55	0.85085	375	1722.971			
	656 Totals	**0.95085**	**367.1123**	**1722.971**	**162**		**1884.971**
Upper Cow Creek							
Station 657							
	Nat Seepage	1.7	461			4231.98	
	Brine	0.3	590		955.8		
49	Bushton	0.10829	320	187.1251			
60	Chase	0.133042	320	229.8966			
52	Claflin	0.116025	316	197.9851			
36	Holyrood	0.080444	297	129.0161			
	657 Totals	**2.437801**	**450.6036**	**744.0228**	**955.8**	**4231.98**	**5931.803**

Scenario Six, 2025 TMDL

Phase Two Low Flow	**Scenario 6 Future Goal 2025** Small Towns at max, brine dilution 15years @ 1%/year						
Site	Municipal & Industrial Point Source	**Flow cfs**	**Conc***	**WLA**	**LA**		TMDL lbs/I
Station 522	Load						
flow in gpn	Seepage						
341	NAS Outfall 001-max	0.76	113	463.752			
0	NAS Outfall 002-off	0	0	0			
81	NAS Outfall 003-	0.18	735	714.42			
0	NAS Outfall 004-max	0	267	0			
	Background seepage	1.35	100		729		
	522 Totals	**5.678651**	**302.9094**	**1178.172**	**729**		**9288.632**
	usgs gage at Lyons on Cow Creek	3.388651	403.3868	7381.46			
Little Cow Creek Station 656							
	Seepage	0.1	300		162		
382	Lyons WW .55	0.85085	300	1378.377			
	656 Totals	**0.95085**	**300**	**1378.377**	**162**		**1540.377**
Upper Cow Creek Station 657							
	Nat Seepage	1.7	461			4231.98	
	Brine	0.3	534		865.08		
49	Bushton	0.10829	320	187.1251			
60	Chase	0.133042	320	229.8966			
52	Claflin	0.116025	316	197.9851			
36	Holyrood	0.080444	297	129.0161			
	657 Totals	**2.437801**	**443.7122**	**744.0228**	**865.08**	**4231.98**	**5841.083**