LOWER ARKANSAS RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body / Assessment Unit: Upper Little Arkansas River
Water Quality Impairment: Chloride

1. INTRODUCTION AND PROBLEM INDENTIFICATION

Subbasin: Little Arkansas

Counties: Ellsworth, Rice, McPherson, Reno and Harvey

HUC 8: 11030012

Ecoregion: Central Great Plains, Smoky Hills (27a)
Central Great Plains, Great Bend Sand Prairie (27c)
Central Great Plains, Wellington-McPherson Lowland (27d)

Drainage Area: Approximately 441 square miles

Water Quality Limited Segment: 10 (Part) & 14

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

HUC 8	**11030012**	
Watershed:	**Upper Little Arkansas River**	
Station 246	**Little Arkansas River (10-part)**	
	Little Arkansas River (14)	Sand Cr (23)
		Lone Tree Cr (20)
		Dry Cr (22)
		Salt Cr (21)
		Horse Cr (19)

Designated Uses: **Little Arkansas River (10 & 14)**: Primary B contact Recreation for segment 14; Primary contact C Recreation for segment 10; Expected Aquatic Life Support, Domestic Water Supply; Food Procurement; Groundwater Recharge, Industrial Water Supply, Irrigation; Livestock Watering.

Sand Cr(23): Expected Aquatic Life Support; Primary contact C Recreation; Designated for Food Procurement use.

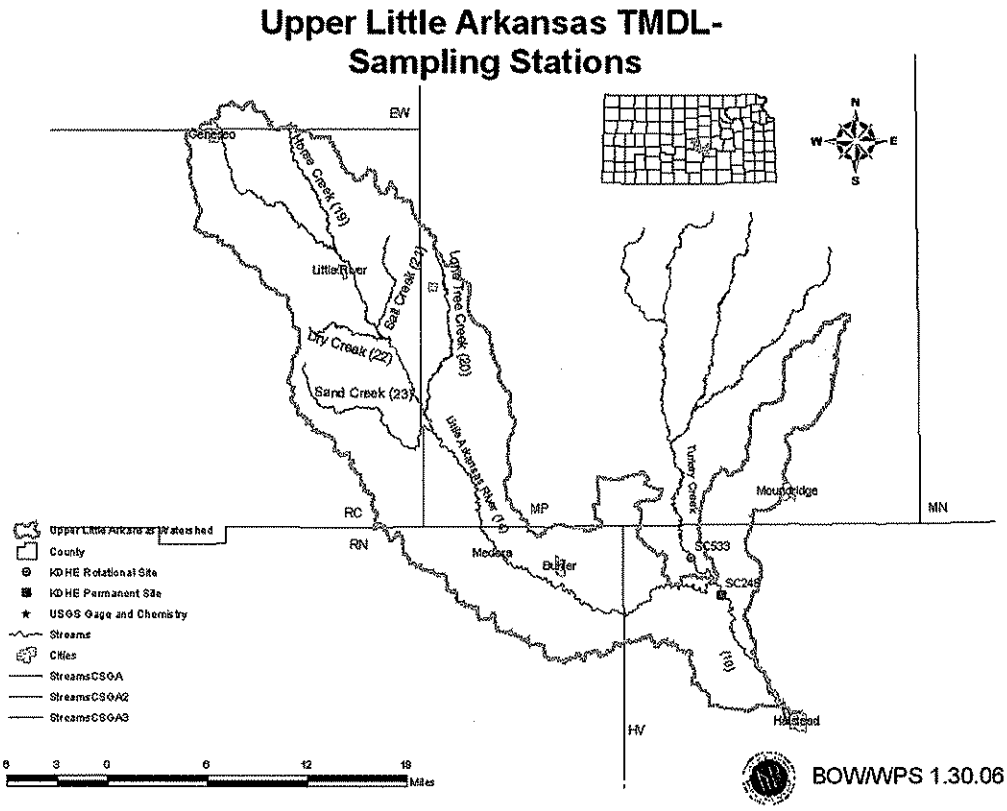
Lone Tree Cr (20), Dry Cr (22), Salt Cr (21), and Horse Cr (19): Expected Aquatic Life Support; Secondary contact b Recreation

1998, 2002 & 2004 303(d) Listing: Lower Arkansas Basin Streams: Little Arkansas River Segments 10 (part) & 14.

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. 28e(c) (3) (A));

Figure 1.



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

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

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 values for station 246 were obtained from USGS gaging station 07143665 data, located at the same location as the KDHE sampling station.

Table 1. Stream Gages and Monitoring Stations data utilized for Upper Little Arkansas River Cl TMDL.

Station	Stream	Type	Period of Record Used	Med Q	Avg. Cl (mg/L)	Max Cl (mg/L)	# of samples	# of Samples >250 mg/L
246 Upper Little Arkansas River	Little Arkansas River	Fixed WQ	1985-2005	21	267	623	144	82
USGS 07143665 Little Arkansas River @ Alta Mills	Little Arkansas River	Q	1973-2006	21	NA	NA	NA	NA

Table 2 indicates the drainage area, mean flows, and estimated flows at selected exceedance percentages as indicated in USGS Scientific Investigations Report 2004-5033 for the Little Arkansas River and select tributaries covered under this TMDL. Flow values for Turkey Creek, segment 11, where derived from the USGS Water-Resources Investigations Report 01-4142 (Estimated Flow-Duration Curves for Selected Ungaged Sites in Kansas).

Table 2. Selected Hydrology for the Turkey Cr TMDL Area.

			Percent of Time Flow Exceeded				
Stream & Segment #	Drainage Area	Est. Mean Flow	90%	75%	50%	25%	10%
Little Arkansas River (10)	755	229	4.9	9.2	22	62	325
Turkey Cr (11)	279	62.4	2.18	3.81	8.16	21.22	81.6
Little Arkansas River (14)	441	127	4.46	9.52	19.4	43.4	182
Lone Tree Cr (20)	69.4	15.1	0	.02	1.47	4.8	15.8
Sand Cr (23)	47.3	10.4	2.58	3.83	4.9	7.27	13.5
Salt Cr (21)	21.6	3.87	0	0	0	.31	2.44
Dry Cr (22)	15.7	2.69	0	0	0	0	1.16
Horse Cr (19)	46.7	6.54	0	0	.68	1.77	5.46

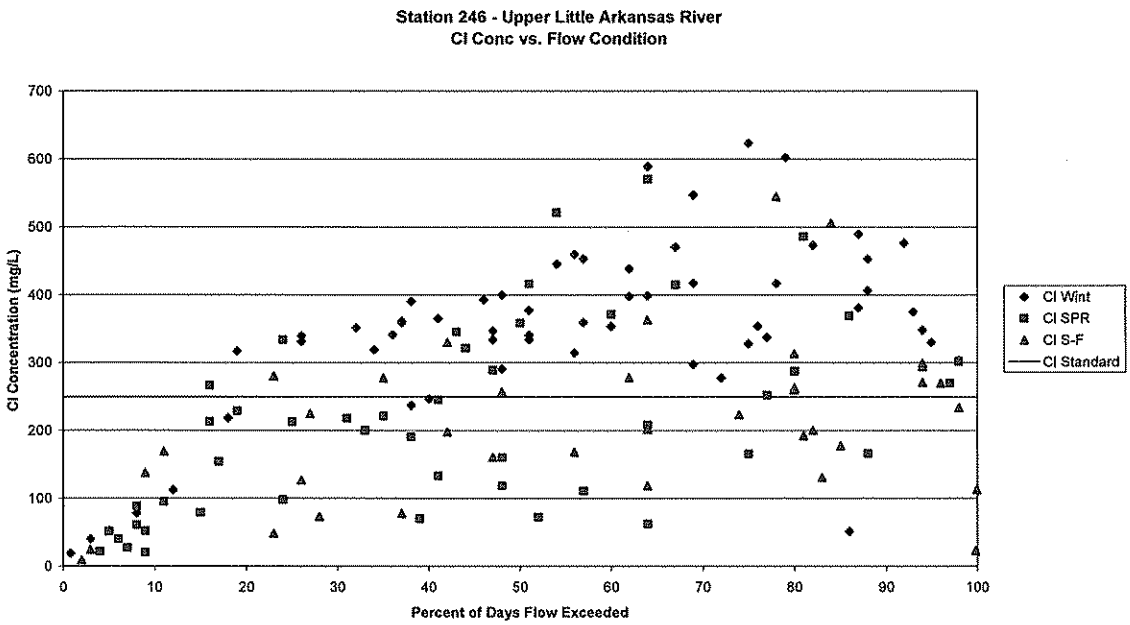
Long Term Flow Conditions at Station 246: Median Flow 21 cfs; 7Q10 = 1 cfs; 10% Exceedance Flow = 306 cfs ; 95% Exceedance Flow = 3.6 cfs

Current Conditions: Over the period of record, chloride concentration averages were established for KDHE ambient stream monitoring stations 246. The chloride averages for the sampling station are illustrated in **Table 1,** which indicates more than half of the samples exceeded the established water quality standards. Station 246 is a fixed KDHE

sampling station that has been sampled since 1985 and is currently sampled every other month.

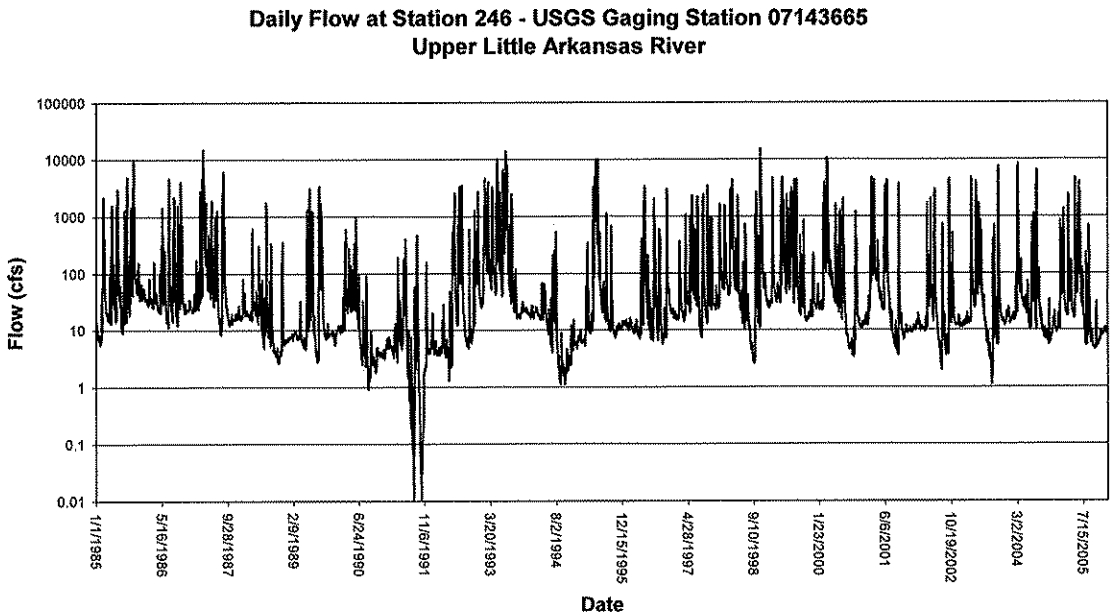
Chloride exceedances over 250mg/L cease once flows reach the 15% exceedance levels at station 246. Chloride concentrations are lower at the 95-99% exceedence levels. The data leads to the assumption that this condition is caused by the lack of flow, or drying up of the streams, within the contributing tributaries that drain oil-field brine pollution under normal flow conditions. Once flows increase to about the 90% exceedance level, the flow in the watershed is sustainable to flush a larger portion of the total chloride load downstream. The highest chloride concentrations are observed between the 50-90% exceedence levels. Flows with the greatest chloride concentrations most likely represent conditions where flows are small in the upper Little Arkansas River watershed but substantial enough in the Turkey Creek watershed to carry appreciable amounts of groundwater discharge polluted by oil-field brine (Whittemore). The chloride load increases as flows increase. The chloride loads and concentrations at station 246 can increase substantially with a small increase in flow as loads are contributed from the higher chloride concentration tributary streams that are affected by oil-field brine pollution.

Figure 2.



The droughts of 1990-1992 appear to be the only period were critical low flows were observed as seen in **Figure 3.** There were two samples collected at station 246 during the critical low flow period, these only averaged 68 mg/L of chloride. **Table 3** illustrates the chloride concentration averages for various flow conditions.

Figure 3.



The National Cooperative Refinery Association (NCRA) consistently discharged an average of 1.03 MGD of water into Bull Creek in the Turkey Creek watershed with an average chloride concentration of 1215 mg/L prior to February 14, 2004. NCRA ceased discharging to Bull Creek as of this date and began routing their outfall water to two Class I deep disposal wells. Prior to February 14, 2004, the average choride concentration at Station 246 was 276 mg/L. After the discharge to Bull Creek was discontinued by NCRA , the average chloride concentration at station 246 has decreased to 178 mg/L as seen in **Table 3**. Turkey Creek enters the Little Arkansas River above station 246. For more information regarding Turkey Creek, please refer to the Chloride TMDL for Turkey Creek.

Table 3.

Flow Duration	Station 246 Cl (mg/L) Avg. – All data	Station 246 Cl (mg/L) Avg. with NCRA discharge	Station 246 Cl (mg/L) Avg without NCRA discharge
All Conditions	267	275	178
Low 50-95%	343	357	212
Low 95-99%	217	217	NA

Oil field brine contamination enters the watershed from Sand Creek and the Little Arkansas River in the area along the Rice and McPherson county line and from the Turkey Creek watershed. As flows increase in the Little Arkansas River during higher flow periods and runoff events, the chloride load expected from natural sources increases as the percentage from oil brine and wastewater decreases. Point source loading is primarily related to the City of McPherson in the Turkey Creek watershed and several minor municipal facilities in the sub-basin.

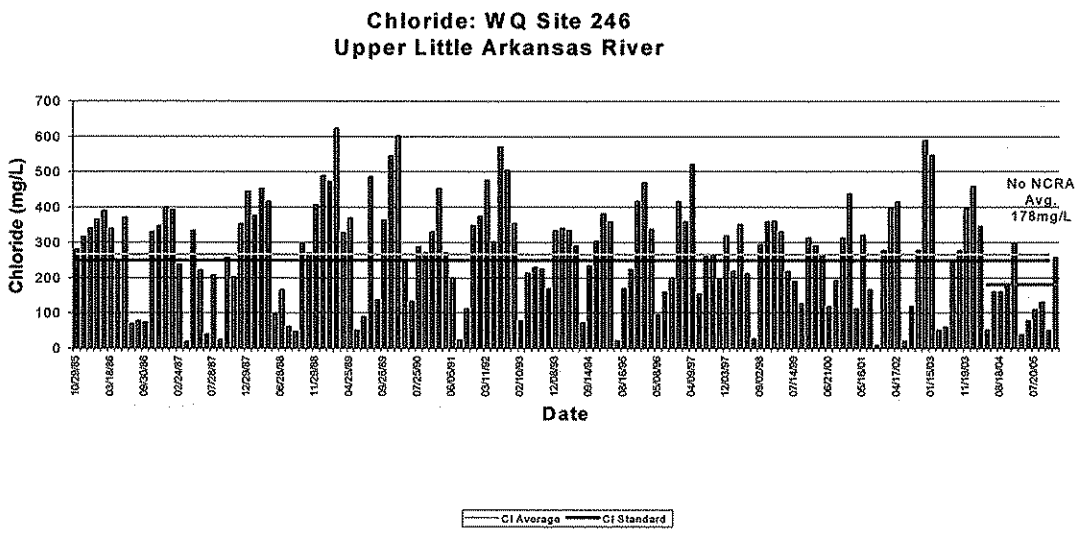
Excursions were seen in each of the three defined seasons as indicated in **Table 4** and **Figure 4** at station 246. Samples were over the domestic water supply criterion in 34% of the Spring Samples, 40% of the Summer-Fall samples, and 85% of the Winter samples. Overall, 56% of the samples were over the criterion. This would represent a baseline condition of non-support of the designated use. There is significant seasonal variation in the chloride concentrations at station 246. Samples obtained in the winter months are much greater than samples obtained in the other seasons.

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 Arkansas River (246)	Spring	0	1	3	6	4	2	16/47=34%
	Summer	0	1	3	2	5	4	15/38=40%
	Winter	0	1	14	18	12	5	50/59=85%

Included in the data tabulated in **Table 4** are thirteen sampling events that have occurred since the NCRA facility in McPherson has discontinued discharging. Of these, four were over the chloride standard. Three of these occurred in winter, two of which were within the 50-75% flow duration and one of which was in the 75-90% flow duration. The other excursion was observed in spring and occurred within the 25-50% flow duration level.

Figure 4.



As part of the Kansas Geological Survey (KGS) Salt Assessment Study for this watershed, two samples were obtained from the Little Arkansas River above the confluence with Turkey Creek and below the confluence at station 246 in February of 2000 and March of 2002. Samples above the confluence averaged 208 mg/L of chloride and samples below the confluence at station 246 averaged 322 mg/L. KGS also sampled several locations along the upper portions of the Little Arkansas River in February of 2000. The chloride concentration and sampling locations along the Little Arkansas River are as follows: upstream of Little River, 117mg/L; downstream of Little River, 127mg/L; upstream of Buhler, 284mg/L; downstream of Buhler, 254 mg/L; and upstream of Blaze Fork, 268mg/L. In addition, Blaze Fork was also sampled upstream of the confluence with the Little Arkansas River and contained 133mg/L of chloride. Blaze Fork flows south out of McPherson County and enters the Little Arkansas River approximately along the county borders between Reno and Harvey counties. Based on the KGS sample data, oil-field brine pollution contributes to the watershed upstream of Buhler originating from the Welch-Bornholdt field in Sand Creek and the Little Arkansas River.

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. Sampling data for station 246 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.

Table 5. Chloride Concentrations mg/L Season 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 Seasons Low Flow Avg.
Station 246- All data	348	396	212	300	211	248	267	331
246 with NCRA discharge	359	413	218	311	217	257	276	343
246 without NCRA discharge	221	266	147	111	157	154	178	212

Figure 5.

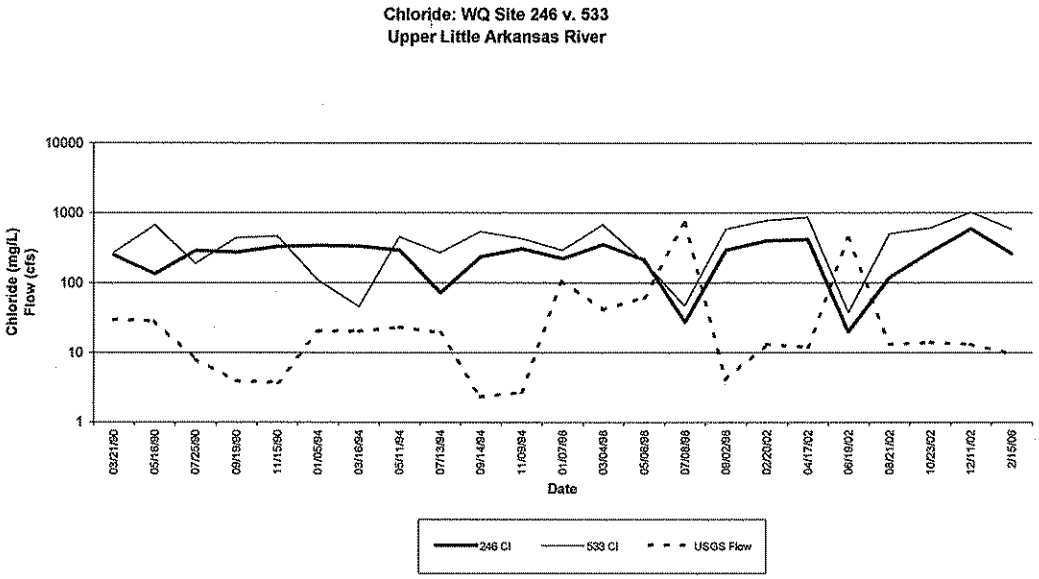


Figure 5 illustrates the relationship between chloride values at station 533 along Turkey Creek and station 246, plotted along with flow values from the USGS gage (07143665) when the two sites were sampled during the same day. Since station 533 is a rotational station, this only occurred every four years. Under all flow conditions, chloride concentrations are approximately 40% less at station 246 than those observed at station 533. In general, the ratio tended to vary seasonally, however the ratio between all flows and low flows within each given season are very similar as indicated in **Table 6**. The only event where both sites were sampled on the same date since NCRA ceased discharging was recently conducted in February of 2006 and resulted in station 246 having a chloride concentration of 258 mg/L, 56% less than the 583 mg/L concentration detected at site 533.

Table 6. Chloride concentration comparison between stations 533 and 246.

Station 533 Data Desc.	533 Cl Avg.	Station 246 Data Desc.	246 Cl Avg.	Comparison Ratio
533 All flow	**438**	**246 All Flow**	**262**	**.598**
533 Low flow	495	246 Low flow	302	.610
533 Wint All	465	246 Wint All	337	.725
533 Wint Low	489	246 Wint Low	365	.746
533 Spr All	342	246 Spr All	182	.532
533 Spr Low	442	246 Spr Low	258	.584
533 S-F All	535	246 S-F All	239	.447
533 S-F Low	535	246 S-F Low	239	.447
533, Feb 2006	**583**	**246 Feb 2006**	**258**	**.443**

Interim Endpoints of Water Quality (Implied Load Capacity) at Site 246 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 the Little Arkansas River. The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards fully supporting Drinking Water use. The current standard of 250 mg/L of chloride was used to establish the TMDL and its Wasteload Allocations. The upper portion of the Little Arkansas sub-basin is affected by the discharge of saline groundwater attributed by brine pollution, which increases the chloride concentrations within portions of the sub-basin. While chloride concentrations have lacked stability at site 246, the concentrations have generally decreased as flows increase over the median flow.

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

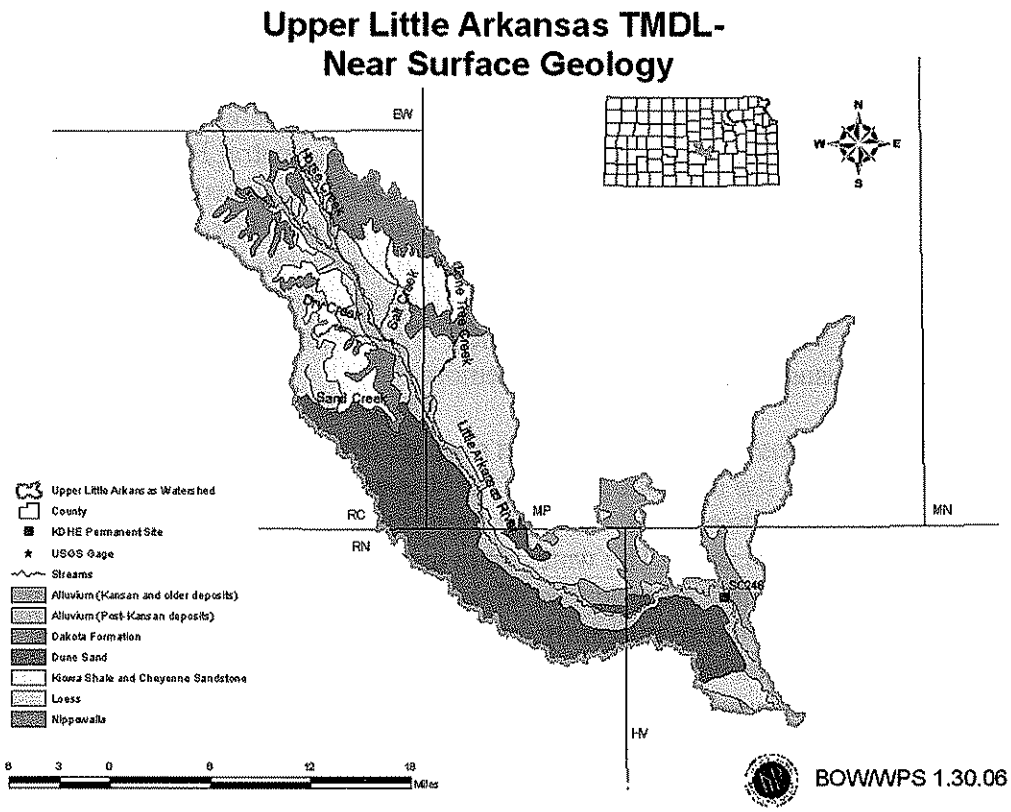
Geology: The primary geologic material underlying the Little Arkansas River watershed in Ellsworth and Rice counties consists of Lower Cretaceous shales and sandstones (primarily the Kiowa Shale and Dakota Sandstone). In east-central Rice County, Permian shales and siltstones underlie the watershed. The unconsolidated sediments of the Equus Beds area of the High Plains aquifer and local alluvial aquifers, which interact with stream flow, predominately underlie the watershed in McPherson County and the rest of the watershed. The unconsolidated sediments in the watershed are above the underlying bedrock formed by Permian shales and siltstones. The Permian bedrock also contains limestone beds, gypsum, and rock salt (Whittemore).

The Little Arkansas River sub-basin's average annual rainfall is approximately 26-28 inches. Flows in the lower portions of the stream segments during most periods are sustained with adequate rainfall, which recharges the High Plains aquifer enough to provide discharge to the stream. The water table in the Equus Beds aquifer in parts of the Turkey Creek watershed have experienced slight declines due to water use. Groundwater discharge may not contribute significantly, or at all, to stream flow in areas where declines in the Equus Beds aquifer have occurred. Less permeable silts and clays are a component of the shallow sediments within the Equus Beds aquifer in the McPherson region. Groundwater recharge is confined by the sediments when the groundwater table is less than the stream bed. This enables runoff from the Equus Beds region to drain faster since the shallow sediments are less permeable (Whittemore).

Natural Chloride: The primary source of natural chloride is derived from groundwater discharge to the streams from the Lower Cretaceous, Permian Bedrock and from the

Equus Beds deposits of the High Plains aquifer. Natural chloride in the Turkey Creek watershed enters the streams from perched groundwater flowing through soils and shallow sediments above less permeable sediments. The Permian bedrock underlying part of the upper Little Arkansas River sub-basin in east-central Rice County may discharge lesser amounts of saline groundwater. Rock salt may be contained in some portions of the Permian bedrock underlying the Equus Beds sediments, however unpolluted groundwater in the Equus Beds aquifer is generally fresh in this watershed. The shale in the Permian bedrock may restrict the upward dispersion of saline groundwater. The Permian chloride that does enter the aquifer may be diluted with the natural recharge of freshwater from rainfall. Natural chloride concentrations in the aquifer are typically less than 100 mg/L, and the chloride content of the water at monitoring station 246 is not expected to have natural sources with a concentration much greater than 100 mg/L during low flows (Whittemore).

Figure 6.



NPDES: There are seven permitted NPDES facilities located upstream of station 246. The facilities consist of: one "non-overflowing" commercial facility, one industrial permitted facility, and five municipal facilities. In addition there are twelve permitted facilities within the Turkey Creek watershed that are above station 533. Of these, the City of McPherson is the only significant discharger in the Turkey Creek watershed (See Turkey Creek Cl TMDL for more information regarding the Turkey Creek watershed).

The municipal NPDES permit for the City of Geneseo requires monthly chloride sampling. The City of Buhler is required to obtain weekday flow measurements of the discharge and monthly chloride samples as a condition of their NPDES permit. The Hutchinson Energy Center is required to obtain monthly flow measurements of the discharge and sample for chlorides quarterly, or every three months.

Table 7. NPDES facilities above station 246, excluding facilities in the Turkey Cr. Watershed.

KS Permit #	Facility / County	Permit Dates	Cl Permit Limits	Design Flow MGD	Type	Receiving Stream
M-LA04-OO01	City of Geneseo, Rice	01/01/03 – 12/31/07	Cl Monthly	.075	Mech, Trickling Filter	Little Arkansas River
M-LA10-OO02	City of Little River, Rice	02/01/06 – 01/31/11		.101	Four Cell Lagoon	Little Arkansas River
C-LA12-NO01	Action Equipment Co., McPherson	01/02/01 – 01/01/06		Non-Overflowing	One Cell Lagoon	
M-LA08-OO01	City of Inman, McPherson	8/1/02-07/31/07		.132	Four Cell Lagoon	Little Arkansas River via Blaze Fork Cr
M-LA18-OO01	City of Windom, McPherson	01/02/02-01/01/07		.0275	Three Cell Lagoon	Little Arkansas River via unnamed trib
M-LA01-OO01	City of Buhler, Reno	08/01/02-07/31/07	Q Weekday; Cl monthly	.168	Mech	Little Arkansas River
I-LA22-PO01	Hutchinson Energy Center, Reno	11/01/03-12/31/07	Q monthly; Cl quarterly	.389	Outfall 001	Little Arkansas River via Unnamed Trib

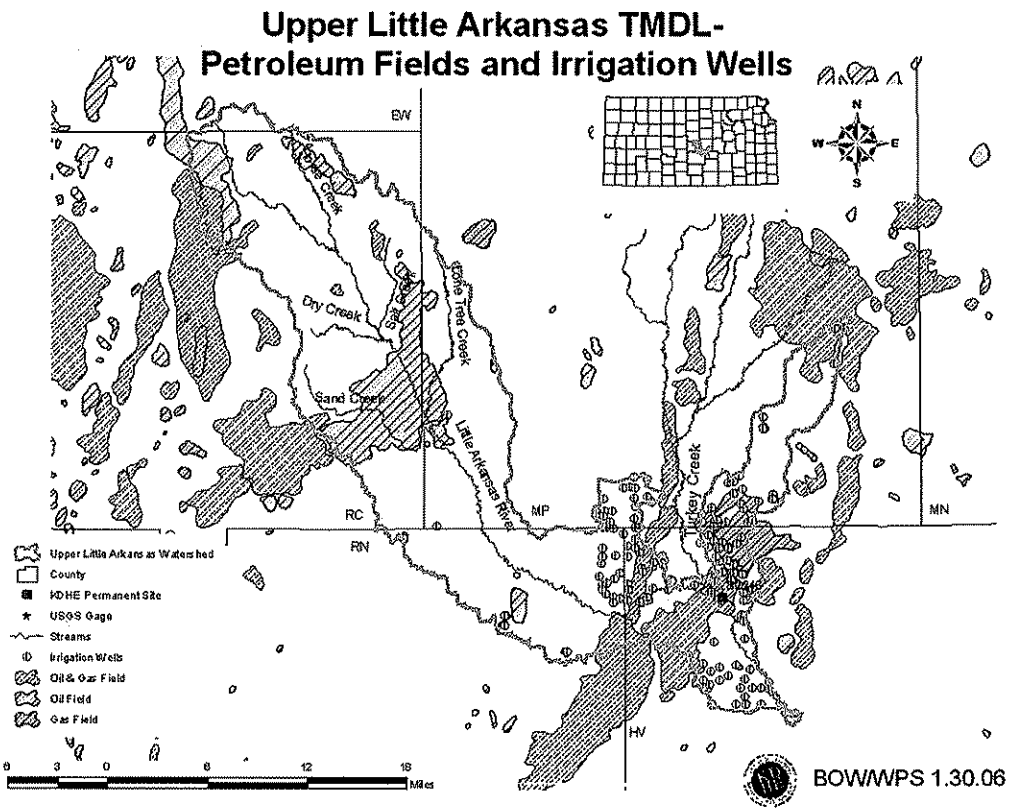
Table 8 . Discharging facilities required to sample for Chloride.

Facility	Period of Record	Flow Avg. (MGD)	Cl Avg. (mg/L)	Cl. Max (mg/L)
City of Geneseo	2001-2005	.26	273	485
City of Buhler	2001-2005	.135	350	470
Hutchinson Energy Center	2001-2005	.317	199	360

Population projections for the City of Geneseo indicates a stable population with no anticipated changes, projections for Buhler, Little River and Inman indicate slight to moderate increases, and projections for Windom indicate slight 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, with the exception of Inman. If population projections hold true, Inman will need to increase their capacity by approximately 2015.

Irrigation: Use of surface and groundwater for irrigation does occur throughout the lower portion of the watershed in northeastern Reno County, northwestern Harvey County, and the eastern part of the Blaze Fork Watershed in McPherson County. The amount of irrigation above Buhler is limited as indicated in **Figure 7**. Although the irrigation return flow could have the potential to affect the background chloride concentrations, return flow is not expected to contribute any significant amount of chloride to the Little Arkansas River at station 246.

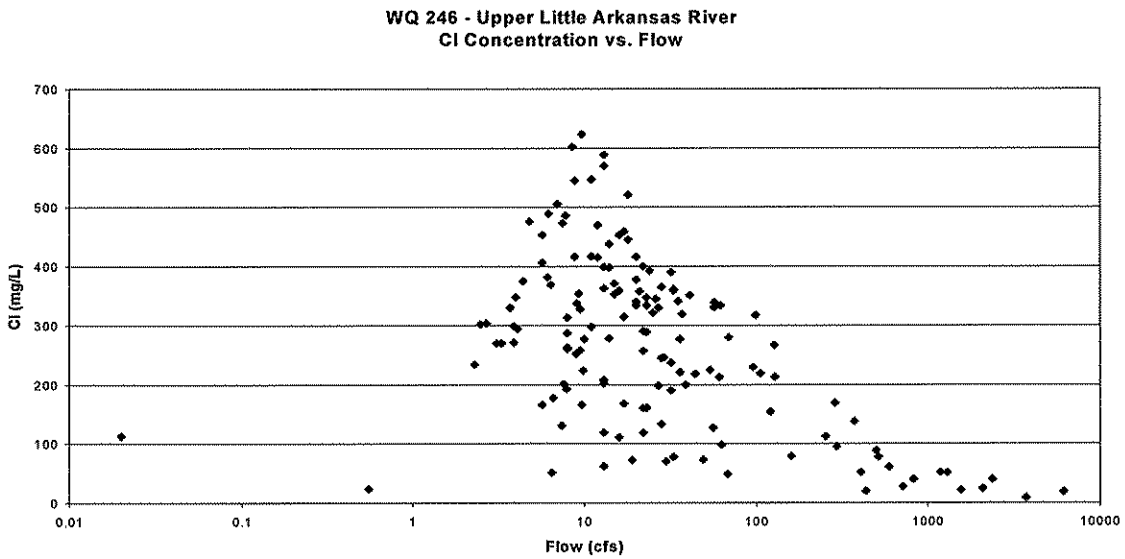
Figure 7.



Animal Wastes: Chloride contributions from animal wastes are likely to enter the Little Arkansas River from Turkey Creek during high runoff events and could contribute to increased chloride concentrations during higher flows (see Turkey Creek TMDL). The impact of animal wastes to the Little Arkansas River at station 246 is minimal as the majority of the chloride load originating from the portion of the Turkey Creek watershed where animal wastes might enter the stream is primarily derived from oil-field brine pollution (Whittemore).

Brine: The majority of the oil-brine pollution entering the Little Arkansas River above station 246 originates from the Ritz-Canton and Voshell fields in the Turkey Creek watershed and from the Welch-Bornholdt and Geneseo-Edwards fields along the Little Arkansas River. The historic disposal of waste brine generally occurred by diverting wastes through drainage ditches, which discharged to surface ponds where contamination seeped into the subsurface. Contamination to the aquifer resulting from the historic oil-field brine activities has been documented. Based on the February 2000 KGS sampling data, the Welch-Bornholdt field between the towns of Little River and Buhler, is where the oil-field brine pollution is elevating the chloride concentration within the Little Arkansas River. As mentioned previously, the KGS data indicated chloride concentrations increased from 127 mg/L downstream of Little River to 284 mg/L upstream of Buhler. KGS estimates the oil-brine concentration derived from the Turkey Creek watershed is greater than that of the Little Arkansas River above the Turkey Creek confluence (Whittemore). As **Figure 8** illustrates, the flushing of brine occurs as flows increase from low to moderate flow conditions, which increases the chloride concentration at station 246. As flows continue to increase to high flow conditions the brine concentration becomes diluted.

Figure 8.



4. ALLOCATION OF POLLUTANT REDUCTION REPONSIBILITY

Point and Non-Point Sources: The success of this TMDL is relative to the success of the Turkey Creek Chloride TMDL. The majority of the current impairment is associated with chloride loads originating from the Turkey Creek watershed and historic oil-field brine pollution above Buhler along the Little Arkansas River. The NCRA facility from the Turkey Creek watershed is no longer discharging, therefore the current load from Turkey Creek is primarily associated with brine pollution and the City of McPherson. Since brine will eventually dilute out over time, a load allocation was estimated under

this TMDL based on the brine concentration diluting at a rate of 1% per year. Should a domestic water supply point of diversion become established within the TMDL area, the current water quality standard of 250 mg/L would be applied to ensure the water supply use was protected.

The total wasteload allocation reaching station 246 under low flow conditions is 8,590 lbs/day, when the entire load reaches station 246. **Table 9** lists the initial allocations by facility.

Table 9. Wasteloads and Allocations for NPDES facilities above Station 246.

Wasteload Allocation	Discharge Flow	Chloride Concentration	Cl Load (lbs/Day)
McPherson	2.0 MGD	400	6,683
Geneseo	.075 MGD	273	171
Little River	.101 MGD	275	232
Windom	.0275 MGD	275	63
Buhler	.168 MGD	350	491
Hutchinson Energy	.389 MGD	200	647
Inman	.132 MGD	275	303
WLA at Station 246	**2.89 MGD**	**355**	**8,590**

The milestone for this TMDL has been set for the year 2025. By this time the chloride concentration attributed to brine should be reduced by approximately 21%. Four scenarios were developed to evaluate the success of this TMDL up to the milestone year.

The first scenario reflects the baseline condition calibrated with chloride concentration averages sampled throughout 2002 from selected data sets from stations 533 and 246, which were also compared with the 2002 KGS sample from the Little Arkansas River above the confluence with Turkey Creek. This scenario reflects the baseline condition where wasteloads reflect the 2002 condition and were derived from average flows and chloride concentrations from the point sources during this period in 2002. The Turkey Creek loads have been carried over from the Turkey Creek TMDL. The natural chloride and brine concentrations and loads were adjusted to achieve the average chloride concentration of 360 mg/L at station 246 for this scenario.

Scenario Two displays the current TMDL. All point sources above Turkey Creek are assumed to be discharging at their design flows and held to their current chloride concentration averages. Where effluent concentrations are unknown, a concentration of 275 mg/L was assigned. The brine concentration has diluted out at a concentration of 1% per year from the year 2002. Scenario three represents the TMDL with the load from Turkey Creek removed. Scenario Four represents the TMDL under median flow conditions.

Scenario Five represents the TMDL in the year 2025. The wasteloads above Turkey Creek remain the same as Scenario Two, however brine will have diluted down to 396 mg/L. The load derived from Turkey Creek has increased since the City of

McPherson is presumed to increase their effluent flow to 2.4 MGD within the next several years due to scheduled plant upgrades.

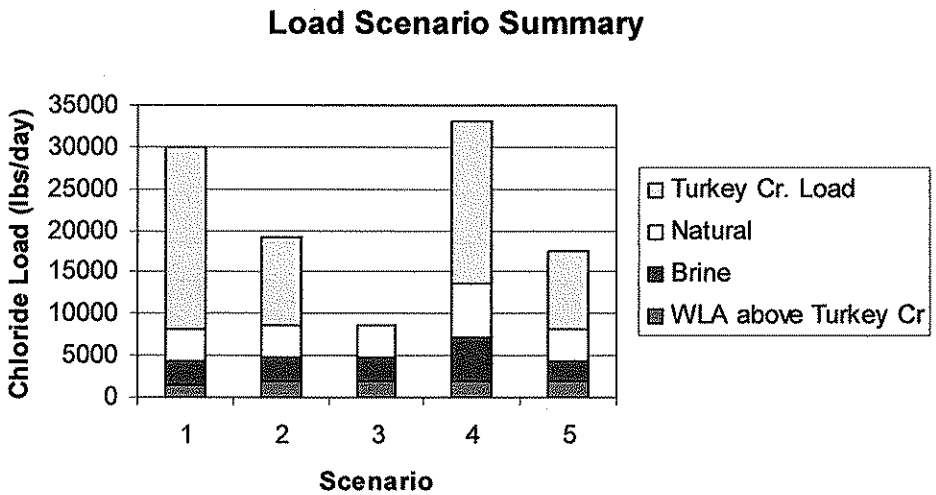
Table 10. Resulting Chloride Concentrations and Loads for Little Arkansas River.

Scenario	**1**	**2**	**3**	**4**	**5**
Cl Conc, Loads, and Allocations	**2002 Baseline**	**2006 TMDL**	**2006 TMDL – w/out Turkey Load**	**TMDL Median Q**	**2025 TMDL**
246 Cl (mg/L)	**357**	**242**	**166**	**245**	**211**
246 Load (lbs/day)	29885	19110	8539	33126	17424
Point Source above Turkey Cr Cl (mg/L)	253	255	255	255	255
Point Source Load above Turkey Cr (lbs/day)	1380	1907	1907	1907	1907
Brine Cl above Turkey Cr. (mg/L)	500	480	480	480	396
Brine Load above Turkey Cr (lbs/day)	2970	2851	2851	5184	2352
Natural Cl above Turkey Cr (mg/L)	100	100	100	100	100
Natural Cl Load above Turkey Cr (lbs/day)	3780	3780	3780	6480	3780
Turkey Cr. Cl (mg/L)*	630	382	0	373	302
Turkey Cr. Load* (lbs/day)	21755	10572	0	19555	9385

* Refer to Turkey Cr Cl TMDL

As flows slighty increase, the full brine load will be flushed from the entire watershed. The brine load contribution significantly affects the chloride concentration and total load estimates at station 246 under moderate to low flow conditions. Since it is difficult to estimate how much of the load does not reach station 246 under low flow conditions during dryer periods, all scenarios assume the entire load is transported downstream.

Figure 9.



Margin of Safety: The Margin of Safety is implicitly established by conservatively assuming the entire chloride load reaches sampling station 246 under low flow conditions, when in fact the flow from several of the streams does not based on available USGS flow data. In addition, the calculated wasteloads for point sources above Turkey Creek assume the permitted facilities are discharging at design flows, which is more than the average flows actually discharged to date.

State Water Plan Implementation Priority: Because the chloride impairment along the Upper Little Arkansas River is primarily due to historical brine pollution, this TMDL will be a Medium Priority for implementation.

Unified Watershed Assessment Priority Ranking: This TMDL addresses streams within the Little Arkansas sub-basin (HUC 8: 11030012) wih a priority ranking of 14 (High Priority of restoration).

Priority HUC 11s: Because of the significant influence of Turkey Creek on chloride levels seen at station 246, the Turkey Creek watershed will be the priority for implementation.

5. IMPLEMENTATION

Desired Implementation Activities

1. Monitor any anthropogenic contributions of chloride loading to the river system.
2. Reduce historic brine pollution concentration through establishing 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 monthly or quarterly chloride monitoring, with the exception of the City of Little River. The permit for the City of Little River will expire in 2011, at this time quarterly chloride sampling should be stipulated. 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.

Pollution Prevention Institute – Kansas State University

a. Work with the cities within the watershed 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 Little Arkansas River sub-basin.

Time Frame for Implementation: The success of this TMDL is dependent upon the success of the Turkey Creek Chloride TMDL, since the majority of the chloride source originates from the Turkey Creek watershed. There is limited data since the NCRA facility ceased discharging. The revision of subsequent permits may be necessary to achieve compliance with this TMDL if the municipal dischargers prove to be a significant chloride source as the brine concentration is reduced.

Targeted Participants: Primary participants for implementation will be KDHE and the City of McPherson.

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 2025, the City of McPherson's treatment plant will have completed the planned upgrades and reduced their effluent's average chloride concentration to 300mg/L through source reduction measures. The actual discharging flows and chloride concentrations may vary outside of the predictions utilized to establish the future wasteload scenarios. This TMDL will be revisited at this time 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 pollution.

1. K.S.A. 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 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 area 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. The watershed and its TMDL are a Low Priority consideration.

Effectiveness: Minimal control can be exerted on natural contribution 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 samples from the station 246 along the Little Arkansas River. Based on that sampling, the priority status will be evaluated in 2011 and thereafter, including application of numeric criterion based on background concentrations.

At a minimum, quarterly monitoring of chloride levels in the effluent discharge will be a condition of the NPDES and state permits for facilities above station 246 that actually discharge to the watershed. This monitoring will continually assess the contributions of chloride in the wastewater effluent released to the Little Arkansas River watershed.

7. FEEDBACK

Public Meeting: 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 TMDLs of the Lower Arkansas Basin was held in Hutchinson on June 7, 2006.

Basin Advisory: The Lower Arkansas Basin Advisory Committee met to discuss the TMDLs in the basin on June 7, 2006. The public record was held open until June 20, 2006. No comments were received by KDHE.

Discussion with Interest Groups: The Kansas Department of Health and Environment met to discuss the implications of this TMDL with the City of McPherson on May 4, 2006.

Milestone Evaluation: In 2011, evaluation will be made to the degree of implementation, which has occurred within the watershed and current condition of the streams of the Turkey Creek watershed. 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 could extend over fifteen to twenty years. However, the stream will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2006-2011. Therefore, the decision for delisting will come about in the preparation of the 2012, 303(d) list. If impairment continues because of Turkey Creek chlorides, the next evaluation for delisting will arrive in 2026 after Turkey Creek has been reduced. 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 2007, 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
Scenario 1

Baseline	**Upper Little Arkansas Baseline 2002**
LowFlowLoad	2002 Avg.

Site	Municipal & Industrial Point Source	Flow cfs	Conc*	WLA	LA	Load %	TMDL lbs/Day	Cl Conc Inputs
533								
	McPherson WWTP	2.50614	415	5616.26				
	NCRA	1.8564	1210	12129.72		81.56915		
	Brine	0.33	1735		3091.77	14.21128		
	Natural	1.7	100		918	4.219575		
	533 Totals	**6.39254**	**630.2412**	**17745.98**	**4009.77**	**100**	**21755.75**	
		Flow cfs	Conc	WLA	LA		Lbs/Day	
246	Geneseo	**0.040222**	**273**	**59.29527**				
	Little River	**0.104165**	**275**	**154.6845**				
	Windom	**0.028362**	**275**	**42.11708**				
	Buhler	**0.208845**	**350**	**394.7171**				
	Hutch Energy	**0.490399**	**199**	**526.9828**				
	Inman	**0.136136**	**275**	**202.162**				
	Total	**1.008128**	**253.4875**	**1379.959**				
	Brine	**1.1**	**500**		**2970**			
	Seepage Upstream of Turkey Confluence	**7**	**100**		**3780**			
								Calibrate site 246 to 360 mg/L
	Station 246	15.50067	357.042	1379.959	6750		29885.71	
	above Turkey	**9.108128**	**165.2972**	**1379.959**	**6750**		**8129.959**	**Calibrate to 158 mg/L**

Scenario 2

Upper Little Arkansas 2006 TMDL

Site	Municipal & Industrial Point Source	Flow cfs	Conc*	WLA	LA	*Load %*	TMDL lbs/Day
533							
	McPherson WWTP	3.094	400	6683.04			
	NCRA	0	0	0		*63.21672*	
	Brine	*0.33*	1667		2970.594	*28.09967*	
	Natural	*1.7*	100		918	*8.683615*	
	533 Totals	**5.124**	**382.0667**	**6683.04**	**3888.594**	***100***	**10571.63**
		Flow cfs	Conc	WLA	LA		Lbs/Day
246	Geneseo	**0.116025**	**273**	**171.0441**			
	Little River	**0.156247**	**275**	**232.0268**			
	Windom	**0.042543**	**275**	**63.17561**			
	Buhler	**0.259896**	**350**	**491.2034**			
	Hutch Energy	**0.601783**	**199**	**646.676**			
	Inman	**0.204204**	**275**	**303.2429**			
	Total	**1.380698**	**255.8246**	**1907.369**			
	Brine	**1.1**	**480**		**2851.2**		
	Seepage Upstream of Turkey Confluence	**7**	**100**		**3780**		
	Station 246	14.6047	242.3143	1907.369	6631.2		19110.2
	above Turkey	**9.480698**	**166.7827**	**1907.369**	**6631.2**		**8538.569**

Scenario 4

Median Flow	**Upper Little Arkansas 2006 TMDL** Median Flows						
Site	Municipal & Industrial Point Source	Flow cfs	Conc*	WLA	LA	*Load %*	TMDL lbs/Day
533							
	McPherson WWTP	3.094	400	6683.04			
	NCRA	0	0	0		*34.17557*	
	Brine	*1.1*	1667		9901.98	*50.63651*	
	Natural	*5.5*	100		2970	*15.18792*	
	533 Totals	**9.694**	**373.561**	**6683.04**	**12871.98**	***100***	**19555.02**
		Flow cfs	Conc	WLA	LA		Lbs/Day
246	Geneseo	**0.116025**	**273**	**171.0441**			
	Little River	**0.156247**	**275**	**232.0268**			
	Windom	**0.042543**	**275**	**63.17561**			
	Buhler	**0.259896**	**350**	**491.2034**			
	Hutch Energy	**0.601783**	**199**	**646.676**			
	Inman	**0.204204**	**275**	**303.2429**			
	Total	**1.380698**	**255.8246**	**1907.369**			
	Brine	**2**	**480**		**5184**		
	Seepage Upstream of Turkey Confluence	**12**	**100**		**6480**		
	Station 246	25.0747	244.6497	1907.369	11664		33126.39
	above Turkey	**15.3807**	**163.4007**	**1907.369**	**11664**		**13571.37**

Scenario 5

Upper Little Arkansas 2025 TMDL

Municipal & Industrial Point Source	Flow cfs	Conc*	WLA	LA	*Load %*	TMDL lbs/Day
533 McPherson WWTP	3.7128	300	6014.736			
NCRA	0	0	0		*64.09041*	
Brine	*0.33*	1376		2452.032	*26.12778*	
Natural	*1.7*	100		918	*9.781808*	
533 Totals	**5.7428**	**302.6259**	**6014.736**	**3370.032**	***100***	**9384.768**
	Flow cfs	Conc	WLA	LA		Lbs/Day
246 Geneseo	**0.116025**	**273**	**171.0441**			
Little River	**0.156247**	**275**	**232.0268**			
Windom	**0.042543**	**275**	**63.17561**			
Buhler	**0.259896**	**350**	**491.2034**			
Hutch Energy	**0.601783**	**199**	**646.676**			
Inman	**0.204204**	**275**	**303.2429**			
Total	**1.380698**	**255.8246**	**1907.369**			
Brine	**1.1**	**396**		**2352.24**		
Seepage Upstream of Turkey Confluence	**7**	**100**		**3780**		
Station 246	15.2235	211.9576	1907.369	6132.24		17424.38
above Turkey	**9.480698**	**194.293**	**3814.738**	**6132.24**		**9946.978**