

LOWER ARKANSAS RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: Arkansas River near Arkansas City Water Quality Impairment: Sulfate

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasins: Middle Arkansas–Slate & Kaw Lake **Counties:** Cowley and Sumner

HUC 8s: 11030013 **HUC 11 (HUC 14s):** 020 (050, 060)
030 (050, 060, 070, 080, and 090)

11060001 **HUC 11 (HUC 14s):** 040 (010)

HUC 11 (HUC 14s): 030 (050, 060, 070, 080, and 090)

Drainage Area: 270.3 square miles between Derby and Arkansas City

Main Stem Segments: WQLS: 1, 2; 14, 18 starting at the Oklahoma border and ending at the confluence with Ninnescah River.

Tributary Segments: WQLS: Spring Creek (19)
Negro Creek (20)
Spring Creek (21)
Salt Creek (22)
Lost Creek (23)
Beaver Creek (33)
Spring Creek (34)

Non-WQLS:
Slate Creek (17)

WQLS: Antelope Creek (25)
Badger Creek (31)
Winser Creek (32)

Designated Uses: Special Aquatic Life Support; Primary & Secondary Contact Recreation; Domestic Water Supply; Food Procurement; Ground Water Recharge; Industrial Water Supply Use; Irrigation Use; Livestock Watering Use for Main Stem Segments

1998 303d Listing: Table 1 - Predominant Point Source and Nonpoint Source Impacts and Table 3 - Predominant Natural Conditions Impact

Impaired Use: Domestic Water Supply

Water Quality Standards: Domestic Water Supply: 250 mg/l at any point of domestic water supply diversion (K.A.R.28-16-28e(c) (3) (A)); Livestock Watering: 1000 mg/l (Table 1a of K.A.R. 28-16-28e(d));

In stream segments where background concentrations of naturally occurring substances, including chlorides, sulfates and selenium, exceed the water quality criteria listed in Table 1a of KAR 28-16-28e(d), at ambient flow, the existing water quality shall be maintained, and the newly established numeric criteria shall be the background concentration, as defined in KAR 28-16-28b(f). (KAR 28-16-28e(b)(9)).

In surface waters designated for the groundwater recharge use, water quality shall be such that, at a minimum, degradation of ground water quality does not occur. Degradation shall include any statistically significant increase in the concentration of any chemical contaminant in ground water resulting from surface water infiltration or injection. (K.A.R. 28-16-28e(c) (5)).

Arkansas River at Arkansas City TMDL Reference Map

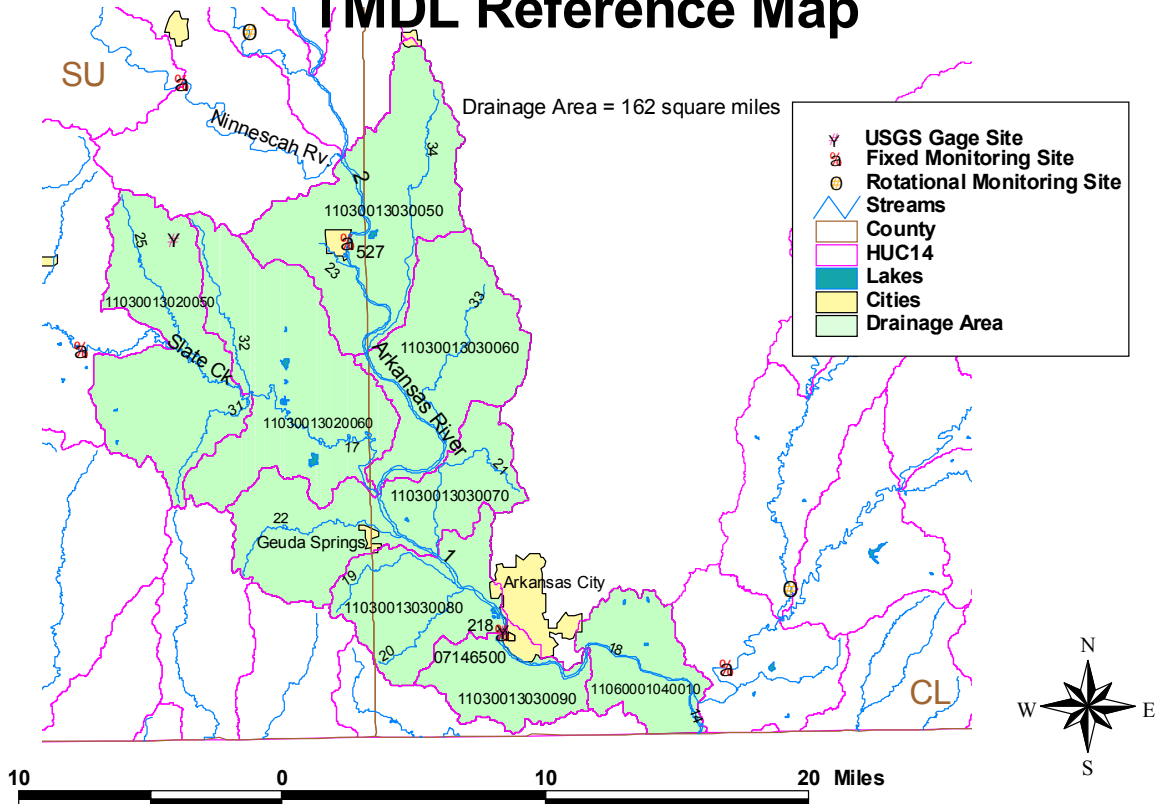


Figure 1

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 1998 303d: Partially Supporting Domestic Water Supply

Monitoring Sites: Station 218 near Arkansas City; Station 527 at Oxford, Station 280 - Ninnescah River near Belle Plaine, Station 528 - Slate Creek near Wellington

Period of Record Used: 1985 to 1999 (Station 218); 1990 to 1999 (Station 527)

Flow Record: Arkansas River at Arkansas City (USGS Station 07146500); 1970 to 2000

Long Term Flow Conditions: Median Flow = 798 cfs, 7Q10 = 170 cfs at Arkansas City

Current Conditions: Sulfate concentrations average 149 mg/l near Arkansas City over 1985-1999 and 160 mg/l near Oxford over 1990-1999. There is considerable linkage in sulfate concentrations at Derby effecting concentrations seen at Oxford and Arkansas City. When sulfate levels at Derby are low (134 mg/l on average), sulfate levels average 113 mg/l at Oxford and 123 mg/l at Arkansas City. However, when sulfates are elevated at Derby (averaging 348 mg/l), the average at Oxford rises to 256 mg/l and 235 mg/l at Arkansas City. There is a significant difference in average concentrations between Derby and Oxford and Arkansas City, under either situation, but no significant difference in concentration between Oxford and Arkansas City. Differences probably reflect the influence of the Ninnescah River between Derby and Oxford.

Both sites are influenced by immigration of sulfate-laden water from the Garden City area moving past Dodge City and Wichita. Sulfate levels over 250 mg/l at Arkansas City seen in 1987 and at Oxford and Arkansas City during 1996-1999, with periods of movement of flow down the Arkansas River past Dodge City, flowing past Wichita. Arkansas River water entering Kansas from Colorado has extreme concentrations of sulfate (>2000 mg/l). The river undergoes dilution as it flows downstream. Frequently, regional conditions in the river and surrounding aquifers causes flow to cease between Dodge City and Garden City, as was the case between 1990 and mid-1996. Under those conditions, sulfate levels seen at Oxford and Arkansas City remain below the water quality standard.

Monitoring Site	Average Sulfate Concentration and Range, 1990 - 1996	Average Sulfate Concentration and Range, 1996 - 1999
Derby	134 mg/L (12-229 mg/l)	348 mg/L (8 - 732 mg/l)
Oxford	113 mg/l (16-168 mg/l)	256 mg/l (9-565 mg/l)
Arkansas City	123 mg/l (18-200 mg/l)	235 mg/l (11-503 mg/l)

Plotting sulfate loads exceeding the standard over the cumulative frequencies of flows seen at Arkansas City reveals the excursions occur at flows near median flow or higher. No violations occur at the extreme low flow condition, where point sources impact dominate. Concentrations at higher flows sporadically exceed the standard. Therefore, sulfate concentrations seen at

Arkansas City reflect three factors: movement of high sulfate water from western Kansas past the Wichita area, dilution of that water by the low sulfate (56-57 mg/l) water of the Ninnescah River above Oxford and some additional loading by Slate Creek with its higher (196-197 mg/l) sulfate water.

Of the 108 samples taken at Arkansas City over 1985-1999, 9 or 8% of the samples exceeded 250 mg/l. One of those occurred in 1987 and the others since late 1996. In both cases, flows in the Arkansas River's western reaches were moving eastward past the historic no flow zone near Dodge City. Of the 9 excursions, all but 2 occurred at flows which were greater than median flow. The other two excursions occurred at flows exceeded 52% and 65% of the time in Spring and Summer, respectively. Since 1990, 14% of the samples were over 250 mg/l at Arkansas City.

NUMBER OF SAMPLES OVER SULFATE STANDARD OF 250 MG/L BY FLOW AND SEASON

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Arkansas City	Spring	0	2	1	1	0	0	4/46= 9%
	Summer	0	1	0	1	0	0	2/27= 7%
	Winter	0	1	2	0	0	0	3/35= 9%

Conditions at Oxford were similar with 10 of 59 or 17% of the samples taken since 1990 were over 250 mg/l. Seasonal distribution of excursions at Oxford were 12%, 21% and 21%, respectively for spring, summer and winter.

Desired Endpoint Condition of Water Quality at Station 218 over 2005 -2010

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 sulfate was used to establish a load duration TMDL curve and represents this endpoint. At 7Q10 flow conditions, the resulting total load would be 98.6 tons per day.

The load will increase during periods when the Arkansas River is flowing from the Colorado stateline to the Oklahoma stateline when there will be continued excursions of the sulfate criterion at flows near or above median flow. However, on average, the sulfate concentration seen under these conditions at Arkansas City is at or below 250 mg/l. Therefore, the existing water quality standard will be used as the endpoint for these conditions as well.

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

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: There are few NPDES permitted wastewater facilities contributing sulfate to these stream reaches. Two of the facilities are the municipal outfalls of Oxford and Arkansas City; the

other is a processing plant under construction and scheduled to come on-line in July 2001. There may also be ground water remediation sites which develop and discharge to the Arkansas River in the future. Currently permitted facilities potentially discharge 5.5 cfs to the river.

Irrigation Return Flow: Surface water irrigation is nonexistent along the Arkansas River (segments 1 & 2). Ground water irrigation is minimal. Irrigation Return Flows do not appear to significantly increase the sulfate load to the Arkansas River in the Mid-Arkansas Slate Subbasin.

Background: The primary geologic material at the flood plain of the Arkansas River is unconsolidated Quaternary sediment comprising the broad alluvial aquifer of the Arkansas River valley. The alluvial aquifer interacts well with the river where it underlies and is adjacent to the river. Permian bedrock underlies the Arkansas River alluvium. Most of this bedrock is the Wellington Formation that includes limestone beds, gypsum ($\text{CaSO}_4 \cdot \text{H}_2\text{O}$), anhydrite (CaSO_4), and rock salt (halite, NaCl). The evaporite deposits (halite, gypsum, and anhydrite) are important to the water quality in the subbasin because they contribute large amounts of chloride and sulfate to groundwater discharging from the Permian rocks to the streams and alluvial aquifers in the subbasin.

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

The nature of sulfate loading along the Arkansas River reflects decades of natural contributions aggravated by patterns of irrigation water use and reuse along the upstream reaches near the state line. Resumption of flow around Dodge City has brought about a significant increase in sulfate seen at Oxford and Arkansas City. Therefore, short term reduction in sulfate loads in this reach of the river will be negligible. Improvement in sulfate levels above Garden City should result in gradual lowering of ambient concentrations of sulfate seen throughout these stream reaches. As such, absolute application of this TMDL and its desired endpoints is limited in these reaches under higher flow conditions, particularly at the upstream reaches near Oxford.

Point Sources: Few point sources discharge into Segments 1 and 2 and they are small relative to the receiving flow in the river. Based on an estimated discharge volume from all point sources of 3.57 MGD (5.5 cfs) a Wasteload Allocation of 3.7 tons per day at 7Q10 flow conditions will be established by this TMDL. Calculations used to estimate wasteload allocations are given in the attached appendix. Since the municipal sources likely have modest (<200 mg/l sulfate) levels, this allocation may be used to manage the major industrial discharger loads as well as any ground water remediation projects along the river.

Non-Point Sources: For the purposes of deriving a TMDL for these river segments, a background flow and sulfate level were estimated for Segment 1, which receives the majority of point source and tributary loads. The assumptions and calculations for the Load Allocation are given in the attached appendix. An assumed 7Q10 flow entering the segment was estimated to be 202 cfs based on the Derby and Arkansas City gage stations. The estimated sulfate concentration attributed to background was calculated to be 174 mg/l based on potential upstream loadings above Oxford and historic median concentrations and low flows seen on the Ninescah River and Slate Creek. Given these assumed background conditions, the Load Allocation is 94.9 tons per day.

Under conditions when Arkansas River water from western Kansas arrives at Wichita, thereby elevating sulfate levels at Oxford and Arkansas City, the Load Allocation increases in response to greater flows and sulfate concentrations. At median flow conditions (798 cfs), the Load Allocation is calculated to be 535 tons per day, reflecting an average sulfate concentration of 250 mg/l, consistent with levels seen from 1996-1999. Most of this Load Allocation originates upstream of Derby with average concentrations of 350 mg/l. Given the dilution impact of the drainage between Derby and Arkansas City, there is an average 33% reduction in sulfate concentration between Derby and Arkansas City. Calculations are provided in the Appendix.

Defined Margin of Safety: The Margin of Safety is largely implicit because of the presumption of existing facilities discharging 250 mg/l sulfate at their design flows, exceeding estimated actual loads assumed from ambient data. Moreover, the relative size of future point source dischargers along Segments 1 and 2 will likely continue to be small relative to the receiving flow of the Arkansas River. Absent Wasteload Allocation increases of an order of magnitude or more, the anticipated loading and ambient concentrations will be similar to those represented by this TMDL.

At higher flows which coincide with the incidence of elevated sulfate, any point source impacts will be masked by upstream nonpoint and natural contributions. Given the dilution impact of the drainage between Derby and Arkansas City, the objective with the higher flow Margin of Safety would be to attempt to maintain a 33% reduction in sulfate concentration between Derby and Arkansas City.

State Water Plan Implementation Priority: This TMDL will be a Low Priority for implementation because of the influence of upstream sulfate loading entering these stream reaches, the time needed to establish any sulfate improvements in the upstream reaches, and the need to ascertain any additional sources along these reaches and within the immediate watershed which might contribute sulfate under conditions seen on the river prior to 1996.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Mid-Arkansas - Slate Subbasin (HUC 8: 11030013) with a priority ranking of 6 (High Priority for restoration work).

Priority HUC 11s and Stream Segments: Because the sulfate impairment is confined to the mainstem of the Arkansas River, priority will be given to Segment 1 which will reflect all potential contributions arriving from upstream.

5. IMPLEMENTATION

Desired Implementation Activities

1. Evaluate any potential sources between Maize and Derby which possibly raise sulfate levels in the river above pre-1996 levels
2. Assess likelihood of river being used for domestic uses.

Implementation Programs Guidance

NPDES and State Permits - KDHE

- a. Evaluate any point sources releasing wastewater in and around these impacted reaches as to potential to contribute sulfate and degrading water quality above Derby.

Non-Point Source Pollution Technical Assistance - KDHE

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

Use Attainability Analysis - KDHE

- a. Consult with Division of Water Resources on locating existing or future domestic points of diversion on the Arkansas River for drinking water purposes.

Time Frame for Implementation: Work on the upstream management of sulfate levels, including that crossing the state line will commence over 2000-2005. Evaluation of impact of any sulfate control on downstream reaches should occur after 2005.

Targeted Participants: Primary participants for implementation will be KDHE. Otherwise, activity is deferred to that which has to occur along the river above Garden City.

Milestone for 2006: The year 2006 marks the midpoint of the ten-year implementation window for the stream segments. At that point in time, some consideration of upstream water quality improvement on downstream reaches should be evaluated. Additionally, sampled data from Station 218 should indicate evidence of reduced sulfate levels at flow conditions relative to the conditions seen over 1990-1999.

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 along the river to reduce pollution.

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the waters of the state.
2. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.

3. K.A.R. 28-16-69 to -71 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas on a watershed basis.
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. 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: Other protection or planning activities are incorporated within the Lower Arkansas Basin Plan of 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 a portion of the \$16-18 million available annually from the State Water Plan Fund to water quality and water conservation projects and programs. This watershed and its TMDL are a Low Priority consideration and should not receive funding.

Effectiveness: Irrigation return flow controls are difficult to implement, although tailwater management has been practiced in Kansas for decades. The influence of upstream sulfate levels complicates the ability of the state to implement this TMDL. As such, the priority for this TMDL will remain low, as the state evaluates downstream benefits from irrigation return flow management in western Kansas and Colorado.

6. MONITORING

KDHE should collect bimonthly samples at Station 218 over 2001-2010 in order to assess progress in implementing this TMDL over each of the three defined seasons during the initial implementation period. Use of the real time flow data available at the Arkansas City stream gaging station can direct sampling efforts.

Monitoring of sulfate levels in effluent will be a condition of NPDES and state permits for facilities discharging to the Arkansas River or tributaries leading to the mainstem of the river.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Lower Arkansas River Basin were held March 9, 2000 and April 26-27, in Hutchinson, Wichita, Arkansas City and Medicine Lodge. An active Internet Web site was established at <http://www.kdhe.state.ks.us/tmdl/> to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Lower Arkansas River Basin. A draft of this TMDL has been maintained on the website

since June 1, 2000 and modifications to the original draft have been available to the public for viewing and review up to the date of submitting this TMDL to EPA.

Public Hearing: A Public Hearing on the original draft of these TMDLs of the Lower Arkansas River Basin was held in Wichita on June 1, 2000.

Basin Advisory Committee: The Lower Arkansas River Basin Advisory Committee met to discuss the TMDLs in the basin on September 27, and November 8, 1999; January 13 and March 9, 2000. The Committee recommended approval of the Basin Plan which set high priority TMDLs in the basin, thereby, delegating medium and low priority status to this and subsequent TMDLs for the basin. The Kansas Water Authority approved the Basin Plan on July 11, 2000.

Discussion with Interest Groups: Meetings to discuss TMDLs with interest groups include:
Agriculture: January 12, February 2 and 29, 2000
Environmental: March 9, 2000
Conservation Districts: November 22, 1999
Industry: December 15, 1999, January 13, February 9 and 22, 2000
Local Environmental Protection Groups: September 30, November 2, December 16, 1999

Milestone Evaluation: In 2006, evaluation will be made as to the degree of improvement in water quality in downstream reaches from activities occurring above Garden City. Subsequent decisions will be made on further implementation after 2006.

Consideration for 303d Delisting: The river will be evaluated for delisting under Section 303d, based on the monitoring data over the period 2005-2009. Therefore, the decision for delisting will come about in the preparation of the 2010 303d list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2002 which will emphasize revision of the Water Quality Management Plan. At that time, incorporation of this TMDL will be made into both documents. Recommendations under this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process after Fiscal Year 2005.

APPENDIX
COMPUTATION OF LOADS AND ALLOCATIONS

1. Estimated historic low flows and median sulfate concentrations

Site	7Q10	Median [SO4]	Remarks
Derby	Est 7Q10=110 cfs;	Median [SO4]=150 mg/l	Segment 3 Terminus
Ninnescah R.	Est 7Q10= 27 cfs;	Median [SO4]= 57 mg/l	Entry into Segment 2
Oxford	Est 7Q10=140 cfs;	Median [SO4]=118 mg/l	Segment 2
Slate Creek	Est 7Q10=0.02 cfs;	Median [SO4]=197 mg/l	Entry into Segment 1
Arkansas City	Est 7Q10=170 cfs;	Median [SO4]=132 mg/l	Segment 1

2. Computation of Intervening Flow

Arkansas City - Derby-Slate Creek- Ninnescah R. = 170 cfs - 110 cfs -0.02 cfs - 27 cfs = 33 cfs; wastewater discharges assumed negligible

3. Computation of Sulfate Concentration of Intervening Flow

Intervening Flow C. =

$[(\text{Ark C Q} * \text{Ark C C}) - (\text{Derby Q} * \text{Derby C}) - (\text{Ninnescah Q} * \text{Ninnescah C}) - (\text{Slate Q} * \text{Slate C})] / \text{Intrv. Flow Q}$

$\text{Intv. Flow C} = [(170*132) - (110*150) - (27*57) - (0.02*197)] / 33 \text{ cfs} = 133 \text{ mg/l}$

4. Future Loadings

Derby Flow increases to 142 cfs; Sulfate increases to 206 mg/l (based on Derby TMDL)

Background Levels at Arkansas City: Flow increases to 202 cfs, Sulfate increases to :

$[(142*206) + (27*57) + (0.02*197) + (33*133)] / 202 \text{ cfs} = 174 \text{ mg/l}$

5. Load Allocation = 202 cfs * 174 mg/l * 5.4 / 2000 = 94.9 T/D

6. Wasteload Allocation = 5.5 cfs * 250 mg/l * 5.4 / 2000 = 3.7 T/D

7. Total Maximum Daily Load at Arkansas City = 94.9 T/D + 3.7 T/D = 98.6 T/D

8 Resulting Ambient Concentration at Arkansas City = 98.6 T/D* 2000 /5.4/202 cfs = 181 mg/l

9. Assessment of Explicit Margin of Safety (Withhold 10% of WLA = 0.4 T/D)

New WLA = 3.7* 0.9 = 3.3 T/D

New Load = 98.2 T/D

New Ambient Concentration at Arkansas City = 180 mg/l (Insignificant Impact)

10. High Flow TMDL = 798 cfs * 250 mg/l * 5.4 / 2000 = 539 T/D

Resulting Load Allocation after accounting for Wasteload Allocation = 539-3.7= 535 T/D

Approved July 27, 2001.