UPPER ARKANSAS BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: **Arkansas River near Garden City**
Water Quality Impairment: Boron

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Middle Arkansas-Lake McKinney **Counties:** Hamilton, Kearney and Finney

HUC 8: 11030001 **HUC 11s:** Not Applicable

Drainage Area: 1661 miles^2 between Garden City and Coolidge

Main Stem Segments: 1, 3, 5, 7 & 9 from stateline to small stream E of Garden City (Figure 1)

Tributary Segments: Frontier Ditch (16)

Designated Uses: All uses including Special Aquatic Life Support and Primary Contact Recreation

1998 303d Listing: Table 1 - Predominant Point and Non-point Source Impacts

Impaired Uses: Irrigation and Livestock Watering

Water Quality Standards: Irrigation Water Supply:750 ug/l supply diversion (K.A.R.28-16-28e(c)(1); Livestock Watering: 5000 ug/l(Table 1a of K.A.R. 28-16-28e(d));

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 1998 303d: Not Supporting Irrigation Water Supply

Monitoring Sites: Station 223 near Coolidge, 598 near Deerfield, 286 near Pierceville

Period of Record Used: 1987--1999

Flow Record: (USGS Stations on Arkansas River near Coolidge (07137500), near Syracuse (07138000) and at Garden City (07139000), Recorded daily data 1987 - 1999)

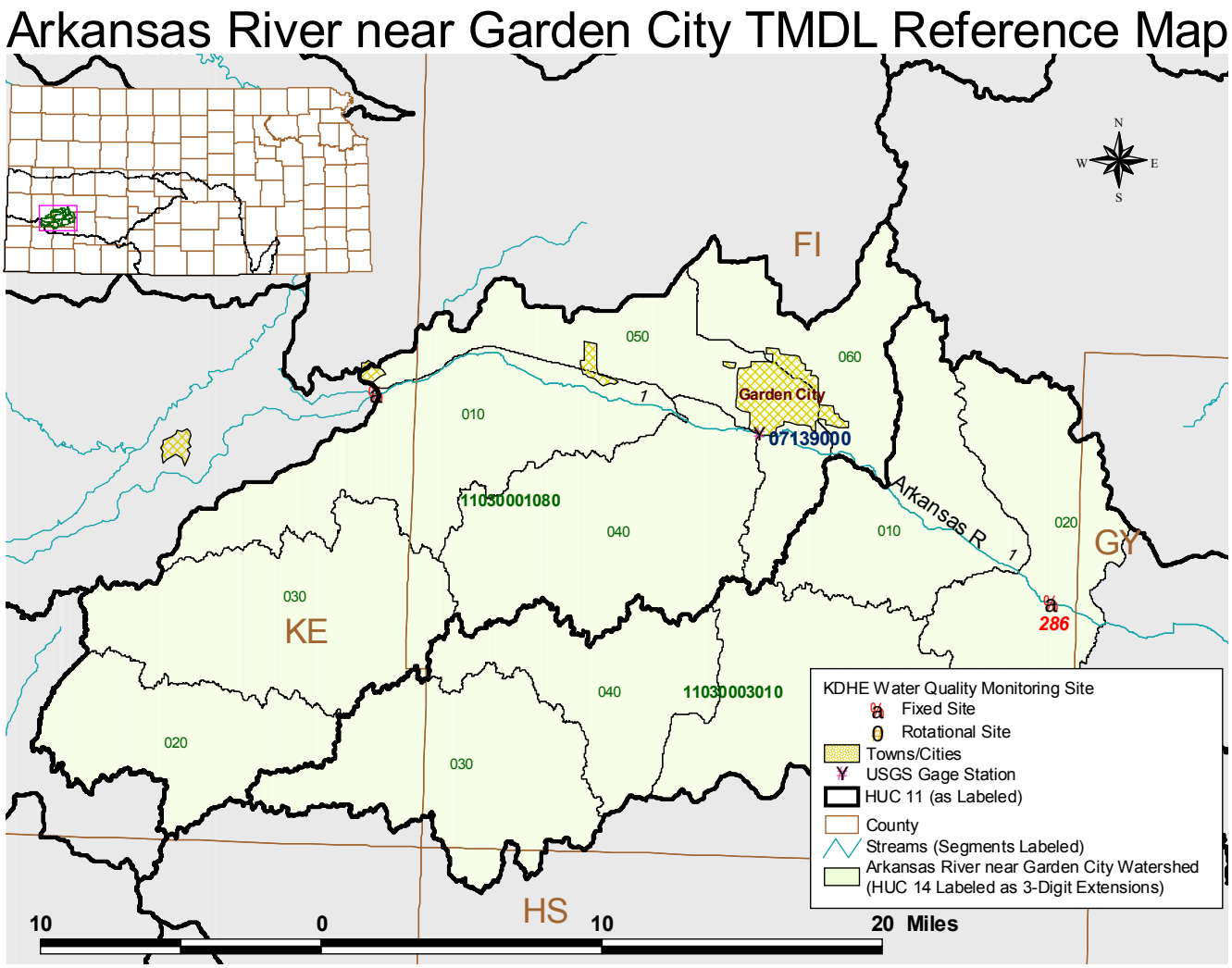

Figure 1

Flow Conditions: Average Flows from 1987 - 1999: Coolidge, 316 cfs; Syracuse, 321 cfs; Garden City, 163 cfs. Median Flows over 1987 - 1999: Coolidge, 191 cfs; Syracuse, 196 cfs; Garden City, 35 cfs.

Current Conditions: Boron concentrations average 0.65-0.71 mg/l along the Arkansas River, from Coolidge to Pierceville near Garden City over 1987-1999. High levels over the irrigation standard of 750 ug/l occurred in 45% of the samples taken at Coolidge over 1987-1999, averaging 854 ug/l. Thirty-six percent of samples taken at Pierceville were over the standard, averaging 829 ug/l. Concentrations between Pierceville and Coolidge are related (Figure 2).

Average concentrations at Pierceville when boron levels at Coolidge are below 750 ug/l are 610 ug/l. The average when Coolidge levels exceed the standard is 780 ug/l. There is also a fairly strong correlation between sulfate levels and boron levels (Figure 3), general regression equations indicate that the boron standard is exceeded when sulfate levels exceed 2100 mg/l, a common occurrence along this segment of the river, suggesting similar mechanisms are at work to place the two salts into solution.

Most crops grown in the Arkansas River valley are semi-tolerant of boron at these levels, therefore, there has been no reported impact to productivity from surface irrigated lands.

Boron tends to be less mobile than other salts and is not as readily leached from soils. Therefore, it is likely that periods of extended flood irrigation is the primary mechanism for putting elevated levels of boron into the river. Furthermore, while there is some gain in boron in the river moving from the stateline to below Garden City when boron levels are low, once boron levels at the stateline exceed the standard, those conditions are carried eastward to the Garden City area.

Desired Endpoint Condition of Water Quality at Station 286 over 2005 -2010
The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standard fully supporting irrigation and livestock watering designated uses. The endpoint of 750 ug/l is desired to result from implementing this TMDL. Unlike the goal of a TMDL related to sulfate, the desired endpoint of this TMDL for boron is likely attainable. The incidence of boron exceedences is not as severe as that of sulfate, in fact, boron levels are in compliance with the standard a majority of the time. There is no seasonal pattern to the boron levels, indicating that they arrive at the river via runoff and baseflow (Figure 4). Monitoring data plotting below the TMDL curve will indicate attainment of the water quality standards.

This endpoint will be reached as a result of expected, though unspecified, reductions in loading from the various sources in the watershed resulting from implementation of corrective actions and Best Management Practices, as directed by this TMDL. Achievement of the endpoint 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

NPDES: There are two NPDES permitted wastewater dischargers located along stream reach 1 of the Arkansas River in the vicinity of Garden City. However, boron is not typically elevated within their wastewater and they should be discounted as sources.

Irrigation Return Flow: As noted in the analysis of the current situation, as large levels of boron enter the state at Coolidge, coincident elevated levels are seen below Garden City. There is some rise in downstream boron levels when Coolidge levels are below the 750 ug/l criterion, but the

Pierceville levels remain in compliance during those conditions. High levels of sulfate attributed to irrigation return flows are correlated to higher levels of boron, indicating similar mechanisms may put boron in the river. The boron loading comes from leaching of boron salts from irrigated soils and the returning drainage of that irrigation water to the river.

Background Levels: Boron is constantly present within river water in this region, possibly reflecting the movement of salts from surrounding soils to the river.

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

The nature of boron loading along the Arkansas River probably mimics the mechanisms responsible for elevating sulfate levels in the river. Those mechanism combine a natural source with aggrevation brought about through soil saturation, salt leaching and seepage of boron loaded water back to the river after widespread flood irrigation followed by evapo-transpiration concentrating levels over time. Therefore, this TMDL will seek to "piggy-back" on the initial efforts of the corresponding sulfate TMDL to bring about reductions in elevated concentrations.

Point Sources: Point sources tend not to utilize boron in their processes and as such are discounted as sources of loading to this river segment. A Wasteload Allocation of zero will be established by this TMDL because of the lack of point sources along the river. Should future point sources be proposed along the river and discharge into the impaired segments, the current wasteload allocation will be revised by adjusting current load allocations to account for the presence and impact of these new point source dischargers.

Non-Point Sources: The primary cause of elevated boron throughout these stream reaches is the natural contribution from the soils of the drainage area in the valley aggravated by the historic pattern of irrigation return flow along the river, a non-point source. A majority of the return flow emanates from the water use pattern in Colorado, since little tailwater occurs within Kansas. The Load Allocation will be to reduce the boron content of flows over the next ten years. This allocation will be marked by plotting of future sampled loads below the TMDL curve (Figure 4).

Activities to reduce boron in this flow range will depend upon appropriate management of soil drainage in irrigated lands.

Defined Margin of Safety: Since the excursions seen in this reach are associated with elevated levels seen at the state line, the margin of safety will be set as a goal of 740ug/l at the stateline, thereby, assuring that there is increased probability that boron levels at Pierceville will remain below the water quality standard (Figure 5).

State Water Plan Implementation Priority: This TMDL will be a Medium Priority for implementation because of its relationship to sulfate controls through appropriate irrigation management, the historic irrigation use made of the river despite elevated boron and the need for collaborative efforts between Colorado and Kansas to promote dissolved solids management in an irrigation setting.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Middle Arkansas-Lake McKinney Subbasin (HUC 8: 11030001) with a priority ranking of 31 (Medium 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 9 as the entry point of water coming from Colorado and Segment 1 where potential return flows are received (Figure 1).

5. IMPLEMENTATION

Desired Implementation Activities

1. Improve soil drainage of irrigated lands
2. Develop long term plan for irrigation return flow management to reduce boron, sulfate and selenium loadings

Implementation Programs Guidance

Water Quality Planning - KDHE

a. Collaborate with Colorado on comprehensive irrigation return flow management plan for reduction in boron, sulfate and selenium loadings
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Extension Service - Kansas State University

a. Assist irrigators evaluate drainage of their soils after application of water to reduce the boron content leached from those soils and entering the river.

Timeframe for Implementation: Integration of water quality management, involving irrigation return flows, should commence in 2005.

Targeted Participants: Primary participants for implementation will be the state agencies in the two states with responsibilities for water right administration and water quality management and agricultural extension agents evaluating soil drainage of irrigated lands. The irrigation ditches in both states will be involved in any return flow management plans.

Milestone for 2004: The year 2005 marks the mid-point of the ten year implementation window for the stream segments. At that point in time, some evaluation of drainage management of irrigated lands should be completed and incorporated within any return flow management plans along the Arkansas River. Additionally, sampled data from Station 286 should indicate evidence of reduced boron levels at conditions relative to the conditions seen over 1987-1999.

Delivery Agents: The primary delivery agents for program participation will be the Division of Water Resources and the Kansas Department of Health and Environment and Kansas State University Extension.

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. The Federal Safe Drinking Water Act empowers KDHE to develop Source Water Protection Assessments and Plans.

5. 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.

6. K.S.A. 82a-1803 creates the Water Conservation Projects Fund to be administered by the Kansas Water Office for water conservation and water use efficiency projects in the Upper Arkansas River Basin impacted by the Arkansas River Compact.

7. The *Kansas Water Plan* and the Upper 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.

8. K.S.A. 82a-520 contains the Arkansas River Compact between Colorado and Kansas, including the provisions for administering the delivery of water between the states..

9. K.S.A. 82a-701, et seq. authorizes the Chief Engineer and the Division of Water Resources to administer water appropriations in the state, including prevention of waste and planning and practicing water conservation.

Funding: The Water Conservation Projects Fund receives a portion of the funds recovered through the litigation over the Arkansas River Compact. The Fund is to be used for projects involving efficiency improvements to canals, water use efficiency devices, tailwater systems of irrigation system efficiency upgrades, monitoring equipment, artificial recharge or water right purchase and maintenance of the Arkansas River channel.

Other protection or planning activities are incorporated within the Upper 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. While most of this Medium Priority TMDL involves implementation activities after 2005 which can be supported through other funds, some monitoring and Source Water Protection Planning activities should be considered for funding in the 2002-2005 time period.

Effectiveness: Irrigation return flow controls are difficult to implement, although tailwater management has been practiced in Kansas for decades. The interaction of the requirements of the Arkansas River Compact complicates the ability of the state to implement this TMDL. As such, the priority for this TMDL will remain Medium, as the state explores collaborative opportunities to reduce the impairment of excessive loading from irrigated lands in Colorado. Furthermore, the more pressing issue of selenium impairment with parallel causes will arise with the development of the 2002 Section 303d list and subsequent TMDL.

Should bi-state cooperation lag below expectations over the next five years to hinder progress in improving water quality conditions from those seen over 1987-1999, the federal government may impose more stringent conditions on the states in order to meet the desired endpoints expressed in this TMDL.

6. MONITORING

KDHE should collect bimonthly samples at Stations 223 and 286 over 2000-2010 in order to assess progress in implementing this TMDL over each of the three defined seasons during the initial implementation period. During the evaluation period (2005-2009), more intensive sampling will need to be conducted under specified seasonal flow conditions in order to determine the achievement of the desired endpoint of this TMDL. The manner of evaluation will be consistent with the assessment protocols used to establish the case for impairment in these streams. Following current (1998) Kansas assessment protocols, monitoring will ascertain if less than 10% of samples exceed the applicable criterion. Use of the real time flow data available at the Coolidge and Garden City stream gaging stations can direct sampling efforts. Additionally, support of a real time conductivity probe at the Coolidge gage will allow additional analysis of the inter-relationship between boron and sulfate levels and flows arriving from Colorado.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Upper Arkansas Basin were held March 8, 2000 and April 24, 2000 in Garden City. 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 Upper Arkansas Basin.

Public Hearing: A Public Hearing on the TMDLs of the Upper Arkansas Basin will be held in

Garden City on May 31, 2000.

Basin Advisory Committee: The Upper Arkansas Basin Advisory Committee met to discuss the TMDLs in the basin on October 6, 1999; January 11 and 24, 2000; March 8, 2000;

Discussion with Interest Groups: Meetings to discuss TMDLs with interest groups include:

Associated Ditches of Kansas: October 6, 1999; January 28, 2000; March 8, 2000; and April 24, 2000.
Agriculture: February 28, 2000
Environmental: March 9, 2000

Milestone Evaluation: In 2005, evaluation will be made as to the degree of incorporation of drainage management in any irrigation return flow water quality planning undertaken by the two states. Subsequent decisions will be made regarding the implementation approach.

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.

For this TMDL, assessment for delisting will evaluate if the percent of samples over the applicable criterion is less than 10% for samples taken over the monitoring period of 2005-2009. This assessment defines full support of the designated use under water quality standards as measured and determined by current Kansas Water Quality Assessment protocols. These assessment protocols are similar to those used to cite the stream segments in this watershed as impaired on the Kansas 1998 Section 303d list. As protocols and assessments for impairment change for future 303(d) lists, the monitoring data collected under this TMDL will use these new assessments and protocols for delisting consideration.

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 of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process after Fiscal Year 2005.

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