UPPER REPUBLICAN BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody/Assessment Unit: Arikaree River
Water Quality Impairment: Selenium

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Arikaree River **County:** Cheyenne

HUC 8: *(In Kansas)* 10250001

HUC 11 (HUC 14s)**:** *(In Kansas)* **080** (030, 040 and 050)

Drainage Area: 37 square miles in Kansas
1725 square miles total above sampling station

Main Stem Segment: WQLS: 1 (Arikaree River) starting at the Kansas-Nebraska state line and traveling upstream through northwest Cheyenne County to the Kansas-Colorado state line (**Figure 1**).

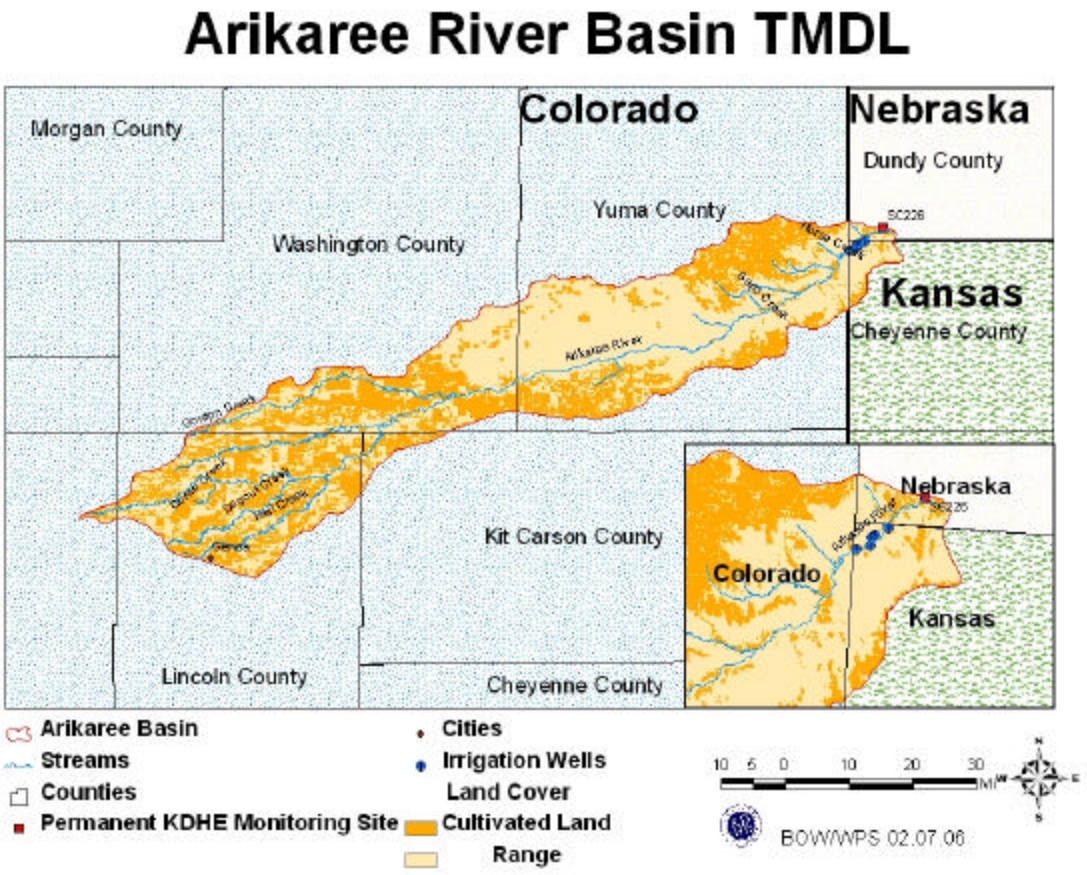
Tributaries: **All tributaries located in Colorado, segment numbers unknown**
Horse Creek
Sand Creek
Gordon Creek
Currie Creek
Dugout Creek
Hell Creek
North Fork Arikaree River

Designated Uses: Special Aquatic Life Support, Primary Contact Recreation (C), Domestic Water Supply; Food Procurement; Ground Water Recharge; Industrial Water Supply Use; Irrigation Use; Livestock Watering Use for Kansas Segment.

Impaired Use: Special Aquatic Life

Water Quality Standard: 5 µg/liter for Chronic Aquatic Life (KAR 28-16-28e(c)(2)(F)(ii)

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(e). Background concentrations shall be established using the methods outlined in the "Kansas implementation procedures: surface water," dated June 1, 1999... (KAR 28-16-28e(b)(9)).



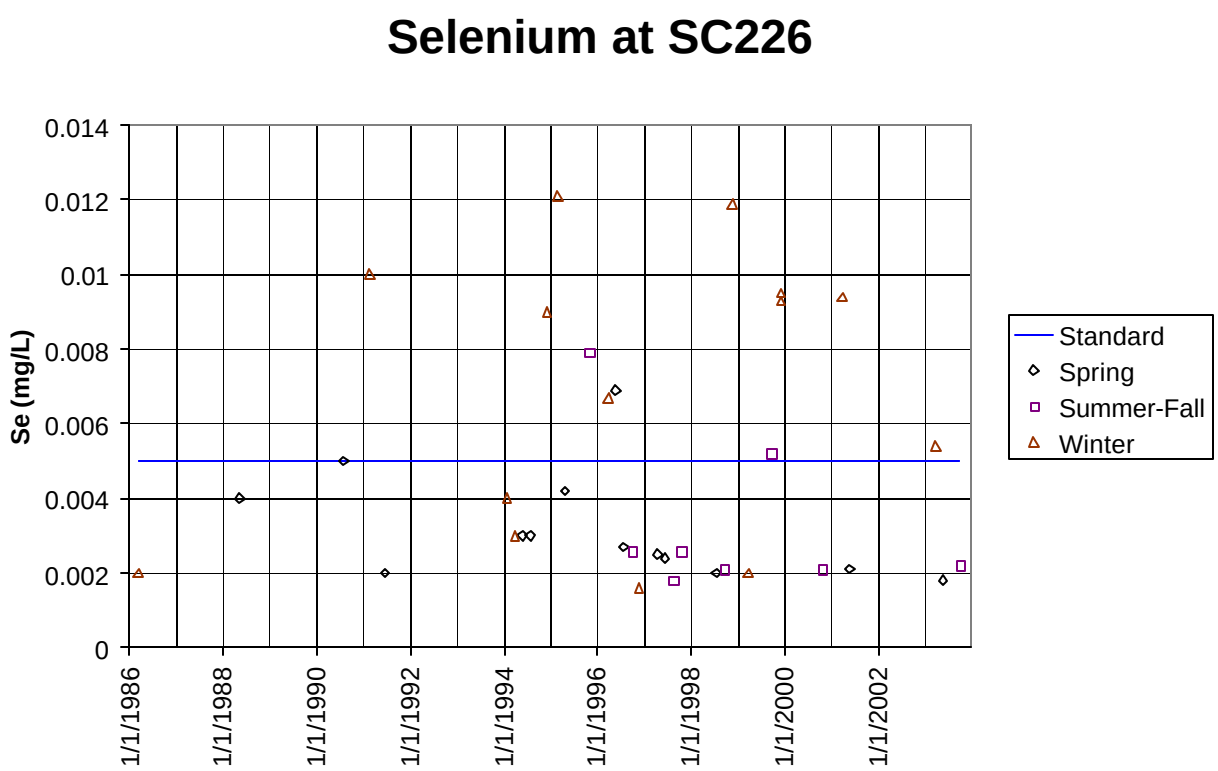
(Figure 1- Land use in the Arikaree River Basin. Kansas irrigation wells are visible in the inset. The KDHE monitoring station is located in Nebraska, the nearest readily accessible sampling point after the Colorado border.**)**

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 2004 303(d): Not Supporting Aquatic Life

Monitoring Sites: Station 226 at Haigler, NE.

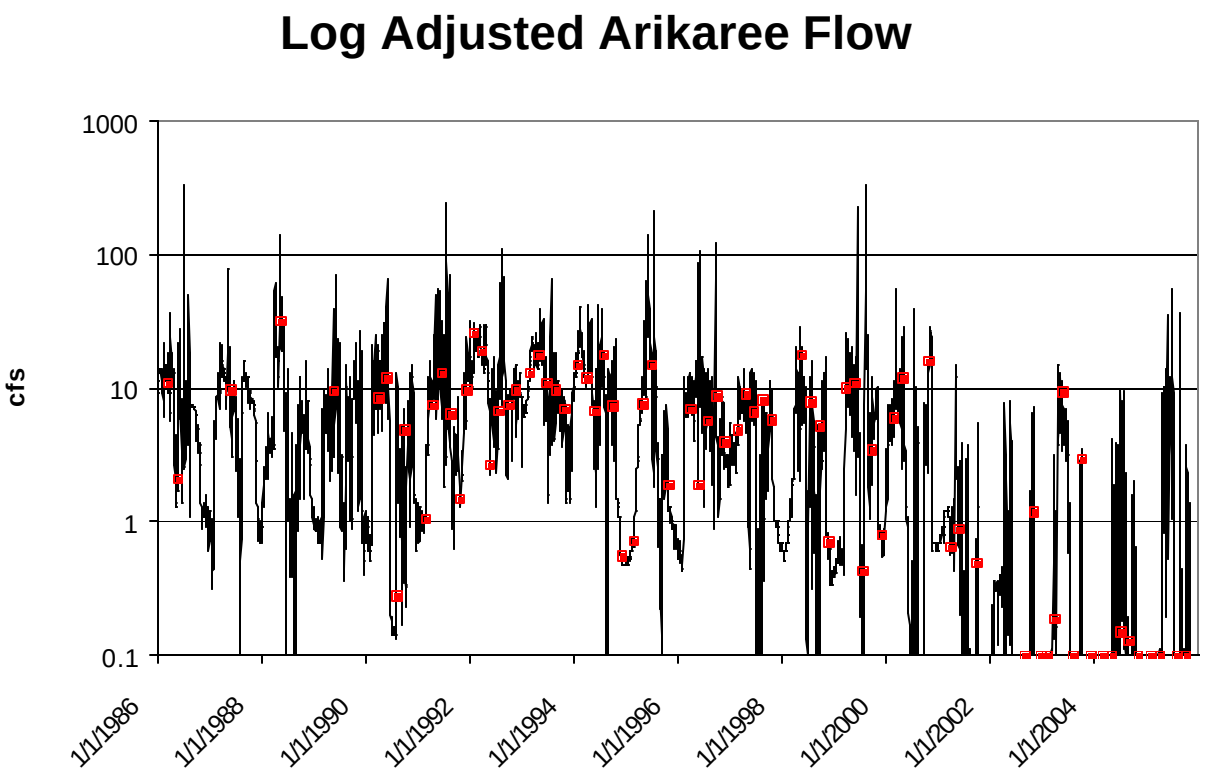
Period of Record Used: 1986-2005 for Station 226 (**Figure 2**)



(Figure 2- Blue line indicates chronic aquatic life criteria. Red line indicates proposed background concentration. Dates without data corresponding to no-flow events when KDHE personnel visited the site for a regularly scheduled sampling and dates for which the selenium concentration was below detection limits are omitted.**)**

Flow Record: Arikaree River at Haigler, NE (USGS Station 06821500); 1970-2005 (**Figure 3**).

Long Term Flow Conditions: 90% Exceedance = 0 cfs, 75% Exceedance = 0.86 cfs, 50% Exceedance = 3.7 cfs, 25% Exceedance = 11 cfs, 10% Exceedance Flows = 21 cfs

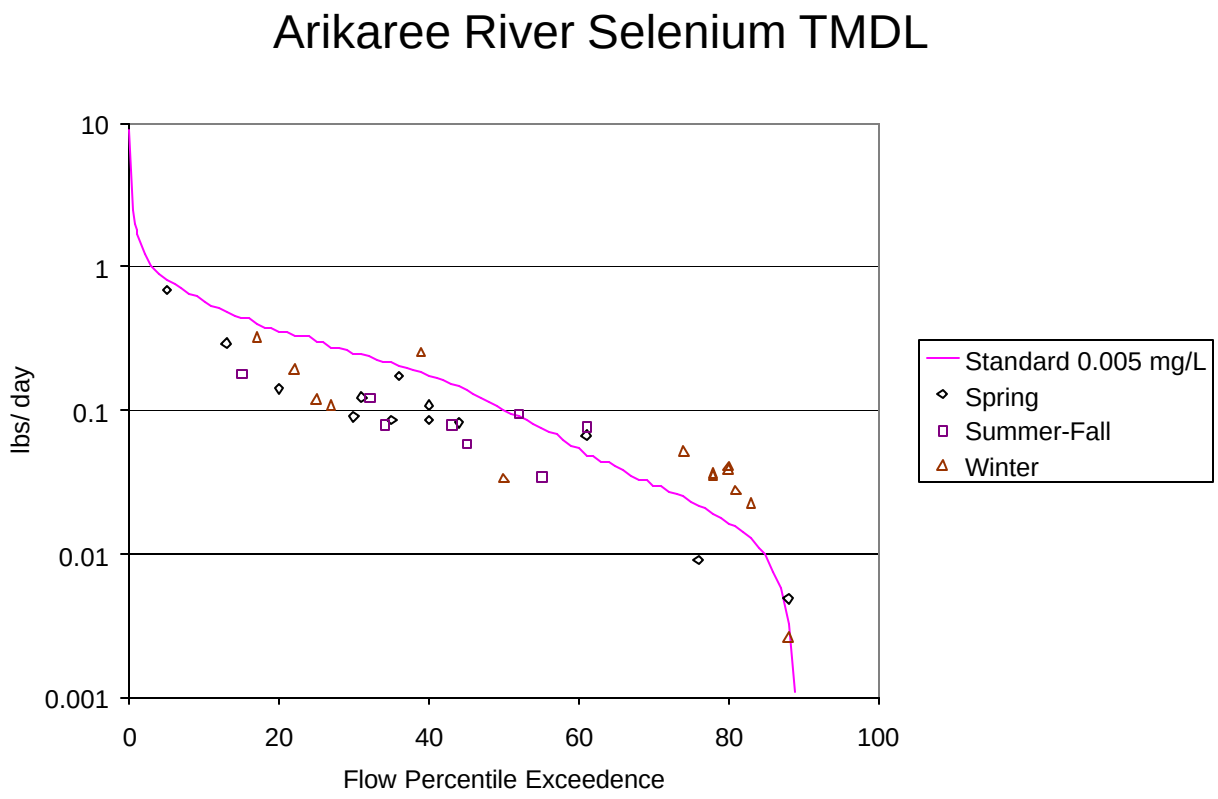


(Figure 3- 20-year flow record. Red squares indicated sampling dates. Flow adjusted by adding 0.1 cfs to all flow values for log transformation. Dates with 0.1 cfs were no flow events, and red squares during no flow events indicate that KDHE personnel visited the site and found insufficient water to conduct routine sampling. Since 2002 15 of 18 site visits corresponded to no-flow events.**)**

Current Conditions: 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. High flows and runoff equate to lower flow durations; baseflow and point source influences generally occur in the 75-99% range. Load Curves were established for the Aquatic Life 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 selenium per day. These load curves represent the TMDL since any point along the curve denotes water quality for the standard at that flow. Historic excursions from the water quality standard are seen as plotted points above the load curve. Water quality standards are met for those points plotting below the load duration curve (**Figure 4**). Nebraska currently does not assess this river. Colorado has not included the Arikaree River on their 303(d) list, suggesting that Colorado also does not monitor this river. Violations of the criteria occur more frequently during less than average flow events during all three defined seasons, Winter: November-March, Spring: April-July, Summer-Fall: August-October (**Table 1**). Exceedences occurred primarily during winter low flow conditions.

Average	Overall	Winter	Spring	Summer-Fall
>3.7 cfs	.003	.004	.003	.002
<3.7cfs	.007	.009	.005	.005

(Table 1- Average selenium concentrations (mg/L) in the Arikaree River at SC226.**)**



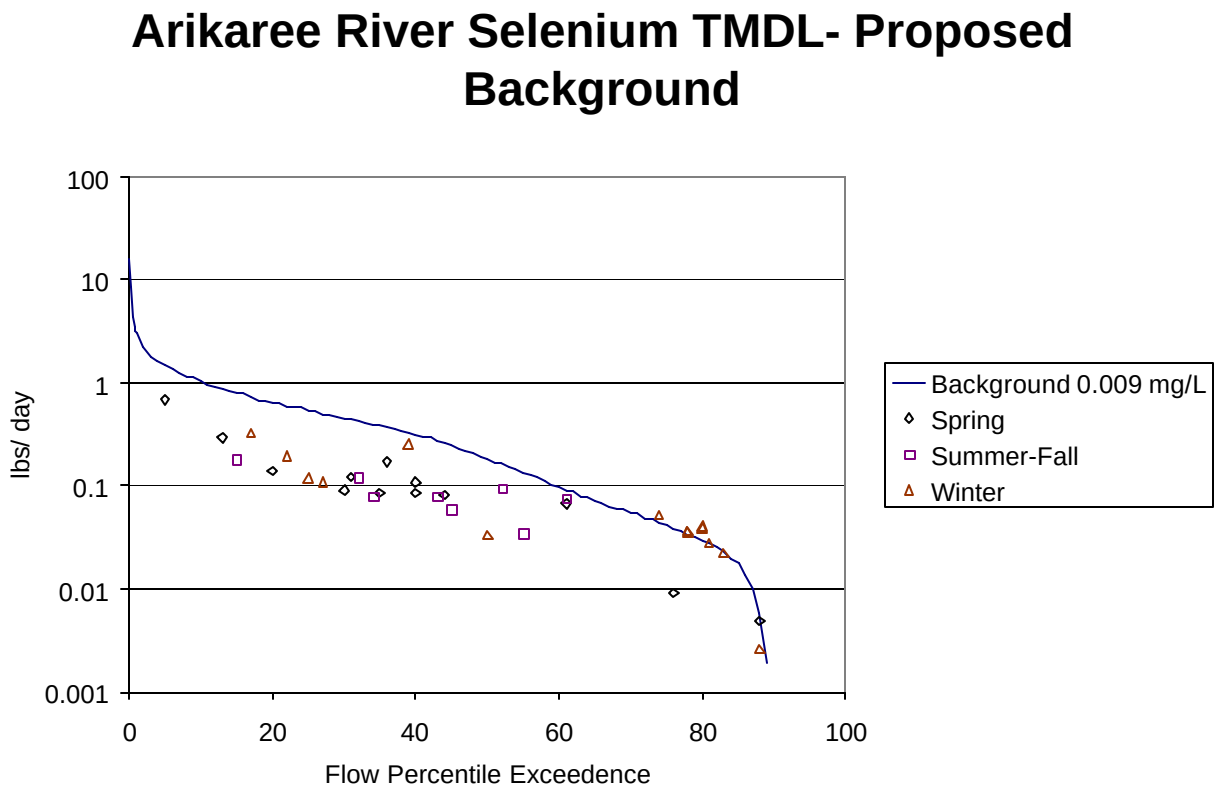
(Figure 4 – Selenium loads in pounds per day based on flow duration curve. No values are projected for 90-100% because long-term gaging data indicate that ten percent of the time the Arikaree River has no flow.**)**

Desired Endpoints of Water Quality (Implied Load Capacity) at Site 226 over 2008 – 2012

The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards fully supporting Aquatic Life. The presence of natural sources may elevate concentrations above the criteria during low flow and suggests this TMDL should be staged. The current criterion of .005 mg/L of selenium was used to establish a load duration curve (**Figure 4)** for the monitoring site.

Kansas Implementation Procedures for Surface Water allow for a background to be established when the monitoring record indicates that the existing criteria is unachievable due to naturally occurring conditions. The specific stream criteria to supplant the general standard will be developed subsequent to Stage One of this TMDL following the assessment of irrigation return

flows. A Stage Two endpoint has been developed for Site 226 based on currently available information and is .009 mg/L (the average seen in winter at less than median flows) from data collected over 1986-2005 (**Figure 5**). Future TMDL assessment will be based on this proposed background standard, if the low flows and associated selenium levels on the Arikaree River during winter arise because of recovering groundwater levels and not irrigation return flows.



(Figure 5– Selenium loads in pounds per day based on flow duration curve for proposed background concentration. No values are projected for 90-100% because long-term gaging data indicate that ten percent of the time the Arikaree River has no flow.**)**

Seasonal variation has been incorporated in this TMDL through the documentation of the elevated selenium levels during winter low flow conditions. 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.

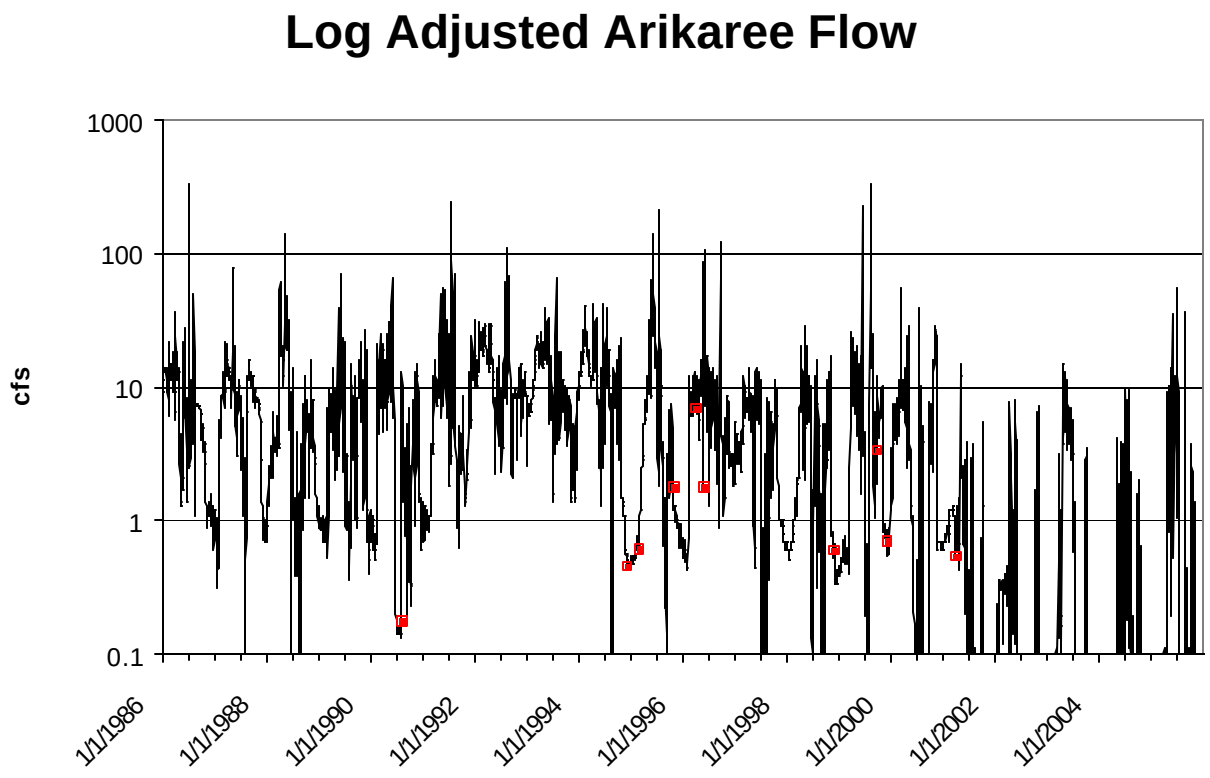
3. SOURCE INVENTORY AND ASSESSMENT

Background Levels:
Significant irrigation activity associated with corn production occurs in the Arikaree basin. Irrigation water is drawn from deepwater wells that tap the High Plains Aquifer and near surface withdrawals from alluvial sources.

The likely source of the selenium in the Arikaree River is percolation through soils with moderate selenium levels discharged to the river either from elevated groundwater levels,

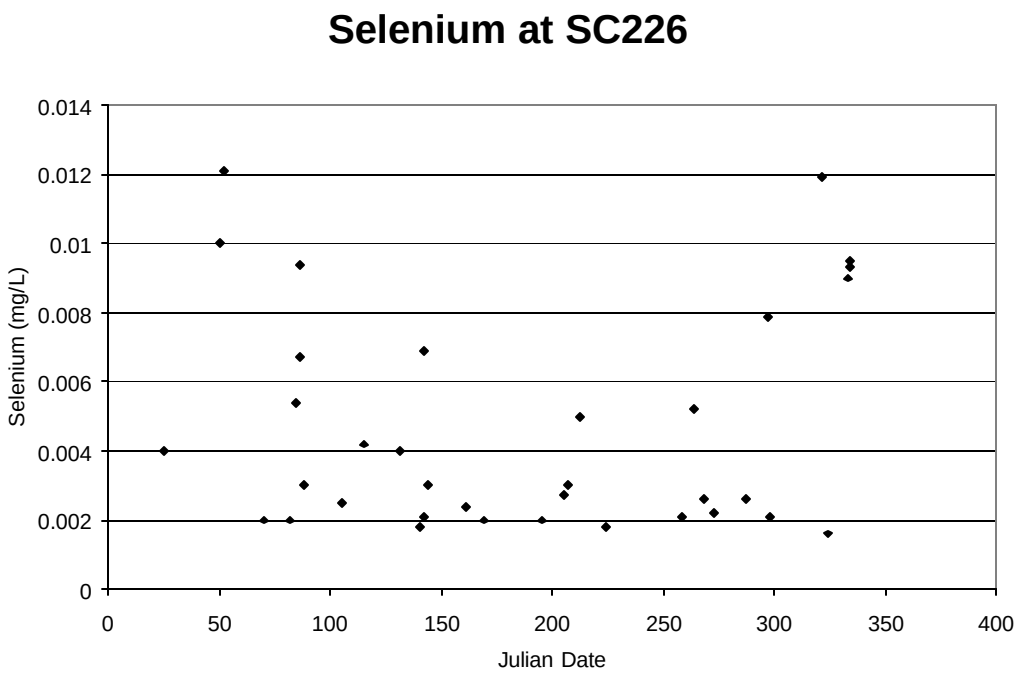
baseflow contributions after runoff events, or return flows from irrigated lands. Colorado pumping in Yuma, Washington and Lincoln counties over 1981-2000 depleted the Arikaree River streamflows by an average of 1289 acre-feet per year. Over the same period pumping in Cheyenne County, KS, was responsible for an average depletions of 175 acre-feet per year. Very little surface water irrigation occurs in the watershed, confined to Yuma County. There is no surface water irrigation in the Kansas portion of the drainage and the five active groundwater rights used an average of 153 acre-feet over 2000-2004 along the Arikaree.

Selenium is widely distributed geologically, and occurs naturally at low levels in many soils. The presence of shale along the channel may also be a source of selenium. The extensive use and reuse of irrigation water can result in buildup of selenium over time, and that selenium may be mobilized when reduced evapo-transpiration demand and reduced irrigation withdrawals allow percolation through the soil and shale with subsequent transport to the river and its tributaries. During periods of greater runoff, the predominant source of river water is likely surface runoff, which should be low in selenium. Elevated selenium levels have been noted in rivers draining irrigated agricultural catchments in other parts of Colorado, and have been attributed to increasing soil concentration resulting from buildup of chemical salts over time. Generally violations of the water quality criteria have occurred during low-flow events during periods of low flow and during the off-season for irrigation (**Figure 6**).



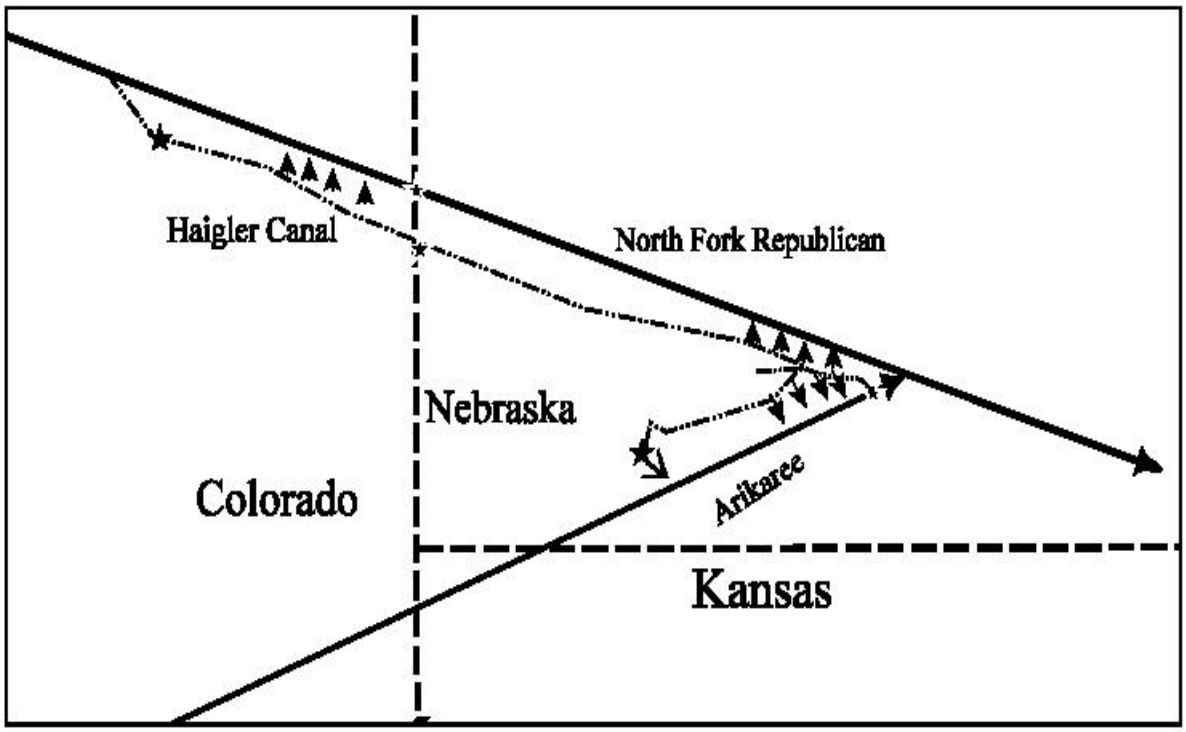
(Figure 6- Selenium water quality criteria violation on the Arikaree River. Since 2002 15 of 18 site visits by KDHE personnel have occurred during no-flow events. New violations may be recorded if regional drought conditions subside and percolating flows return.**)**

Any Kansas contribution to the selenium impairment on the Arikaree River is likely low, as the result of the small area of the drainage located in Kansas, and the lack of surface water rights for irrigation activity. There is an unusual seasonal pattern in selenium concentration on the Arikaree River (**Figure 7**). Selenium is typically below the chronic criterion between Memorial Day and mid-October, then rises significantly between October and May.



(Figure 7- Selenium concentrations at SC226, which generally show that during periods of low irrigation activity, October through May, concentrations can be elevated over chronic criteria.**)**

Documentation provided by the Kansas Division of Water Resources (DWR) suggests that samples taken by KDHE, especially at lower flows, may not reflect conditions in the Arikaree River in Kansas. Pursuant to the Republican River Compact, DWR obtained maps of the Haigler Irrigation Ditch servicing an irrigation district in eastern Colorado and western Nebraska near the Kansas-Nebraska border (**Figure 8**). As marked in the map, this irrigation ditch diverts water from the North Fork of the Republican River to provide irrigation water to fields in Colorado and Nebraska. The ditch carries wasteway water or return flows from the irrigated lands into the channel of the Arikaree River, which then joins the North Fork to form the Republican River below Haigler. These flows return to the Arikaree River upstream of the KDHE sampling point, which is located at Haigler, the first readily accessible location in the vicinity of the Kansas-Nebraska border. .



(Figure 8- A general schematic of the location of withdrawals and returns associated with the Haigler irrigation ditch. Provided by the Kansas Division of Water Resources as part of supporting documentation related to the Republican River Compact.**)**

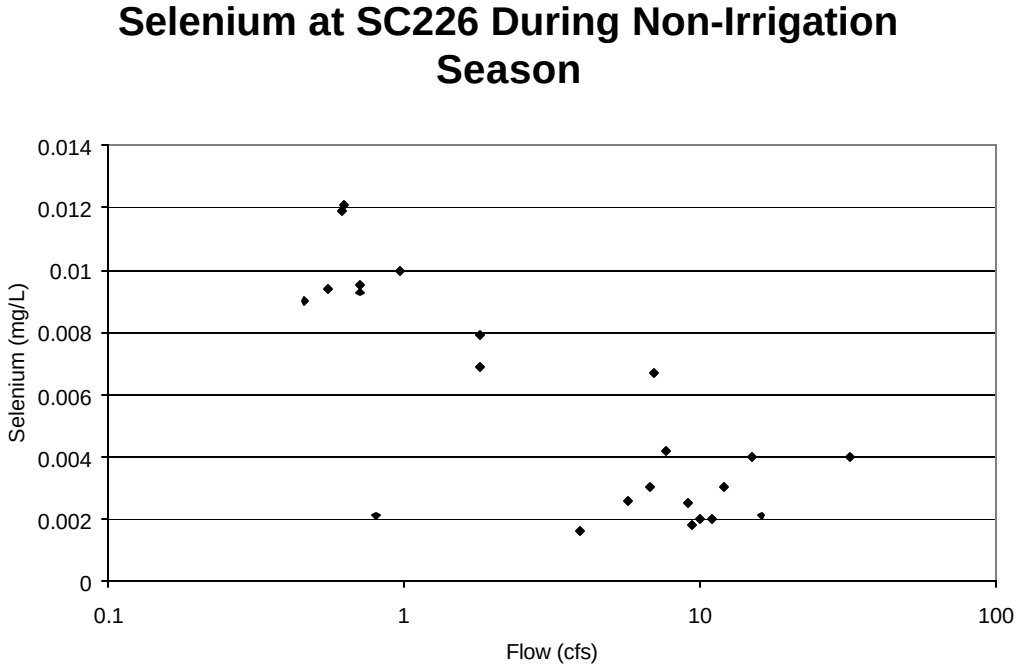
Field investigation by KDHE personnel during the winter of 2006 revealed that flows originating in the Haigler Ditch system contributed all flows at the KDHE monitoring site. The Arikaree River contained no flow in the Kansas segment, but had flow downstream of the Haigler Ditch return, located in Nebraska. While it is possible that the Arikaree River is impaired in Kansas, sampling at Haigler does not necessarily provide direct evidence of that impairment, given the multiple sources of water seen at Haigler that are not related to Kansas. The field investigation indicated that the channel of the Arikaree River in Kansas had not had flow for some time, based on the state of vegetation encroachment in the flow way. Therefore, to the extent that the impairment originates in Colorado and flows directly to Nebraska via the Haigler Ditch, the impairment is a concern for those states, and does not suggest action by Kansas.

Further evidence of the influence of surface water irrigation in Colorado and Nebraska is provided by the tracking the constituent ion levels during the irrigation season and the remainder of the year (**Figure 9 and 10**). Conventional wisdom suggests that the concentration of conservative ions, like selenium, will be lower during high flow events when compared to low flow, or base flow conditions. In the case of data collected by KDHE at SC226, a strong negative relationship exists between flow and concentration of selenium ions during the non-irrigation months, as expected if mounded ground water from irrigation returns to the Arikaree through the alluvial aquifer with occasional dilution during runoff events. Mounding of groundwater as the result of irrigation activities can provide a source of extended residence groundwater experiencing the conditions described elsewhere in this TMDL. As that water leaves the alluvial aquifer and enters the return ditch, and ultimately the Arikaree River, it will carry with it the ions

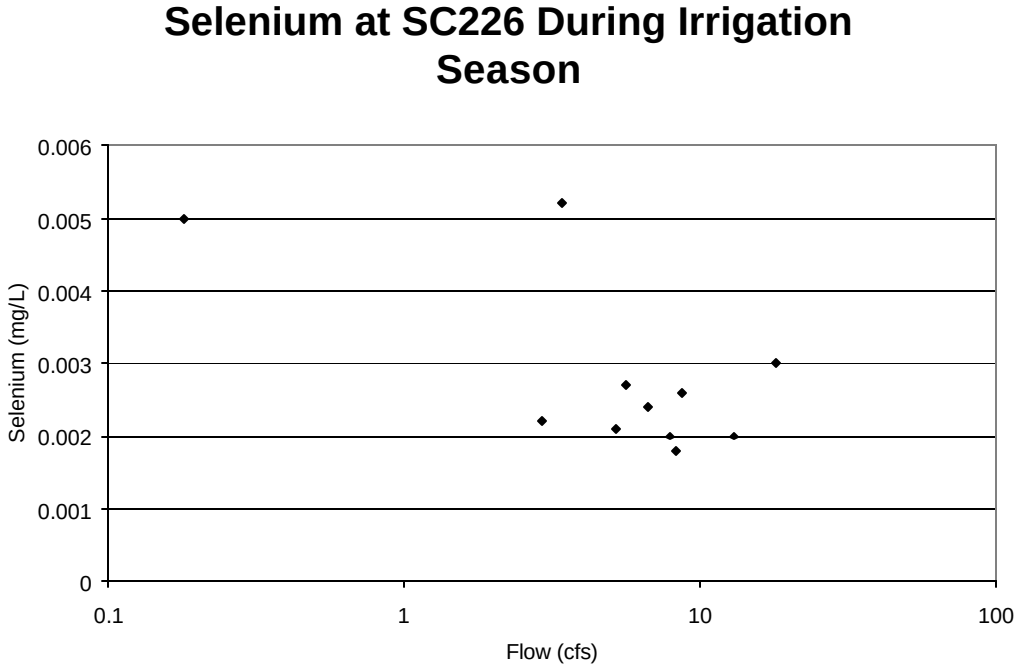
of concern that have accumulated in the soils of the irrigated fields and obtained from near surface geologic formations.

During the irrigation season no pattern is evident at all, though overall levels are generally lower, which is consistent with anecdotal descriptions of the relative quality of the water in the North Fork of the Republican River. The hydraulic function of irrigation ditches requires some wasteway water to exit the ditch into the Arikaree River to facilitate the gravity flow of North Fork Republican water through the irrigation system. Hence the water seen at Haigler during irrigation season is predominantly North Fork Republican water and thus, of a better quality than water native to the Arikaree.

Colorado sampling of the North Fork of the Republican River during 1968-1977 included many non-detects for selenium and only 3 of 43 samples over 5 ppb. A more limited data set for the Arikaree River indicated only 1 elevated level among 11 samples, most of which were non-detects. Limited samples taken in 1980-1984 from the Republican River below the confluence with the Arikaree were consistently in the 2-3 ppb range. One sample taken in May 1973 had 14 ppb of selenium. This tends to support the notion of regionally acceptable selenium levels. Additionally, any elevated selenium tends to be localized and likely originates from irrigation return flows in the winter.



(Figure 9- Selenium concentrations at SC226 as a function of flow during the non-irrigation season. Samples were assigned Julian dates, and sorted. The irrigation season was defined as starting on Julian date 151 (the beginning of June) and ending on Julian date 280 (the end of September). Concentrations displayed in Figure 9 are from samples with Julian dates less than 151, or greater than 280.**)**



(Figure 10- Selenium concentrations at SC226 as a function of flow during the irrigation season. Samples were assigned Julian dates, and sorted. The irrigation season was defined as starting on Julian date 151 (the beginning of June) and ending on Julian date 280 (the end of September). Concentrations displayed in Figure 9 are from samples with Julian dates less than 151, or greater than 280.**)**

NPDES: There are no NPDES permitted dischargers within the Kansas portion of the watershed. There is one city within the watershed; Genoa, CO. US Census figures list 211 people in Genoa in 2000.

Livestock Waste Management Systems: There are no confined animal feeding operations within the Kansas portion of the watershed.

Land Use: National Land Cover Database GIS layers were used to assess land use in the basin. Most of the watershed is grassland (59% of the area) or cropland (41%). Major crops were estimated by county level National Agricultural Statistics records. The majority of crop production is dryland wheat and irrigated corn. Irrigation water likely draws on deepwater wells drawing from the high plains aquifer.

Population Density: Most of the watershed's population density is low throughout the basin. Colorado county level populations statistics for 2000 are, Yuma- 4 person/ sq. mile, Washington- 2 persons/ sq. mile, and Lincoln- 2 person/ sq. mile. The rural population projection for Cheyenne County through 2020 shows slight declines (7% decrease). The small population is not likely to contribute significant selenium loading from wastewater.

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

Additional assessment will be necessary to ascertain the natural selenium loading within the watershed and balance due to anthropogenic contributions. The following can be anticipated:

Point Sources:
Site 226: A current Wasteload Allocation of zero is established by this TMDL because of the lack of point sources located within the state upstream of the sampling site. Should future point sources be proposed in the watershed 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.

There will be a wasteload allocation of zero for state and NPDES permitted CAFO's within the drainage because no such facilities exist in Kansas in this drainage basin.

Non-Point Sources: The majority of the selenium load in the Arikaree River appears to be background in nature. At site 226 the Load Allocation based on the existing selenium standard of 0.005 mg/L across all flow conditions is shown in **Figure 4**, and is .0999 pounds per day of selenium at the median flow of 3.7 cfs. The LA at station 226 will increase if the elevated background concentration (0.009 mg/L) becomes the applicable criteria (0.17982 lbs/day at median flow of 3.7 cfs). Exceedances were noted at flows below the median flow. Additional assessment of the contribution from irrigation return flows is needed before the background concentration becomes the criterion.

Defined Margin of Safety: The Margin of Safety provides some hedge against the uncertainty of loading and the selenium endpoints for the Arikaree River system, specifically, lack of knowledge between effluent limitations and the river's water quality. Since there are no point sources discharging to the Arikaree River, there are no effluent limitations, there is complete certainty over the impact of this lack of point source loading, and, hence, the Margin of Safety for this TMDL will be set at zero. Incidentally, the Stage One criterion will remain in place until irrigation return flows can be discounted as a cause of the winter elevated selenium levels.

State Water Plan Implementation Priority: Because the likely dominant source for selenium in the stream is from irrigation return flows from upstream sources above the monitoring station and additional source assessment is necessary to examine the impact of irrigation along the main stem, this TMDL will be a low Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Arikaree River Basin (HUC 8: 10250001) and is classified as a Category I, priority 55 watershed under the Unified Watershed Assessment, a low priority for restoration.

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

5. IMPLEMENTATION

Desired Implementation Activities

1. Establish alternative background criterion.
2. Evaluate the impact of irrigation return flows in Colorado.

Implementation Programs Guidance

Division of Water Resources- KDA

a. Assess the occurrence of winter irrigation return flows on the Arikaree River in Kansas as irrigation management to comply with the Republican River Compact.

Water Quality Standards – KDHE Technical Services

a. Establish background levels of selenium for the river and tributaries if irrigation is not a factor.

Timeframe for Implementation: Development of a background level-based water quality standard should be accomplished with the 2011 water quality standards revision.

Targeted Participants: Primary participants for implementation will be the Technical Services Section of KDHE and the northwest field office of DWR.

Milestone for 2011: The year 2011 marks the mid-point of the ten-year implementation window for the watershed. At that point in time, additional monitoring data from Arikaree River will be reexamined to confirm the impaired status of the river and the suggested background concentration will be assessed against possible irrigation return flows occurring in winter.

Delivery Agents: The primary delivery agents for program participation will be the Kansas Division of Water Resources.

Reasonable Assurances:

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

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

5. The *Kansas Water Plan* and the Upper Republican Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund, annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollution 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 and should not receive funding.

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

6. MONITORING

KDHE will continue to collect bimonthly samples at Station 226, including selenium samples, in each of the three defined seasons. Based on that sampling application of numeric criterion based on background concentrations will be considered if irrigation return flows are eliminated as a source and conditions at SC226 reflect conditions within Kansas. If both situations are noted in the Arikaree River, the desired endpoints under this TMDL will be refined using the background concentration established by this TMDL.

7. FEEDBACK

Public Meeting: A Public Meeting to discuss TMDLs in the Upper Republican Basin were held March 2, 2006 in Atwood. An active Internet Web site was established at http://www.kdheks.gov/tmdl/index.htm to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Upper Republican Basin.

Public Hearing: A Public Hearing on the TMDLs of the Upper Republican Basin were held in Atwood on March 2, 2006. The public comment period remained open until April 1, 2006.

Basin Advisory Committee: The Upper Republican Basin Advisory Committee met to discuss the TMDLs in the basin on March 2, 2006.

Milestone Evaluation: In 2011, evaluation will be made to confirm the degree of impairment that has occurred within the watershed of the Arikaree River. Subsequent decisions will be made regarding the need for an implementation approach if selenium levels in Kansas elevate because of irrigation return flows from Colorado.

Consideration for 303(d) Delisting: 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. Should modifications be

made to the applicable water quality criteria during the intervening implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities might be adjusted accordingly.

6/26/06