

UPPER REPUBLICAN BASIN TOTAL MAXIMUM DAILY LOAD

**Waterbody/Assessment Unit: Upper and Lower South Fork Republican River
Water Quality Impairment: Fluoride**

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: S. Fk. Republican River

County: Cheyenne

HUC 8: 10250003

HUC 11 (HUC 14s): **130** (030 and 040)
 150 (010, 020, 030, 040, 070, 080 and 090)
 160 (010, 020, 030, 040, 050 and 060)

Drainage Area: 582.8 square miles

Main Stem Segment: WQLS: 2, 4, 6, 7 and 9 (S. Fk. Republican River) starting at the Kansas-Nebraska state line and traveling upstream to southwest Cheyenne County and the Kansas-Colorado state line (**Figure 1**).

Tributaries: Big Timber Cr (61)
 Delay Cr (66)
 Hackberry Cr (3)
 Bluff Cr (70)
 Valley Cr (69)
 Spring Cr (67)
 Sand Cr (68)
 Drury Cr (60)
 Crosby Cr (72)
 Battle Cr (71)
 Cowpe Cr (8)

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

Impaired Use: Irrigation Use

Water Quality Standard: Fluoride: 1 mg/L for Agricultural Water Supply (Irrigation) Use, 2 mg/L for Livestock and Domestic Water Supply (KAR 28-16-28e(c)(1)).

Upper and Lower S. Fk. Republican River Watershed Fluoride TMDL HUC and Stream Segment Map

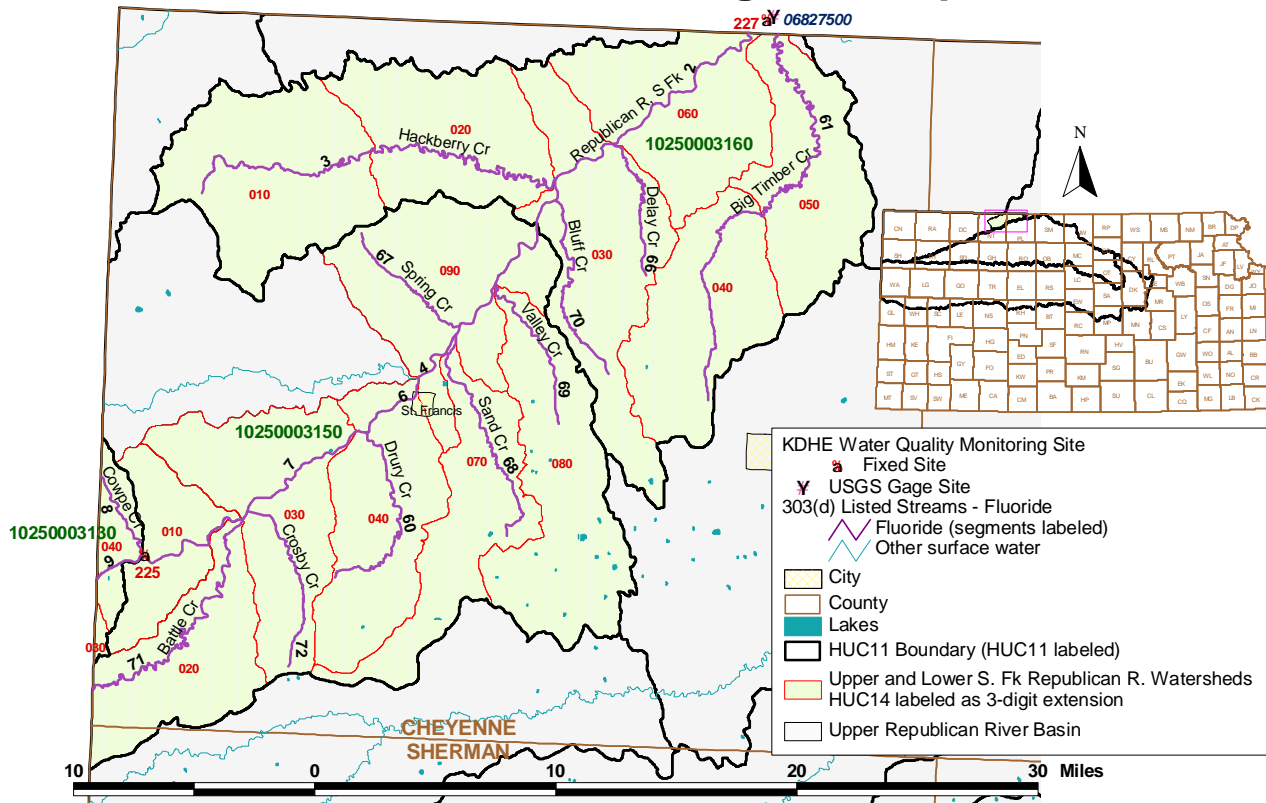


Figure 1

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 2002 303(d): Not Supporting Irrigation

Monitoring Sites: Stations 225 southwest of St. Francis and 227 near Benkelman, NE.

Period of Record Used: 1994 –2001 for Stations 225 and 227 (**Figures 2 and 3, respectively**)

Flow Record: S. Fk. Republican R. near Benkelman, NE (USGS Station 06827500); 1970-2002.

Long Term Flow Conditions: 10% Exceedance Flows = 48 cfs, 95% = 0.0 cfs

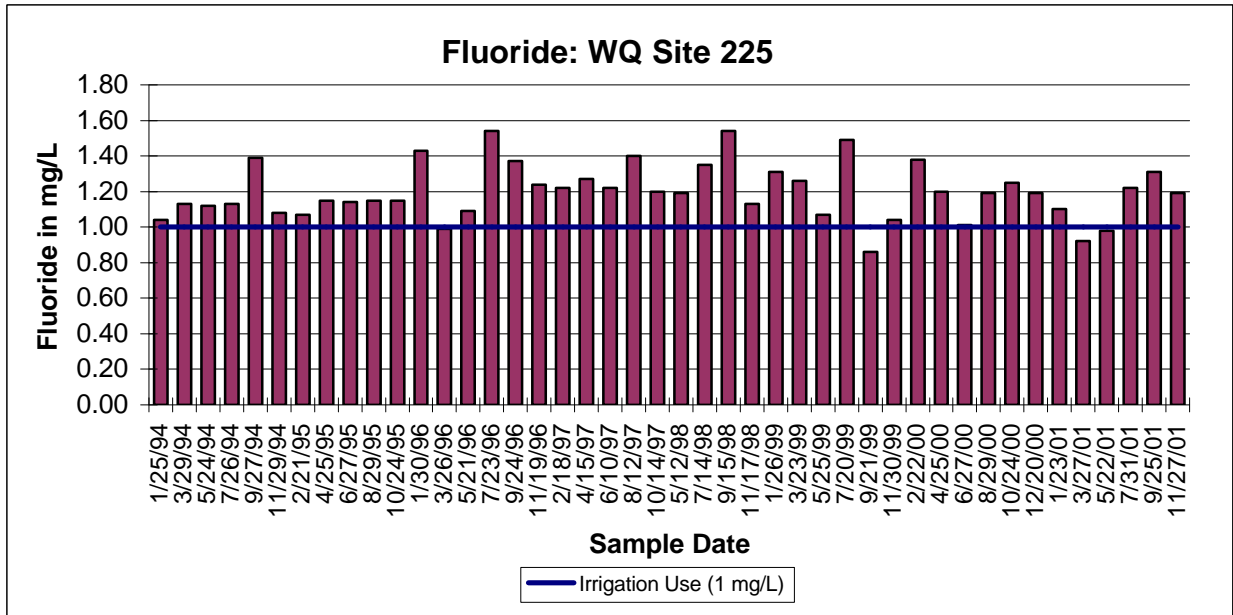
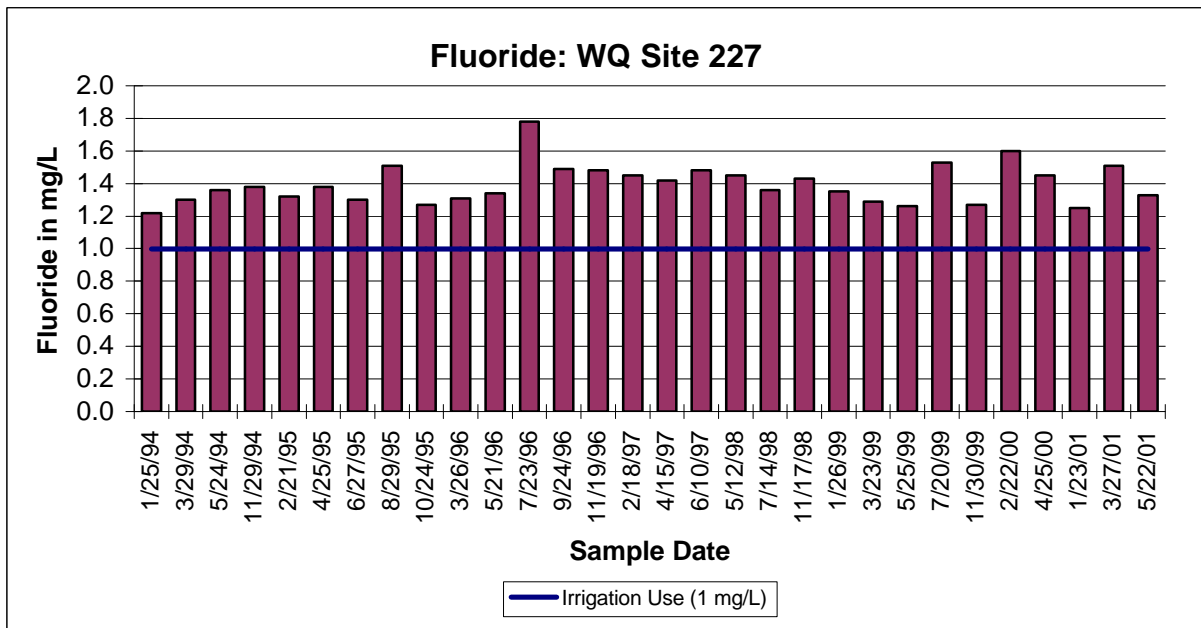


Figure 2



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. Sample data for the sampling sites were categorized for each of the three defined seasons: Spring (Apr-Jul), Summer-Fall (Aug-Oct) and Winter (Nov-Mar). High flows and runoff equate to lower flow durations; baseflow and point source influences generally occur in the 75-99% range. Load Curves were established for the Irrigation Use 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 fluoride 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 (**Figures 7 and 8**).

Site 225: Excursions were seen in each of the three defined seasons and are outlined in **Table 1**. Ninety-four percent of Spring samples and 91% of Summer-Fall samples were over the irrigation use criterion. Eighty-eight percent of Winter samples were over the irrigation use criterion. Overall, 91% of the samples were over the criteria. This would represent a baseline condition of non-support of the impaired designated use (irrigation). Samples have never exceeded the livestock or domestic water supply criterion (full support).

Table 1

NUMBER OF SAMPLES OVER FLUORIDE IRRIGATION USE STANDARD OF 1 mg/L BY FLOW								
Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum. Freq.
S. Fk. Republican R. southwest of St. Francis (225)	Spring	0	4	4	5	2	No Flow	15/16 = 94%
	Summer/Fall	1	0	0	3	6	No Flow	10/11 = 91%
	Winter	0	3	5	5	2	No Flow	15/17 = 88%

Site 227: Excursions were seen in each of the three defined seasons and are outlined in **Table 2**. All of the samples collected at site 227 have exceeded the criteria, regardless of season. This would represent a baseline condition of non-support of the impaired designated use (irrigation). Samples have never exceeded the livestock or domestic water supply criterion (full support).

Table 2

NUMBER OF SAMPLES OVER FLUORIDE IRRIGATION USE STANDARD OF 1 mg/L BY FLOW								
Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum. Freq.
S. Fk. Republican R. near Benkelman, NE (227)	Spring	0	4	4	5	No Flow	No Flow	13/13 = 100%
	Summer/Fall	1	0	0	2	No Flow	No Flow	3/3 = 100%
	Winter	0	3	7	4	No Flow	No Flow	14/14 = 100%

The range and average fluoride concentration for station 225 were 0.86-1.54 mg/L and 1.2 mg/L, respectively, and for station 227 were 1.22-1.78 mg/L and 1.39 mg/L, respectively, for 1994-2001.

Desired Endpoints of Water Quality (Implied Load Capacity) at Sites 225 and 227 over 2008 – 2012

The ultimate endpoint for this TMDL will be to Achieve the Kansas Water Quality Standards fully supporting Irrigation Water Use. The current standard of 1 mg/L of fluoride was used to establish load duration curves (**Figures 7 and 8**) for each monitoring site. The presence of natural sources elevating concentrations above the standard over all but the highest flows requires this TMDL, however, to be phased.

Kansas Implementation Procedures for Surface Water allow for a numerical criterion based on natural background to be established using the mean concentration of in stream measurements gathered when stream flow was less than the median flow on the river. A minimum of five data

points is needed to determine the background concentration. The specific stream criteria to supplant the general standard will be developed concurrent with Phase One of this TMDL following the appropriate administrative and technical Water Quality Standards processes. Meanwhile, a Phase One endpoint has been developed for Site 225 based on currently available information and is 1.21 mg/L from data collected over 1994-2001 at flows equal to or less than 14 cfs (**Figure 6**) and a Phase One endpoint has been developed for Site 227 based on currently available information and is 1.41 mg/L from data collected over 1994-2001 at flows equal to or less than 14 cfs (**Figure 7**). The Phase Two TMDL will be based on the future criteria values.

Seasonal variation has been incorporated in this TMDL through the documentation of the seasonal consistency of elevated fluoride levels across all flows. 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: Based upon observations provided by the Kansas Geological Survey, the source of the dissolved fluoride in the river water is ground-water discharge from the Ogallala-High Plains aquifer to the river. The Ogallala portion of the High Plains aquifer typically has higher fluoride concentrations than in the Quaternary portion of the aquifer in south-central Kansas and the alluvial aquifers in eastern Kansas. The higher fluoride concentration in the High Plains aquifer of Kansas is generally associated with higher silica content in the ground water. The higher silica concentrations are generally derived from dissolution of the ash deposits in the Tertiary Ogallala deposits. The amorphous glass in the ash has a higher solubility than silica in the form of quartz that composes most of the silt, sand, and gravel in the aquifer sediments. Fluoride is commonly associated with volcanic gases, therefore, fluoride could be expected to be associated with volcanic ash.

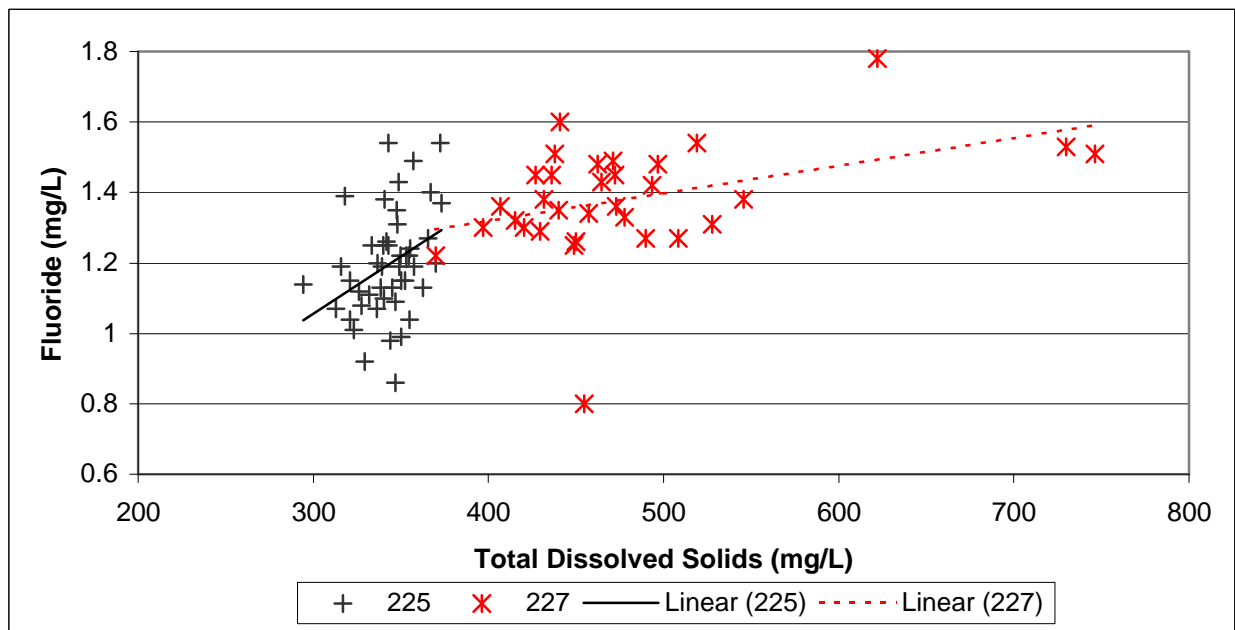


Figure 4

The fluoride concentration average for site 227 is greater than that for site 225, although the silica concentration range is slightly less and the average silica content is smaller for site 227 than for site 225. The average dissolved solids concentration of the South Fork Republican River at station 227 (479 mg/L) is greater than that at station 225 (343 mg/L). The dissolved constituent that shows the greatest percentage increase from station 225 to 227 is sulfate. The difference in the chemistry of the water at the two sites suggests that evapotranspiration concentration of the dissolved solids could be the major factor causing the higher dissolved solids. There is a general correlation between the total dissolved solids and fluoride concentrations in the water at station 227 (**Figure 4**). Thus, evapotranspiration concentration of the water between stations 225 and 227 that leads to higher dissolved solids content could also be responsible for the small increase in the fluoride concentration.

Supporting the assertion that the fluoride source in the S. Fk. Republican River is from natural sources are data from water quality monitoring Site 725, Cherry Creek near St. Francis. Cherry Creek is a tributary to the S. Fk. Republican River and their confluence marks the transition from segment 4 to 6 on the main stem of the Republican (**Figure 1**). Although not currently listed as impaired by fluoride, 5 of 7 samples collected from Cherry Creek exceeded the irrigation use standard and the average fluoride concentration for those exceedances was 1.39 mg/L fluoride. No point sources are located in the Cherry Creek watershed and no irrigation of cropland from the Cherry Creek alluvium exists. The elevated fluoride in Cherry Creek also indicates the regional groundwater contribution of fluoride.

NPDES: There is one NPDES municipal permitted wastewater discharger within the watershed (**Figure 5**). This system is outlined below in **Table 3**. St. Francis Sand and Ready Mix has a non-discharging industrial pond that may discharge to Segment 6 of the South Fork Republican River under extreme precipitation events (stream flows associated with such events are typically exceeded only 1-5 % of the time). Such events would not occur at a frequency or of a duration that they would constitute a chronic impairment to the designated uses of the river. All non-discharging lagoon systems are prohibited from discharging to the surface waters of the state. Under standard conditions of these non-discharging facility permits, when the water level of the lagoon rises to within two feet of the top of the lagoon dikes, the permit holder must notify KDHE. Steps may be taken to lower the water level of the lagoon and diminish the probability of a bypass of industrial waste during inclement weather. Bypasses may be allowed if there are no other alternatives and 1) it would be necessary to prevent loss of life, personal injury or severe property damage; 2) excessive stormwater inflow or infiltration would damage the facility; or 3) the permittee has notified KDHE at least seven days before the anticipated bypass. Any bypass is immediately report to KDHE.

Table 3

Facility	NPDES Permit	Stream Reach	Segment	Design Flow	Type
St. Francis WTF	M-UR18-OO01	Sand Cr	68	0.212 mgd	Lagoon
Cheyenne Co Feedyard	A-URCN-C001			Non-Disch.	Lagoon
Callicrate Cattle Co.	A-URCN-C002			Non-Disch	Lagoon
St. Francis Feedyard	A-URCN-C002			Non-Disch	Lagoon

Since drinking source water (groundwater wells) is likely the ultimate source of fluoride loading from municipalities in the watershed, their contribution to impaired segments is generally limited, given the small size of the municipal population as compared to the magnitude of the natural sources in the watershed. St. Francis drinking water samples (2000-2003) averaged 1.75 mg/L fluoride. Since city does not fluoridate their source water and the source of drink water supply is groundwater, this supports the premise that fluoride is naturally high in the groundwater contributing flow to the stream.

The population projection for St. Francis to the year 2020 indicates a nominal increase (< 1% growth). Projections of future water use and resulting wastewater for the city appears to be within the design flows of their current system's treatment capacity. At site 227, excursions from the water quality standards occur under all flow conditions; a strong indication that the source of the fluoride impairment is a natural background contribution rather than the point source discharge of 0.33 cfs or less.

Upper and Lower S. Fk. Republican R. Watershed NPDES and Livestock Waste Management Facilities

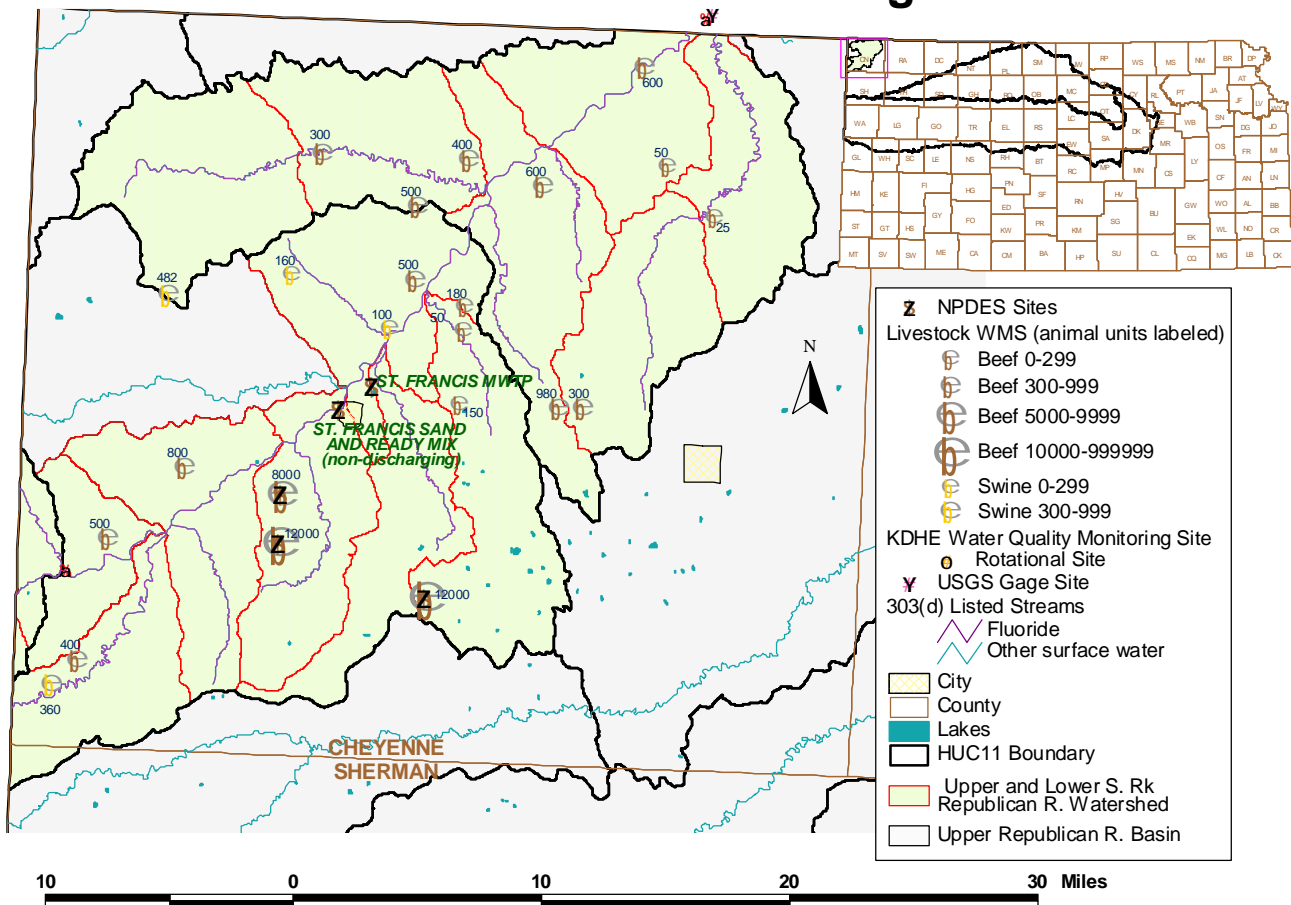


Figure 5

Livestock Waste Management Systems: Twenty-three operations are registered, certified or permitted within the watershed. These facilities, either beef or swine, are evenly distributed across the watershed (**Figure 5**). Three beef facilities are NPDES permitted, non-discharging facilities (**Figure 5**) located toward the upper end of the watershed south of the main stem in the drainage of Segment 6 or 4 of South Fork Republican River. Permitted livestock facilities have waste management systems designed to minimize runoff entering their operations or detaining runoff emanating from their areas. Such systems are designed to retain the 25 year, 24 hour rainfall/runoff event, as well as an anticipated two weeks of normal wastewater from their operations. Such rainfall events typically coincide with stream flows which are exceeded less than 1 - 5 percent of the time. Therefore, events of this type, infrequent and of short duration, are not likely to cause chronic impairment of the designated uses of the waters in this watershed. Requirements for maintaining the water level of the waste lagoons a certain distance below the lagoon berms ensures retention of the runoff from these intense, local storm events. In Cheyenne County, such an event would generate 4.1 inches of rain, yielding 3.0 to 3.8 inches of runoff in a day. The watershed's total potential animal units, for all facilities combined, is 41,721. The actual number of animal units on site is variable, but typically less than potential numbers.

Upper and Lower S. Fk. Republican R. Watershed Land Use and Population Density

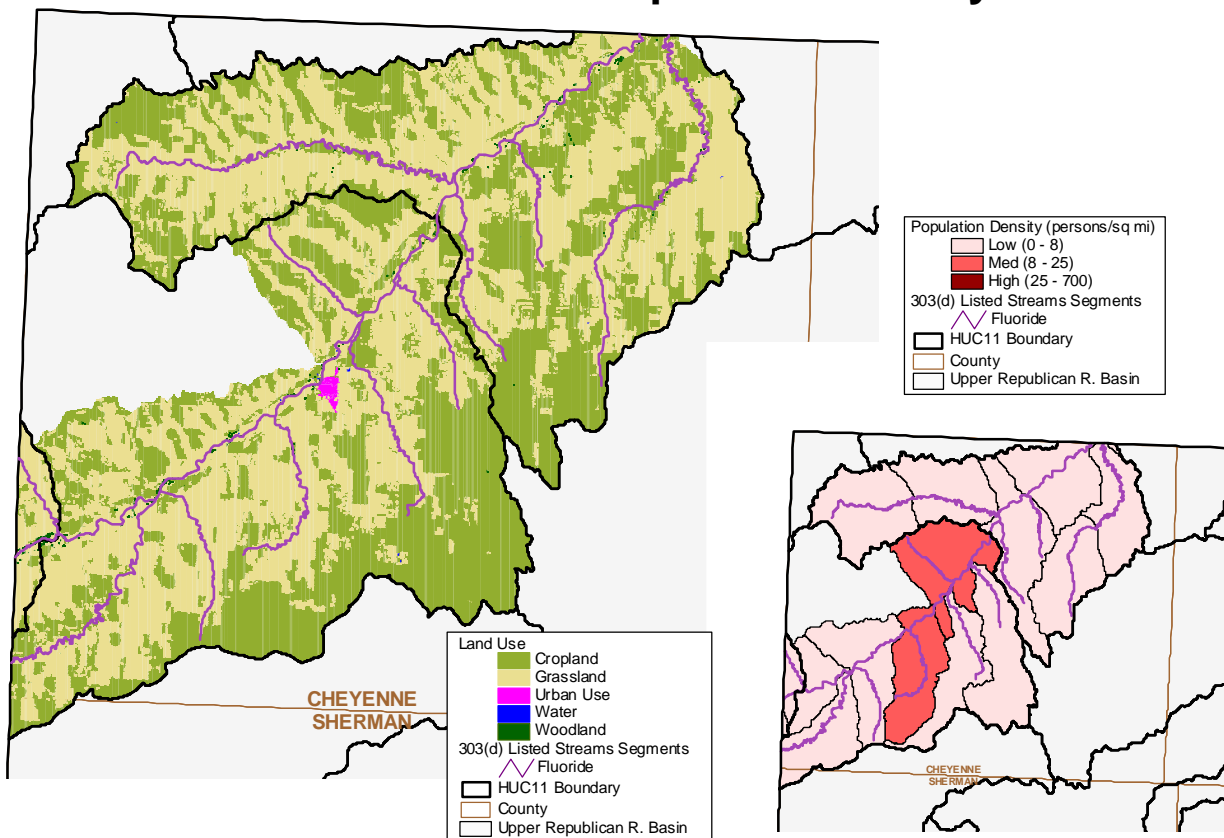


Figure 6

Land Use: Most of the watershed is grassland (53% of the area) or cropland (46.5%). Most of the cropland is located at higher elevations in the watershed (lesser slope) and to a smaller extent in the watershed's alluvial valley (**Figure 6**). Based on 1998 water use reports, about 34% of the cropland in the watershed is irrigated.

On-Site Waste Systems: Most of the watershed's population density is low when compared to densities elsewhere in the Upper Republican Basin (<2 person/mi²) except for those areas associated with the city of St. Francis where the density is average for the Upper Republican Basin (12-24 persons/mi²) (**Figure 6**). The rural population projection for Cheyenne County through 2020 shows slight declines (7% decrease). Based on 1990 census data, about 34% of households in Cheyenne County are on septic systems. Since drinking source water is likely the primary source of fluoride loading from these systems, their contribution to impaired segments is generally limited, given the small size of the rural population as compared to the magnitude of the natural sources in the watershed.

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

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

Point Sources:

Site 225: 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.

Site 227: Based on design flow (0.33 cfs) of the single municipal point source contributing to site 227, a Wasteload Allocation of 1.78 pounds of fluoride per day will be established by this TMDL at the 1.0 mg/L standard at station 227. Pursuant to Kansas implementation procedures for wastewater permitting, should the elevated background concentration be established at Site 227 of 1.41 mg/L, the WLA would increase 2.51 pounds per day (**Figure 8**). The non-discharging St. Francis Sand and Ready Mix facility will have a wasteload allocation of zero.

There will be a wasteload allocation of zero for state and NPDES permitted CAFO's within the drainage because of requirements for no discharge of livestock waste except at 25 year, 24 hour storm events. Management of available freeboard and required holding capacities in these livestock waste management systems should ensure rare contribution of fluoride to the S. Fk. Republican River.

Non-Point Sources: The majority of the fluoride load in the S. Fk. Republican River appears to be background in nature. At Sites 225 and 227 the Load Allocation based on the existing fluoride standard of 1.0 mg/L across all flow conditions is shown in **Figures 7 and 8**, respectively and is 75.6 pounds per day of fluoride at the median flow of 14 cfs. The LA at station 225 will increase if the elevated background concentration (1.22 mg/L) becomes the applicable criteria (92.2 lbs/day at median flow of 14.0 cfs). The LA increases at site 227 to

106.6 pounds per day at median flow if the elevated background concentration (1.41 mg/L) becomes the applicable criteria. At both monitoring locations in the watershed, exceedances were noted at flows in excess of the median flow. Additional assessment of the contribution from upstream sources is needed.

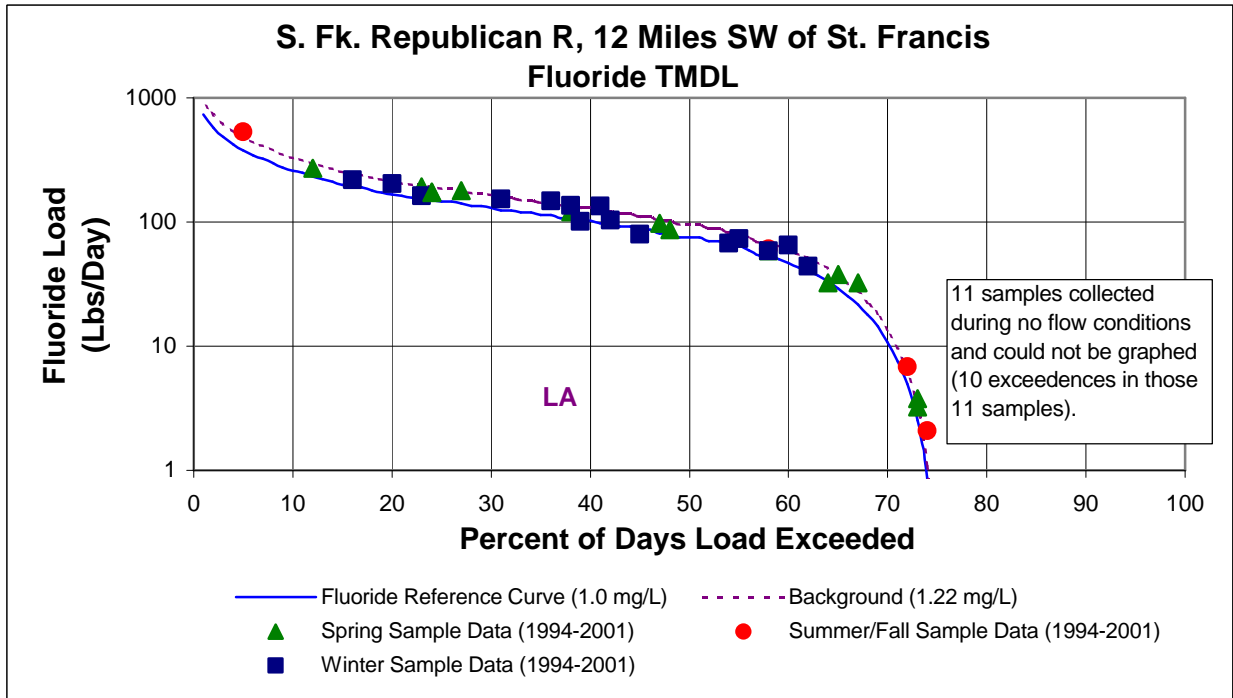


Figure 7

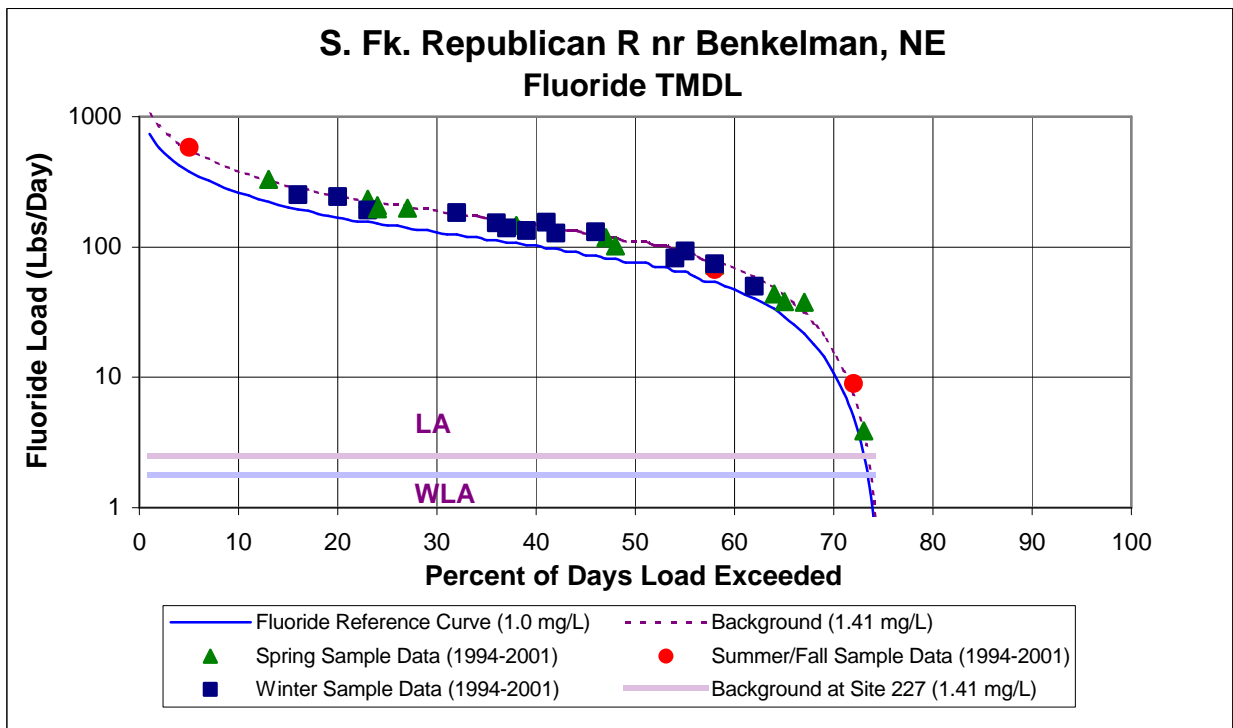


Figure 8

Defined Margin of Safety: The Margin of Safety provides some hedge against the uncertainty of loading and the fluoride endpoints for the S. Fk. Republican River system and is considered implicit in this TMDL. The irrigation water use standard of 1.0 mg/L is extremely conservative considering it was developed for fluoride toxicity in acid soils. The soils in Cheyenne County are neutral to alkali (pH 6.1 – 9.0) and should effectively inactivate fluoride applied in irrigation water at the levels found in the river. Only six surface water rights exist in the watershed and no irrigation use has been made of these rights in recent history (probably due to a more reliable alternative source of supply; groundwater wells). No evidence exists to document a seasonal or flow variation in the fluoride concentration in the river indicating the source of fluoride loading is natural in source. There are no violations of the 2 mg/L criteria impacting the two more likely uses of surface water; livestock watering and domestic water supply.

State Water Plan Implementation Priority: Because the dominant source for fluoride in the stream is from natural sources, upstream sources are likely contributors to the fluoride problems seen at the monitoring stations and additional source assessment is necessary to examine contributing activities along the main stem, this TMDL will be a low Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the South Fork Republican Basin (HUC 8: 10250003) and is classified as a Category II watershed under the unified assessment.

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.

Implementation Programs Guidance

Water Quality Standards and Assessment - KDHE

- a. Establish background levels of sulfate for the river and tributaries.

Timeframe for Implementation: Development of a background level-based water quality standard should be accomplished with the 2003 water quality standards revision.

Targeted Participants: Primary participants for implementation will be KDHE.

Milestone for 2007: The year 2008 marks the mid-point of the ten-year implementation window for the watershed. At that point in time, additional monitoring data from S. Fk Republican River will be reexamined to confirm the impaired status of the river and the suggested background concentration.

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. 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 Stations 225 and 227, including fluoride samples, in each of the three defined seasons. Based on that sampling, the priority status will be evaluated in 2008 including application of numeric criterion based on background concentrations. Should impaired status remain, the desired endpoints under this TMDL will be refined and the established background concentration will be re-examined.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Upper Republican Basin were held October 2, 2002 in Oberlin, January 6, 2003 in Norton and March 4, 2003 in Colby. 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 Republican Basin.

Public Hearing: Public Hearings on the TMDLs of the Upper Republican Basin were held in Atwood on June 3, 2003.

Basin Advisory Committee: The Upper Republican Basin Advisory Committee met to discuss the TMDLs in the basin on October 2, 2002, January 6, March 4, and June 3, 2003.

Milestone Evaluation: In 2008, evaluation will be made to confirm the degree of impairment that has occurred within the watershed of the South Fork Republican River. Subsequent decisions will be made regarding the need for an implementation approach.

Consideration for 303(d) Delisting: The stream will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2004-2008. Therefore, the decision for delisting will come about in the preparation of the 2008 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 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 (CPP), the next anticipated revision will come with the adoption of the new EPA Watershed Rule which will emphasize implementation of TMDLs. At that time, incorporation of this TMDL will be made into the CPP. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process after Fiscal Year 2008.