MARAIS DES CYGNES BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: **Marmaton River**
Water Quality Impairment: Nutrients and Oxygen Demand Impact on Aquatic Life

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Marmaton **Counties:** Bourbon, Allen and Crawford

HUC 8: 10290104

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

Drainage Area: 421 square miles

Main Stem Segment: WQLS: 5 & 7; starting at the state line, traveling upstream, and ending at the western boundary of Fort Scott.

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 on Main Stem Segments.

1998 303(d) Listing: Table 2–Stream Segments Identified by Biological Monitoring

Impaired Use: Special Aquatic Life Support on Main Stem Segments.

Water Quality Standard: Nutrients--Narrative: The introduction of plant nutrients into streams, lakes, or wetlands from artificial sources shall be controlled to prevent the accelerated succession or replacement of aquatic biota or the production of undesirable quantities or kinds of aquatic life. (KAR 28-16-28e(c)(2)(B)).

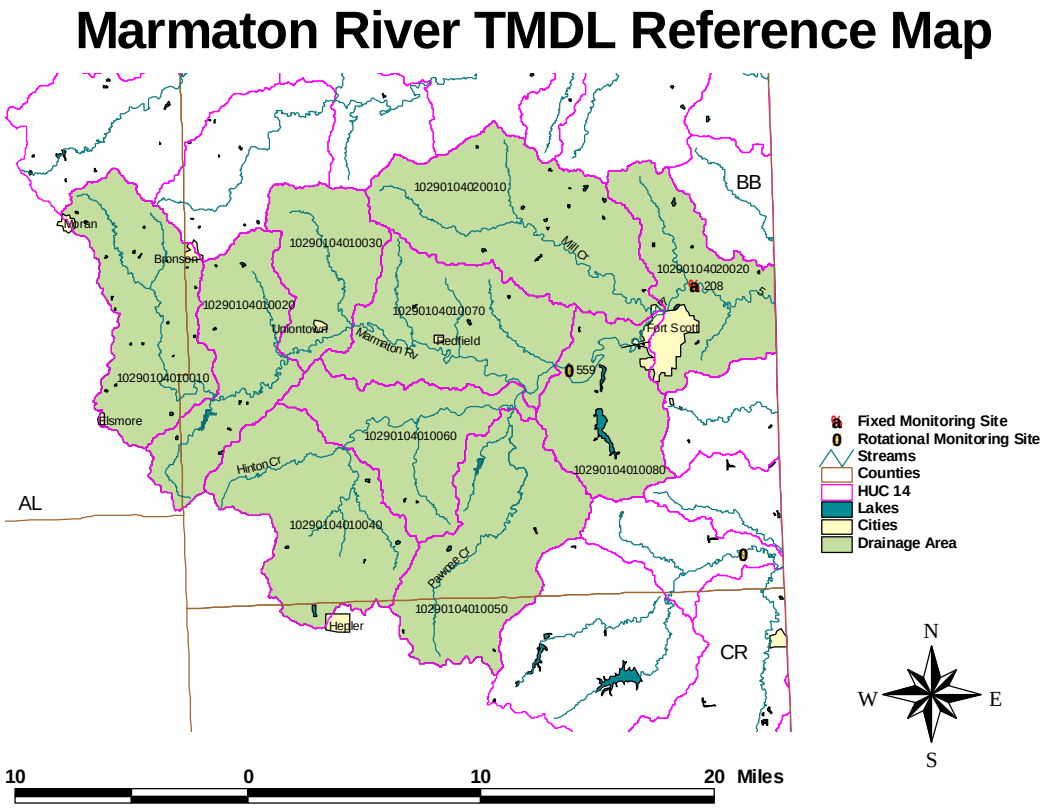
2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 1998 303(d): Partially Supporting

Monitoring Sites: Stream chemistry station 208 near Fort Scott (Figure 1)
and biological monitoring station SB325

Period of Record Used: 1985-2000 for Station 208 and 1980-2000 for Station SB325

Figure 1



Flow Record: Site 208: calculated flow based on measurements at 06917550 (Marmaton R. near Kansas-Missouri state line); Site 559: Marmaton near Marmaton (USGS Station 06917380); *1975* to 1999.

Long Term Flow Conditions: Median Flow = 71.6 cfs, 7Q10 = 0.1 cfs

Current Conditions:

Parameter	**Historical Average & Range**
Macroinvertebrate Biotic Index (MBI)	4.73 (3.71 - 5.86)
% Ephemeroptera, Plecoptera, and Trichoptera (EPT) Taxa (Count)	46.6% (19 - 82%)
Biochemical Oxygen Demand (BOD)	4.83 mg/L (10.0 - 28.0 mg/L)
Phosphorus	205 ug/L (50 - 970 ug/L)
Ammonia	380 ug/L (10 - 7,003 ug/L)
Nitrate	514 ug/L (10 - 3,480 ug/L)
TSS	*79 mg/L (1 mg/L - 1,820 mg/L)*

Three main parameters (MBI, %EPT, and BOD) were analyzed to address the nutrient/ oxygen demand impairment. The Macroinvertebrate Biotic Index rates the nutrient and oxygen demanding pollution tolerance of large taxonomic groups (order and family). Higher values indicate greater pollution tolerances. Along with the number of individuals within a rated group, a single index value is computed which characterizes the overall tolerance of the community. The higher the index values the more tolerant the community is of organic pollution exerting oxygen demands in the stream setting. Index values greater than 5.4 are indicative of non-support of the aquatic life use; values between 4.51 and 5.39 are indicative of partial support and values at or below 4.5 indicate full support of the aquatic life use.

The EPT index is the proportion of aquatic taxa present within a stream belonging to pollution intolerant orders; Ephemeroptera, Plecoptera and Trichoptera (mayflies, stoneflies and caddisflies). Higher percentages of total taxa comprising these three groups indicate less pollutant stress and better water quality.

On this stream segment, the average MBI value indicates that aquatic life support is partially impaired (MBI between 4.51 and 5.39). Sixty-two percent of the surveys resulted in MBI values over 4.5; the rest were under 4.5. Average MBI under partial support conditions was 4.92; average MBI under full support conditions was 4.23. When aquatic life is partially impaired, the percentage of EPT taxa ranges from 30 - 65% (42% average). Under full support conditions, the percentage averages 58%. The historical average of BOD (4.87 mg/L) is slightly above normal background levels (3 - 4 mg/L).

Phosphorus, ammonia, and nitrate were graphed against the flow. (See graphs in Appendix B). In the ammonia and nitrate graphs, the nutrient concentration decreased slightly with increased flow, which suggests that ammonia and nitrate are being diluted during high runoff events. Although the phosphorus graph shows a general trend downward, phosphorus concentrations rise at high flows. This rise may be related to increased sediment transport. Overall, the average concentration of nutrients in the Marmaton River watershed tends to be high (205 ug/L phosphorus, 380 ug/L ammonia, and 514 ug/L nitrate).

Desired Endpoints of Water Quality at Site 208 over 2005 - 2009

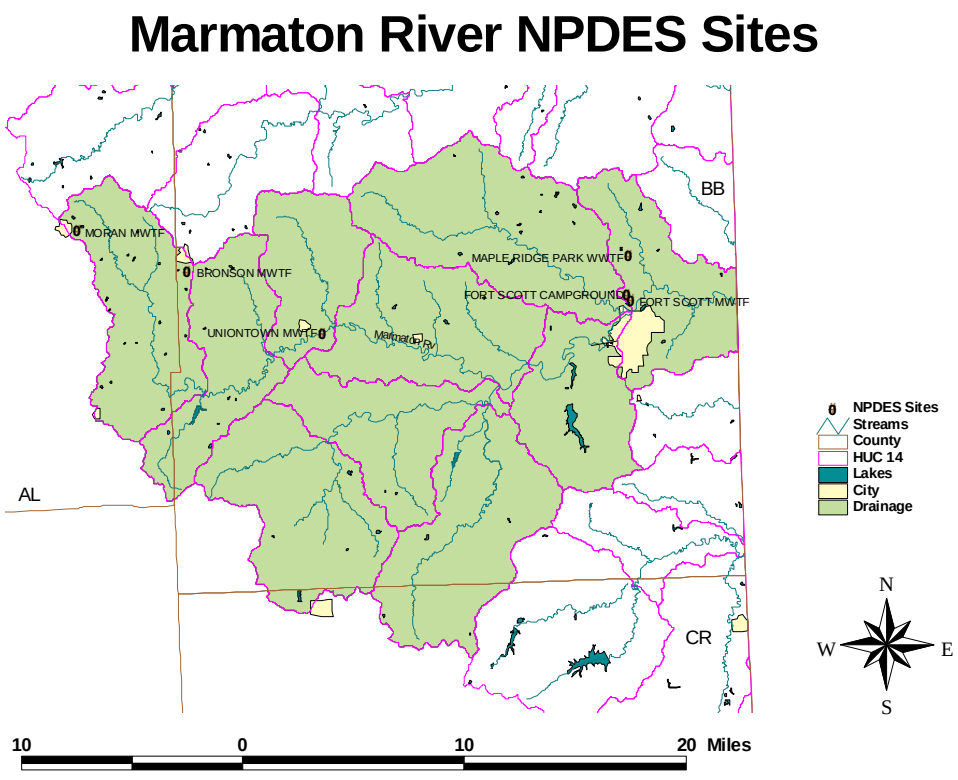
The use of biological indices allows assessment of the cumulative impacts of dynamic water quality on aquatic communities present within the stream. As such, these index values serve as a baseline of biological health of the stream. Sampling occurs during open water seasons (April to November) within the aquatic stage of the life cycle of the macroinvertebrates. As such there is no described seasonal variation of the desired endpoint of this TMDL. The endpoint would be average MBI values of 4.5 or less over 2005-2009.

Achievement of this endpoint would be indicative of full support of the aquatic life use in the stream reach. While the narrative water quality standard pertaining to nutrients and total suspended solids is utilized by this TMDL, there is no direct linkage between MBI values and nutrient and total suspended solids levels. A number of factors may contribute to the occasional excursion in index values above 4.5. These include flows, adequate habitat, and stream

modifications. The link between MBI values and nutrient and total suspended solids levels on Marmaton River remains qualitative at this phase of the TMDL.

3. SOURCE INVENTORY AND ASSESSMENT

Figure 2



NPDES:
There are six NPDES permitted wastewater dischargers within the watershed (Figure 2). These systems are outlined below.

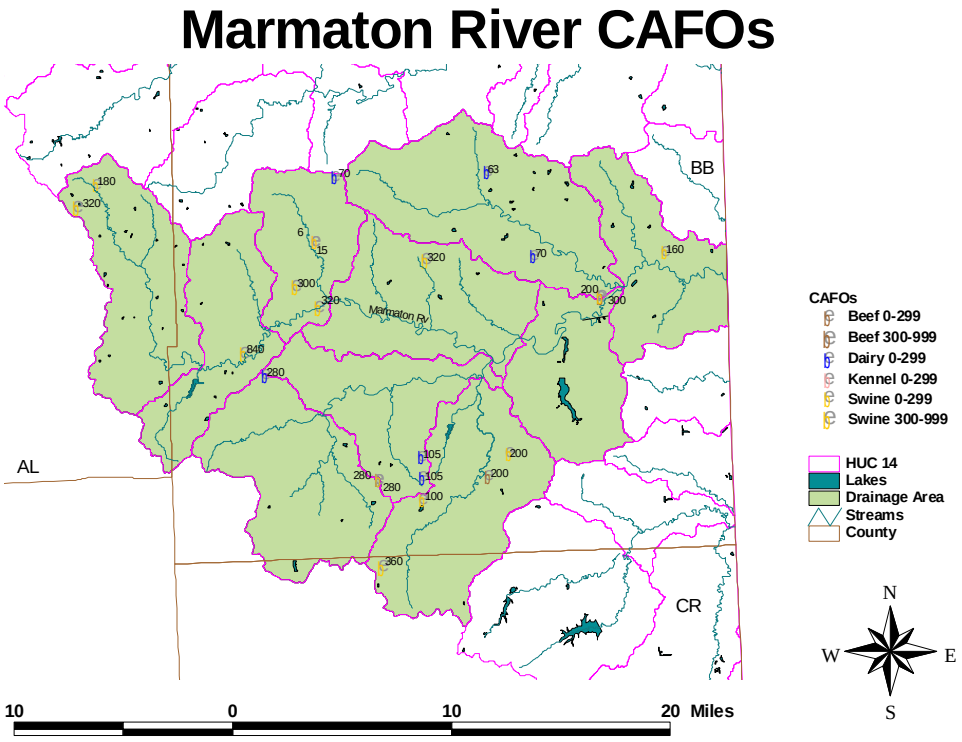
MUNICIPAL FACILITY	STREAM REACH	SEGMENT	DESIGN FLOW	TYPE
Bronson MWTP	Marmaton R. via unnamed tributary	12	0.064 mgd	Lagoon
Fort Scott Campground	Marmaton R.	7	0.00825 mgd	Lagoon
Fort Scott MWTP	Marmaton R.	7	3.0 mgd	Lagoon/ Mech.
Maple Ridge MHP	Wolverine Cr.	35	0.0033mgd	Lagoon
Moran MWTP	Marmaton R. via unnamed tributary	12	0.098 mgd	Lagoon
Uniontown MWTP	Marmaton R.	12	0.045 mgd	Lagoon

The Fort Scott MWTP has permit violations through May 2000 for ammonia. The limits under the current permit (as a weekly average) are as follows: 120 mg/L total suspended solids and 1.3 to 8.0 mg/L ammonia nitrogen, depending on the month. The city of Fort Scott is under a schedule of compliance to upgrade its waste treatment facility (adding a mechanical treatment system to its current lagoon system) by March 31, 2004. The effluent will be re-aerated after denitrification. The final limitations are as follows: 45 mg/L total suspended solids (as a weekly average) and 1.3 mg/L ammonia nitrogen (as a monthly average).

Population projections for both Fort Scott and Uniontown to the year 2020 indicate modest growth. Projections for Bronson, Hepler, Redfield, Elsmore, and Moran to the year 2020 indicate no change to slight declines. Projections of future water use and resulting wastewater appear to be within design flows for each of the current system's treatment capacity. Examination of effluent monitoring indicates very high levels of BOD leaving the treatment plants and entering the stream system between site 559 and 208.

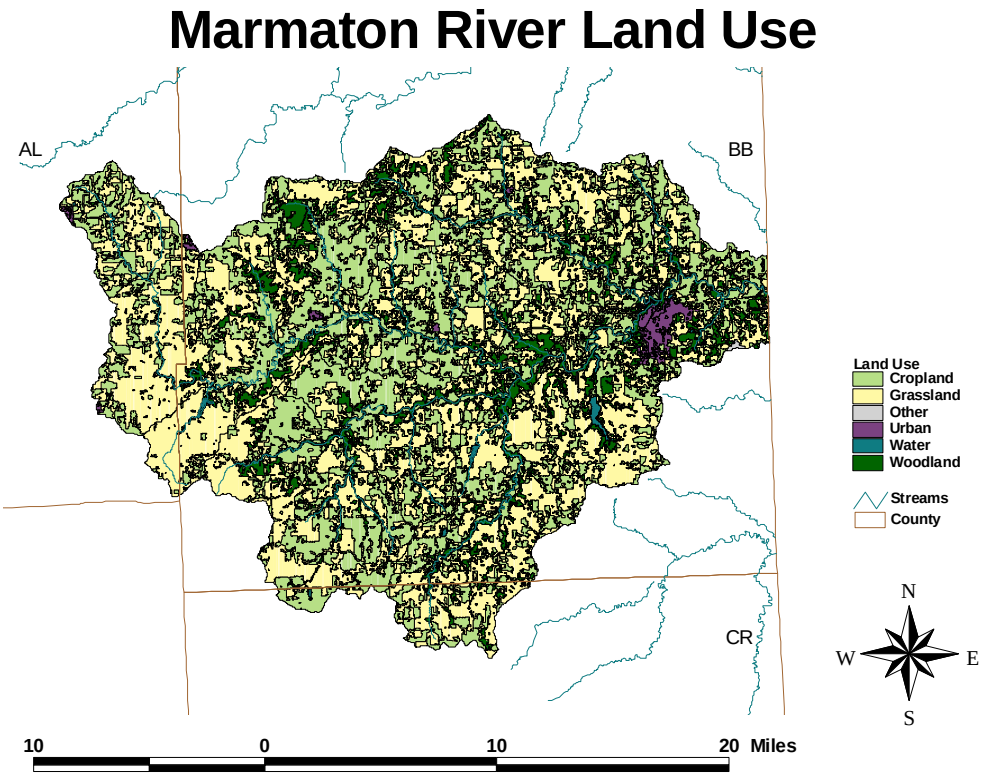
Livestock Waste Management Systems: Twenty-three operations are registered, certified or permitted within the watershed (Figure 3). The facility type is either beef(2), dairy(7), swine (13), or a kennel (1). Potential animal units for all facilities in the watershed total 5,074. The actual number of animal units on site is variable, but typically less than potential numbers.

Figure 3



Land Use: Most of the watershed is grassland (49% of the area), cropland (40%), woodland (10%) or urban use (1%). (See Figure 4). The growing season grazing density is low to moderate for the watershed when compared to densities for the Marais des Cygnes and Missouri Basins.

Figure 4



On-site Waste Systems: The population density is low for the watershed area (5 - 17 persons/mi^2) except for areas associated with the city of Fort Scott (74-185 persons/mi^2). The rural population projections for Allen and Bourbon County through 2020 show slight growth (3-12% increase, respectively).

Contributing Runoff: The watershed's average soil permeability is 0.9 inches/hour according to NRCS STATSGO data base. About 96.8% of the watershed produces runoff even under relative low (1.5''/hr) potential runoff conditions. Under very low (<1"/hr) potential conditions, this potential contributing area reduced by more than half (37.8%). Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.5"/hr of rain will generate runoff from only 6% of this watershed, chiefly along the stream channels.

Background Levels: Eight percent of the Marmaton River watershed is woodland. Leaf litter falls into the streams and decomposes increasing the oxygen demand. Small amounts of phosphorus are contributed from the watershed soils. Nitrogen loads may be contributed from the atmosphere.

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

There is a direct, yet unquantified relation between nutrient loading and biological integrity. Decreased loads should result in aquatic communities, indicative of improved water quality. The TMDL goals and gross allocations for the Marmaton River are outlined in the table below. Due to the lack of linkage between nutrient loading and biological integrity, a 15% reduction was used to test the response of the aquatic community to the reduced nutrient load.

The ability of biological data to integrate the various physical and chemical impacts of the entire watershed on the aquatic community defies allocation of specific nutrient loads between point and nonpoint sources. Additionally, no specific relationship between the observed ambient nutrient levels and the biological impairment indicated by the MBI value could be established. Because biological integrity is a function of multiple factors, the initial pollution load reduction responsibility will be to decrease the average condition of nutrients and sediment over the range of flows encountered on the Marmaton River. Future monitoring will be designed to uncover the actual reasons for the impairment, and this TMDL will be adjusted to reflect the new information.

For this phase of the TMDL, an average condition is considered across the seasons, to establish goals of the endpoint and desired reductions. Therefore, average ambient levels are multiplied by the average flow estimated for the Marmaton River. This is represented graphically by the integrated area under each load duration curve established by this TMDL. The area is segregated into allocated areas assigned to point sources (WLA) and nonpoint sources (LA). Future growth in wasteloads should be offset by reductions in the loads contributed by nonpoint sources. This offset along with appropriate limitations should eliminate the impairment. This TMDL represents the “Best Professional Judgment” as to the expected relationship between these sources and the expected MBI score.

Point Sources: There are six municipal facilities releasing effluent into the watershed. The existing loads contributed by these facilities are unknown and will need to be determined in the future through monitoring of effluent and ambient receiving streamflow. Assuming the total design effluent volume arrives at the monitoring site, that flow (5 cfs) would likely influence flow conditions up to those which are exceeded 75% of the time on the Marmaton River. Therefore, the allocation for point sources is demarcated by the area under each respective load duration curve bounded from 75% to 100%. At this stage of the TMDL, the assumed condition is maintenance of current conditions at those low flows, presuming an offset of lower nonpoint loading at higher flows. The Wasteload Allocation represents the load in the stream which the point sources contribute. In most cases, this is a function of permit limits and plant performance; in the case of nutrients and BOD, there are some assimilation and degradation of the constituents in transit while flowing downstream. Further refinement of this allocation will come with

information on effluent concentrations and developed nutrient criteria for streams, resulting in specific permit limits in the second stage of this TMDL.

Nonpoint Sources: Given the runoff characteristics of the watershed, overland runoff can easily carry sediment, phosphorus, and nitrogen from the watershed into the stream reaches. The composition of the watershed indicates a mixture of rural and urban nonpoint sources which may contribute to the downstream impairment. These sources tend to become dominant under higher flow conditions. Therefore, the area under the load duration curves bounded from 1-75% constitutes the Load Allocation for this TMDL. Because of the predominant loads under runoff conditions, the Load Allocation will be a reduction of nutrient loadings such that average phosphorus concentrations are below 100 ppb in stream and nitrate concentrations average below 200 ppb.

TMDL Goals and Gross Allocations for the Marmaton River

	MBI	Total Phosphorus	Potential Available N	BOD	TSS
Current	4.73	79.3 #/D	346.0 #/D	1,870.0 #/D	30,400.0 #/D
Reduction	0.23	12.0 #/D	52.0 #/D	750.0 #/D	4,600.0 #/D
TMDL	4.50*	67.3 #/D	294.0 #/D	1,120.0 #/D	25,800.0 #/D
WLA		*27.0 #/D*	*62.1 #/D*	*608.0 #/D*	*2,160.0 #/D*
LA		*40.3 #/D*	*231.9 #/D*	*512.0 #/D*	*23,640.0 #/D*

* A concurrent requirement will be that the EPT individuals shall make up at least 58% of the sample population.

Defined Margin of Safety: Given the variable nature of the MBI values seen on this stream, additional biological measures are necessary to assure indications of good aquatic community health. Therefore, the defined Margin of Safety for this TMDL will be a proportion of EPT individuals making up at least 58% of the sample population when MBI values are 4.5 or lower. This will ensure that the majority of aquatic macroinvertebrate population is composed of pollution intolerant taxa. This measure may also correlate with the availability of adequate habitat in the stream to support such a community.

State Water Plan Implementation Priority: Because this watershed is impaired due to nonpoint pollutants indicated by biological monitoring, this TMDL will be a High Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Marmaton River Subbasin (HUC 8: 10290104) with a priority ranking of 17 (High Priority for restoration work).

Priority HUC 11s and Stream Segments: Because the impairment is in segments 5 and 7, the priority HUC 11s are 010 and 020.

5. IMPLEMENTATION

Desired Implementation Activities

1. Implement necessary soil sampling to recommend appropriate fertilizer applications on cropland
2. Maintain necessary conservation tillage and contour farming to minimize cropland erosion.
3. Install necessary grass buffer strips along streams.
4. Reduce activities within riparian areas
5. Install proper manure storage
6. Implement necessary nutrient management plans to manage manure application to land
7. Monitor wastewater discharges for excessive nutrient loadings

Implementation Programs Guidance

NPDES - KDHE

a. Monitor effluent from wastewater systems to determine their nutrient contributions and ambient concentrations of receiving streams.

b. Ensure proper monitoring, permitting, and operations of municipal wastewater systems to limit nutrient and BOD discharges after numeric criteria are established.

Nonpoint Source Pollution Technical Assistance - KDHE

a. Support Section 319 demonstration projects for reduction of sediment runoff from agricultural activities as well as nutrient management.

b. Provide technical assistance on practices geared to establishment of vegetative buffer strips.

c. Provide technical assistance on nutrient management in vicinity of streams.

d. Assist evaluation of stormwater quality from urbanized areas of watershed.

Technical Services - KDHE

a. Incorporate numeric nutrient criteria into water quality standards after final EPA nutrient criteria guidance is issued.

Local Environmental Protection Program - KDHE

a. Support inspection of on-site wastewater systems to minimize nutrient loadings

Water Resource Cost Share & Nonpoint Source Pollution Control Programs - SCC

a. Apply conservation farming practices, including terraces and waterways, sediment control basins, and constructed wetlands.

b. Provide sediment control practices to minimize erosion and sediment and nutrient transport

Riparian Protection Program - SCC

a. Establish or reestablish natural riparian systems, including vegetative filter strips and streambank vegetation.

b. Develop riparian restoration projects
c. Promote wetland construction to assimilate nutrient loadings

Buffer Initiative Program - SCC

a. Install grass buffer strips near streams.
b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance - Kansas State University

a. Educate agricultural producers on sediment, nutrient and pasture management
b. Provide technical assistance on buffer strip design and minimizing cropland runoff
c. Encourage annual soil testing to determine capacity of field to hold phosphorus

Time Frame for Implementation: Pollutant reduction practices should be installed within the priority subwatersheds during the years 2002-2006, with minor follow up implementation, including other subwatersheds over 2006-2009. To some degree, reduction practices associated with reducing dissolved oxygen impairment will have an impact on reducing nutrient loads to the stream.

Targeted Participants: Primary participants for implementation will be the City of Fort Scott and agricultural producers operating within the drainage of the priority subwatershed. Initial work should include an inventory of activities in those areas with greatest potential to impact the stream, including, within a mile of the stream:

1. Total rowcrop acreage
2. Cultivation alongside stream
3. Fields with manure applications
4. On-site wastewater discharges to stream
5. Condition of riparian areas
6. Presence of livestock along stream

Some inventory of local needs should be conducted in 2001 to identify such activities. Such an inventory would be done by local program managers with appropriate assistance by commodity representatives and state program staff in order to direct state assistance programs to the principal activities influencing the quality of the streams in the watershed during the implementation period of this TMDL.

Municipal point sources will initiate monitoring and subsequently treat effluent to reduce nutrient loading once EPA guidance and numeric criteria are in place. Some assessment of stormwater quality coming from urbanized areas of the watershed will be needed to direct any appropriate stormwater management practices.

Milestone for 2006: The year 2006 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, adequate source assessment should be complete which

allows an allocation of resources to responsible activities contributing to the nutrient impairment. Additionally, biological data from Marmaton River over 2002-2006 should not indicate trends of reduced support of the aquatic community. Numeric nutrient criteria should be established by 2006 and sampled data from Marmaton River should indicate evidence of reduced nutrient levels relative to the conditions seen over 1980-2000.

Delivery Agents: The primary delivery agents for program participation will be the conservation districts for programs of the State Conservation Commission and the Natural Resources Conservation Service. Producer outreach and awareness will be delivered by Kansas State Extension and agricultural interest groups such as Kansas Farm Bureau or Kansas Livestock Association, the Kansas Pork Producers Council and the Kansas Dairy Association. On-site waste system inspections will be performed by Local Environmental Protection Program personnel for Bourbon County.

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.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. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

5. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.

6. 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.

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

8. The *Kansas Water Plan* and the Marmaton 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 **High Priority** consideration. Priority should be given to activities which reduce loadings of nutrients to the stream prior to 2006.

Effectiveness: Nutrient control has been proven effective through conservation tillage, contour farming and use of grass waterways and buffer strips. The key to success will be widespread utilization of conservation farming and waste management within the watersheds cited in this TMDL.

Technology exists for nitrogen and phosphorus removal and can be placed in wastewater systems with proper planning and design.

Should participation significantly lag below expectations over the implementation period or monitoring indicates lack of progress in improving water quality conditions from those seen over 1980-2000, the state may employ more stringent conditions on agricultural producers in the watershed through establishment of a Critical Water Quality Management Area in order to meet the desired endpoints expressed in this TMDL.

6. MONITORING

As numeric nutrient criteria become established, KDHE will continue to collect seasonal biological samples from Marmaton River for three years over 2001 - 2005 and an additional three years over 2005-2009 to evaluate achievement of the desired endpoint. Periodic monitoring of nutrient content of wastewater discharged from treatment systems will be expected under reissued NPDES and state permits.

Additional source assessment needs to be conducted and local program management needs to identify its targeted participants of state assistance programs for implementing this TMDL. This information should be collected in 2001-2005 in order to support appropriate implementation projects.

7. FEEDBACK

Public Meeting: The public meeting to discuss TMDLs in the Marais des Cygnes Basin was held February 28, 2001 in Ottawa. 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 Marais des Cygnes Basin.

Public Hearings: Public Hearings on the TMDLs of the Marais des Cygnes Basin were held in Fort Scott on May 30 and Ottawa on May 31, 2001.

Basin Advisory Committee: The Marais des Cygnes Basin Advisory Committee met to discuss the TMDLs in the basin on October 4, 2000, February 28 and May 30, 2001.

Milestone Evaluation: In 2006, evaluation will be made as to the degree of implementation which has occurred within the watershed and current condition of the Marmaton River. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The river will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2005-2009. Therefore, the decision for delisting will come about in the preparation of the 2010 303(d) 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 of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2002-2006.

APPENDIX A

CALCULATIONS OF CURRENT AND DESIRED LOADS

Estimated Existing Loads calculated by average flow and average concentration:

Total Phosphorus: 71.6 cfs * 0.205 mg/l * 5.4 = 79.3 #/D
Nitrate: 71.6 cfs*0.514 mg/l*5.4 = 199.0 #/D
Ammonia: 71.6 cfs*0.380 mg/l*5.4 = 147.0 #/D
BOD: 71.6 cfs*4.83 mg/l*5.4 = 1,870.0 #/D
TSS: 71.6 cfs*78.5 mg/l*5.4 = 30,400.0 #/D

Desired Loads recalculated using lower ambient concentrations:

Total Phosphorus: 71.6 cfs * 0.174 mg/l * 5.4 = 67.3 #/D
Nitrate: 71.6 cfs*0.44 mg/l*5.4 = 170.0 #/D
Ammonia: 71.6 cfs*0.32 mg/l*5.4 = 124.0 #/D
BOD: 71.6 cfs*2.9 mg/l*5.4 = 1,120.0 #/D (BOD Endpoint is detailed in Marmaton DO TMDL).
TSS: 71.6 cfs*66.7 mg/l*5.4 = 25,800.0 #/D

Wasteload Allocations calculated by design flow and desired or permitted concentrations

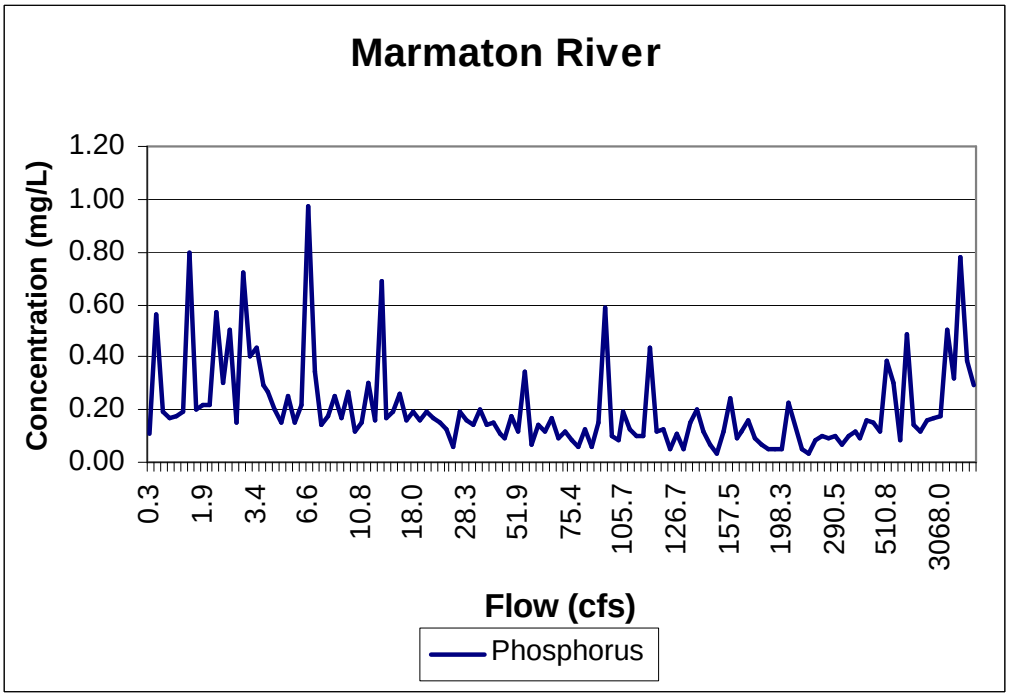
Sum of upstream dischargers = 3.22 MGD (4.99 cfs)

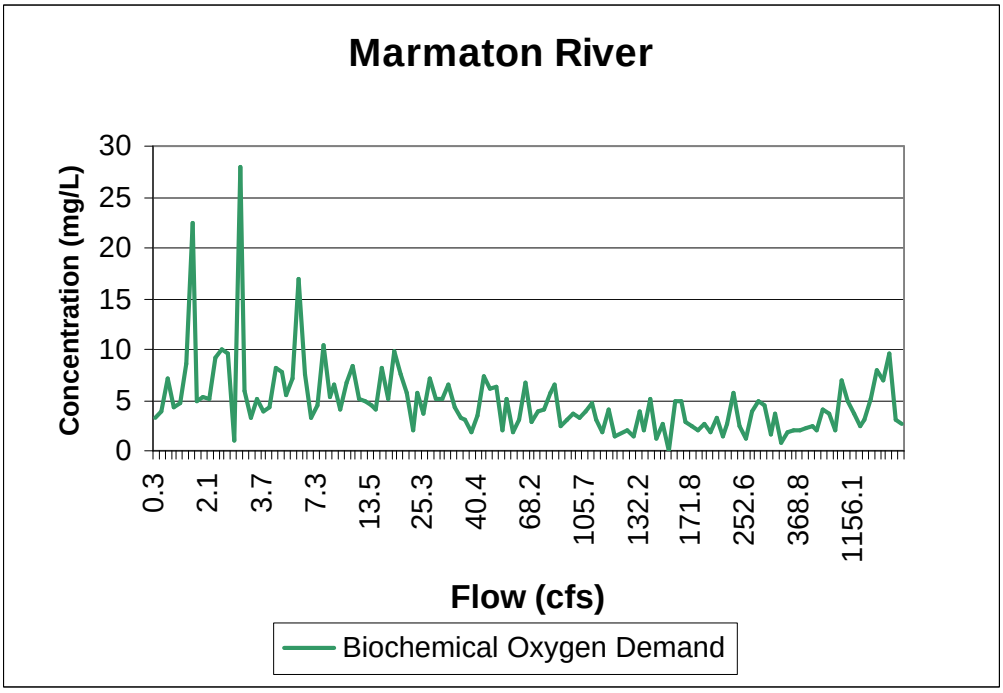
Total Phosphorus: 5 cfs * 1.00 mg/l * 5.4 = 27.0 #/D
Nitrate: 5 cfs*1.0 mg/l*5.4 = 27.0 #/D
Ammonia: 5 cfs*1.3 mg/l*5.4 = 35.1 #/D
BOD: 5 cfs*22.5 mg/l*5.4 = 608.0 #/D
TSS: 5 cfs*80 mg/l*5.4 = 2,160.0 #/D

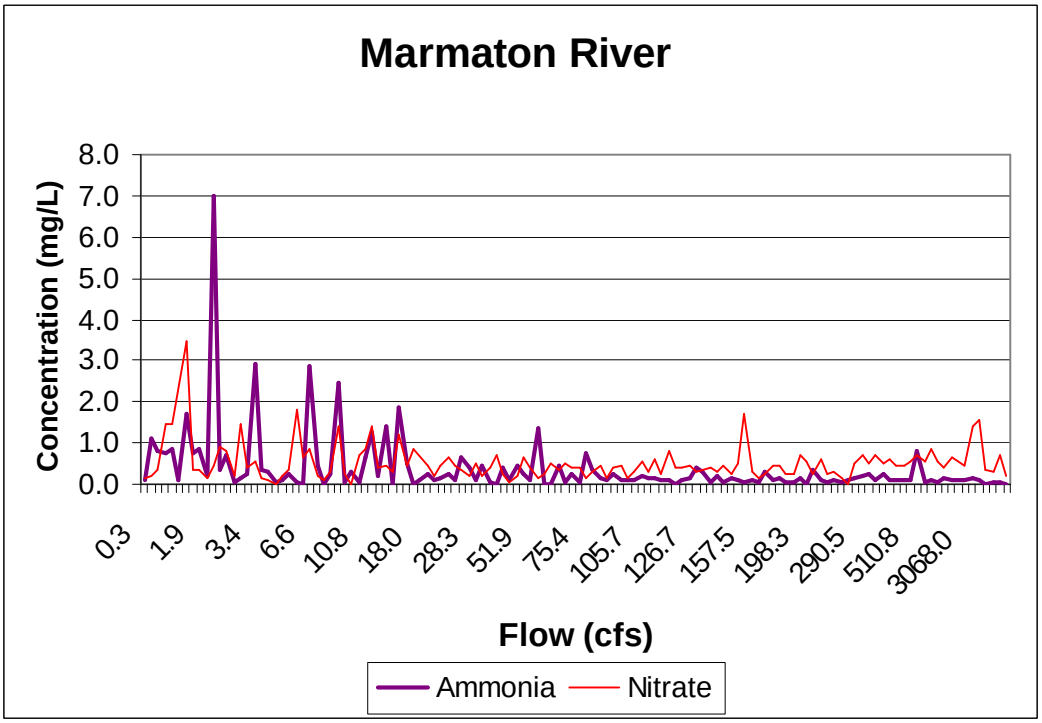
Load Allocations found by subtracting Wasteload Allocation from Desired Load:

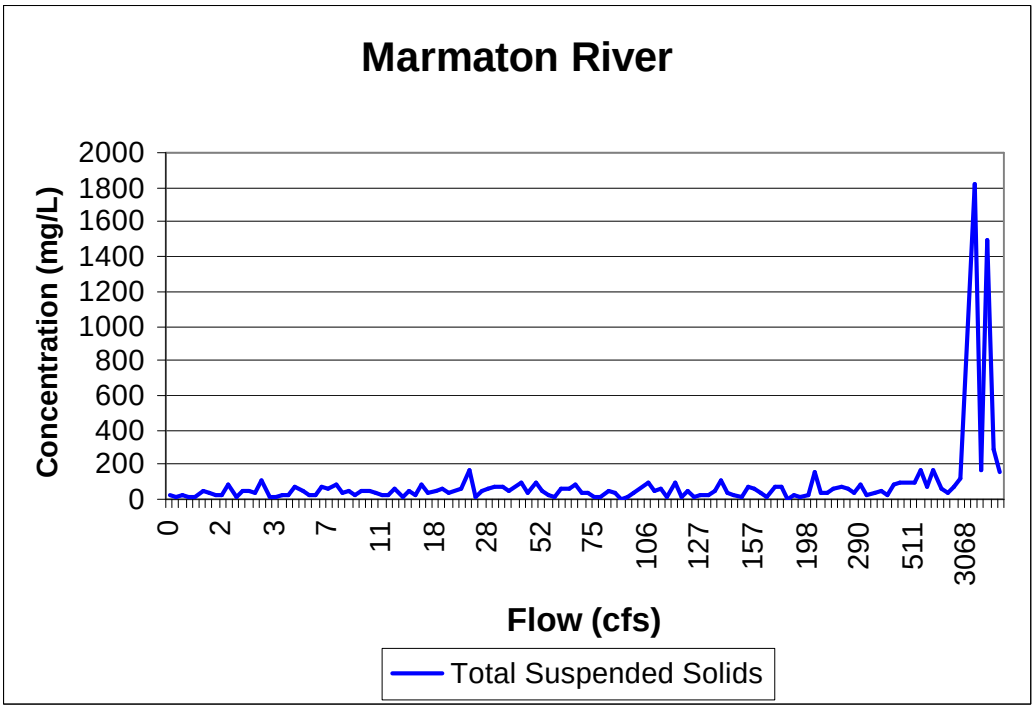
Total Phosphorus: 40.3 #/D
Nitrate: 143.0 #/D
Ammonia: 88.9 #/D
BOD: 982.0 #/D
TSS: 23,640.0 #/D

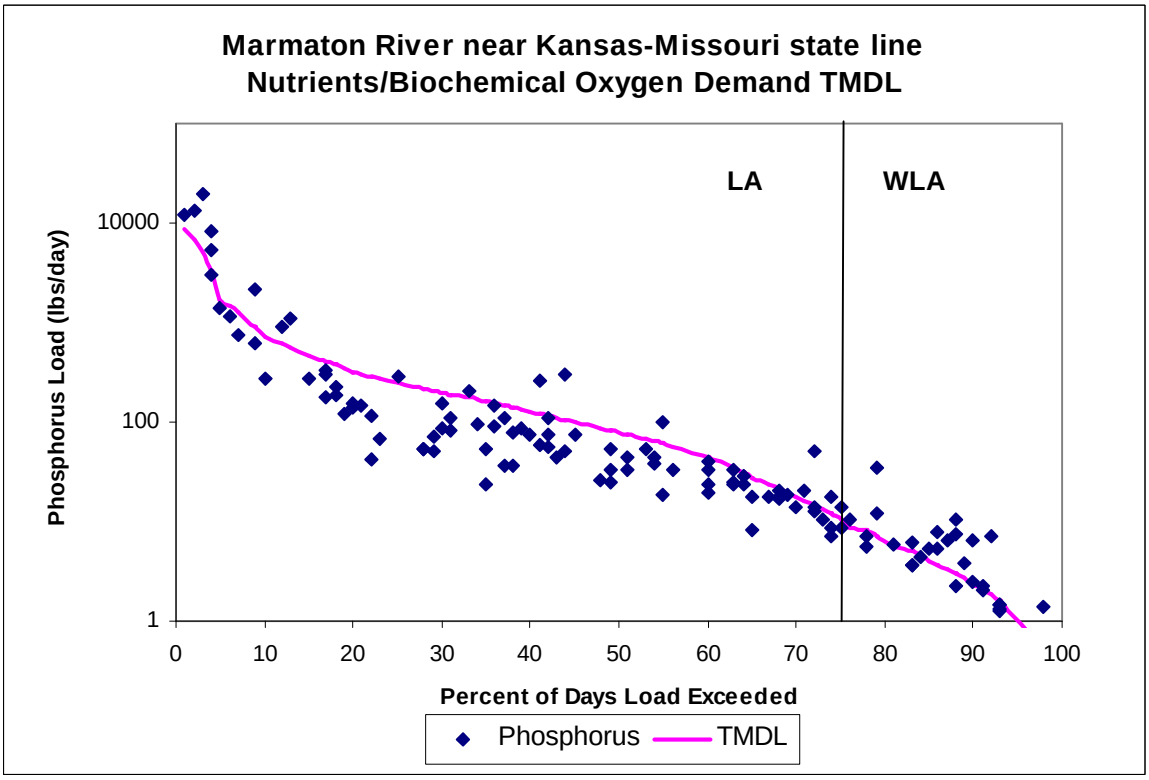
APPENDIX B

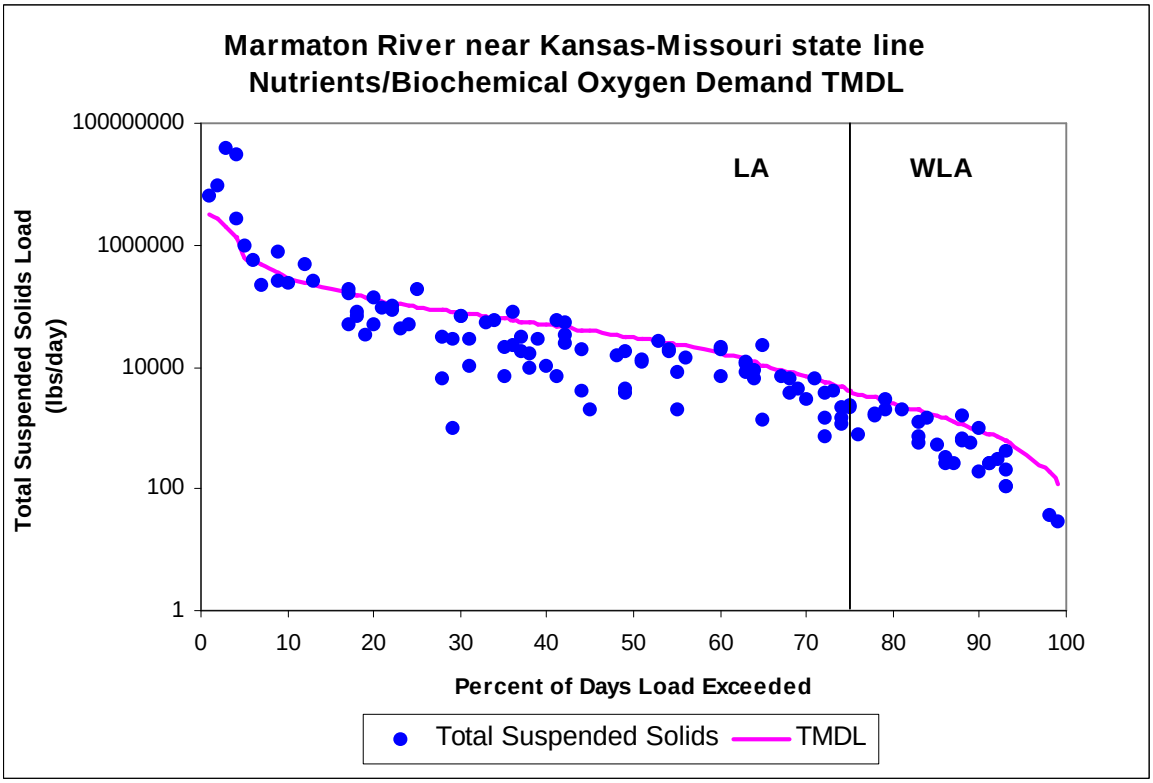

Marmaton River
Concentration (mg/L)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.3
1.9
3.4
6.6
10.8
18.0
28.3
51.9
75.4
105.7
126.7
157.5
198.3
290.5
510.8
3068.0
Flow (cfs)
Phosphorus

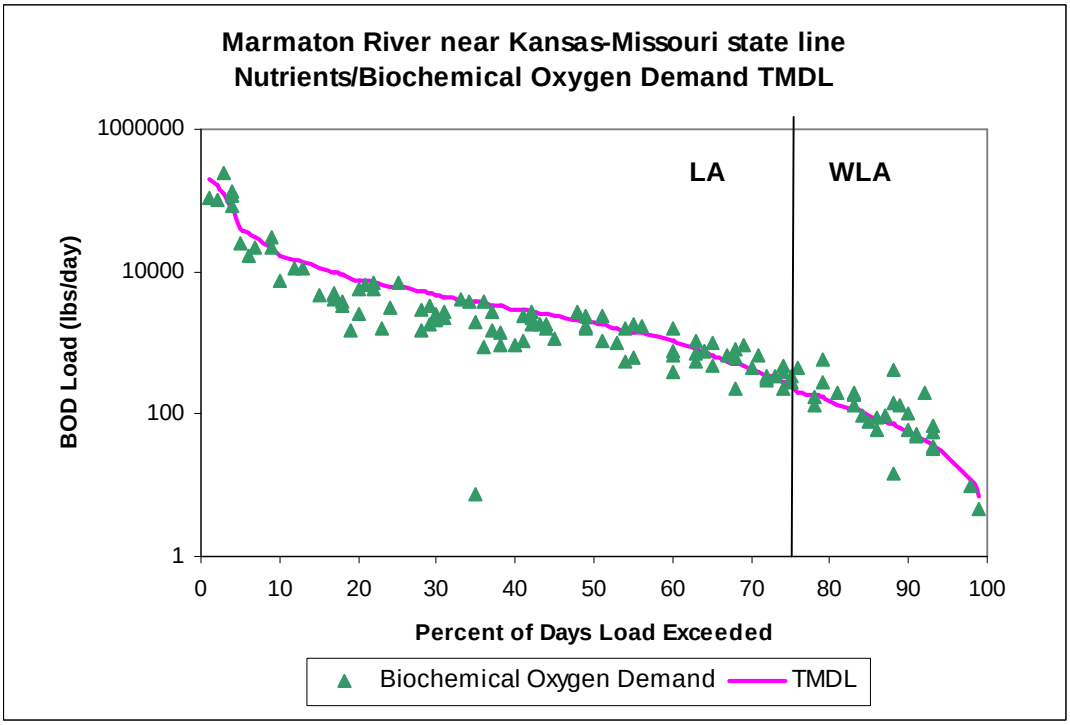

Marmaton River
Concentration (mg/L)
30
25
20
15
10
5
0
0.3
2.1
3.7
7.3
13.5
25.3
40.4
68.2
105.7
132.2
171.8
252.6
368.8
1156.1
Flow (cfs)
Biochemical Oxygen Demand

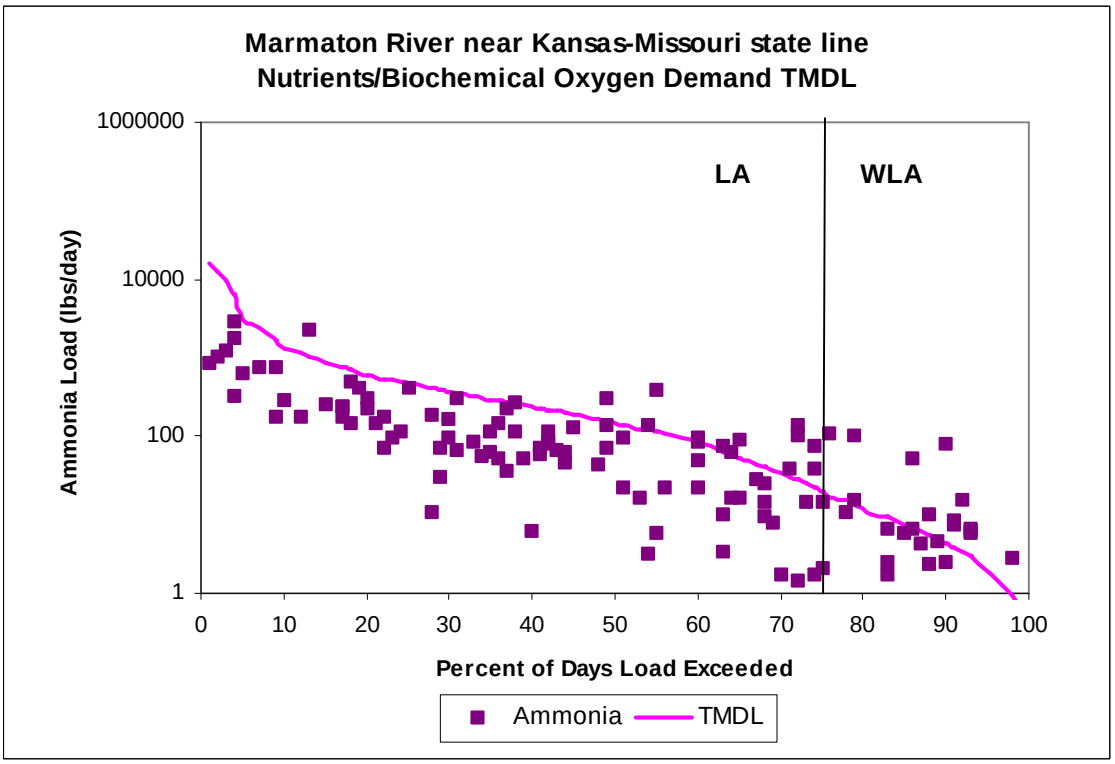

Marmaton River
Concentration (mg/L)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.3
1.9
3.4
6.6
10.8
18.0
28.3
51.9
75.4
105.7
126.7
157.5
198.3
290.5
510.8
3068.0
Flow (cfs)
Ammonia
Nitrate

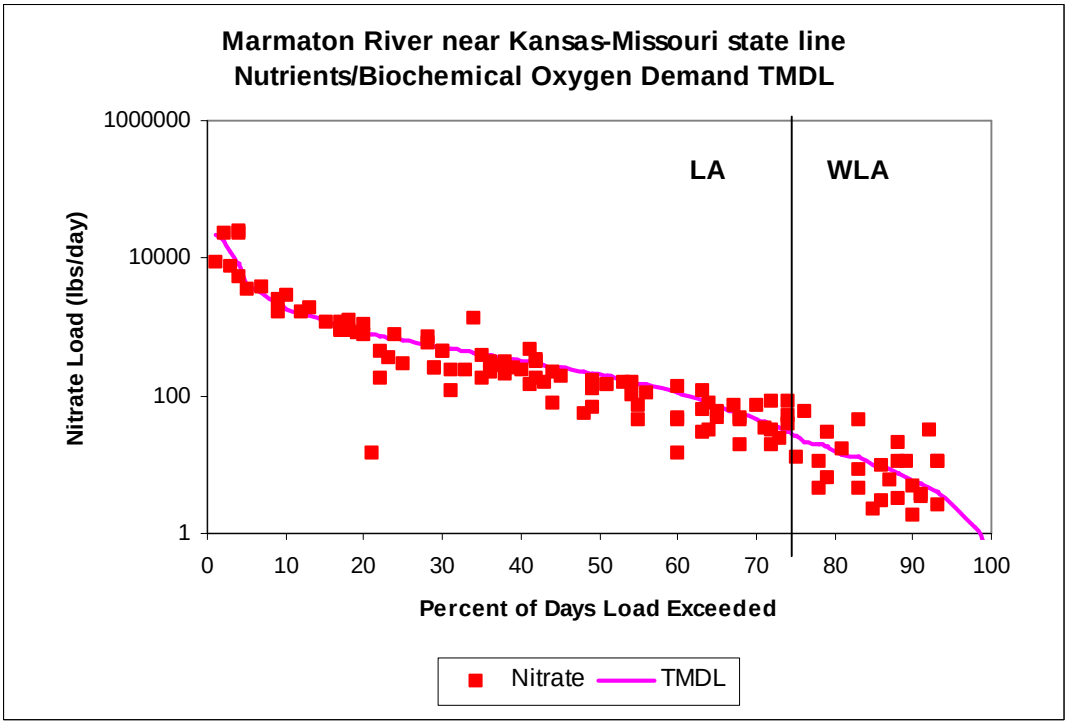

Marmaton River
Concentration (mg/L)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
2
3
7
11
18
28
52
75
106
127
157
198
290
511
3068
Flow (cfs)
Total Suspended Solids

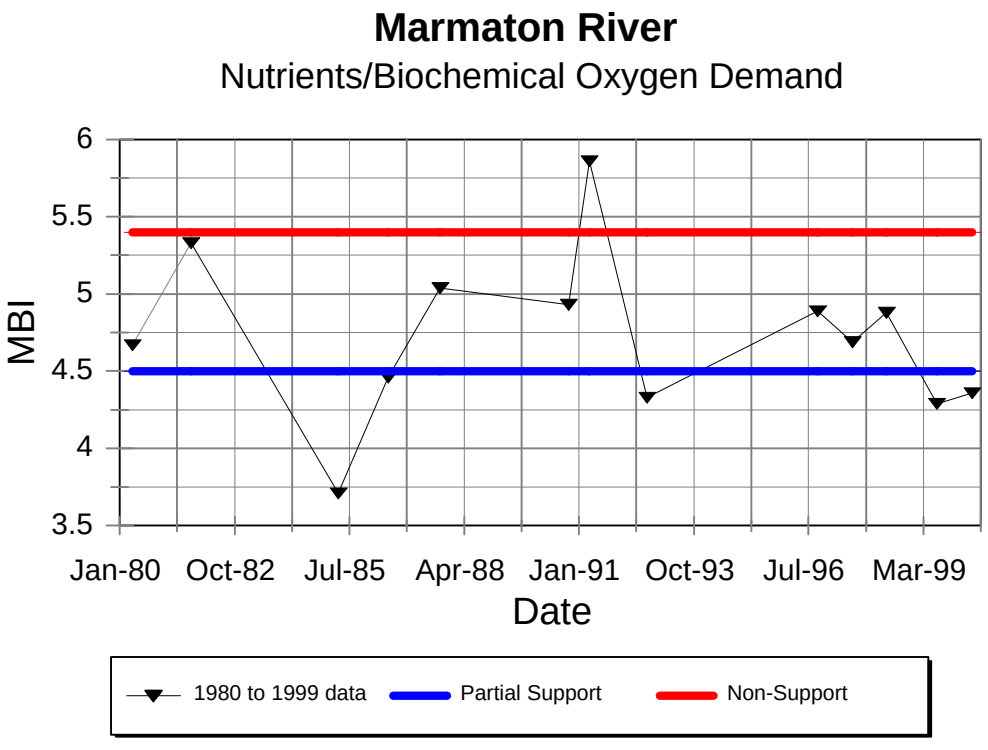

Marmaton River near Kansas-Missouri state line
Nutrients/Biochemical Oxygen Demand TMDL
LA
WLA
Phosphorus Load (lbs/day)
10000
100
1
0
10
20
30
40
50
60
70
80
90
100
Percent of Days Load Exceeded
Phosphorus
TMDL

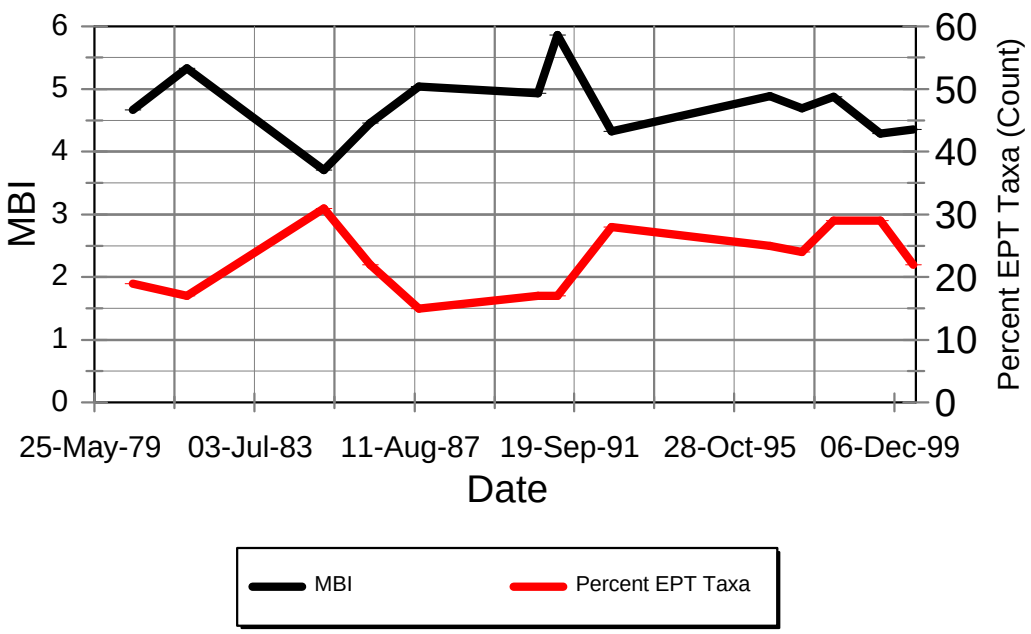

Marmaton River near Kansas-Missouri state line
Nutrients/Biochemical Oxygen Demand TMDL
LA
WLA
Total Suspended Solids Load (lbs/day)
100000000
1000000
10000
100
1
0
10
20
30
40
50
60
70
80
90
100
Percent of Days Load Exceeded
Total Suspended Solids
TMDL


Marmaton River near Kansas-Missouri state line
Nutrients/Biochemical Oxygen Demand TMDL
1000000
10000
100
1
BOD Load (lbs/day)
LA
WLA
0
10
20
30
40
50
60
70
80
90
100
Percent of Days Load Exceeded
Biochemical Oxygen Demand
TMDL


Marmaton River near Kansas-Missouri state line
Nutrients/Biochemical Oxygen Demand TMDL
1000000
10000
100
1
Ammonia Load (lbs/day)
LA
WLA
0
10
20
30
40
50
60
70
80
90
100
Percent of Days Load Exceeded
Ammonia
TMDL


Marmaton River near Kansas-Missouri state line
Nutrients/Biochemical Oxygen Demand TMDL
1000000
10000
100
1
Nitrate Load (lbs/day)
LA
WLA
0
10
20
30
40
50
60
70
80
90
100
Percent of Days Load Exceeded
Nitrate
TMDL


Marmaton River
Nutrients/Biochemical Oxygen Demand
6
5.5
5
4.5
4
3.5
MBI
Jan-80
Oct-82
Jul-85
Apr-88
Jan-91
Oct-93
Jul-96
Mar-99
Date
1980 to 1999 data
Partial Support
Non-Support


Marmaton River
Nutrients/Biochemical Oxygen Demand
MBI
Percent EPT Taxa (Count)
0
1
2
3
4
5
6
0
10
20
30
40
50
60
25-May-79
03-Jul-83
11-Aug-87
19-Sep-91
28-Oct-95
06-Dec-99
Date
MBI
Percent EPT Taxa