U.S. Environmental Protection Agency Region 7

Flat Creek
Pettis and Benton Counties, Missouri

Total Maximum Daily Load

October, 2006

Approved by:

/s/ 11/22/2006

William A. Spratlin **Date**
Director
Water, Wetlands and Pesticides Division

Total Maximum Daily Load (TMDL)
For Flat Creek

Pollutant: Sediment

Name: Flat Creek

Location: Pettis and Benton Counties, Missouri

Hydrologic Unit Code (HUC): 10300103 - 010

Waterbody Identifications (WBID): 865

Missouri Stream Classification: Class C[1]

Beneficial Uses[2]:
- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life
- Human Health Protection (Fish Consumption)
- Whole Body Contact Recreation–Category B
- Secondary Contact Recreation

Impairment: Protection of Warm Water Aquatic Life

Size of Impaired Segment: 20 miles

Location of Impaired Segment: From (upstream) T43N, R23W, Section 2 to (downstream) in T45N, R21W Section 13

Pollutant Source: Agricultural Nonpoint Sources

Pollutant: Sediment

TMDL Priority Ranking: High

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[1] Class C - Streams that may cease flow in dry periods but maintain permanent pools which support aquatic life, see Missouri Water Quality Standards (WQS) 10 Code of State Regulations 20-7.031(1)(F). The WQS can be found at the following uniform resource locator (URL): www.dnr.mo.gov/env/wpp/rules/index.html#Chap7.
[2] For Beneficial uses see 10 CSR 20-7.031(1)(C) and Table (H).

1. Introduction

This Flat Creek Total Maximum Daily Load (TMDL) for sediment is being established in accordance with Section 303(d) of the Clean Water Act, because the State determined on the 1998 and 2002 303(d) lists of impaired waters that the water quality standards (WQS) for Flat Creek were exceeded due to sediment. To meet the milestones of the 2001 Consent Decree, *American Canoe Association, et al. v. EPA*, No. 98-1195-CV-W in consolidation with No. 98-4282-CV-W, February 27, 2001, EPA is establishing this TMDL.

Flat Creek was placed on the Missouri 303(d) list due to sedimentation. Little sediment data exists to directly document sediment as a significant impact to the stream. General fisheries data and the effect of sediment on fish were the initial data used to consider Flat Creek for 303(d) listing. For this TMDL, sediment targets were derived using generalized information from the ecological drainage unit (EDU).

The purpose of a TMDL is to determine the pollutant loading a waterbody can assimilate without exceeding the WQS for that pollutant. The TMDL also establishes the pollutant load necessary to meet the WQS established for each waterbody based on the relationship between pollutant sources and in-stream water quality conditions. The TMDL consists of a wasteload allocation (WLA), a load allocation (LA), and margin of safety (MOS). The WLA is the fraction of the total pollutant load apportioned to point sources. The LA is the fraction of the total pollutant load apportioned to nonpoint sources. The MOS is a percentage of the TMDL that accounts for the uncertainty associated with the model assumption and data inadequacies.

2. Background and Water Quality Problems

Background

Flat Creek is approximately fifty-two miles long and originates in northern Benton County. It flows northeast toward Sedalia, and then continues eastward to its confluence with Richland Creek to form the Lamine River. A twenty-mile section of Flat Creek is listed as impaired by sediment. The associated watershed for the impaired section of Flat Creek is approximately 206 mi^2 with predominant land use of approximately 42% grassland, 39% cropland and 15% woodland (Appendix A).

Flat Creek watershed lies within the Lamine River Basin, which lies within the Central Plains/Blackwater/Lamine EDU. Early descriptions of the basin indicate forests occurred along the stream valleys and steeper slopes leading to prairies on uplands. The Lamine River Watershed Inventory and Assessment describes the basin:

> During the 1800's, common forest flora included hickory, oak, walnut, gum and bottom land hardwoods. As settlement continued, clearing of forests for cropland progressed. By the 1900's, tree cutting increased for fuel and building material and the land was drained as agricultural production expanded. As the land was changed to

agricultural use, sediment became a major pollutant affecting the river's ecosystem. Analysis of historic aerial photos of the Lamine River in the region of the Lamine River Wildlife Area show dismal land practices within that portion of the basin in the late 1930's. Extensive overgrazing and gully formation on agricultural land are evident. Aerial photos taken in the 1950's and 1960's reveal abandoned pasture and cropland which was severely eroded. Much of the same land was cleared again in the 1970's for agricultural use.

The Lamine River Basin lies primarily in the Cherokee Prairies soil region. Highly erodible loess soils are well drained in most areas but poorly drained in other areas. Sheet and rill erosion from tilled land (9-13 tons/acre) is relatively high. Erosion from permanent pasture is much lower (2.5-5.0 tons/acre). Gully erosion is considered severe 200 - 500 tons/acre. Baseflow is not well sustained during dry periods because most water movement in the basin is through the surface stream network and few notable springs exist.[3]

Water Quality Problems

Flat Creek was placed on the Missouri 303(d) list due to sedimentation. The number one pollutant entering Missouri's waters is sediment, with about 59 million tons of soil eroding from Missouri's land each year.[4] Sedimentation occurs when wind or water runoff carries soil particles from an area and transports them to a stream or lake. Excessive sedimentation clouds the water, which reduces the amount of sunlight reaching aquatic plants; covers fish spawning areas and food supplies; and clogs the gills of fish. In addition, other pollutants like phosphorus, pathogens, and heavy metals are often attached to the soil particles and wind up in the streams with the sediment.[5] Since little sediment data exists to directly document sediment as a significant impact to Flat Creek, a Biological Assessment on Flat Creek was conducted by Missouri Department of Natural Resources' (MDNR) Environmental Services Program (ESP) in fall 2004 and spring 2005; the data is shown in Appendix B.

All waters of the State, as per Missouri WQS, must provide suitable conditions for aquatic life. The conditions include both the physical habitat and the quality of the water. TMDLs are not written to address habitat, but are written to correct water quality conditions. Because the water body addressed by this TMDL was assessed as to its biological function, many factors may have contributed to the impairment. The State of Missouri continues to do field evaluation and in the future, may define the role sediment is playing in the potential biological impairment of this waterbody. However, the water quality condition for which Troublesome Creek is currently listed is sedimentation; therefore, this TMDL addresses sediment. The State of Missouri may submit and EPA may approve another TMDL or a

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[3] Missouri Department of Conservation, West Central Fisheries, Lamine River Watershed Inventory and Assessment, 2005, http://mdc.mo.gov/fish/watershed/lamine/contents/180cotxt.htm.
[4] Missouri Soil and Water Districts Commission, March 2003, Needs Assessment, Plan To Address Identified Needs & A Summary To Date, http://www.dnr.mo.gov/env/swcp/2003%20needs%20assessment.pdf.
[5] Agricultural Nonpoint Source (AgNPS), Special Area Land Treatment (SALT) Program, NPS Problems, http://www.dnr.mo.gov/env/swcp/service/Salt/nps_problems.htm#improper%20animal%20waste%20management.

modified 303(d) listing for this water at a later time to address new information on the impairment.

The quality and quantity of habitat for aquatic life have been affected generally in Missouri. A combination of natural geology and land use in the prairie portions of the state (where Flat Creek is located) is believed to have reduced the amount and impaired the quality of habitat for aquatic life. The Lamine River Basin is a rural watershed dominated by agriculture; the largest community is Sedalia with a population of about 20,000.[6] The major problems are excessive rates of sediment deposition due to stream bank erosion and sheet erosion from agricultural lands, and changes in basin hydrology that have increased flood flows and prolonged low flow conditions. Loss of tree cover in riparian zones has caused elevated water temperatures in summer and a reduction in woody debris, a critical aquatic habitat component in prairie streams. The most compelling evidence of loss or impairment of aquatic habitat is the change in historical distribution of fishes in Missouri. Many species of fish no longer appear in portions of the state where they once lived. Some efforts underway to improve conditions on Flat Creek include an Environmental Quality Incentive Program (EQIP) project as well as technical and cost-share assistance to landowners from the Missouri Department of Conservation[7].

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3. Description of Sources

Point Sources

Potential point sources of sediment to Flat Creek are facilities with permits through the National Pollution Discharge Elimination System (NPDES). There are thirty-eight permitted facilities within the Flat Creek watershed, including, eighteen Concentrated Animal Feeding Operations (CAFO), see tables 1 and 2. All 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 for a 25-year, 24-hour rainfall/runoff event. According to the individual permits for CAFOs in the Flat Creek watershed, the total

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[6] Missouri Department of Conservation, West Central Fisheries, Lamine River Watershed Inventory and Assessment, 2005, http://mdc.mo.gov/fish/watershed/lamine/contents/180cotxt.htm.

[7] Missouri Department of Conservation, West Central Fisheries, Lamine River Watershed Inventory and Assessment, 2005, http://mdc.mo.gov/fish/watershed/lamine/contents/180cotxt.htm.

permitted number for all facilities is 28,965 animal units (AU). The actual number on site is variable, but typically less than potential numbers.

Table 1. NPDES-permitted Facilities in Flat Creek Watershed

Facility	NPDES Permit #	County	Facility Type	Design Flow (MGD)	Receiving Stream
Municipal					
Green Ridge Lagoon	MO0049654	Pettis	SUBD	0.068000	Basin Fork Creek
Sedalia SE WWTP Outfall #1	MO0101567	Pettis	POTW	6.500000	Breakfast Branch Cr
Sedalia SE WWTP Outfall #3 Stormwater	MO0101567	Pettis	POTW	0.300000	Breakfast Branch Cr
Sedalia SE WWTP Outfall #4 Stormwater	MO0101567	Pettis	POTW	0.170000	Breakfast Branch Cr
Ionia, City Of	MO0130028	Benton	POTW	0.020700	Un Tr S Flat Cr
Non-Municipal					
Elm Hills Park	MO0088382	Pettis	SUBD	0.058617	Trib Flat Creek
Southgate Subdivision	MO0094196	Pettis	SUBD	0.019760	Trib Breakfast Br
Oak Tree Apartments WWTF	MO0097276	Pettis	SUBD	0.001800	Trib Flat Cr
Meadowlark MHP	MO0106755	Pettis	MHP	0.018000	Trib Spring Fk Cr
Hillcrest MHP	MO0112291	Pettis	MHP	0.002250	Trib Flat Creek
Sunset Motel	MO0115592	Pettis	MOTEL	0.002760	Trib Flat Cr
Union Pacific RR, Sedalia	MO0116327	Pettis	RAILR	stormwater only	Cedar Cr
Stardust Motor Inn	MO0118427	Pettis	APTS	0.003300	Trib Flat Cr
Budget Host Super 7 Motel	MO0118516	Pettis	MOTEL	0.003000	Trib Flat Cr
Mexico Lindo Restaur/Club	MO0119849	Pettis	EATS	0.000690	Trib Flat Cr
Cambridge Village	MO0125628	Pettis	SUBD	0.025252	Trib Flat Cr
Temp-Stop #103/Pit Stop	MO0129402	Pettis	SER S	0.001500	Trib Flat Cr
MFA Bulk Plant-Sedalia	MOG350151	Pettis	PET S	Above ground storage of petroleum products	Trib Flat Cr
Fischer Prop-Fischer Conc	MOG490598	Pettis	LIM Q	Limestone and rock quarries, concrete, glass and asphalt	Trib Flat Cr
Sedalia WTP	MOG640204	Pettis	WATER	Water treatment plants filter backwash	Trib Flat Cr

Table 2. NPDES-permitted CAFOs in Flat Creek Watershed.

Facility	NPDES Permit #	County	Facility Type	Design Flow (MGD)
CAFO				
Cloud Farms Inc.	MOG010003	Pettis	HOGS	Non-discharging
Purchase, Scott	MOG010042	Pettis	POULT	
Deer Run Farms Green Rdge	MOG010043	Pettis	POULT	
Chanticleer Ranch, Inc.	MOG010045	Pettis	POULT	
6 Six Feathers	MOG010051	Pettis	POULT	
Stanly Selleck	MOG010144	Benton	BIRD	
Shenandoah Farms LLC	MOG010146	Pettis	POULT	
Millsap's Breeders	MOG010147	Pettis	BIRD	
Young, Harry Jr.	MOG010168	Pettis	BIRD	
Bright Ranch	MOG010174	Pettis	BIRD	
Camp Branch Ranch, Inc.	MOG010175	Pettis	HOGS	
Flat Cr Farms Pettis Cnty	MOG010229	Pettis	POULT	
Miller, Jeffrey	MOG010242	Pettis	POULT	
Hillbilly Ranch, LLC	MOG010402	Benton	POULT	
Chesapeake Farm, LLC	MOG010405	Pettis	POULT	
Eilks, Kevin, Carrie	MOG010406	Pettis	BIRD	
Bohon, Doug And Bonnie	MOG010588	Benton	POULT	
County Line Three	MOG010623	Pettis	POULT	

Nonpoint Sources

The main source of sediment is believed to be runoff from agricultural nonpoint sources. Problems from agricultural runoff include turbidity, sedimentation, low dissolved oxygen (DO), high nitrogen and phosphorous concentrations, high ammonia and high fecal coliform counts. Over one-third of the land cover in the Flat Creek watershed is cropland. Much of the impaired segment of Flat Creek is near or adjacent to cropland (Appendix A) which could contribute to sediment loading of the streams. The agricultural areas of the basin also contain livestock which are not held in permitted CAFOs, see Table 3. The grassland portions of the watershed contain pastures, and approximately 83% of the forested lands in the basin are grazed by livestock. Barren or narrow stream corridors are typical for the area, causing stream bank erosion and floodplain scour. Livestock waste in the basin is estimated at over 2.6 million PE (human population equivalent).[8]

[8] Missouri Department of Conservation, West Central Fisheries, Lamine River Watershed Inventory and Assessment, 2005, http://mdc.mo.gov/fish/watershed/lamine/contents/180cotxt.htm.

Table 3. Agriculture Census County Summary for Pettis and Benton Counties, 2002[9].

Livestock and Poultry	Pettis	Benton
Cattle and calves	30,017	44,897
Beef cows	17,193	22,515
Milk cows	616	1,289
Hogs and pigs	1,810	1,501
Sheep and lambs	992	595
Layers 20 wks old and older	1,099	(D)
Broilers sold	214	4,434,160

(D) Withheld to avoid disclosing data for individual farms.

4. Description of the Applicable WQS and Numeric Water Quality Targets

Beneficial Uses

The designated uses of Flat Creek, WBID 865, are:

- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life
- Human Health Protection (Fish Consumption)
- Whole Body Contact Recreation – Category B
- Secondary Contact Recreation

The stream classifications and designated uses may be found at 10 CSR20-7.031(1)(C) and (F) and Table H.

Use that is impaired

- Protection of Warm Water Aquatic Life

Antidegradation Policy

Missouri's WQS include the U.S. Environmental Protection Agency's (EPA) "three-tiered" approach to antidegradation, and may be found at 10 CSR 20-7.031(2).

Tier 1 – Protects existing uses and provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after November 29, 1975, the date of EPA's first WQS Regulation, or uses for which existing water quality is suitable unless prevented by physical problems such as substrate or flow.

[9] Census of Agriculture, Volume 1 Chapter 2: Missouri County Level Data, 2002, http://www.nass.usda.gov/census/census02/volume1/mo/index2.htm.

Tier 2 – Protects the level of water quality necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water in waters that are currently of higher quality than required to support these uses. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economical or social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices (BMP) for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national resources, such as waters of national and state parks, wildlife refuges and waters of exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality (with the exception of some limited activities that result in temporary and short-term changes in water quality).

Specific Criteria

The impairment of this waterbody is based on exceedence of the general, or narrative, criteria contained in Missouri's WQS, 10 CSR 20-7.031(3)(A), (C) and (G):

(A) Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses.

(C) Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses.

(G) Waters shall be free from physical, chemical or hydrologic changes that would impair the natural biological community.

When the WQS is expressed as a narrative value, a measurable indicator of the pollutant may be selected to express the narrative as a numeric value. There are many quantitative indicators of sediment, such as, total suspended solids (TSS), turbidity, and bedload sediment, which are appropriate to describe sediment in rivers and streams.[10] TSS was selected as the numeric target for this TMDL because it enables the use of the highest quality data available, including permit conditions and monitoring data.

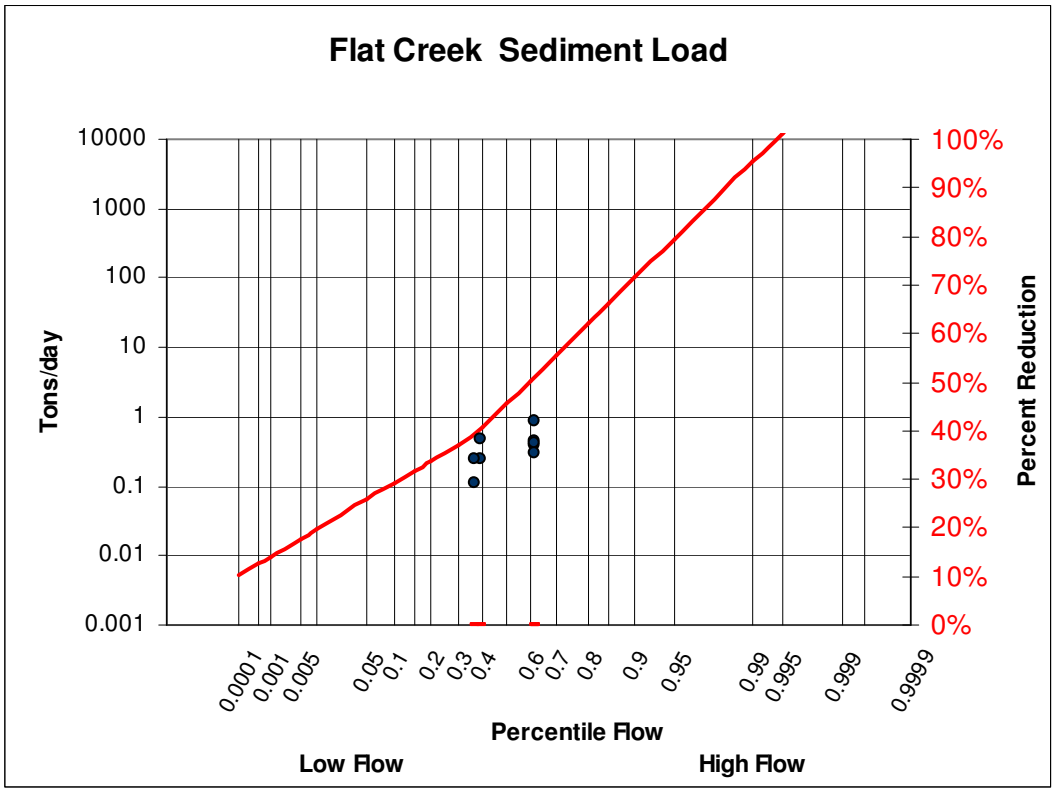
5. Calculation of Load Capacity

Load capacity (LC) is defined as the maximum pollutant load that a waterbody can assimilate and still attain WQS. This total load is then divided among a WLA for point sources, a LA for nonpoint sources and a MOS. The LC for this TMDL has been defined as a curve over the range of flows for Flat Creek, see Figure 1, where the solid (red) curve is the TMDL.

[10] Framework for Developing Suspended and Bedded Sediments (SABS) Water Quality Criteria, U.S. Environmental Protection Agency, EPA-822-R-06-001, May 2006.

Turbidity measurements taken during the biological assessment were used to estimate TSS concentrations using relationships developed by Doisey and Rabeni[11]. These estimates, along with measured TSS concentrations, are shown in figure 1, where the round (black) points are loads calculated from the estimated concentrations and the corresponding horizontal bars (red) are percent reduction to meet the TMDL.

Figure 1. TMDL Curve Over the Range of Flows.



Modeling Approach

In cases where pollutant data for the impaired stream is not available a reference approach is used. In this approach, the target for pollutant loading is the 25th percentile of the current EDU condition calculated from all data available within the EDU in which the waterbody is located. Therefore, the 25th percentile is targeted as the TMDL load duration curve (LDC). For a full description of the development of suspended sediment targets using reference LDC refer to Appendix C. For Flat Creek flow estimate and source data for the reference EDU refer to Appendix D.

[11] Effects of Suspended Sediment on Native Missouri Fishes: A Literature Review and Synthesis, K.E. Doisey and C.F. Rabeni, 2004, University of Missouri.

6. Load Allocation (Nonpoint Source Loads)

LA is the allowable amount of the pollutant that can be assigned to nonpoint sources. The LA is set at 90% of the TMDL, leaving 10% of the TMDL as a MOS. For example, at median flow (0.5 percentile flow) the TMDL is approximately 1.54 tons/day, so the LA would be approximately 1.39 tons/day and the MOS would be approximately 0.15 tons/day.

7. Waste Load Allocation (Point Source Loads)

WLA is the allowable amount of the pollutant that can be assigned to point sources. The WLA is set to the lesser of current permit limits or technology based effluent limits (TBELs). TBELs are defined in a permit based on facility type. Mechanical waste water treatment facilities' (WWTF) permit limits are a weekly average TSS concentration of 45 mg/L and a monthly average TSS concentration of 30 mg/L. Secondary equivalent WWTFs' permit limits are a weekly average TSS concentration of 60 mg/L and a monthly average TSS concentration of 45 mg/L. Waste water treatment lagoon facilities' permit limits are up to a weekly average TSS concentration of 120 mg/L and a monthly average TSS concentration of 80 mg/L. Additionally, permits can be written to target lower limits if the specific facility is capable of performance exceeding TBELs. Table 4 lists the permitted point sources in the watershed and WLAs based on their current permit limits and permitted design flows. In addition, any general permits need evaluation to determine if a site specific permit is needed to address sediment loading. Based on the assessment of sources, point sources do not contribute to water quality impairment relative to sediment impacts on stream biology. Thus, the WLAs are zero percentage net reduction in sediment load. These facilities' WLAs are set at the current permit limits and conditions. The WLAs listed in this TMDL do not preclude the establishment of future point sources of sediment loading in the watershed. Any future point sources should be evaluated in light of the TMDL established and the range of flows into which any additional load will impact.

All permitted CAFOs are non-discharging permits and therefore their WLAs are set at zero.

Table 4. Waste Load Allocations for Point Sources of Sediment in Flat Creek Watershed.

Facility	NPDES Permit #	Design Flow (MGD)	Permitted TSS Effluent Limits (mg/L) d/w/m*	WLA (tons/day) d/w/m*
Municipal				
Green Ridge Lagoon	MO0049654	0.068000	NA/110/70	NA/0.0312/0.0198
Sedalia SE WWTP Outfall #1	MO0101567	6.500000	NA/45/30	NA/1.2197/0.8132
Sedalia SE WWTP Outfall #3 Stormwater	MO0101567	0.300000	l.5 mL/L/hr SS** / NA / 1.0 mL/L/hr SS	Max. l.5 mL/L/hr SS / NA / 1.0 mL/L/hr SS, inclusion of BMPs
Sedalia SE WWTP Outfall #4 Stormwater	MO0101567	0.170000	l.5 mL/L/hr SS / NA / 1.0 mL/L/hr SS	Max. l.5 mL/L/hr SS / NA / 1.0 mL/L/hr SS, inclusion of BMPs
Ionia, City Of	MO0130028	0.020700	NA/110/70	NA/0.0095/0.0060
Non-Municipal				
Elm Hills Park	MO0088382	0.058617	NA/120/80	NA/0.0293/0.0196
Southgate Subdivision	MO0094196	0.019760	NA/45/30	NA/0.0037/0.0025
Oak Tree Apartments WWTF	MO0097276	0.001800	NA/120/80	NA/0.0009/0.0006
Meadowlark MHP	MO0106755	0.018000	NA/110/70	NA/0.0082/0.0053
Hillcrest MHP	MO0112291	0.002250	NA/120/80	NA/0.0011/0.0008
Sunset Motel	MO0115592	0.002760	NA/120/80	NA/0.0014/0.0009
Union Pacific RR, Sedalia	MO0116327	stormwater only	l.5 mL/L/hr SS / NA / 1.0 mL/L/hr SS	Max. l.5 mL/L/hr SS / NA / 1.0 mL/L/hr SS, inclusion of BMPs
Stardust Motor Inn	MO0118427	0.003300	NA/120/80	NA/0.0017/0.0011
Budget Host Super 7 Motel	MO0118516	0.003000	NA/110/70	NA/0.0014/0.0009
Mexico Lindo Restaur/Club	MO0119849	0.000690	NA/120/80	NA/0.0003/0.0002
Cambridge Village	MO0125628	0.025252	NA/45/30	NA/0.0047/0.0032
Temp-Stop #103/Pit Stop	MO0129402	0.001500	NA/120/80	NA/0.0008/0.0005
MFA Bulk Plant-Sedalia	MOG350151	Above ground storage of petroleum products	NA	Storm water discharge, implementation of Storm water pollution prevention plan (SWPP) required
Fischer Prop-Fischer Conc	MOG490598	Limestone and rock quarries, concrete, glass and asphalt	NA	Non-storm water discharges TSS 70mg/L, storm water discharges SS daily max. 1.5mL/L/Hr, inclusion of BMPs
Sedalia WTP	MOG640204	Water treatment plants filter backwash	NA	Max. daily SS 1.0mL/L/Hr, inclusion of BMPs

*Permit limits based on current design loads where d=daily, w=weekly average, m=monthly average.
**Settleable Solids.

8. Margin of Safety

A MOS is added to a TMDL to account for the uncertainties inherent in the calculations and data gathering. The MOS is intended to account for such uncertainties in a conservative manner. Based on EPA guidance, the MOS can be achieved through one of two approaches:

(1) Explicit – Reserve a numeric portion of the LC as a separate term in the TMDL.
(2) Implicit – Incorporate the MOS as part of the critical conditions for the waste WLA and the LA calculations by making conservative assumptions in the analysis.

Available data for Flat Creek shows instances where load is near the TMDL (Figure 1). In addition, the Biological Assessment for Flat Creek (Appendix B) indicates that Flat Creek is not fully sustaining aquatic life at all sampling locations. To account for uncertainties in the modeling an explicit 10% MOS is assigned to this TMDL. A numeric example of the MOS at median flow is given in the LA section above.

9. Seasonal Variation

The TMDL curve represents flow under all seasonal conditions. The LA and TMDL are applicable at all flow conditions, hence all seasons. The advantage of LDC approach is to avoid the constraints associated with using a single-flow critical condition during the development of a TMDL. Therefore, all flow conditions including seasonal variation are taken into account for TMDL calculations.

10. Monitoring

No future monitoring has been scheduled for Flat Creek at this time. However, MDNR will routinely examine physical habitat, water quality, invertebrate community, and fish community data collected by the Missouri Department of Conservation under its Resource Assessment and Monitoring (RAM) Program. This program randomly samples streams across Missouri on a five to six year rotating schedule.

11. Public Participation

EPA regulations, 40 CFR 130.7, require that TMDLs be subject to public review. EPA is providing public notice of this TMDL for Flat Creek on the EPA, Region 7, TMDL website: http://www.epa.gov/region07/water/tmdl_public_notice.htm. The response to comments and final TMDL will be available at: http://www.epa.gov/region07/water/apprtmdl.htm#Missouri.

This water quality limited segment of Flat Creek in Pettis and Benton Counties, Missouri, is included on the approved 1998 and 2002 303(d) lists for Missouri. This TMDL is being produced by EPA to meet the requirements of the 2001 Consent Decree, *American Canoe Association, et al. v. EPA*, No. 98-1195-CV-W in consolidation with No. 98-4282-CV-W, February 27, 2001. EPA is developing this TMDL in cooperation with the State of Missouri, and

EPA is establishing this TMDL at this time to fulfill the *American Canoe* consent decree obligations. Missouri may submit and EPA may approve another TMDL for this water at a later time.

As part of the public notice process, MDNR will assist EPA by providing a distribution list of interested persons to which EPA will provide an announcement of the Flat Creek TMDL. Groups that receive the public notice announcement will include the Missouri Clean Water Commission, the Missouri Water Quality Coordinating Committee, Stream Team Volunteers in the counties, county legislators, and potentially impacted cities, towns and facilities. The EPA public noticed this TMDL from October 6, 2006, to November 5, 2006, and the Summary of response to Comment(s) is posted on the EPA website: http://www.epa.gov/region07/water/apprtmdl.htm#Missouri.

12. References

Agricultural Nonpoint Source (AgNPS), Special Area Land Treatment (SALT) Program, NPS Problems, http://www.dnr.mo.gov/env/swcp/service/Salt/nps_problems.htm#improper%20animal%20waste%20management.

Biological Assessment, Flat Creek, Pettis County, Missouri, December 14, 2005, Missouri Department of Natural Resources.

Effects of Suspended Sediment on Native Missouri Fishes: A Literature Review and Synthesis, K.E. Doisey and C.F. Rabeni, 2004, University of Missouri.

Framework for Developing Suspended and Bedded Sediments (SABS) Water Quality Criteria, U.S. Environmental Protection Agency, EPA-822-R-06-001, May 2006.

Missouri Soil and Water Districts Commission, March 2003, Needs Assessment, Plan To Address Identified Needs & A Summary To Date, http://www.dnr.mo.gov/env/swcp/2003%20needs%20assessment.pdf.

Missouri Department of Conservation, West Central Fisheries, Lamine River Watershed Inventory and Assessment, 2005, http://mdc.mo.gov/fish/watershed/lamine/contents/180cotxt.htm.

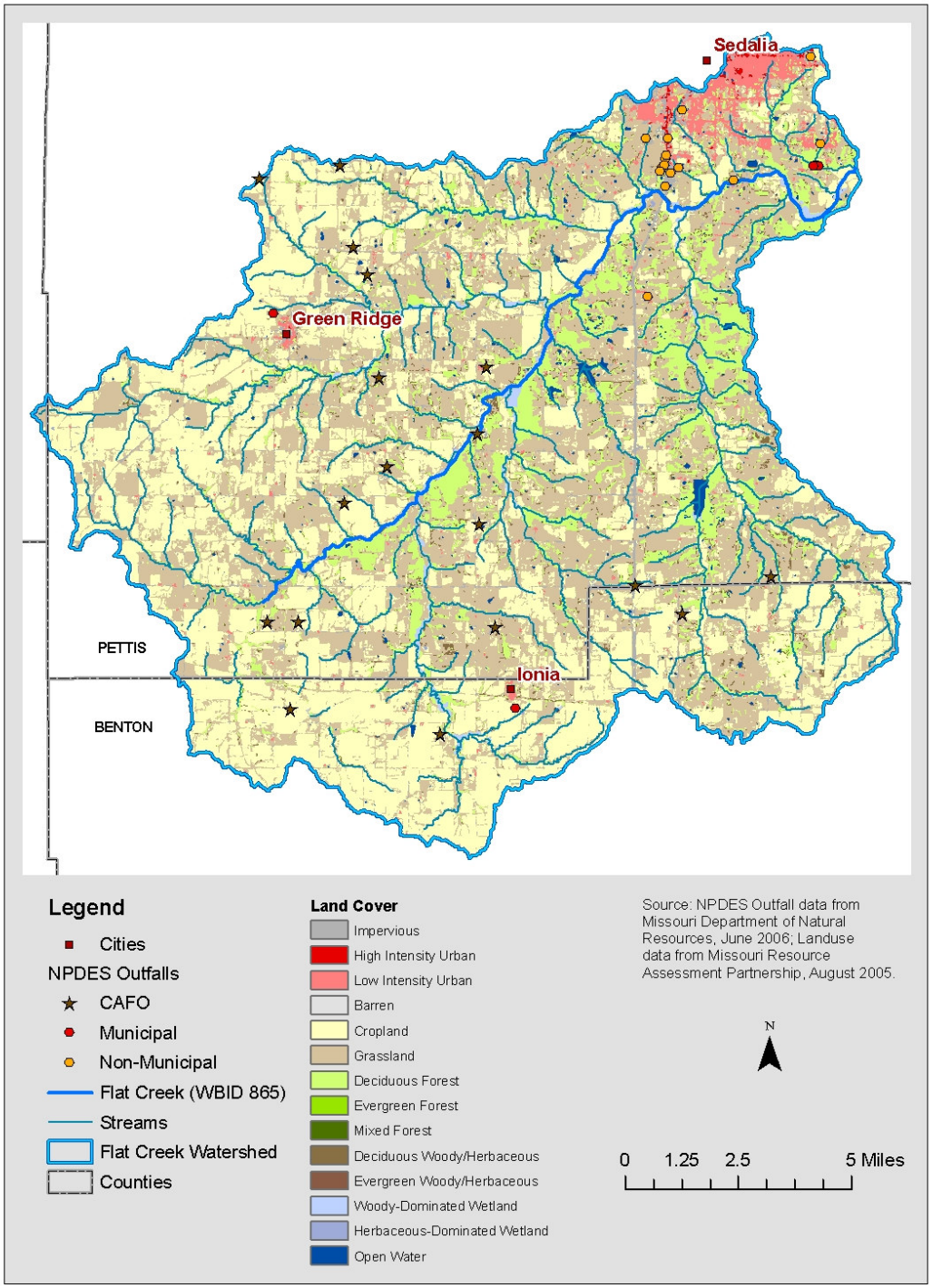
13. Appendices

Appendix A – Map Of Flat Creek Watershed And Impaired Segment – WBID 865
Appendix B – Flat Creek Biological Assessment Data
Appendix C – Development of Pollutant Targets using Reference Load Duration Curves
Appendix D – Flat Creek Flow Estimate and Source Data for Reference EDU

Appendix E – Missouri Department of Natural Resources Total Maximum Daily Load Information Sheet For Streams with Aquatic Habitat Loss that are Listed for Sediment

Appendix A

Map Of Flat Creek Watershed And Impaired Segment – WBID 865



Appendix B

Flat Creek Biological Assessment Data

Flat Creek Metric Values and Scores, Fall 2004 Season, Using Plains/Missouri Tributaries between the Blue and Lamine Rivers Biological Criteria Reference Database

Site	TR	EPTT	BI	SDI	SCI	Support
#1 Value	82	12	6.22	3.14		
#1 Score	5	3	5	5	18	**Full**
#2 Value	69	17	6.61	2.99		
#2 Score	5	5	5	3	18	**Full**
#3 Value	68	11	6.54	2.95		
#3 Score	3	3	5	3	14	**Partial**
#4 Value	62	10	6.82	2.98		
#4 Score	3	3	5	3	14	**Partial**
#5 Value	70	10	7.03	2.80		
#5 Score	5	3	5	3	16	**Full**

Flat Creek Metric Values and Scores, Spring 2005 Season, Using Plains/Missouri Tributaries between the Blue and Lamine Rivers Biological Criteria Reference Database

Site	TR	EPTT	BI	SDI	SCI	Support
#1 Value	69	14	5.81	3.12		
#1 Score	3	5	5	5	18	**Full**
#2 Value	65	16	6.30	3.06		
#2 Score	3	5	5	5	18	**Full**
#3 Value	57	10	6.52	3.09		
#3 Score	3	3	3	5	14	**Partial**
#4 Value	67	10	6.80	3.13		
#4 Score	3	3	3	5	14	**Partial**
#5 Value	58	7	6.97	2.96		
#5 Score	3	3	3	5	14	**Partial**

Flat Creek Sample Stations
Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU

Appendix C

Development of Pollutant Targets using Reference Load Duration Curves

Overview

This procedure is used when a lotic system is placed on the 303(d) impaired waterbody list for a pollutant and the designated use being addressed is aquatic life. In cases where pollutant data for the impaired stream is not available a reference approach is used. The target for pollutant loading is the 25th percentile calculated from all data available within the ecological drainage unit (EDU) in which the waterbody is located. Additionally, it is also unlikely that a flow record for the impaired stream is available. If this is the case a synthetic flow record is needed. In order to develop a synthetic flow record calculate an average of the log discharge per square mile of USGS gaged rivers for which the drainage area is entirely contained within the EDU. From this synthetic record develop a flow duration from which to build a load duration curve for the pollutant within the EDU.

From this population of load durations follow the reference method used in setting nutrient targets in lakes and reservoirs. In this methodology the average concentration of either the 75th percentile of reference lakes or the 25th percentile of all lakes in the region is targeted in the TMDL. For most cases available pollutant data for reference streams is also not likely to be available. Therefore follow the alternative method and target the 25th percentile of load duration of the available data within the EDU as the TMDL load duration curve. During periods of low flow the actual pollutant concentration may be more important than load. To account for this during periods of low flow the load duration curve uses the 25th percentile of EDU concentration at flows where surface runoff is less than 1% of the stream flow. This results in an inflection point in the curve below which the TMDL is calculated using this reference concentration.

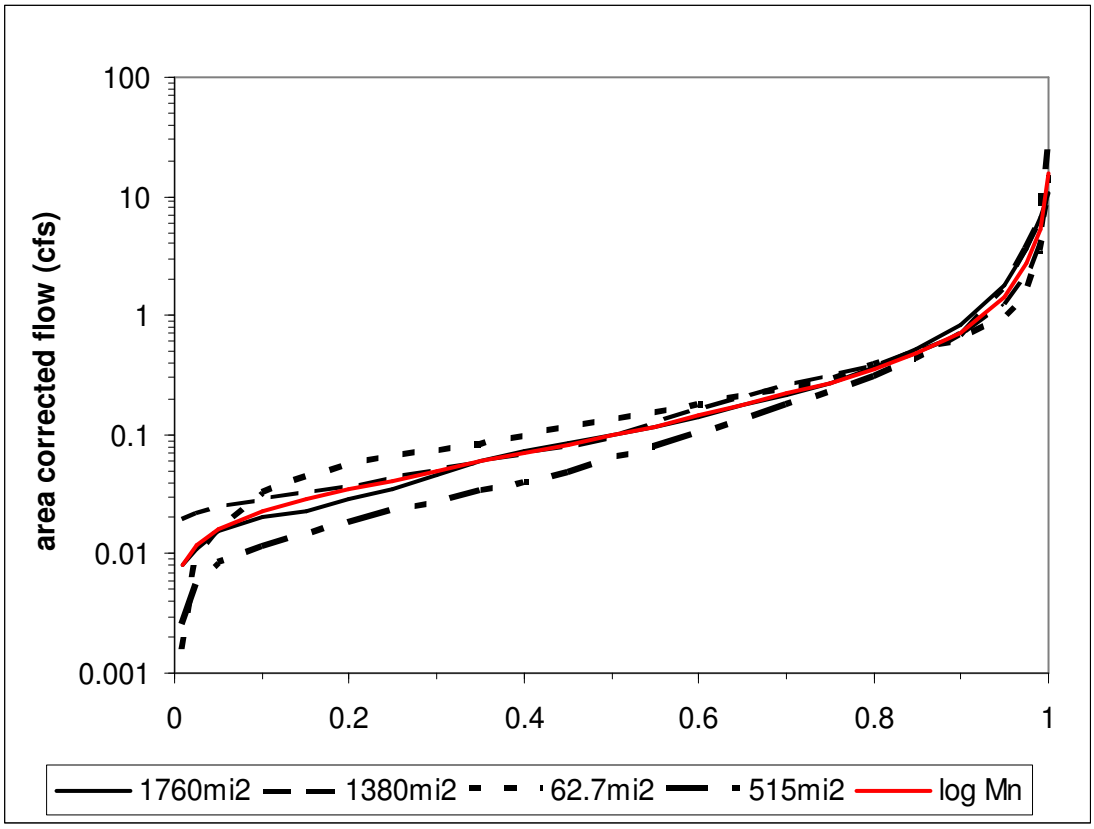
Methodology

The first step in this procedure is to locate available pollutant data within the EDU of interest. These data along with the instantaneous flow measurement taken at the time of sample collection for the specific date are recorded to create the population from which to develop the load duration. Both the date and pollutant concentration are needed in order to match the measured data to the synthetic EDU flow record.

Secondly, collect average daily flow data for gages with a variety of drainage areas for a period of time to cover the pollutant record. From these flow records normalize the flow to a per square mile basis. Average the log transformations of the average daily discharge for each day in the period of record. For each gage record used to build this synthetic flow record calculate the Nash-Sutcliffe statistic to determine if the relationship is valid for each record. This relationship must be valid in order to use this methodology. This new synthetic record of flow per square mile is used to develop the load duration for the EDU. The flow record should be of sufficient length to be able to calculate percentiles of flow.

The following examples show the application of the approach to one Missouri EDU.

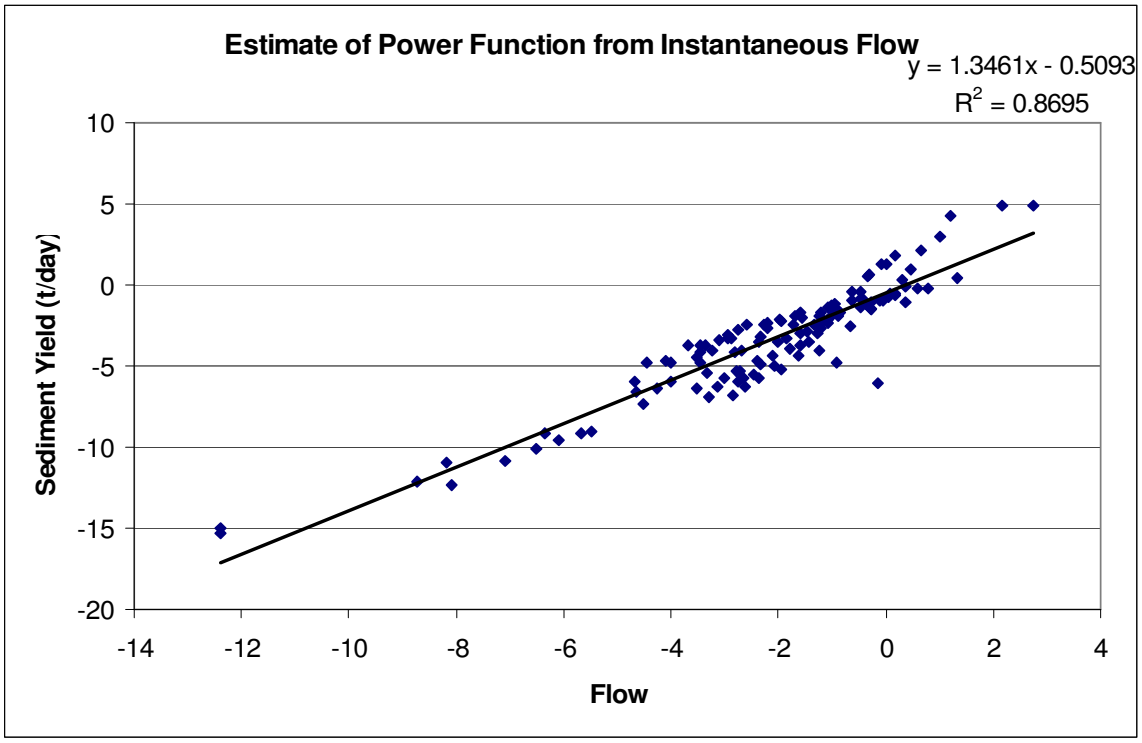
The watershed-size normalized data for the individual gages in the EDU were calculated and compared to a pooled data set including all of the gages. The result of this analysis is displayed in the following figure and table:



Gage	gage	area (mi^2)	normal Nash-Sutcliffe	lognormal Nash-Sutcliffe
Platte River	06820500	1760	80%	99%
Nodaway River	06817700	1380	90%	96%
Squaw Creek	06815575	62.7	86%	95%
102 River	06819500	515	99%	96%

This demonstrates the pooled data set can confidently be used as a surrogate for the EDU analyses.

The next step is to calculate pollutant-discharge relationships for the EDU, these are log transformed data for the yield (tons/mi^2/day) and the instantaneous flow (cfs/mi^2.) The following graph shows the EDU relationship:



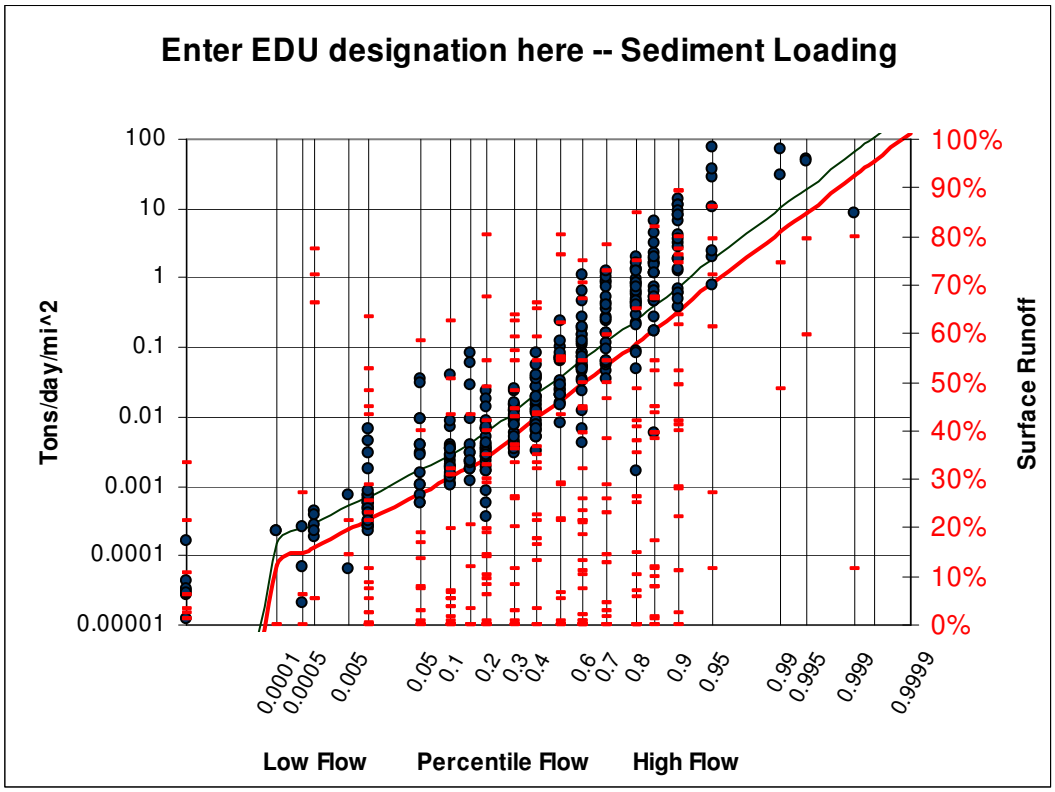
Further statistical analyses on this relationship are included in the following Table:

m	1.34608498	b	-0.509320019
Standard Error (m)	0.04721684	Standard Error (b)	0.152201589
r^2	0.86948229	Standard Error (y)	1.269553159
F	812.739077	DF	122
SSreg	1309.94458	SSres	196.6353573

The standard error of y was used to estimate the 25%ile level for the TMDL line. This was done by adjusting the intercept (b) by subtracting the product of the one-sided Z_{75} statistic times the standard error of (y). The resulting TMDL Equation is the following:

*Sediment yield (t/day/mi^2)=exp(1.34608498 * ln (flow) - 1.36627)*

A resulting pooled TMDL of all data in the watershed is shown in the following graph:



To apply this process to a specific watershed would entail using the individual watershed data compared to the above TMDL curve that has been multiplied by the watershed area. Data from the impaired segment is then plotted as a load (tons/day) for the y-axis and as the percentile of flow for the EDU on the day the sample was taken for the x-axis.

For more information contact:
Environmental Protection Agency, Region 7
Water, Wetlands, and Pesticides Division
Total Maximum Daily Load Program
901 North 5th Street
Kansas City, Kansas 66101
Website: http://www.epa.gov/region07/water/tmdl.htm

Appendix D

Flat Creek Flow Estimate and Source Data for Reference EDU

Estimated Flow for Range of Percentiles at the Impaired Segment Outlet

	Percent of Flow	Discharge (cubic feet per second)
Flow estimate for Flat Creek based on drainage area and synthetic ecological drainage unit flow.	10	2.61
	30	9.06
	50	22.9
	70	61.2
	90	294

USGS stream gages used to generate synthetic flow

Lamine River nr Otterville	06906800
Blackwater R at Blue Lick	06908000

USGS stream sample sites used to generate EDU TMDL

Blue River nr Stanley KS	06893080
Blue River at Kenneth Road, OP KS	06893100
Lamine River near Pilot Grove, MO	06907300
Lamine River near Blackwater, MO	06908800

Appendix E

Missouri Department of Natural Resources

Total Maximum Daily Load Information Sheet

For Streams with Aquatic Habitat Loss that are Listed for Sediment

Waterbody Segment at a Glance:

Location: Streams in Northern and West Central Missouri and in the Mississippi Embayment of Southeast Missouri and the Missouri and Mississippi Rivers.

Impairment: In 1998 the Department of Natural Resources listed 38 streams with habitat impairment due to agricultural nonpoint source problems. Twelve of them were delisted because new data showed they were higher quality reference streams, not impaired by sediment. One of them was retained on the list for "unknown" pollutants. The other 25 of them appear on the 2002 US EPA 303(d) list for Missouri as being impaired by "sediment".

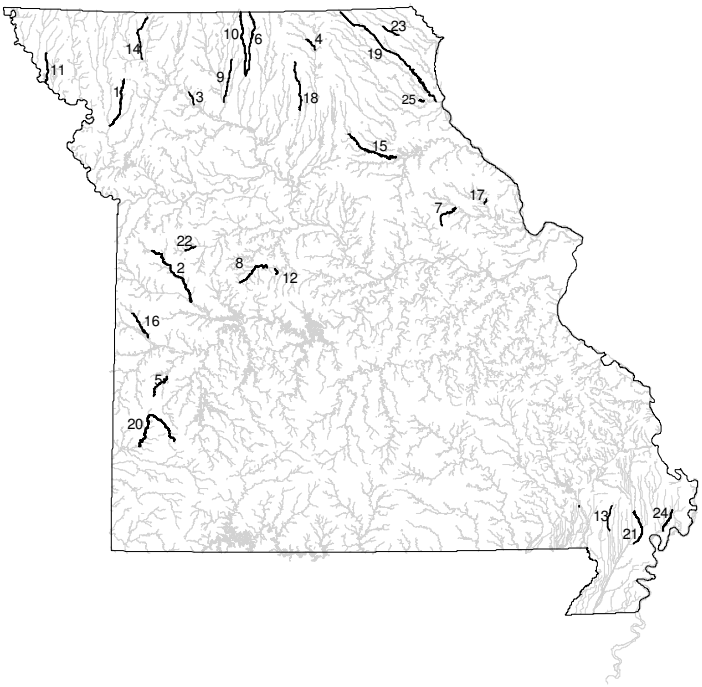
Description of the Problem

All of these waters, as per Missouri Water Quality Standards, must provide a suitable home for aquatic life. A combination of natural geology and land use in the prairie portions of the state and the Mississippi Embayment is believed to have reduced the amount and impaired the quality of aquatic habitat. The major problems are excessive rates of sediment deposition due to streambank erosion and sheet erosion from agricultural lands, loss of stream length and loss of stream channel heterogeneity due to channelization, and changes in basin hydrology that have increased flood flows and prolonged low flow conditions. Loss of tree cover in riparian zones has caused elevated water temperatures in summer and a reduction in woody debris, a critical aquatic habitat component in prairie streams. The most compelling evidence of loss or impairment of aquatic habitat is the historical change in distribution of fishes in Missouri. Many species of fish no longer appear in portions of the state where they once lived.

The department proposed changing the listing of "sediment" to "habitat loss." This change was proposed because sediment is often an important, but certainly not the only, pollutant or condition causing degradation of aquatic habitat in these streams. With this proposed change, other problems such as channelization, alteration of streambanks and riparian zones, and alteration of normal flow regimes would be included as conditions contributing to impairment. The US Environmental Protection Agency denied this change because habitat loss is "pollution", not a specific "pollutant" that can be measured and calculated. This is necessary because a TMDL (Total Maximum Daily Load) is a numeric calculation.

The department is developing a sediment protocol to determine if sediment is actually the pollutant in these streams and a standard way to measure sediment.

Missouri Streams with Loss of Habitat due to Agricultural Non-Point Source Pollution



#	Waterbody	County (lower section)	Miles affected		#	Waterbody	County (lower section)	Miles affected
1	3rd Fork Platte River	Buchanan	31.5		14	M. Fork Grand River	Gentry	25
2	Big Creek	Henry	49		15	M. Fork Salt River	Monroe	49
3	Big Muddy Creek	Daviess	8		16	Miami Creek	Bates	18
4	Clear Creek	Adair	10.5		17	Mill Creek	Lincoln	4
5	Clear Creek	Vernon	18		18	Mussel Fork	Macon	29
6	E. Fork Medicine Cr.	Grundy	36		19	N. Fabius River	Marion	82
7	Elkhorn Creek	Montgomery	19		20	N. Fork Spring River	Jasper	51.5
8	Flat Creek	Pettis	20		21	Old Channel Little R.	New Madrid	20
9	Honey Creek	Livingston	23		22	S. Fork Blackwater R.	Johnson	5
10	Little Medicine Creek	Grundy	40		23	S. Wyaconda River	Clark	9
11	Little Tarkio Creek	Holt	17.5		24	Spillway Ditch	New Madrid	13.5
12	Lake Creek	Pettis	5		25	Troublesome Creek	Marion	3.5
13	Lateral #2 Main Ditch	Stoddard	11.5					

For more information call or write:
Missouri Department of Natural Resources
Water Protection Program
P.O. Box 176, Jefferson City, MO 65102-0176
1-800-361-4827 or (573) 751-1300 office or (573) 751-9396 fax
Program Home Page: www.dnr.state.mo.us/deq/wpcp