Total Maximum Daily Load:
Hardies Creek
Trempealeau County, WI

Hardies Creek, Trempealeau County, WI

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Bureau of Watershed Management

Sediment Total Maximum Daily Load for Hardies Creek

PREFACE

The development of a Total Maximum Daily Load (TMDL) for Hardies Creek parallels other sediment TMDLs already submitted and approved (e.g. Gills Coulee Creek, 2006, Sugar-Pecatonica, 2005). These TMDLs focused on sediment delivery from both streambank erosion and agricultural land-use. Comparatively, the relatively undisturbed stream corridor and small acreage of agricultural land-use in the Hardies Creek watershed provide an opportunity to focus the Hardies Creek TMDL exclusively on streambank erosion.

The Hardies Creek TMDL is a product of a partnership between the Wisconsin Department of Natural Resources (WDNR) and the Galesville-Ettrick-Trempealeau High School (GET) Science Department. In 2004, the WDNR provided funding, through a local water quality assistance grant to GET, to support supplemental data collection for the development of the TMDL. In coordination with WDNR field staff and under the direction of Mr. Jon Johnson (GET Science Teacher), students monitored habitat, macro-invertebrates, and water chemistry and assisted with fish electro-shocking in Hardies creek. Some of the information collected by students with WDNR supervision was used in the development of this TMDL. More information about GET environmental monitoring activities is published online at: http://www.getschools.k12.wi.us/hs/staff/jonjohnson/Final%20Webpage/EVS%20Whole%20Mainpage.html.

INTRODUCTION

Hardies Creek is approximately five-miles long, located in the southeast portion of Trempealeau County in western Wisconsin. (Appendix A, Figure A-1). The Wisconsin Department of Natural Resources (WDNR) placed the lower 3.54[1] miles of Hardies Creek on the state's 303(d) impaired waters list in 1998 as low priority due to degraded habitat caused by excessive sedimentation (Table 1). The Clean Water Act and US EPA regulations require that each state develop TMDLs for waters on the Section 303(d) list. The purpose of this TMDL is to identify load allocations and management actions that will help restore the biological integrity of Hardies Creek.

[1] The 2006 Impaired Waters list for Wisconsin lists Hardies Creek as impaired for 3.1 miles. Wisconsin's new database WADRS uses a 24,000 hydrolayer reflecting that 3.54 miles are impaired. Previous mileage was calculated using older methods (i.e. a mapwheel). The segment downstream of Highway 54, is codified as default, upstream is codified as Cold III. Corrections for Hardies Creek will be made on the 2008 303(d) Impaired Waters List.

Waterbody Name	WBIC	TMDL ID	Impaired Stream Miles	Existing Use*	Codified Use*	Potential Use*	Pollutant	Impairment
Hardies Creek (Segment 1)	1686900	181	0-1.64	WWFF	Default (WWSF)	Cold III	Sediment	Degraded Habitat
Hardies Creek (Segment 2)	1686900	181	1.64-3.54	WWFF	Cold III	Cold II	Sediment	Degraded Habitat

Table 1. Designated Uses of Hardies Creek.
*See Appendix B for Stream Classification Descriptions.

PROBLEM STATEMENT

Due to excessive sedimentation, Hardies Creek is currently not meeting applicable **narrative water quality criterion** as defined in NR 102.04 (1); Wisconsin Administrative Code:

"To preserve and enhance the quality of waters, standards are established to govern water management decisions. Practices attributable to municipal, industrial, commercial, domestic, agricultural, land development, or other activities shall be controlled so that all waters including mixing zone and effluent channels meet the following conditions at all times and under all flow conditions:

(a) Substances that will cause objectionable deposits on the shore or in the bed of a body of water, shall not be present in such amounts as to interfere with public rights in waters of the state."

Excessive sedimentation is considered an objectionable deposit.

In addition, Hardies Creek is currently supporting a warm water forage fishery and not its codified use as a warm water sport fishery or coldwater fish community (Cold III). The designated uses applicable to this stream are as follows:

S. NR 102.04 (3) intro, (a) and (c), Wisconsin Administrative Code:
"FISH AND OTHER AQUATIC LIFE USES. The department shall classify all surface waters into one of the fish and other aquatic life subcategories described in this subsection. Only those use subcategories identified in pars. (a) to (c) shall be considered suitable for the protection and propagation of a balanced fish and other aquatic life community as provided in federal water pollution control act amendments of 1972, P.L. 92-500; 33 USC 1251 et.seq.

"(a) Cold water communities. This subcategory includes surface waters capable of supporting a community of cold water fish and aquatic life, or serving as a spawning area for cold water fish species. This subcategory includes, but is not restricted to, surface waters identified as trout waters by the department of natural resources (Wisconsin Trout Streams, publication 6-6300 (80))."
"(b) Warm water sport fish communities. This subcategory includes surface waters capable of supporting a community of warm water sport fish or serving as a spawning area for warm water sport fish.

"(c) Warm water forage fish communities. This subcategory includes surface waters capable of supporting an abundant diverse community of forage fish and other aquatic life."

HARDIES CREEK BACKGROUND

Hardies Creek flows southeast into the Black River, south of North Bend, Wisconsin. It has a moderate gradient and drains an area of approximately 11.7 square miles. The headwaters, upstream segment (1.37 miles) of Hardies Creek is currently meeting the designated use of Class III trout stream. The lower 3.54 miles of Hardies Creek (Segments 1 and 2) are currently listed as warm water forage fishery with potential to meet a Class II or Class III trout stream (Table 1).

Land use in the watershed is dominated by upland forest with steep wooded hills and some lowland pasture and agricultural cropland (Table 2 and Appendix A, Figure A-1).

Land Use	Acres	%
Forest	5383	71.9%
Agricultural	1340	17.9%
Grassland	689	9.2%
Wetland	75	1.0%
Total	7487	100%

Table 2. Watershed land use. WISCLAND

Habitat surveys from the 1950's and 1960's indicate fair habitat for brook trout with no references to excessive bank erosion or sedimentation. The following was recorded in a Reconnaissance Survey from the Wisconsin Conservation Department, July 7, 1950:

"This is a brook trout stream suited to fingerling stocking, or yearlings may be stocked if fishing pressure warrants. There are 2 ½ miles of trout water having an average width of 3 feet. Pools are generally absent in this stream, but overhanging bank cover of alder, willow, and grasses, undercut banks and aquatic vegetation provides amply shelter for brook trout. The bank cover is mostly fair except for the upper reaches where it is generally poor. As the stream passes through pasture lands the water flows at a moderate rate over a bottom consisting of mainly sand with some gravel."

In the 1980's, the upper portions of Hardies Creek still provided fair in-stream habitat although some impacts of agricultural impacts were observed (Appendix C). Fish assemblages in the headwaters indicated stable coldwater temperatures sufficient to support a stocked brook trout population with some limited reproduction. However, the lower portion of Hardies Creek was clearly impacted by agricultural practices. At station 2, field notes remarked:

"This section was grazed heavily and the banks of the creek were all trampled down. This section was very wide and shallow and only 1 fish was encountered. When asking permission to shock, the landowner thought we were there to complain about his barnyard. His barnyard appears to have several fences that aren't working properly, this allows cattle free access to the creek. I report seeing cow feces right in the creek. Only one longnose dace was captured." (August 25, 1988, DNR Stream Survey Station Report)

Currently, poor agricultural practices and cattle access to the creek directly affect the biological community in Hardies Creek and prevent the creek from obtaining its designated use as a coldwater stream. More recently, historical deposits of sediment continue to impact Hardies Creek through stream bank erosion and degraded habitat. The fish community is depressed with low numbers and low diversity. Many of the fish surveys did not collect the prerequisite 25 fish to calculate a valid IBI (although included in Appendix C, these IBIs are flagged as invalid). The coldwater fish species present in Hardies Creek like brook trout, American lamprey and burbot, are consistent with monitored continuous water temperature data collected in Hardies Creek, indicating that Hardies Creek has the potential to be a cold water trout stream with improvement of habitat by stabilization of the streambanks (Appendix C, Figure C-1).

Water chemistry data collected by the WDNR and GET was compiled and reviewed to characterize water quality conditions at several locations along the stream. Total suspended solids in the stream reached 243 mg/l during storm events. Data collected include grab samples for phosphorus, temperature, and dissolved oxygen, taken between the years of 2003 and 2006. Biological surveys were conducted by WDNR between the years of 2003 and 2005 and include habitat assessments, fish surveys, and macroinvertebrate surveys (Appendix C).

SOURCE ASSESSMENT

Point Sources

There are no point sources located on or discharging to Hardies Creek.

Nonpoint Sources

Direct measurements of bank erosion were used to assess the nonpoint sources of sediment in Hardies Creek. Quantitative habitat measurements of bank erosion were used as input values. The total sediment load generated from streambank erosion was calculated by estimating eroding area from quantitative habitat measurements taken at four sites and integrating those estimates along intermediate stream reaches. Estimates of lateral recession rates for stream banks were based on reference sources (NRCS 2003) and best professional judgment. Dry soil densities used in the calculations were 100 pounds per cubic foot, the average value for sandy loam in Wisconsin. Sandy loam is determined to be the dominant soil type along the stream, according to the NRCS State Soil Geographic (STATSGO) database. Erosion (lbs/yr) was calculated for each quantitative station by multiplying average annual lateral recession rate, eroding area, and soil bulk density. Existing and target erosion values for each of the four stream sections are outlined in Appendix D.

LINKAGE ANALYSIS

Establishing the link between watershed characteristics and resulting water quality is a crucial step in TMDL development. By striving to return watershed characteristics closer to natural conditions, improvements in overall stream health can be achieved.

Determining the natural stream bank conditions of this stream is challenging because of a lack of historical data to represent conditions prior to human disturbance. It is believed that stream bank instability was initially caused by heavy pasturing and overgrazing of the hillsides in the early 20th century. Historically, removal of trees and compaction of the soils due to the grazing of hillsides caused gullies to form. Tons of sediment moved from the hillsides during rain events via gullies to the valley floor. In parts of Wisconsin's driftless area, 10 or more feet of sediment transported from the hillsides can be documented at the streambank (Knox and Faulkner, 1994). Currently, during high velocity runoff events, sediment is carved out from severely exposed banks, contributing further to sedimentation and stream bank instability. On a positive note, there are no portions of streambank eroding due to livestock trampling and the watershed sediment delivery is assumed to be a minor component.

Sedimentation from stream bank erosion is the suspected cause of habitat degradation in Hardies Creek. Fine sediments covering the stream substrate reduce suitable habitat for fish and other biological communities by filling in pools and reducing available cover for juvenile and adult fish. Sedimentation of riffle areas compromises reproductive success of fish communities by covering the gravel substrate necessary for spawning conditions. The filling in of riffle areas also affects the fish communities' food source, macroinvertebrates, which have difficulty thriving in areas with predominately sand substrate as opposed to a substrate composed of gravel, cobble/rubble, and sand mixture. In addition, sedimentation can increase turbidity in the water column, causing reduced light penetration necessary for photosynthesis in aquatic plants, reduced feeding efficiency of visual predators and filter feeders, and a lower respiratory capacity of aquatic macroinvertebrates due to clogged gill surfaces. Sedimentation of the substrate can also cause an increase in other contaminant levels, such as nutrients, which are attached to sediment particles and transported into the stream during runoff events.

Biotic integrity scores for fish and macroinvertebrate communities are expected to increase as measures are taken to reduce sedimentation and embeddedness of the substrate, and increase stability of exposed banks.

TMDL DEVELOPMENT

A TMDL is a quantitative analysis of the amount of specific pollutants reaching an impaired lake or stream to the extent that water quality standards will be met. As part of a TMDL, the amount of pollutant that the water can tolerate and still meet water quality standards must be identified. Hardies Creek habitat has been impaired by a combination of flashy flow conditions during runoff events, severe bank erosion, and excessive sedimentation of the stream substrate. The goal of this TMDL is to reduce sediment loads to Hardies Creek to a level that narrative water quality standards will be met and the biological communities in the stream will be restored to their potential.

In addition to identification of pollutant loading, a TMDL also identifies critical environmental conditions used when defining allowable pollutant levels. However, in this circumstance there is no critical condition in the sedimentation of this stream. Sediment is a "conservative" pollutant and does not degrade over time or during different critical periods of the year. EPA acknowledges this in its 1999 Protocol for Developing Sediment TMDLs, "the critical flow approach might be less useful for the sediment

TMDLs because sediment impacts can occur long after the time of discharge and sediment delivery and transport can occur under many flow conditions." The excessive sedimentation is a year-round situation. This is not to say that there is no variation in the sediment carried via runoff to a stream (refer to Seasonality Section below).

ALLOCATIONS

The total annual loading capacity for sediment is the sum of the wasteload allocations for permitted sources, the load allocations for non-point sources, and the margin of safety, as generally expressed in the following equation:

TMDL Load Capacity = WLA + LA + MOS

WLA = Wasteload Allocation (From Point Sources) = 0 tons/year (no point sources)
LA = Load Allocation (From Nonpoint Sources)
MOS = Margin of Safety

Waste Load Allocation

Since there are no point sources in the watershed, the wasteload allocation is zero. If a point discharge were proposed, one of the following would need to occur:

- An effluent limit of zero sediment load would be included in the WPDES permit
- An offset would need to be created through some means, such as pollutant trading.
- A re-allocation of sediment load would need to be developed and approved by EPA.

Load Allocation

The load allocation corresponds to the total load capacity since the WLA and MOS are zero.

Existing Conditions	TMDL	WLA	LA	MOS	Reduction
2.6 tons/day	**0.79 tons/day**	0	0.79 tons/day	0	**70%**

Table 3. TMDL (Load Capacity) = WLA + LA + MOS
The TMDL for Hardies Creek is 0.79 tons/day

The upstream portion of Hardies Creek (1.37 miles) that is not impaired, still had moderate streambank erosion, with a lateral recession rate of 0.2 feet/year. The mean eroded bank height in the portion of Hardies Creek that is not impaired ranged between 0.42 and 0.74 feet with a bank erosion sediment load of 14 lbs/ft/yr. The banks along this upper portion of Hardies Creek are less shaded and have vegetative ground cover that stabilizes the bank. Comparatively, the bank erosion sediment load along the impaired portions of Hardies Creek ranged between 45 and 87 lbs/ft/yr with eroded bank height generally exceeding one foot. The lower potion of Hardies Creek has more canopy coverage and less vegetative ground cover on the banks as reflected by the erosion width measurements.

The total existing sediment load contributed to Hardies Creek from streambank erosion calculations is approximately 2.6 tons per day. The target sediment load for the eroding streambanks is 0.79 tons per day for an overall reduction of 70% in Hardies Creek. A target recession rate of 0.1 ft/year was chosen for the entire stream, which falls in the middle of the NRCS "moderate" erosion category: "Bank is predominately bare with some rills and vegetative overhang. Some exposed tree roots but no slumps or slips." It is expected that once streambanks are stabilized, there will be some naturally occurring erosion and a 0.1 recession rate reflects a reasonable target to achieve.

If the load reduction is sufficient to achieve the load capacity and the stream has not adequately responded, the load capacity will be reviewed and lowered appropriately. In the event that the stream adequately responds with a load reduction that is still above the load capacity, the WDNR will either pursue "de-listing" of the stream or will revisit the load capacity.

MOS

The margin of safety (MOS) accounts for the uncertainty about the relationship between the sediment loads and the response in the waterbody. The MOS is implicit in this TMDL because a conservative lateral recession rate of 0.1 ft/yr was chosen as the target. A lateral recession rate of 0.2 ft/yr was considered because the upstream reach that is not currently impaired has a recession rate of 0.2 ft/yr. However, a lateral recession rate of 0.2 ft/yr lies on the high end of the "moderate" category for rates in the NRCS technical bulletin. Even though the recessional rate of 0.1 ft/yr calls for a 50% reduction in the portion of Hardies Creek that is not impaired, by choosing this number we are being more protective of the downstream reaches that are affected by cumulative sedimentation.

SEASONALITY

Sediment can be considered a "conservative" pollutant because it does not degrade over time. The detrimental effects of sediment on the aquatic community can be seen year-round, even though sediment loading occurs seasonally. Undoubtedly, the amount of bank sediment delivered to Hardies Creek varies throughout the year depending on flow regimes and vegetative cover. Under some flow regimes, sediment is deposited, and at other times, sediment is scoured and transported downstream. Much of the sediment in this system remains within the confines of the stream until major floods scour accumulated sediment. The net result over time is an accumulation of sediments in and along the stream banks.

Erosion and sediment delivery are largely a function of climate where wet water years typically produce the highest sediment loads. Sediment inputs tend to be seasonal in association with high flows, typically during spring run-off or summer thunderstorm events. WDNR has directly considered sediment loading seasonal variation by basing the Hardies Creek TMDL on stream bank erosion calculations that were based on survey measurements performed during summer and spring seasons.

REASONABLE ASSURANCE

No new or additional enforcement authorities are provided under this TMDL. There are currently no point sources discharging to Hardies Creek. To ensure the reduction goals of this TMDL are attained, management measures must be implemented and maintained to control sediment loadings from nonpoint source pollution. Many of these measures require local participation to properly implement.

The Trempealeau County Land Conservation Department (LCD) and other local units of government may apply for WDNR's Targeted Runoff Management (TRM) grants. The TRM Grant Program provides competitive cost-sharing grants to support small-scale, 2-year projects to reduce nonpoint source pollution. TRM grants fund up to 70% of eligible project costs, with the grant amount capped at $150,000 per grant. In the event that the Trempealeau County LWCD receives and targets TRM cost-sharing funds in the Hardies Creek watershed, installation of streambank stabilization practices would greatly reduce sedimentation and benefit habitat.

The Environmental Quality Incentive Program (EQIP) is another option available to farmers. EQIP is a federal cost-share program administered by the Natural Resources Conservation Service (NRCS) that provides farmers with technical and financial assistance. Farmers may receive up to 75 percent reimbursement for installing and implementing best management practices, including streambank stabilization.

MONITORING

The WDNR will monitor Hardies Creek based on the rate of implementation of the TMDL, including the sites where implementation of Targeted Runoff Management (TRM) grants are aimed at mitigating the intense stream bank erosion. Monitoring will continue until it is deemed that the stream has responded to the point where it is meeting its codified use or until funding for these studies are discontinued. In addition, the stream will be monitored on a 5 to 6 year interval as part of a special project strategy to assess temporary conditions and trends in overall stream quality. The monitoring will consist of metrics contained in WDNR's baseline protocol for wadeable streams, such as the Index of Biotic Integrity (IBI), the Hilsenhoff Biotic Index (HBI), the current habitat assessment tool, and sampling of water quality parameters at a subset of sites.

PUBLIC PARTICIPATION

This TMDL was subject for public review from August 3, 2007 through September 4, 2007. On August 3, 2007 a press release was sent to: newspapers, television stations, radio stations, interest groups, and interested individuals in the west central region portion of the state. The news release indicated the public comment period and how to obtain copies of the public notice and the draft TMDL. The news release, public notice, and draft TMDL were also placed on the DNR's website. No comments were received by the department for the Hardies Creek TMDL.

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APPENDIX A
WATERSHED AND SAMPLING MAPS

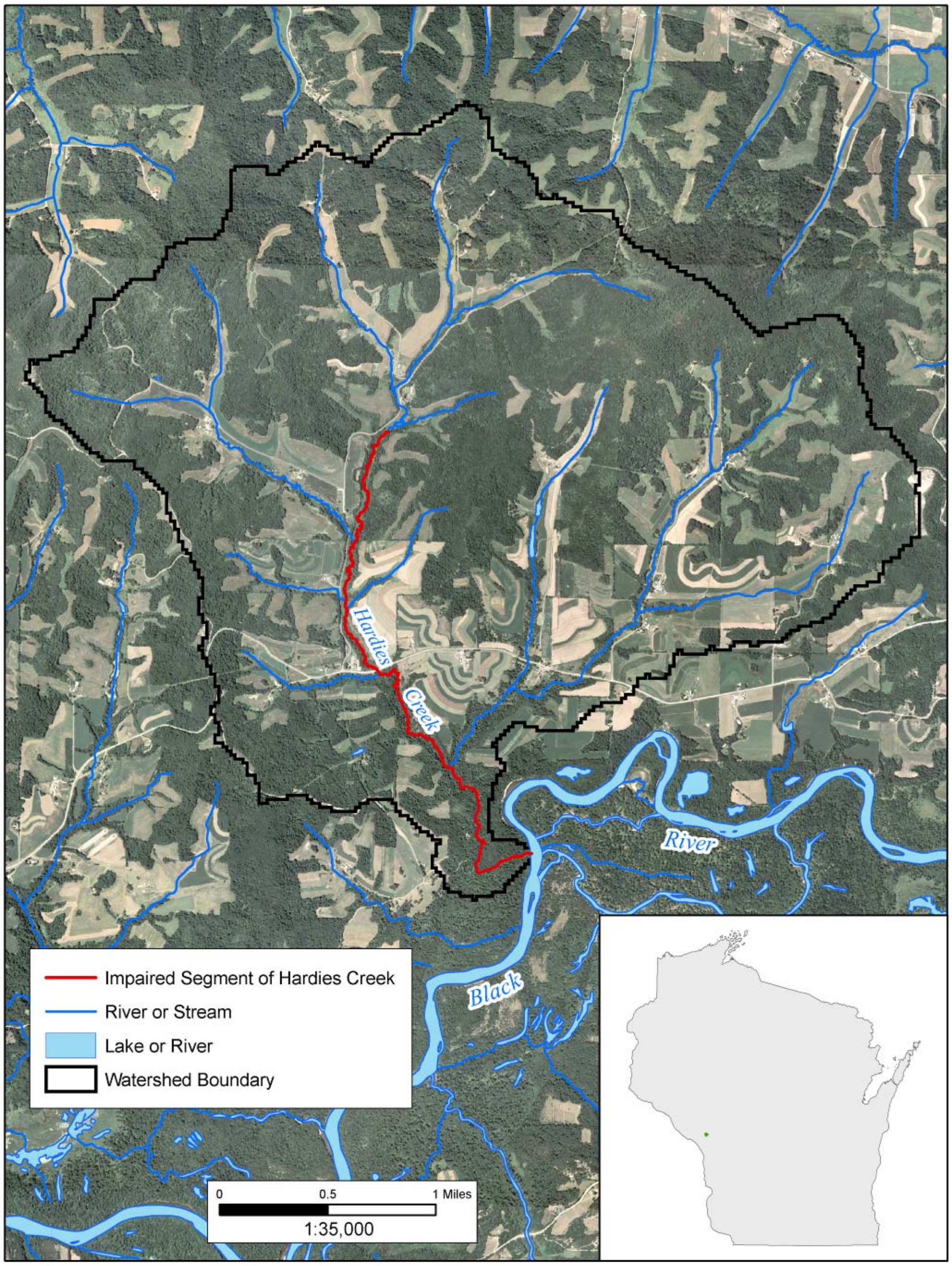

Figure A-1. Aerial Photo of the Hardies Creek Watershed, Trempealeau County, WI.

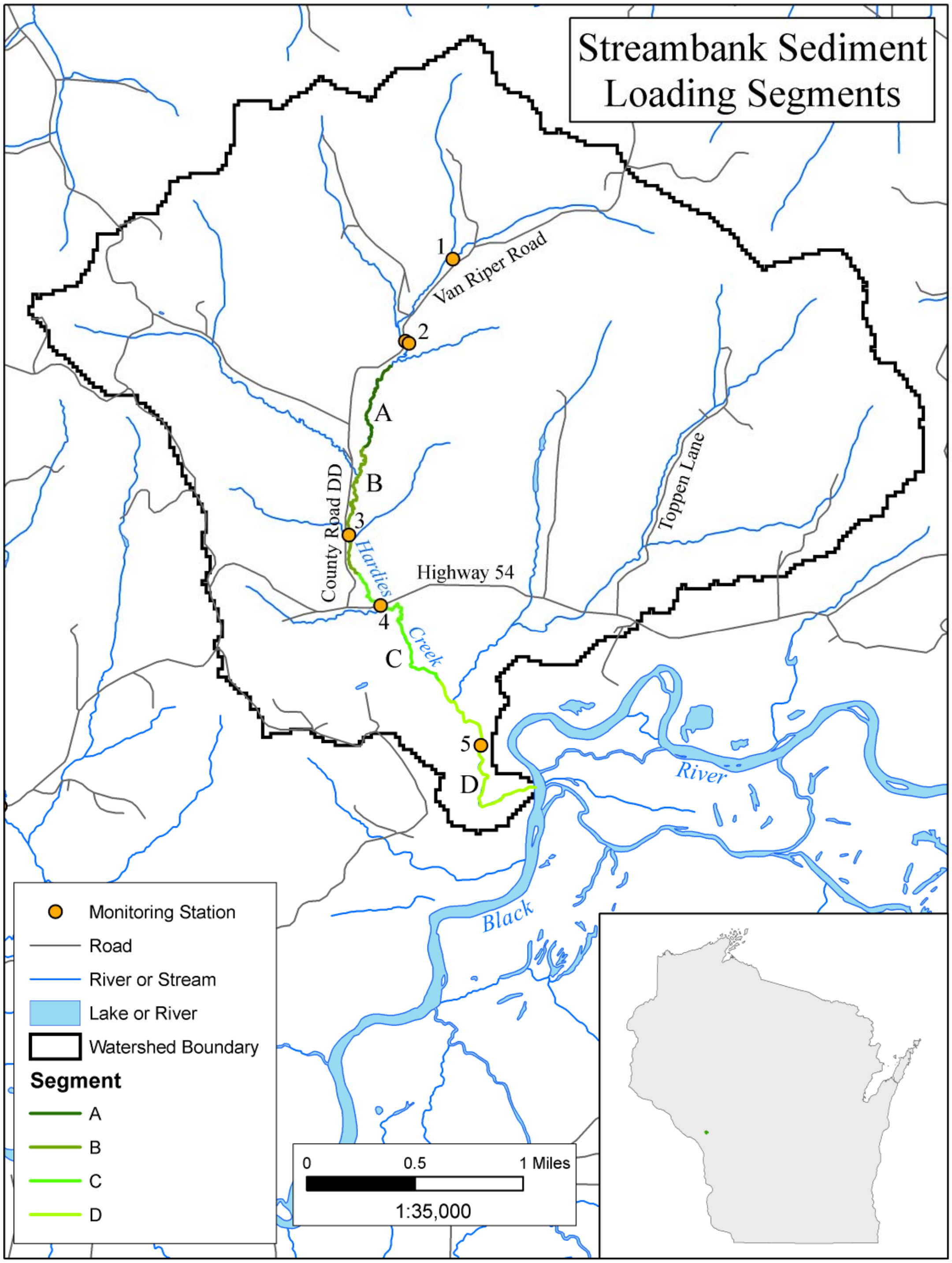

Figure A-2. Map of Water Quality Monitoring Stations and Associated Stream Segments for Streambank Erosion Analyses.

APPENDIX B
STREAM CLASSIFICATION AND DESCRIPTION

Stream Use Classification	Description
Cold	Cold water community; includes surface waters that are capable of supporting a cold water fishery and other aquatic life and serving as a spawning area for cold water species. This includes three levels of cold water classification (Class I, II, or III).
WWSF	Warm water sport fish communities; includes surface waters capable of supporting a community of warm water sport fish or serving as a spawning or nursery for warm water sport fish.
WWFF	Warm water forage fish communities; includes surface waters capable of supporting an abundant and diverse community of forage fish and other aquatic life.
LFF	Limited forage fishery; (intermediate surface waters (INT-D) includes surface water of limited capacity because of low stream flow, naturally poor water quality or poor habitat. These surface waters are capable of supporting only a limited community of tolerant forage fish and aquatic life.

Trout Stream Classification	Description
Class I	These are high quality trout waters, having sufficient natural reproduction to sustain populations of wild trout at or near carrying capacity. Consequently, streams in this category require no stocking of hatchery trout. These streams or stream sections are often small and may contain small or slow-growing trout, especially in the headwaters.
Class II	Streams having this classification may have some natural reproduction but not enough to utilize available food and space. Therefore, stocking is sometimes required to maintain a desirable sport fishery. These streams show good survival and carryover of adult trout often producing some fish of better than average size.
Class III	These waters are marginal trout habitat with no natural reproduction occurring. They require annual stocking of legal-size fish to provide trout fishing. Generally, there is no carryover of trout from one year to the next.

Table B-1. Stream use classifications. The existing use of Hardies Creek is a warm water forage fishery.

APPENDIX C
FISH AND HABITAT DATA

Fish Species	Station				Total
	1	2	3	4	
Brook Trout	0	0	4	2	6
White Sucker	80	0	0	0	81
Common Shiner	77	0	0	0	77
Longnose Dace	59	1	0	0	60
Brook Stickleback	0	0	125	20	145
Spottail Shiner	32	0	0	0	32
Quillback Carpsucker	24	0	0	0	24
Johnny Darter	109	0	0	0	109
Burbot	1	0	0	0	1
Total	301	1	129	22	535

Table C-1. Fish Sampling Hardies Creek, 8/25/1988

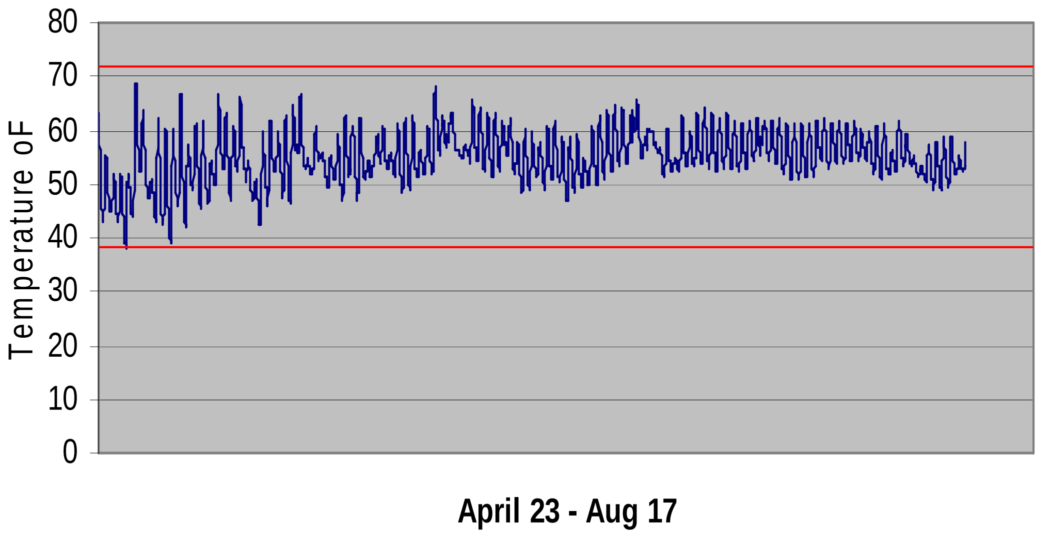

Figure C-1. Continuous temperature data from station 3 in 2005. Red lines show upper and lower thresholds for coldwater brook trout species.

APPENDIX C (Continued)

	Station 1 08/21/2001	Station 1 04/23/2003	Station 1 09/17/2004	Station 2 08/26/1988
IBI Score	40	60	-	-
IBI Rating	Fair	Good	NA	NA
Total # Fish	76	65	20	1
Total # Species	3	4	2	1
Total # Trout	10	5	17	0

Table C-2. Fish Index of Biological Integrity calculations from Lyons and Wang (1996)

	Station 3 09/23/1971	Station 3 08/14/2002	Station 3 09/17/2004	Station 5 08/25/1988	Station 5 04/28/2005
IBI Score	-	-	-	30	-
IBI Rating	NA	NA	NA	Fair	NA
Total # Fish	9	3	7	35	18
Total # Species	1	2	5	8	7
Total # Trout	9	3	1	0	1

Table C-3. Fish Index of Biological Integrity calculations from Lyons and Wang (1996)

	Score	Rating
Station 1	40	Fair
Station 2	43	Fair
Station 3	55	Good
Station 5	55	Good
Habitat rating index is a generic rating of a stream’s ability to hold adult fish, but does not necessarily consider impacts of excessive sedimentation impacts on habitat across a larger stream segment		

Table C-4. Fish habitat index rating for Hardies Creek Stations using Simonson et al. 1994.

APPENDIX D
STREAMBANK EROSION CALCULATIONS

Table D-1. Existing conditions: streambank erosion measurements for each station.

Station 1 – Van Riper Road DNR Habitat Survey June 6, 2002 Station Length 306 feet				**Station 1 – Van Riper Road GET Habitat Survey August 10, 2005 Station Length 285 feet**		
Transect #	**Right Bank Erosion Width (ft)**	**Left Bank Erosion Width (ft)**		**Transect #**	**Right Bank Erosion Width (ft)**	**Left Bank Erosion Width (ft)**
1	0.00	0.00		1	0.62	0.47
2	1.49	0.00		2	0.93	0.68
3	0.00	2.20		3	0.00	0.00
4	0.00	0.00		4	0.00	1.27
5	3.10	0.31		5	1.77	0.50
6	0.62	0.62		6	0.25	0.34
7	0.00	0.31		7	0.00	0.00
8	0.00	0.56		8	0.50	0.62
9	0.00	0.00		9	0.93	0.71
10	0.00	0.56		10	0.93	0.93
11	0.00	0.47		11	0.00	0.00
12	1.18	0.00		12	0.56	0.99
13	3.10	0.46		13	3.10	0.47
Mean	**0.73**	**0.42**		**Mean**	**0.74**	**0.54**

Station 3 – County Road DD GET Habitat Survey August 8, 2005 Station Length 322 feet				**Station 4 – Hwy 54 GET Habitat Survey August 10, 2005 Station Length 285 feet**		
Transect #	**Right Bank Erosion Width (ft)**	**Left Bank Erosion Width (ft)**		**Transect #**	**Right Bank Erosion Width (ft)**	**Left Bank Erosion Width (ft)**
1	2.79	0.62		1	0.31	1.36
2	1.49	3.10		2	1.24	3.10
3	1,61	1.86		3	1.49	1.98
4	0.93	0.62		4	0.78	1.40
5	1.49	0.00		5	1.86	1.55
6	0.00	0.06		6	3.10	3.10
7	0.93	2.17		7	2.48	3.10
8	1.64	1.24		8	0.76	2.17
9	2.11	1.55		9	0.76	1.55
10	1.40	0.62		10	0.93	1.24
11	1.40	0.62		11	0.93	1.24
12	0.93	1.40				
Mean	**1.39**	**1.15**		**Mean**	**1.33**	**1.98**

Table D-1 (continued). Existing conditions: streambank erosion measurements for each station.

Station 4 – Hwy 54 DNR Habitat Survey April 28, 2003 Station Length 324 feet				**Station 5 – Black River Confluence DNR Habitat Survey April 28, 2003 Station Length 324 feet**		
Transect #	**Right Bank Erosion Width (ft)**	**Left Bank Erosion Width (ft)**		**Transect #**	**Right Bank Erosion Width (ft)**	**Left Bank Erosion Width (ft)**
1	0.25	0.58		1	2.17	0.71
2	0.25	0.83		2	1.86	0.47
3	3.25	0.17		3	1.40	2.02
4	0.75	1.00		4	1.24	0.65
5	0.33	1.92		5	0.71	2.67
6	0.33	1.25		6	0.62	2.76
7	0.00	0.42		7	1.40	3.10
8	1.67	0.92		8	0.71	3.10
9	0.75	1.00		9	1.05	2.79
10	0.83	1.00		10	1.18	2.79
11	0.83	0.83		11	1.33	1.67
12	0.42	2.50		12	2.33	1.05
13	1.00	1.58		13	2.08	.65
Mean	**0.82**	**1.08**		**Mean**	**1.39**	**1.88**

APPENDIX D (continued) STREAMBANK EROSION CALCULATIONS

Station	Right Mean Erosion Width(ft)	Left Mean Erosion Width (ft)	Station Length (ft)	Recession Rate (ft/year)	Sediment Density (pcf)	Sediment Loading Rate (lbs/ft/yr)
1-GET	0.74	0.54	285	0.2	100	25.60
1-DNR	0.73	0.42	306	0.2	100	23.00
3-GET	1.39	1.15	322	0.3	100	76.20
4-GET	1.33	1.98	285	0.3	100	99.30
4-DNR	0.82	1.08	324	0.3	100	57.00
5-DNR	1.39	1.88	324	0.45	100	147.15

Stream Segment	Length (ft)	Sediment Loading Rate (lbs/ft/yr)	Sediment Load (lbs/yr)	Sediment Load (tons/day)
Segment A[2]	11844	24.3	287809.2	0.39
Segment B	4559	76.20	347395.8	0.48
Segment C	4085	78.15	319242.75	0.44
Segment D	6440	147.15	947646	1.30
Entire Stream				2.61

Table D-2. Existing Sediment Loads from Streambank Erosion for Hardies Creek

Station	Right Mean Erosion Width(ft)	Left Mean Erosion Width (ft)	Station Length (ft)	Recession Rate (ft/year)	Sediment Density (pcf)	Sediment Loading Rate (lbs/ft/yr)
1-GET	0.74	0.54	285	0.1	100	12.80
1-DNR	0.73	0.42	306	0.1	100	11.50
3-GET	1.39	1.15	322	0.1	100	25.40
4-GET	1.33	1.98	285	0.1	100	33.10
4-DNR	0.82	1.08	324	0.1	100	19.00
5-DNR	1.39	1.88	324	0.1	100	32.70

Stream Segment	Length (ft)	Sediment Loading Rate (lbs/ft/yr)	Sediment Load (lbs/yr)	Sediment Load (tons/day)	Percent Reduction
Segment A	11844	12.15	143904.6	0.20	50
Segment B	4559	25.40	115798.6	0.16	67
Segment C	4085	26.05	106414.25	0.15	67
Segment D	6440	32.70	210588	0.29	78
Entire Stream				**0.79**	70

Table D-3. Target Sediment Loads from Streambank Erosion for Hardies Creek.

[2] Station 1 (DNR and GET) are combined to be an averaged representation of conditions for Segment A. Segment B is represented by Station 3. Station 4 (DNR and GET) are combined to be an averaged representation for Segment C, and Station 5 represents downstream conditions for Segment D.

APPENDIX E
PHOTOGRAPHIC DOCUMENTATION OF STREAMBANK EROSION

Figure E-1. Typical bank erosion along the lower portion of Hardies Creek

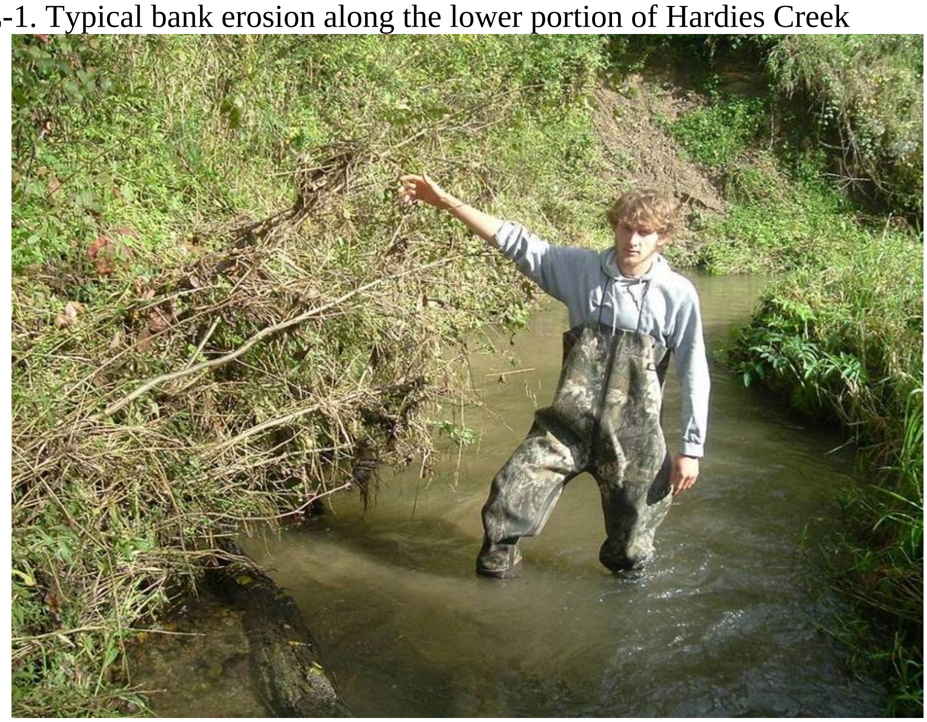

Figure E-2. GET High School Student points to debris left in bank vegetation as a result of high flows

Figure E-3. Typical bank erosion along the outside of stream bend of Hardies Creek

Figure E-4. GET High School students assist DNR fish sampling crew.