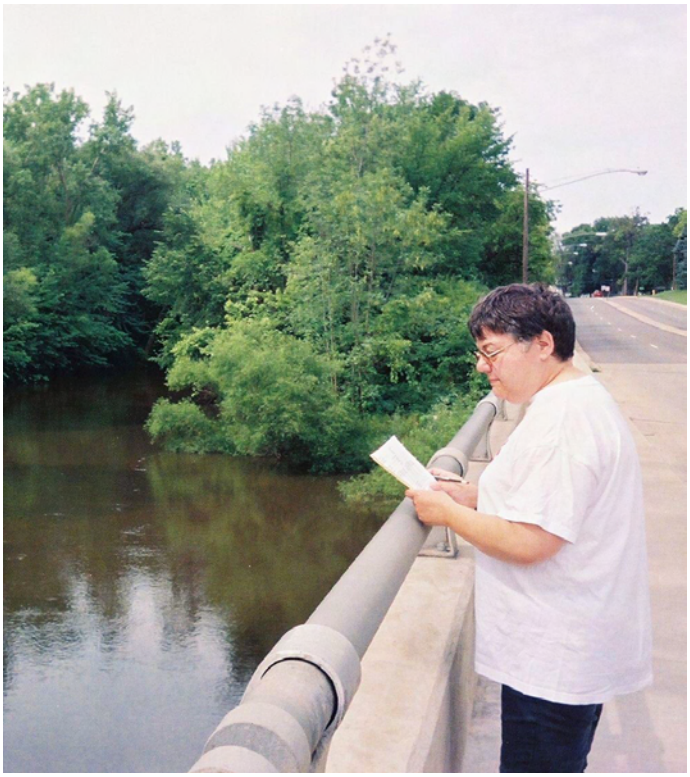
Volunteer Inventory of the Paw Paw River Watershed



Final Report
8/07/08

Paw Paw River Watershed Planning Project

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Table of Contents

List of Figures

Acknowledgments

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Sincerely,
Matthew A. Meersman
Project Manager

Cover Photo: Toni Miller completing Volunteer Inventory Field Form.

Introduction

This volunteer inventory project was conducted in the Paw Paw River Watershed (PPRW) to establish a baseline characterization of the watershed and identify potential or existing problem sites as part of the PPRW Planning Project. The data was used in the development of the PPRW Management Plan. A riparian survey form was completed by volunteers at over 200 road/stream crossing sites within the PPRW from July through September of 2006. The survey assessed stream bank erosion potential and other riparian criteria, such as stream width, canopy coverage and vegetation type. A database was developed in order to store survey results, calculate erosion potential and organize over 900 photographs taken during the survey.

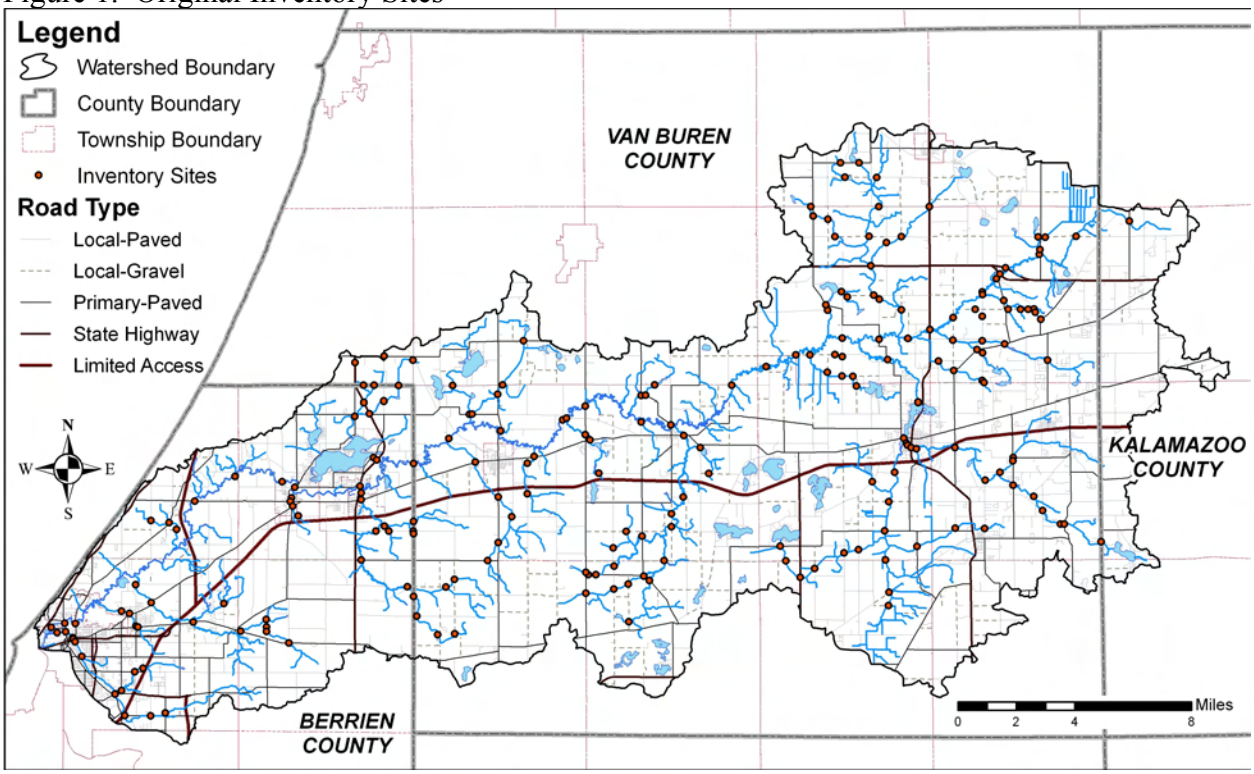
Methods

Site Selection

Road/Stream Crossing Inventory

The Project Manager selected 217 sites throughout the PPRW where volunteers completed the Inventory Field Form (see Appendix A). The selected sites were all road/stream crossings, which provided accessible locations to complete the Inventory Field Form. Many of the sites were surveyed by the MDEQ as part of their 2004 Road/Stream Crossing Survey. Sites were selected in order to provide the most complete coverage of the watershed possible. Figure 1 illustrates the location of the selected sites.

Figure 1. Original Inventory Sites



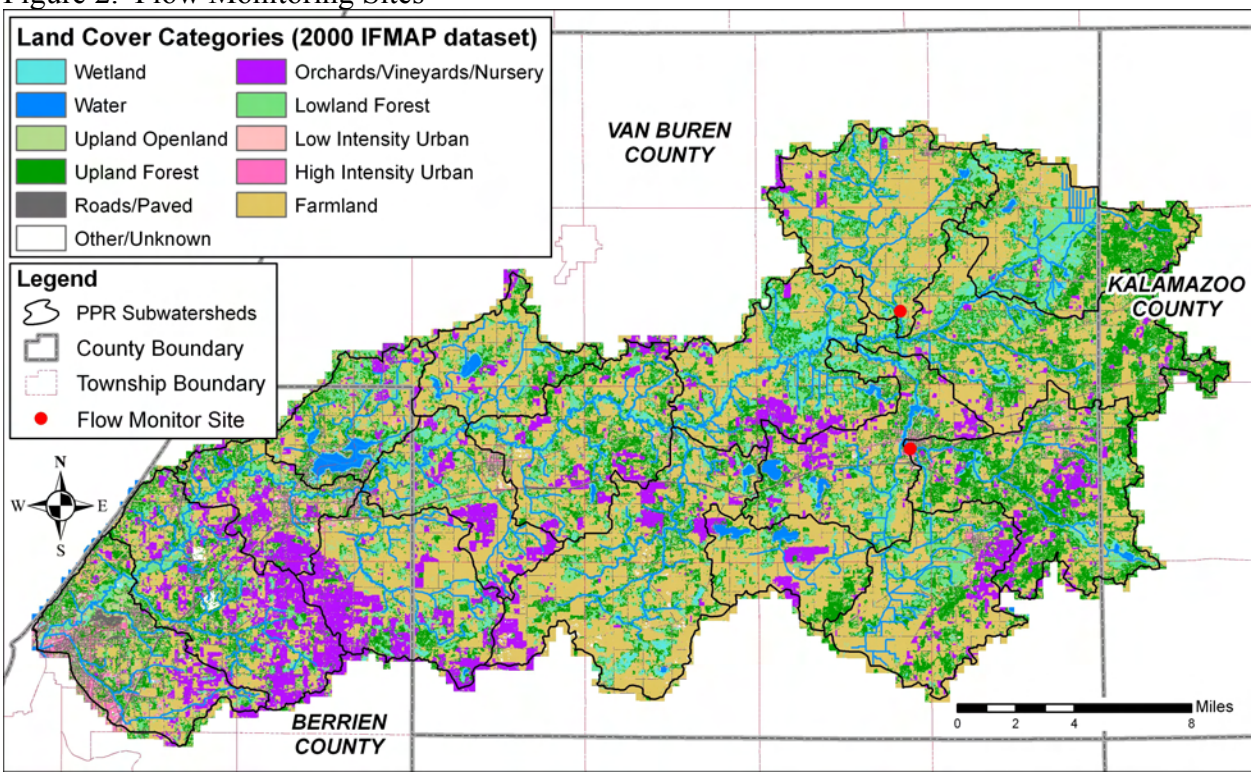
Flow Monitoring

Site selection for the hydrologic study was based on the desire to compare and contrast a heavily agricultural subwatershed with a natural subwatershed. Stream flow monitoring for the hydrologic study took place at the following sites:

- Brandywine Creek below 38th Ave. (land use approx. 70% agricultural)
- E. Branch Paw Paw River below M-40 (land use approx 45% forest/wetland)

Figure 2 illustrates the location of flow monitoring sites and the land cover in their respective subwatersheds.

Figure 2. Flow Monitoring Sites



Volunteer Training

Volunteers were required to attend a training program conducted by the Project Manager and other partners trained by MDEQ water quality personnel on July 6th, 2006. The Inventory Field Form and Bank Erosion Hazard Index (BEHI) standard operating procedure (see Appendix B) was explained to volunteers. Photographs were used to illustrate different BEHI criteria conditions. A detailed Inventory Field Form instruction sheet was provided for reference in the field (see Appendix C).

Quality Control

The Berrien County Conservation District lead a Quality Control (QC) process in which 15 randomly selected sites were resurveyed in September of 2006. The results of this process confirmed there were large differences between volunteers. Of the 15 sites resurveyed the average difference in BEHI score was 5.8. The BEHI scores from 9 of the QC sites were different enough to raise or lower the erosion hazard category by 1. Two sites were different by 2 categories and 4 sites remained the same. The variability between individual surveyors was not limited to the BEHI portion of the survey. 6 QC sites had stream widths that were different by 1 category and one site was different by 2 full categories. 9 QC sites had differences in whether there was observable erosion present.

Due to the large difference between volunteer and QC scores, a second round of surveys was completed by the Berrien County Conservation District in July of 2007. The Project Manager selected 53 sites, which were re-surveyed in this follow-up inventory. Many of these sites had poor BEHI scores that were not reflected in photographs from the original survey.

Photo Documentation

Volunteers took several photographs at each site. If the volunteer did not have a digital camera, they were provided with a disposable camera. The photographs from the disposable cameras were processed and placed on a CD. The CDs were returned to the Project Manager with the completed Inventory Field Forms. Volunteers were instructed to complete a Photo Documentation sheet where they recorded the photo #, time, site ID #, photo location, bearing to subject, and subject description. The completed Photo Documentation sheets were used to describe and link the 941 photographs collected throughout the project to the correct sites in the Volunteer Inventory Database.

Results

Road/Stream Crossing Inventory

Out of the 217 original inventory sites, only 98 sites were selected to represent the Final Volunteer Inventory results. Inventory sites located on small first order tributaries were removed from the final results due to complications described in the Discussion section below. Figure 1 illustrates the location of the original inventory sites. Figures 3-6 illustrate the location of the Final Volunteer Inventory sites.

Riparian Environmental Factors

Riparian environmental factors varied greatly throughout the watershed. Average stream width was estimated just once at each site. Figure 3 illustrates the average stream width for the final inventory sites. Factors such as stream canopy coverage and the presence of aquatic plants were estimated for the upstream and downstream reaches at each site. The upstream and downstream estimates were averaged to create an overall site condition category. Figure 4 illustrates the average stream canopy coverage for the final inventory sites. Riparian vegetation width and vegetation type was estimated for the upstream right and left banks, as well as the downstream right and left banks at each site. The width estimates from all 4 banks were averaged to create an overall site condition category. Figure 5 illustrates the average riparian vegetation width for the final inventory sites.

Figure 3. Average Stream Width

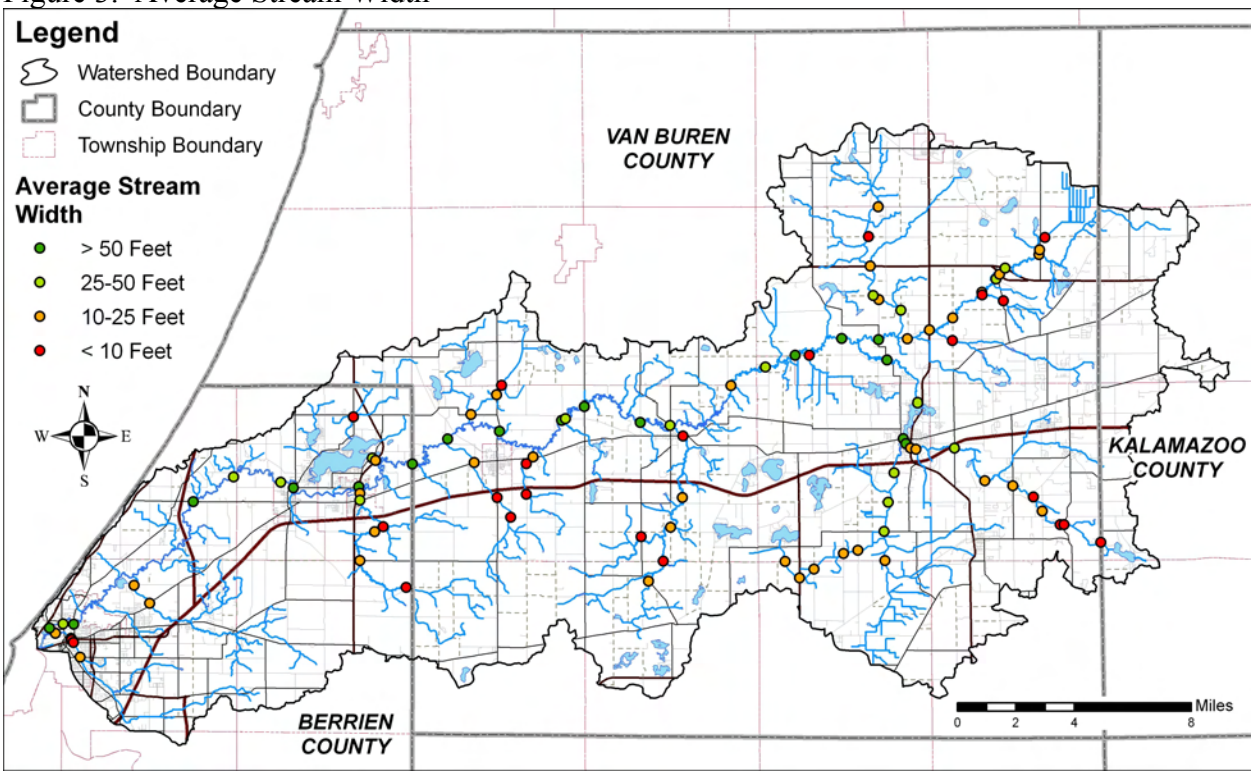


Figure 4. Average Stream Canopy Coverage

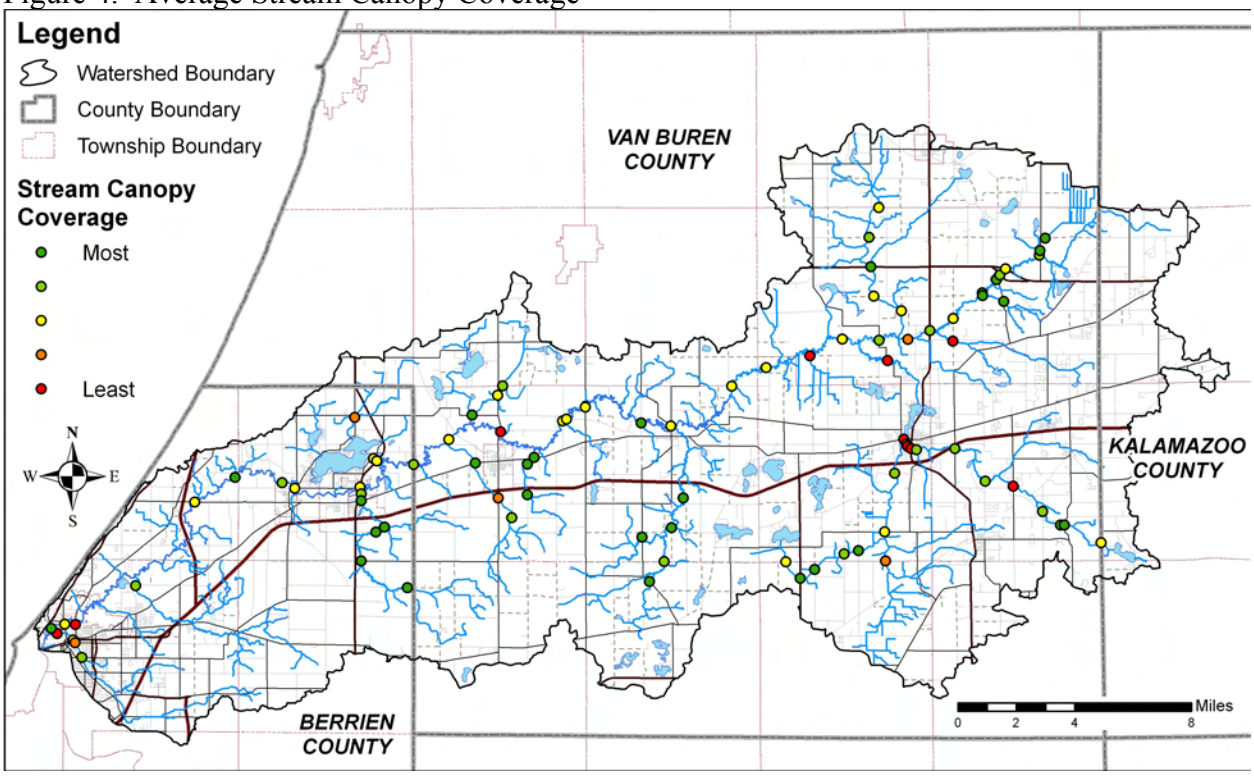
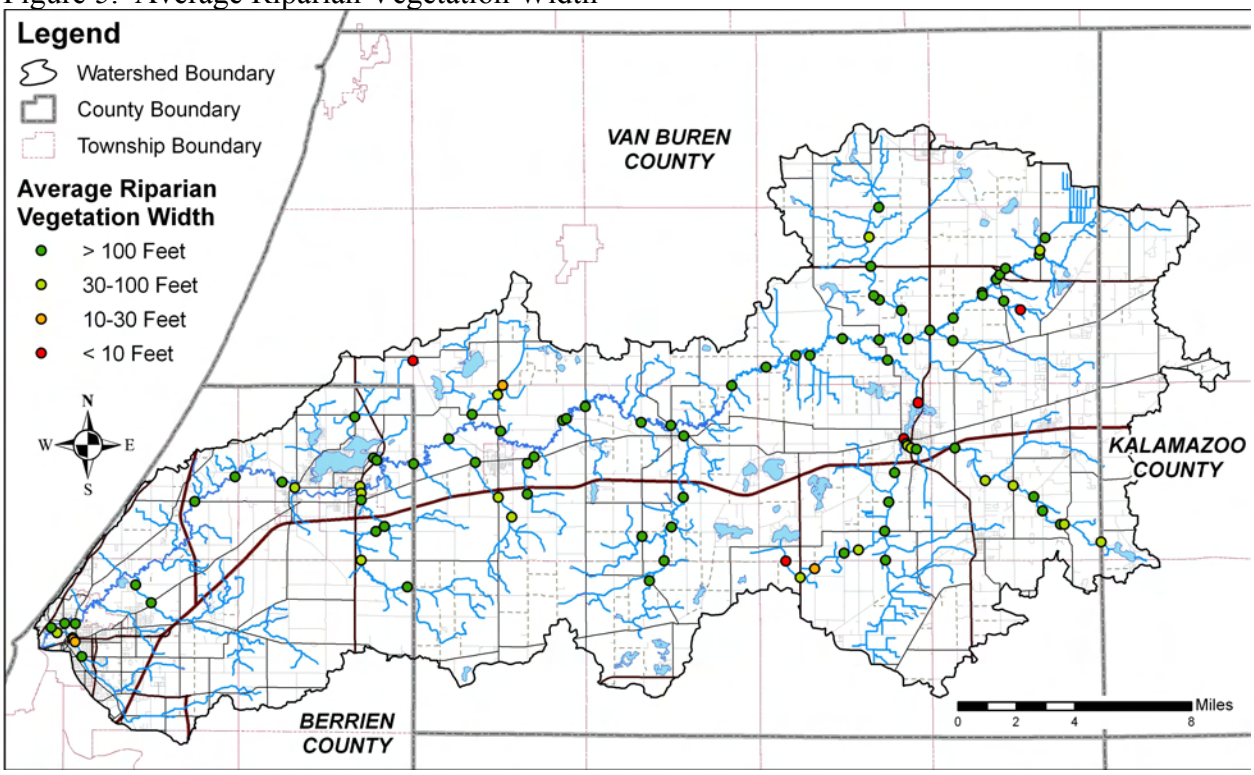


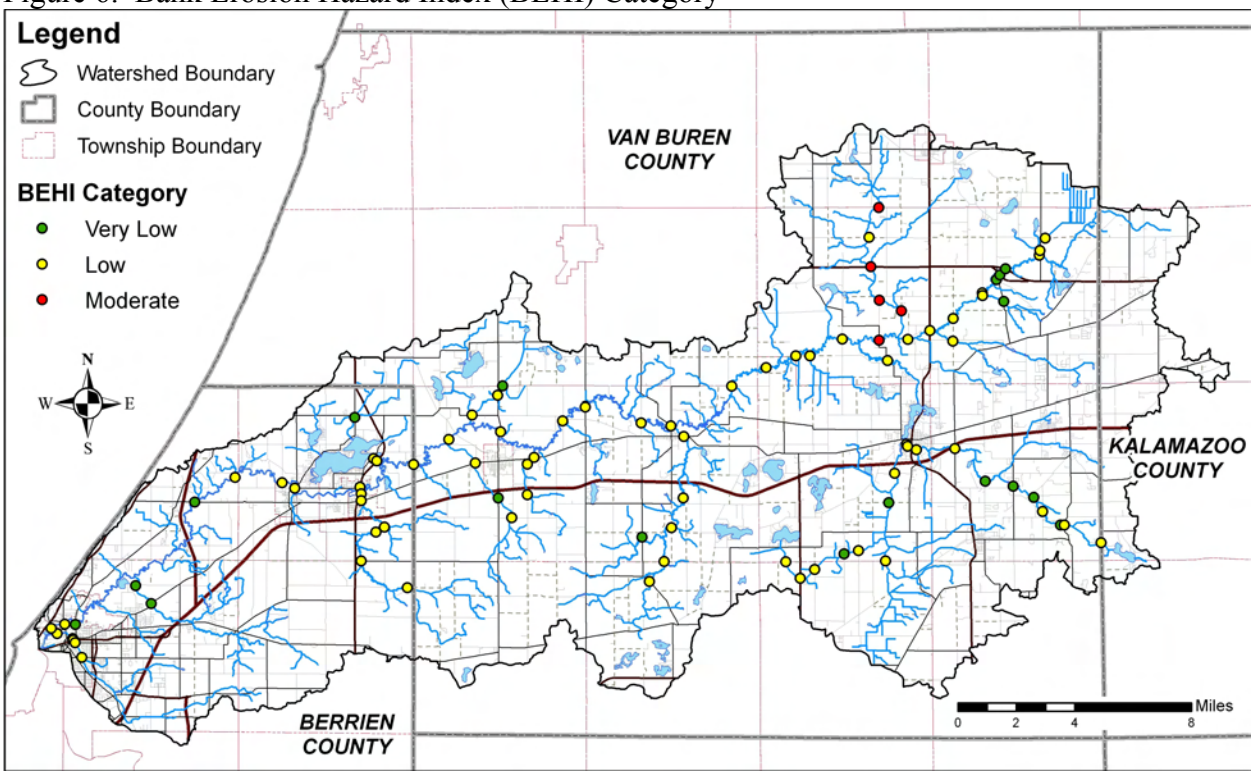
Figure 5. Average Riparian Vegetation Width



Bank Erosion Potential

Bank erosion potential was assessed using a modified version of Rosgen's Bank Erosion Hazard Index (BEHI – see Appendix B). At each inventory site BEHI surveys were completed for the upstream left and right banks, as well as the downstream left and right banks. The scores from all 4 banks were averaged to estimate an overall "site BEHI score" and accompanying category. Overall BEHI scores were low in the PPRW. Several stream banks along Brandywine Creek in northeast Van Buren County received BEHI scores high enough to have 4 sites in the Moderate category. Although there were individual stream banks throughout the PPRW that received high scores, there were no sites with average scores high enough to fall into the High, Very High, or Extreme categories. Figure 6 illustrates the overall site BEHI category for the final volunteer inventory sites.

Figure 6. Bank Erosion Hazard Index (BEHI) Category



Flow Monitoring

A hydrologic study was performed to collect stream flow and rainfall data. Dave Fongers (MDEQ, HSU) and Jeff Spoelstra (Kieser & Associates, Project Scientist) were responsible for completing all flow measurements and accompanying data sheets. The results of hydrologic study were not used to validate modeling efforts, which took place as part of the planning project, as expected. Results of stream flow portion of this study can be found in Appendix D.

Discussion

Road/Stream Crossing Inventory

The results of the BEHI portion of the inventory survey are of limited use for characterizing the condition of the entire PPRW due to inconsistency between volunteers. Although each volunteer completed a comprehensive training program, their own judgment varied greatly once they were in the field. Volunteers tended to over or underestimate the scores for the BEHI metrics. It would be misleading to use the results of this BEHI study to characterize the entire watershed.

The inconsistency problem only occurs between sites surveyed by different volunteers. There was a great deal of consistency between the sites surveyed by any one volunteer. This allowed valuable information to be obtained by comparing the data collected from one site to other sites surveyed by the same volunteer. The survey results provide a general understanding of the condition of each site relative to other sites surveyed by the same volunteer.

In addition to inconsistency between volunteers, BEHI results were also compromised by inventory site selection. A large number of survey sites were located on small first order tributaries. These streams and drains were often found dry or heavily vegetated. These conditions made it very difficult to determine the scores for the BEHI metrics. Inventory sites located on first order tributaries (approx. 119 sites) were removed from the final BEHI results by the project manager due to these problems. However, it should be noted that inventory surveys from these sites were very valuable for locating problems like unrestricted livestock access sites.

Flow Monitoring

The results of the flow monitoring portion of this study are also of limited use for characterizing the hydrologic conditions of either the Brandywine Creek subwatershed or the East Branch subwatershed due to the short time period in which monitoring took place. Ideally, flow monitoring would occur over several seasons. Although the results of this portion of the inventory are of limited use, the differences in response to rain events between each subwatershed was consistent with what was expected.

Appendix A: Inventory Field Form

Date:		Location:	
Surveyor Name:		Latitude (DD):	
Waterbody Name:		Longitude (DD):	

Downstream Observations

L Veg. Width (ft)	<10	10-30	30-100	>100	L Veg. Type	Bare	Mowed	Tall Grass	Tree/Shrub
R Veg. Width (ft)	<10	10-30	30-100	>100	R Veg. Type	Bare	Mowed	Tall Grass	Tree/Shrub

Stream Canopy %	<25	25-50	>50	Aquatic Plants	N/A	Absent	Present	Abundant

Left Bank BEHI

Root Depth (% of BH)	Root Density (%)	Surface Protection (Avg. %)	Bank Angle (degrees)
90-100	80-100	80-100	0-20
50-89	55-79	55-79	21-60
30-49	30-54	30-54	61-80
15-29	15-29	15-29	81-90
5-14	5-14	10-14	91-119
< 5	< 5	< 10	> 119

Right Bank BEHI

Root Depth (% of BH)	Root Density (%)	Surface Protection (Avg. %)	Bank Angle (degrees)
90-100	80-100	80-100	0-20
50-89	55-79	55-79	21-60
30-49	30-54	30-54	61-80
15-29	15-29	15-29	81-90
5-14	5-14	10-14	91-119
< 5	< 5	< 10	> 119

Upstream Observations

L Veg. Width (ft)	<10	10-30	30-100	>100	L Veg. Type	Bare	Mowed	Tall Grass	Tree/Shrub
R Veg. Width (ft)	<10	10-30	30-100	>100	R Veg. Type	Bare	Mowed	Tall Grass	Tree/Shrub

Stream Canopy %	<25	25-50	>50	Aquatic Plants	N/A	Absent	Present	Abundant

Left Bank BEHI

Root Depth (% of BH)	Root Density (%)	Surface Protection (Avg. %)	Bank Angle (degrees)
90-100	80-100	80-100	0-20
50-89	55-79	55-79	21-60
30-49	30-54	30-54	61-80
15-29	15-29	15-29	81-90
5-14	5-14	10-14	91-119
< 5	< 5	< 10	> 119

Right Bank BEHI

Root Depth (% of BH)	Root Density (%)	Surface Protection (Avg. %)	Bank Angle (degrees)
90-100	80-100	80-100	0-20
50-89	55-79	55-79	21-60
30-49	30-54	30-54	61-80
15-29	15-29	15-29	81-90
5-14	5-14	10-14	91-119
< 5	< 5	< 10	> 119

Combined Observations

Average Stream Width (ft)	<10	10-25	25-50	>50

Is observable erosion occurring at this site? Y / N *If* **yes***, please describe the severity below.*

Is the erosion on the outside of a bend? Y / N

Can you identify a potential cause of the erosion? Y / N

Comments (erosion severity, land use/activities in the visible surrounding area & presence of structures, pipes, trash, etc.):

_____

_____

_____

Appendix A: BEHI – Standard Operating Procedure

ASSESSING BANK EROSION POTENTIAL USING ROSGEN'S BANK EROSION HAZARD INDEX (BEHI)

1.0 Overview

While stream bank erosion is a natural process that occurs in every watershed, excessive erosion has serious adverse consequences for the physical and biological function of rivers. Eroding stream banks can be a major source of sediment to a stream (up to 80% of the annual load; Simon and Thorne, 1996), and human activities such as urbanization or dam construction can accelerate bank erosion rates by more than an order of magnitude. It is often difficult, however, to distinguish between stream banks that are eroding at a natural rate from those that are or have the potential to erode at unnaturally high rates due to altered watershed hydrology or sediment loads. The Bank Erosion Hazard Index (BEHI), created by Dave Rosgen of Wildland Hydrology, Inc. (Rosgen, 2001), is one of several procedures for assessing stream bank erosion condition and potential. It assigns point values to several aspects of bank condition and provides an overall score that can be used to inventory stream bank condition over large areas, prioritize eroding banks for remedial actions, etc. This standard operating procedure (SOP) describes two versions of the BEHI technique.

2.0 Procedure

Below are descriptions of two BEHI procedures. The first describes the complete BEHI procedure created by Rosgen, including identification of bankfull width. The second describes a modified BEHI procedure, which does not require identification of bankfull width. The modified BEHI procedure is intended for use by workers who lack experience in identifying bankfull indicators, including volunteer monitors. Correctly identifying appropriate bankfull indicators requires considerable experience, and is the most subjective step in the original BEHI procedure.

In truth, both procedures described below are 'modified', in that the step of calculating BEHI scores has been simplified such that there is only a single score for each metric, rather than the range of possible scores provided in Rosgen's original paper. This simplification is intended to remove some unnecessary subjectivity from the field observations, without overly reducing the utility of the procedure.

A. Complete BEHI Procedure

The complete BEHI procedure consists of five metrics; four observational and one requiring some measurements. They are:

1. Ratio of bank height to bankfull height
2. Ratio of root depth to bank height
3. Root density, in percent
4. Bank angle, in degrees

5. Surface protection, in percent

Brief descriptions of each metric are provided below.

Point values for these metrics (Table 1) should only be assigned after a sufficient length of the stream channel (the 'stream reach') has been examined (at least 100'; 2 to 3 meander lengths is preferable), so that representative conditions are identified. Conditions on both banks should be assessed, and scored separately if they are consistently different. See Section 4 for further advice on where to make – and not make – the observations.

Ratio of bank height to bankfull height. This is the most challenging of the BEHI metrics, as it requires accurate identification of bankfull indicators. A full discussion of different bankfull indicators is beyond the scope of this SOP, but it is thoroughly discussed in Williams (1978), and a useful free video is available from the U.S. Forest Service (2003). Common bankfull indicators in stable southern Michigan streams include top of bank, top of point bars, and other changes in channel slope. Vegetative indicators are seldom useful in southern Michigan streams. Bankfull indicators in unstable streams (i.e., incising or aggrading streams) can be more difficult to identify, but are usually less than top of bank.

Ratio of root depth to bank height. Root depth is the ratio of the average plant root depth to the bank height, expressed as a percent (e.g., roots extending 2' into a 4' tall bank = 0.50.)

Root density. Root density, expressed as a percent, is the proportion of the stream bank surface covered (and protected) by plant roots (e.g., a bank whose slope is half covered with roots = 50%).

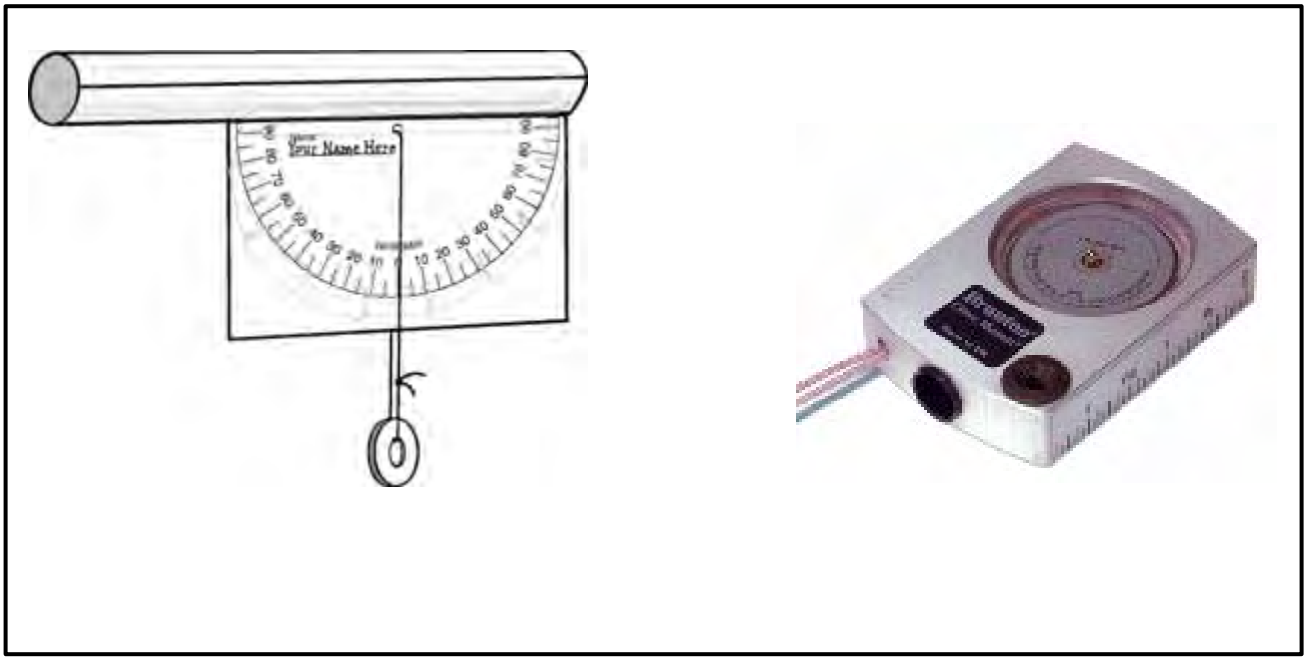
Bank angle. Bank angle is the angle of the "lower bank" – the bank from the waterline at base flow to the top of the bank, as opposed to benches that are higher on the floodplain. Bank angles great than 90º occur on undercut banks. Bank angle can be measured with an inclinometer (Figure 1), though given the broad bank angle categories (Table 1), visual estimates are generally sufficient.

Surface protection. Surface protection is the percentage of the stream bank covered (and therefore protected) by plant roots, downed logs and branches, rocks, etc. In many streams in southern Michigan, surface protection and root density are synonymous.

B. Modified BEHI Procedure

If the field staff lack experience with identifying bank full indicators, it is recommended that the bank height/bankfull height ratio metric be dropped from the BEHI calculation, leaving four metrics:

Figure 1. Simple and More Expensive (~ $100) Inclinometers



1. Ratio of root depth to bank height
2. Root density, in percent
3. Bank angle, in degrees
4. Surface protection, in percent

Observations for these metrics are made as described in Section 2A, and the overall BEHI score is calculated using Table 2.

3.0 Data Calculation and Interpretation

A draft field sheet for recording observations for the modified BEHI procedure is in Appendix 1. Overall scores for the Complete BEHI are calculated by summing the scores for each individual metric using the values in Table 1, and scores for the Modified BEHI are similarly calculated using the values in Table 2. The overall BEHI score corresponds to an erosion hazard category. It should be noted that the overall BEHI scores and categories were created by Rosgen's work in the Rocky Mountain states, and in the future these may be modified for conditions in Michigan. Illustrated examples from southern Michigan streams are in Appendix 2.

BEHI scores have several potential uses, including ranking multiple stations for further study or remedial actions (Figure 2).

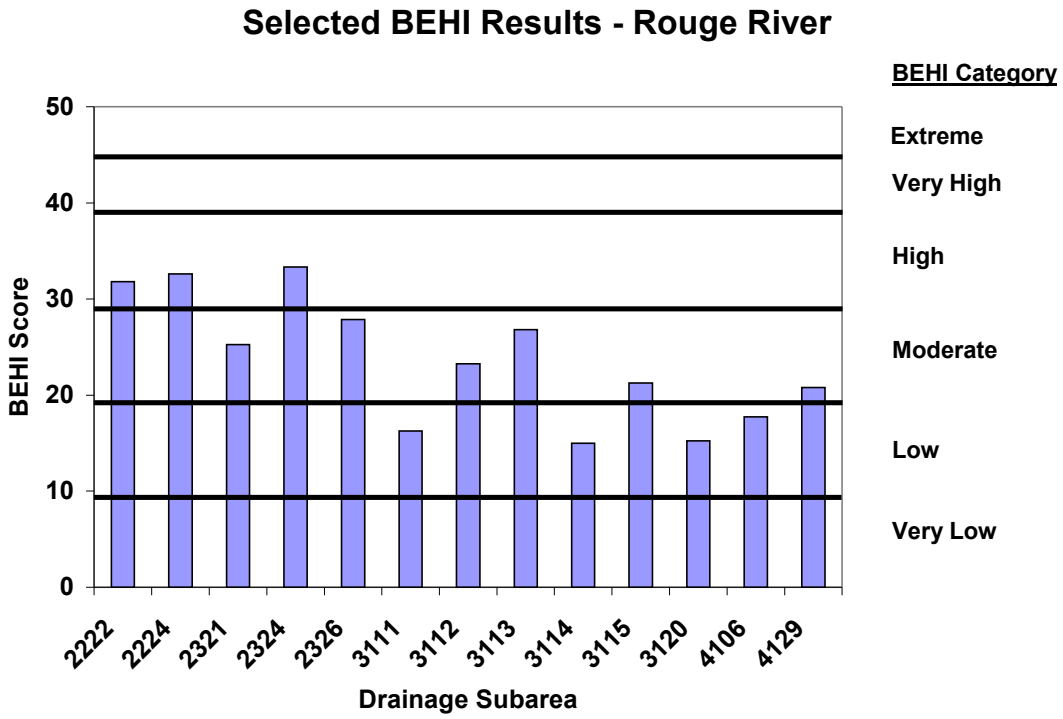
Table 1. Scores for the Complete BEHI.

BEHI Category	Bank Height/ Bankfull Height	BH/BFH Score	Root Density (%)	Root Density Score	Root Depth (% of BFH)	Root Depth Score	Bank Angle (degrees)	Bank Angle Score	Surface Protection (Avg. %)	Surface Protection Score	Total Score, by Category
Very low	1.0-1.1	**1.45**	80-100	**1.45**	1.0-0.9	**1.45**	0-20	**1.45**	80-100	**1.45**	**≤ 7.25**
Low	1.11-1.19	**2.95**	55-79	**2.95**	0.5-0.89	**2.95**	21-60	**2.95**	55-79	**2.95**	**7.26 – 14.75**
Moderate	1.2-1.5	**4.95**	30-54	**4.95**	0.3-0.49	**4.95**	61-80	**4.95**	30-54	**4.95**	**14.76 – 24.75**
High	1.6-2.0	**6.95**	15-29	**6.95**	0.15-0.29	**6.95**	81-90	**6.95**	15-29	**6.95**	**24.76 – 34.75**
Very high	2.1-2.8	**8.5**	5-14	**8.5**	0.05-0.14	**8.5**	91-119	**8.5**	10-14	**8.5**	**34.76 – 42.50**
Extreme	>2.8	**10**	< 5	**10**	< 0.05	**10**	> 119	**10**	< 10	**10**	**42.51 - 50**

Table 2. Scores for the Modified BEHI.

BEHI Category	Root Density (%)	Root Density Score	Root Depth (% of BH)	Root Depth Score	Bank Angle (degrees)	Bank Angle Score	Surface Protection (Avg. %)	Surface Protection Score	Total Score, by Category
Very low	**80-100**	1.45	**1.0-0.9**	1.45	**0-20**	1.45	**80-100**	1.45	≤ 5.8
Low	**55-79**	2.95	**0.5-0.89**	2.95	**21-60**	2.95	**55-79**	2.95	5.8 – 11.8
Moderate	**30-54**	4.95	**0.3-0.49**	4.95	**61-80**	4.95	**30-54**	4.95	11.9 – 19.8
High	**15-29**	6.95	**0.15-0.29**	6.95	**81-90**	6.95	**15-29**	6.95	19.9 – 27.8
Very high	**5-14**	8.5	**0.05-0.14**	8.5	**91-119**	8.5	**10-14**	8.5	27.9 – 34.0
Extreme	**< 5**	10	**< 0.05**	10	**> 119**	10	**< 10**	10	34.1 - 40

Figure 2. BEHI Score Example



4.0 Quality Control Issues

(1) Accuracy: Accuracy as traditionally defined is difficult to assess for this largely subjective, observational procedure. When performed by volunteers, however, the accuracy of their observations can be maximized by training from others more experienced in river morphology studies, and verified by spot-checks of their work by the trainers.

(2) Precision: Precision as traditionally defined is also difficult to assess for this largely subjective, observational procedure. Spot-checks within a few weeks of volunteer observations can be used to assess precision as well as accuracy.

(3) Reference reaches: In addition to the erosion hazard categories generated by this procedure, it can also be useful to make these observations at reference reaches – stream reaches in portions of the same watershed, or an adjacent watershed, that are believed to be (relatively) undisturbed by urban development, stream channelization, etc. A good document describing how to choose and document conditions at a reference site is the U.S. Forest Service report by Harrelson, et al. (1994). Alternatively, contact the author of this SOP for advice on selecting a representative reference reach. In general, reference reaches are best established in the same watershed as the stream reach of interest, in a stream of the same size (e.g., same stream order, or baseflow wetted width) and with similar soil type and channel slope.

(4) Stream reach selection (Representativeness): Selection of specific stream reaches for BEHI observations will depend on the objectives of the study, but a few general rules apply:

- Stream bank conditions are naturally variable even in stable streams, and to characterize a stream reach it is recommended that at least 100' of the stream reach be viewed before the BEHI observations are made.
- Stream banks adjacent to riffle areas tend to be the most stable section of a stream channel, while banks in meander bends tend to have the highest erosion rates – even in geomorphically stable streams.
- Stream banks in 'high traffic' areas (parks, livestock crossings, etc.) are not representative of average conditions and should be avoided – unless they are the specific focus of the study.

5.0 References

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SOP Prepared by:

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Appendix C: Inventory Field Form Instructions

Date:	*Date of Survey*	Location:	*Describe Site or Name Road Crossing*
Surveyor Name:	*Your Name*	Latitude (DD):	*Latitude in decimal degrees if known*
Waterbody Name:	*Name of stream if known*	Longitude (DD):	*Longitude in decimal degrees if known*

Downstream Observations

L Veg. Width (ft)	<10	10-30	30-100	>100	L Veg. Type	Bare	Mowed	Tall Grass	Tree/Shrub
R Veg. Width (ft)	<10	10-30	30-100	>100	R Veg. Type	Bare	Mowed	Tall Grass	Tree/Shrub

*Choose the best approximate **width** for vegetation on the left (L) & right (R) banks FACING DOWNSTREAM, **then** choose the MOST COMMON **type** of vegetation on the left (L) & right (R) banks FACING DOWNSTREAM.*

Stream Canopy %	<25	25-50	>50	Aquatic Plants	N/A	Absent	Present	Abundant

*Choose the best approximation of the PERCENT of stream covered by tree canopy DOWNSTREAM of survey site (**use examples on back of Inventory Field Form for guidance**), **then** choose the best description of the presence of aquatic plants IN the water DOWNSTREAM of survey site (**choose N/A if stream bottom is not visible**).*

Left Bank BEHI

Root Depth (% of BH)	Root Density (%)	Surface Protection (Avg. %)	Bank Angle (degrees)
90-100	80-100	80-100	0-20
50-89	55-79	55-79	21-60
30-49	30-54	30-54	61-80
15-29	15-29	15-29	81-90
5-14	5-14	10-14	91-119
< 5	< 5	< 10	> 119

Right Bank BEHI

Root Depth (% of BH)	Root Density (%)	Surface Protection (Avg. %)	Bank Angle (degrees)
90-100	80-100	80-100	0-20
50-89	55-79	55-79	21-60
30-49	30-54	30-54	61-80
15-29	15-29	15-29	81-90
5-14	5-14	10-14	91-119
< 5	< 5	< 10	> 119

Choose for each category based on the AVERAGE condition of the stream bank on the appropriate side facing DOWNSTREAM at the survey site. To properly characterize stream bank conditions, as much stream reach as possible (at least 100') should be viewed before BEHI observations are made. BEHI CATEGORY DEFINITIONS:

Root Depth (% of BH): *Root depth is the ratio of the AVERAGE plant root depth to the bank height, expressed as a percent (e.g., roots extending 2 feet into a 4 foot bank=50%)*
Root Density (%): *Root density, expressed as a percent, is the proportion of the stream bank surface covered (and protected) by plant roots (e.g., a bank whose slope is half covered with roots=50%)*
Surface Protection (Avg. %): *Surface protection is the percentage of the stream bank covered (and therefore protected) by plant roots downed logs and branches, rocks, etc. In many streams in southern Michigan, surface protection and root density will be the same. Surface protection should never be LESS than root density.*
Bank Angle (degrees): *Bank angle is the angle of the "lower bank" - the bank from the waterline at base flow to the top of the bank, as opposed to benches that are higher on the floodplain. Bank angles greater than 90 degrees occur on undercut banks.* ***Use EXAMPLES on back of the Field Form to determine the appropriate bank angle.***

Upstream Observations

Same procedure as "Downstream Observations" except ALL observations are made facing UPSTREAM at survey site. Left and Right are ALWAYS the observers Left and Right.

Combined Observations

Average Stream Width (ft)	<10	10-25	25-50	>50

Choose the best APPROXIMATE width. Use the AVERAGE of upstream and downstream if they are different.

Comments: *Use this area to describe not only the severity of erosion & presence of specific items (structures, pipes, oil, dumping, stream alteration, etc.) but also general observations about land use and activities in the surrounding area. Indicate whether erosion is occurring near structures and if possible include apparent causes.*

Appendix D. Hydrologic Study Results

Contact Dave Fongers, MDEQ Hydrologic Studies Unit for more information