

Stream Bank Stabilization

updated September, 1997

Description

This BMP discusses the thought process that should be used when eroding stream banks are deemed in need of stabilization. Emphasis is placed on stabilization at the watershed level first, then individual sites. Several systems of BMPs are discussed, with reference to specific BMPs. Emphasis is given to “softer”, less rigid structures.

In all aspects of stream bank erosion—from source and cause identification to design and implementation of BMPs—people are encouraged to work with Department of Environmental Quality (DEQ) Nonpoint Source staff in Surface Water Quality Division, or with other stream bank experts.

Note that all stream bank stabilization activities will require permits from the Department of Environmental Quality, Land and Water Management Division. For a discussion on the use of gabions, seawalls and retaining walls, groins, shoreline revetments, and breakwalls, see the Slope/Shoreline Stabilization BMP.

Other Terms Used to Describe

Armoring
Revetments
Riprapping (Note that Riprap is a separate BMP)
Soil Bioengineering/Bioengineering
Stream Bank Protection

Pollutants Controlled and Impacts

Stabilizing stream banks can:

- * Prevent the loss of land or damage to utilities, roads, buildings or other facilities adjacent to a watercourse, and prevent the loss of stream bank vegetation,
- * Reduce sediment loads to streams,
- * Maintain the capacity of the stream channel,
- * Improve the stream for recreational use or as habitat for fish and wildlife, and
- * Control unwanted meander of a river or stream.

Application

Land Use

This practice is applicable to all land uses.

Soil/Topography/Climate

The site-specific stream bank practices used will be partially dependent upon the types of soils present, the slope of the bank, gradient of the river, flow, and uses of the watercourse.

When to Apply

The appropriate time to apply stream bank erosion controls is dependent upon the method used. Some seasonal limitations are included in the specifications of referenced BMPs.

Where to Apply

Apply this practice in areas where stream banks are eroding.

Relationship With Other BMPs

Geotextile materials (Filters) are often used underneath Riprap.

Specifications

Since each reach of a watercourse is unique, stream bank protection techniques must be selected on a site-by-site basis; the specifications for each technique differ. The following is guidance which can be used to determine appropriate stream bank erosion control practices.

Planning Considerations:

It is important to remember that streams are dynamic. Even without human influence streams may meander, and in the process, cause banks to erode. Therefore, not all eroding banks are “bad” and in need of repair. In fact, the wrong system of BMPs installed in the wrong place may cause more damage downstream (and therefore to the entire stream system) than leaving the stream in its natural state. For example, “hard structures” like large riprap or gabions, placed on one eroding bank, can displace the stream’s energy downstream to a previously stable bank, causing the downstream bank to erode. If this downstream bank is also stabilized with a hard structure, the stream’s energy may be moved further downstream to another previously stable bank, and so on.

So before stabilizing stream banks, consider the cause of the stream bank erosion. If the banks are eroding due to a natural meander, then it may be best to leave the bank alone. If the banks are eroding due to fluctuations in hydrology, the hydrologic fluctuations should be addressed before the banks are stabilized.

Once the cause of erosion is addressed, determine the goal in stabilizing the stream banks. Some banks are stabilized to protect buildings and land. Others are stabilized to keep soil from entering the stream and to allow angler access to the stream. The purpose for stabilizing the banks and the users of the stream will help determine the type of structures needed.

Once the above concerns have been addressed, then it is important to work with agencies with expertise in stream bank erosion techniques to address stream bank erosion at the watershed level. Looking at the entire watershed will help prioritize bank stabilization efforts. If you are only interested in site-specific alternatives, please turn to “Methods” on page 5.

1) compile land use data on the watershed to determine if there is a direct link between land use and soil erosion. For example, land in livestock production can be a source of sediment if the livestock have direct access to the stream. If land uses are being converted from agriculture to urban, the increased impervious areas may cause increased flows to the stream, which may scour stream banks and cause erosion. Put simply, land uses can help pinpoint potential sources of erosion.

The DEQ, Land and Water Management Division’s Michigan Resource Information System (MIRIS) database contains information on the soils, land uses, streams, roads and other features in watersheds throughout the state. Keep in mind that as of the date of this printing, MIRIS data was based mostly on 1978 land use data. Many Soil Conservation District offices also have land use data (often based in part on the MIRIS). Several universities have sophisticated land use decision-making ca-

pabilities (which may include MIRIS data), as well as the capabilities to determine future land uses based on current trends.

Other important sources of land use information include topographic maps of the area, soil maps (if available), and aerial photos. These will show the pattern of the river as it meanders through the watershed. Comparing recent aerial photos to historic photos will also help determine if the river is widening, meandering or otherwise in a state of change.

2) Field verify the data. Because land uses change, it is important to field verify land use data in order to ensure decisions are made based on current and accurate information. This is particularly important in rapidly developing areas. Field verify data by walking or canoeing the entire river, or, if granted permission by property owners, by walking the stream banks. If you're not familiar with the river or stream, contact the DEQ, Surface Water Quality Division or Land and Water Management Division, or DNR, Fisheries Division to find out if the stream is wadable. In National Forest Service lands, contact the US Forest Service. These and other agencies will likely have some information on the stream you're interested in.

When you go out in the field, take a measuring tape, clipboard, pencil or waterproof pen, and multiple copies of the attached worksheet (Exhibit 1). A camera is also important when discussing site-specific conditions with other people. On wadable streams, take hip boots or waders. Use the attached worksheet while noting the specific areas of stream bank erosion. Note soil type and any log jams, construction activities, eroding road crossings, and improper stream access (e.g. cows in the water, areas where people have accessed the river for recreational opportunities, etc.). Where possible, measure the length and height of the eroded stream banks.

Back in the office, incorporate your visual observations with the land use data. Ideally, this will be done by incorporating your notes into the land use database.

3) Estimate the magnitude of the erosion and all potential sources of erosion. Sources of sediment to the stream may include angler access, livestock access, or poorly maintained or improperly designed road crossings. The magnitude of the erosion can be determined by ranking each site as severe, moderate or minor, using the attached field sheet (Exhibit 1). Use of the Universal Soil Loss Equation is discussed in an appendix of the Guidebook of BMPs.

4) Rank the sites. At its simplest, ranking sites can be based on addressing the most severe sites first and working from upstream to downstream, including tributaries. Another alternative is to rank sites based on four criteria: 1) degree of impact (severe, moderate, minor); 2) the cost of installing the system of BMPs needed; 3) landowner willingness to cooperate; and 4) "demonstration-ability." (i.e. amount of public visibility). "Demonstration-ability" is important if you plan to solicit volunteers or funding for stabilization efforts. This site ranking method was used in the Bear Creek watershed, Kent County.

5) Determine appropriate options for the high priority sites. Use the information gathered on land use and from visual observations (including photos) to evaluate stream bank stabilization alternatives. The BMPs selected should also help to achieve the overall goals for the watershed (such as improving fish habitat or providing greater recreational access). Review the scenarios below, the various Methods on page 5, and then contact stream bank experts to discuss site-specific options.

Stream Bank Stabilization Scenarios:

The following hypothetical scenarios illustrate various alternatives for stream bank stabilization:

Scenario 1: Visual observations show several minor stream bank erosion sites. Erosion was determined to be caused by stream flow. The amount of human influence on flow is low (i.e. it is naturally “flashy” versus flashiness caused by increased flow from urbanization). The decision in this case is to leave the eroding banks alone.

Scenario 2: Comparing aerial photos from 1938 and 1990 shows that the stream hasn’t meandered much, yet there are hundreds of banks along the stream that are bare, mostly due to angler and canoeist access. The stream is a high quality trout stream and local people hold the river in high esteem. Since sediment is detrimental to trout habitat, the decision was made to stabilize stream banks in this watershed, providing access via stairways and canoe landings, and restricting access via practices such as fencing and brush mulch. Since the greatest reduction in sediment load will be gained by stabilizing severe sites, the most severe banks will be stabilized first, going from upstream areas, downstream. If more money becomes available, then moderate sites would be stabilized, again, starting upstream.

Scenario 3: The predominant land use is urban. Severe erosion is observed downstream of the urban area. In this hydrologically unstable area a stormwater management plan will be developed in conjunction with or prior to stream bank stabilization to reduce extreme hydrologic fluctuation and velocities. In this example, the decision was also made to work on an ordinance which would address stormwater practices to prevent additional flows to the stream.

Scenario 4: The predominant land use is agricultural. Moderate and severe bank erosion is occurring at several livestock access areas. In this example, cattle exclusion systems, including fencing and alternative watering areas, were designed and implemented in conjunction with stream bank stabilization techniques.

Scenario 5: Visual observations and historical aerial photographs show the stream to be relatively stable. Most of the adjoining land is rural/agricultural but is expected to experience 35% growth in the next 15 years: therefore, additional flows to the stream are expected. Two new road crossings are causing severe erosion downstream of the crossings. The decision was made to stabilize the banks downstream of the new crossings with structures which help absorb some of the energy from stream flow (see soil bioengineering structures, below). The decision was also made to work with the road commission so that future road designs would be done such that downstream areas are not impacted. An ordinance to provide on-site detention/retention of stormwater from the newly constructed area was also proposed.

Other Things to Consider

In selecting site-specific options to stabilize eroding stream banks, consult the Michigan Department of Environmental Quality (Surface Water Quality Division or Land and Water Management Division), local Conservation District, or other agencies or consultants experienced in stream bank erosion control. Also, be sure to check Exhibit 2 to see if your river is included on the list of Natural or Wild and Scenic Rivers. These rivers have special restrictions, depending on their designation. Contact the MDEQ, Natural Rivers Program staff for further information on the types of stream bank practices that can be used in Natural Rivers.

It is also important to get input from the people who may use the watercourse at the specific site in need of stabilization, (i.e. river boat guides, anglers, canoeists, etc.). Consider working through a local watershed steering committee, if available. These committees include representatives from a variety of backgrounds and interests.

NOTE: While considering BMP options, remember that no removal of sediment bars, snags, stumps, debris drifts, trees, brush or similar material should be done unless absolutely necessary, and upon approval by the MDEQ, Land and Water Management Division. This in-stream cover is necessary for channel diversity and aquatic habitat.

Methods:

There are numerous methods available to stabilize stream banks. Rather than discuss all of them or any of them in detail, below is a discussion of the most common practices.

Riprap:

Riprap is one of the more commonly used stream bank stabilization techniques. It is a permanent cover of rock used to stabilize stream banks, provide in-stream channel stability, and provide a stabilized outlet below concentrated flows. It is generally used on stream banks at the toe (bottom) of the slope, with other structures placed up-slope to prevent soil movement. It is often a component of many soil bioengineering techniques. Specifications for riprap used in stream bank stabilization is discussed in the [Riprap BMP](#).



Picture 1, above: The bank was stabilized with rock riprap from the toe (bottom) of the bank to the top of bank. This may be needed on streams with unstable hydrology (i.e. “flashy” streams), and where banks have groundwater seeps. Source: North Branch Chippewa River Nonpoint Source Project.

The Department supports the use of natural fieldstone for riprap; only natural fieldstone is allowed in rivers designated under the Natural Rivers program. The use of vegetation in conjunction with riprap is encouraged to “soften” stream bank structures.



Picture 2, right: Riprap was placed to 3 feet above the ordinary high water mark and a portion back-filled with soil. Log terraces were placed on the bank and the bank was seeded. This approach can be used on top of fish lunger structures and on banks where stream flows are relatively stable. Also note the fence and stairway to direct recreationist access. Source: Boardman River Nonpoint Source Project.



Soil Bioengineering:

Soil bioengineering is a method of using vegetation to stabilize a site with or without structural controls. Some refer to bioengineering as softening the traditional rock-the-bank approach because non-invasive vegetation is used to blend the site into its surrounding landscape. Bioengineering techniques may be as simple as using stop-logs to form terraces, then seeding exposed soil to help prevent soil movement. Techniques also include using fascines (long bundles of willow or dogwood), with layers of brush, along with individual plantings.

Picture 3, left, shows a fascine, brush layering and live stakes. **Picture 4, below,** shows new growth from a live stake. Source: Whetstone Creek Nonpoint Source Watershed Project.

fascine

brush layering

live stake



Chapter 18 of the USDA Soil Conservation Service (now Natural Resource Conservation Service (NRCS)) Engineering Field Handbook is one of the most comprehensive sources of information on soil bioengineering. Chapter 18 describes soil bioengineering as a combination of biological and ecological concepts to arrest and prevent shallow slope failures and erosion. Rather than duplicate NRCS' efforts to describe soil bioengineering techniques here, people interested in exploring soil bioengineering are encouraged to work with the NRCS, MDEQ, and other agency staff familiar with bioengineering practices.

As another example of a system of practices used to stabilize a bank, refer to Picture 2. In addition to riprap, seed and log terraces, the system of BMPs on the bank in Picture 2 included fencing to direct foot traffic, and a set of stairs.

Maintenance

A maintenance plan should be included with all site plans. The maintenance plan should indicate when inspections of the site will be made and who will be responsible for needed maintenance. Site inspections, conducted to ensure the stream bank structures are staying in place, are particularly important within the first few months of installation, and following storm events which result in bank-full streams. More specific maintenance procedures can be found in the referenced BMPs.

Exhibits

- Exhibit 1: Field Data-Entry Form which can be used in the stream bank erosion inventory, Northwest RC&D Council. (This type of approach has been used to identify and rank eroding sites on the Muskegon, Au Sable, Pine and Betsie Rivers).
- Exhibit 2: Michigan's Natural Rivers System. List of rivers designated or proposed under the Natural Rivers program.

Field Data-Entry Form for Stream Bank Erosion Inventory

This form is intended to be used to compare the severity of eroding stream banks within a watershed. Results can be used to help prioritize stream bank stabilization efforts. Fill in all known information. Where provided, fill in the appropriate number per each category, then total the "points" on the last page.

Date: _____
County: _____
Stream: _____
Observer: _____

SITE LOCATION:

Township Name: _____ No. _____ Range _____ Sec. _____
Bank (right or left, looking downstream): _____
Property Owners: _____
Other info re: location: _____
Accessibility for machinery/materials (good/bad)
Access Problems: _____

SITE NUMBER: _____

MEAN WIDTH OF RIVER: _____
(no points)

CONDITION OF BANK:

_____ 5 Toe and upper bank eroding
_____ 3 Toe undercutting
_____ 1 Toe stable, upper bank eroding

_____ 5 Length of eroding bank > 50 ft.
_____ 3 Length of eroding bank 20-50 ft.
_____ 1 Length of eroding bank < 20 ft.

_____ 5 Side slope vertical 1:1
_____ 3 Side slope 2:1, 3:1
_____ 1 Side slope 4:1 or flatter

PROBLEM TREND

_____ 5 Increasing
_____ 1 Decreasing or stable

(continued, next page)

DEPTH OF RIVER

- _____ 1 > 3 feet
- _____ 2 < 3 feet

VEGETATIVE COVER

- _____ 5 Vegetative cover 0-50%
- _____ 3 Vegetative cover 50-80%
- _____ 1 Vegetative cover 80-100%

MEAN HEIGHT OF BANK

- _____ 5 Mean height of bank > 20 ft.
- _____ 3 Mean height of bank 10-20 ft.
- _____ 1 Mean height of bank < 10 ft.

SOIL TYPE OR TEXTURE

- _____ 3 Sand
- _____ 2 Gravel
- _____ 2 Stratified
- _____ 1 Clay or loam

APPARENT CAUSE OF EROSION

- _____ 1-Light access traffic
- _____ 1-Obstruction in river
- _____ 1-Bank seepage
- _____ 1-Gullyng by side channels
- _____ 2-Bend in river
- _____ 3-Road-stream crossing, grade/shoulder runoff
- _____ 3-Moderate access traffic
- _____ 5-Heavy access (foot, horse, etc.) traffic
- _____ 5-Construction site erosion

- _____ TOTAL POINTS: more than 36 — severe
- 30-36 — moderate
- less than 30 — minor

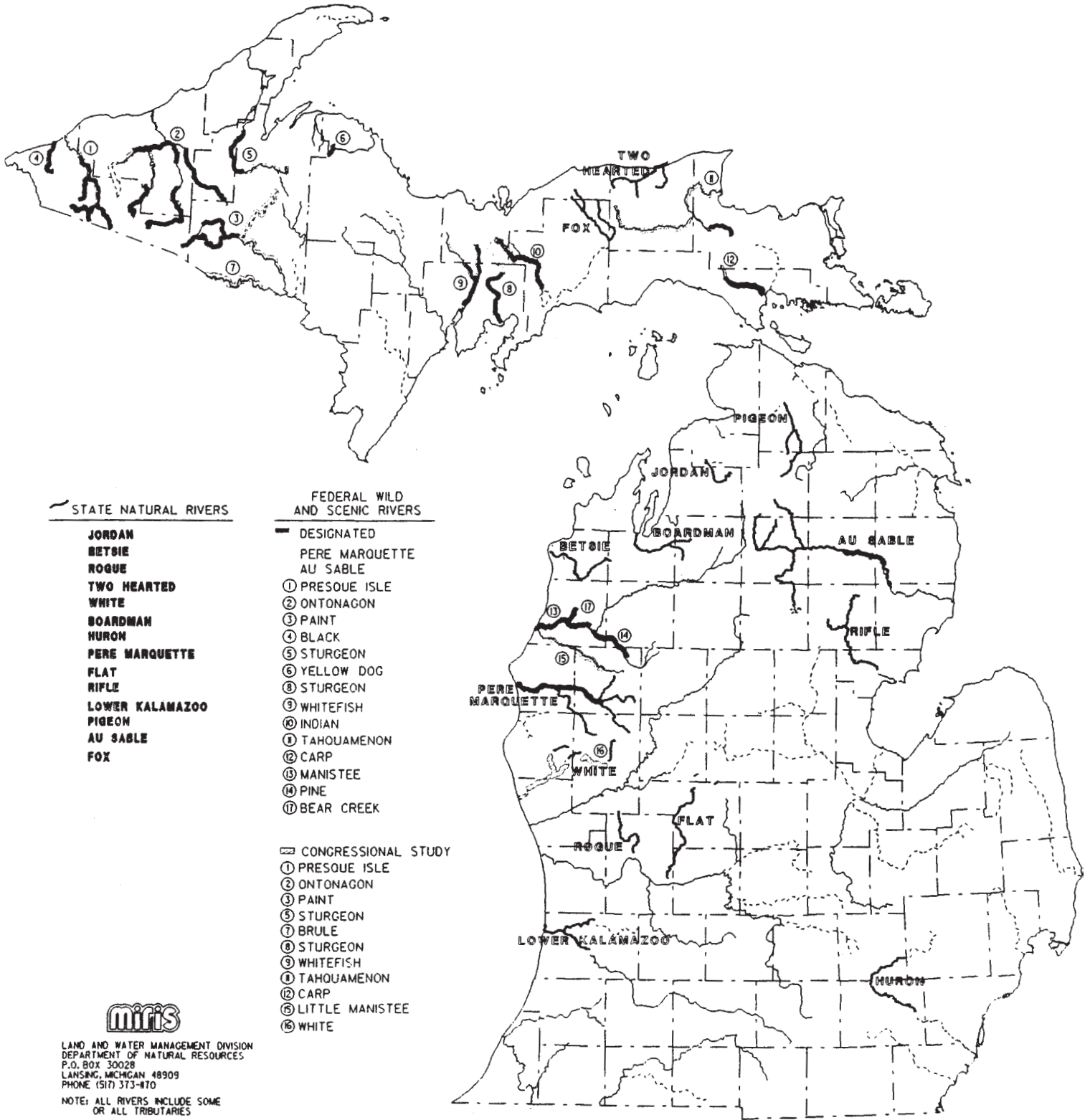
RECOMMENDED TREATMENT

Describe a potential system of BMPs for the site:

NOTE: Sketch location on a separate sheet, showing any unusual circumstances. Also, provide black-and-white or color photograph, if possible.

Source: Modified from the inventory sheet used in the Upper Manistee Stream Bank Erosion Inventory.

Exhibit 2
Michigan's Natural Rivers



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