STREAMBANKS AND SHORELINES

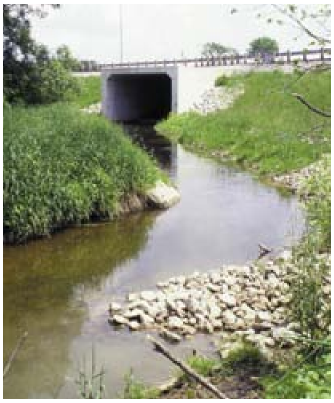
Some watercourse erosion is natural. Sediment is needed to replenish gravel and sand beds, and bars in watercourse curves. But too much erosion causes problems, such as destruction of fish and wildlife habitat and loss of land.

Streams will form meanders, thus reducing the erosive energy of watercourses.

Watercourses are dynamic, in a constant state of flux. In their natural state, streams will balance water flow, sediment load and shape. Flowing water moves from bank to bank and over time develops meanders. Meanders, pools, non-obstructive streambank vegetation and fallen trees will reduce the erosive energy of watercourses.

But when there is a drastic change in the balance that a watercourse has attained, erosion and flooding result. There are three major causes for increased streambank erosion, and they're outlined in the photos below.

STRAIGHTENING STREAMS – when urban development, road works or surface drainage construction leads to straightened streams, there is less bank resistance to flow. Consequently, flow rate increases sharply, causing severe erosion and flooding in high-risk areas.



LAND USE CHANGES – whenever natural land cover is replaced by hardened surfaces such as roads, parking lots and sidewalks, runoff increases and infiltration is reduced. In rural areas, land use changes include wetland drainage and woodlot removal. Cropping and grazing too close to riparian areas will also increase runoff.

FLOW OBSTRUCTIONS – roads, culverts, in-stream irrigation dams, poorly designed crossings, and large fallen trees can all have a "damming" effect. These "dams" will slow water energy and cause suspended sediment to drop out. The next time the flowing water reaches its peak flow, it will use some of that energy to erode susceptible banks.

In most cases, bank and shoreline stabilization projects are complex. You should always consult your local Conservation Authority and municipality. Seek advice on construction, habitat issues, permits and approvals.

KNOW WHAT YOU'VE GOT

You'll very likely need professional assistance to really understand what's going on and what needs to be done. The first thing they'll need to know is what kind of erosion needs to be addressed. Look for evidence of one or more of the following types:

- **stream flow** – high flow rates at high water levels cause erosion in the bottom of the channel and on the banks
- **surface runoff** – concentrated flow in the form of rill erosion can lead to gully erosion
- **bank damage** – direct and excessive livestock access or equipment use can lead to bank damage or bank destabilization
- **subsurface flow** – where there are two contrasting layers of soil material, groundwater movement can be accelerated or "piped" out of the streambanks; projects that address this require designs from professional engineers.

Knowing what your erosion problem is before you consider any work on banks is the key to successful erosion control.

Bank erosion from streamflow.

Bank damage from livestock access.

If livestock access is the problem, address this first! See the Livestock Grazing Near Water chapter, starting on page 35.

If there is no buffer between the top of the bank and adjacent cropland, see Establishing and Managing Buffer Strips, page 64.

If there is excessive cropland soil erosion and runoff, address these first. For BMPs to control runoff around municipal drains, see page 110. For soil and water BMPs, see the previous chapter, beginning on page 93.

Bank erosion is often the symptom of one or more of the foregoing problems. If these are addressed adequately, much of the work is done.

STREAMBANKS

BANK EROSION CONTROL STRUCTURES

These structures involve hard materials such as rock, concrete and wood being anchored to a bank to protect it from erosion (e.g., crib walls, rock riprap).

Several generations of field experience suggest that, in streams, “hard” structures are not always suitable.

Hard techniques provide a solid defence against the energy of flowing water, particularly at the “toe” of the slope where erosive energy is greatest. When designed and constructed properly, they work well. However, when poorly designed or improperly constructed, they can be susceptible to collapsing. Areas with significant subsurface flow, areas with wide fluctuations in stream flow, and strongly meandering watercourses are particularly vulnerable.

There is a place for hard structures – in channelized watercourses, or when used in combination with plant bioengineering methods, or when placed in spots of extreme bank failure. Some of these techniques are described below.

BIOENGINEERING helps streams naturalise quickly.

ROCK RIPRAP is a hard erosion control structure for banks where angular rocks are strategically placed at 2-ft. horizontal for every 1-ft. vertical rise, or flatter to protect bank soil materials. The structure must be underlaid with filter cloth.

Rock riprap is most suited to local spots of extreme erosion. It may not be suitable for sandy areas or areas with significant subsurface flow. In these areas, soil materials can be washed from beneath the rock, causing failure and severe erosion. Consider using these structures in combination with plant bioengineering techniques.

The creation of RIFFLES AND POOLS helps slow water. Coarse materials are placed in beds to create riffles. Streambeds are deepened to create pools.

BMPS FOR SOIL BIOENGINEERING

Soil bioengineering involves living and dead plant materials being used to restabilize eroding soil materials in banks (e.g., live fascine or brush mattresses).

Rocks, logs and roots, when combined with live plant materials, will hold soil, slow water, filter contaminants and grow to provide habitat. Several techniques are described below. See the next page for project tips.

LIVE STAKING

Live, rootable cuttings are planted along eroded banks of small streams to create a living root mass that will stabilize and bind the soil.

BRUSH LAYERS

Bundles of live cuttings are set at right angles of slopes to break up slope length and create a living root mass.

GEOTEXTILES

Also known as biodegradable soil support materials, geotextiles can be used with other soil bioengineering techniques to cover bare banks until the vegetation becomes established.

Rootwads have been placed along vulnerable outside bends of streambanks to protect them.

YOU CAN BANK ON THIS: CONSIDERATIONS FOR BANK PROJECTS

BEFORE YOU START

Verify the problem. What type of erosion is it, e.g., is it stream or subsurface flow?

GET TECHNICAL ASSISTANCE from your Conservation Authority, the Ministry of Natural Resources or Ducks Unlimited, to name a few. They can help you assess the situation and discuss BMP options. Some groups may offer financial assistance.

Talk to your neighbours. You may share a problem, and perhaps a project. At the very least, share your views!

Get the necessary permits and approvals. Don't let oversight stop good intentions.

Use local natural materials and plants wherever possible. Select the most suitable species for the job.

ONCE YOU'VE STARTED

Install sediment control features, e.g., coir logs, erosion control blankets, bales, etc.

Disturb only when necessary: soil and plants in place are already stable. Don't use invasive species or wood treated with preservatives.

WHEN THE PROJECT IS COMPLETED

Restrict access to plantings during establishment. Water plants during droughts. Control weeds until your plants are established. Monitor the site and make adjustments.

Look into local habitat or environmental group initiatives. Volunteers can make a difference.

Riffle and pool structures were strategically placed into the south branch of the South Nation River municipal drain in Dundas. The work was completed as part of the engineer's report, in hopes of providing fish habitat.

Coir logs made from coconut fibre can be put in place to narrow flow channels, and trap sediment behind them to encourage vegetation to stabilize.

BMPS FOR DITCHBANKS

Open drains are waterways that have been changed or constructed, and therefore have unique ditchbank challenges when compared to streams or rivers. Usually, the ditchbanks are meant to quickly convey the channelled flow of drainage water. Streambanks, on the other hand, have been formed by the erosive action of naturally flowing water.

Nevertheless, ditchbanks need to be stable to prevent bank erosion. Ditchbanks are mostly subject to the same erosive forces as streambanks (i.e., channel flow, bank damage, surface runoff and subsurface flow). However, generally ditchbanks have fewer problems with channel flow and more with cropland runoff and bank damage from cropping practices.

Ditches, whether for private open drains, mutual agreement open drains or open municipal drains, convey subsurface drainage water and surface water from cropland. As such, they have tile outlets and surface inlets entering into them. If improperly designed or managed, they can be a source of bank erosion.

All ditches should have a 5-metre (16-ft.) maintained, grassed buffer on each side to keep cropping practices and farm equipment away from surface water. (A 3-metre or 10-ft. buffer is an absolute minimum.) Minimum-width grassed buffer strips can be enhanced with any of the following:

- trees or shrubs on one side to improve wildlife habitat potential and add biodiversity
  - if positioned on the outside edge, woody vegetation can help keep cropping equipment from encroaching on the buffer
- a secondary buffer to make it wider and more effective, and
- drop structures and berms where field runoff regularly flows in a draw before it reaches the ditch.

The following BMPs are unique to ditchbanks.

Ditches should have a 5-metre (16-ft.) buffer.

Design

Two numbers separated by a colon (e.g., 2.0:1.0 or 1.5:1.0) indicate the side slope. The first number represents a horizontal distance and the second a vertical distance. An important advantage of the flatter slope, other than stability, is that it's easier to get vegetation established on the banks.

Angular rock was used by the engineer to stabilize the "toe"of the bank on this outside corner. Vegetation alone will stabilize the upper bank.

To prevent erosion and provide bank stability, ditchbanks should be shaped. Different soil types naturally require different side slopes. In general, however, 1.5 horizontal to 1.0 vertical should be considered an absolute minimum with 2.0 to 1.0 preferred maximum. Fine sands and silts may require much flatter side slopes to provide a stable channel.

Some "hard" bank erosion control structures may be necessary on sharp turns. See the section on Bank Erosion Control Structures on pages earlier in this chapter.

Establish vegetative cover as soon as possible on the bare ditchbank. A proven method of seed establishment is called "daily seeding", which simply means that a section of ditch constructed on a specific day is seeded the same day. This can be easily achieved with a cyclone seeder. The main reason for this method's success is that a newly cut bank will normally provide enough moisture to germinate the seed.

Remember that all ditches are connected to a downstream watercourse. Consult the drainage superintendent and ensure you get the proper permits before proceeding if the project is along a municipal drain.

Tile Outlet Protection

To reduce bank erosion around tile outlets, install non-perforated rigid pipe (minimum length of 3 metres or 10 ft.) with a rodent gate, filter cloth and rock riprap. Install a header tile to reduce the number of outlets.

Improperly protected tile outlets can be a source of bank erosion. Tile outlets can also carry pollutants from cropped lands. Here are some BMPs to reduce the risk of surface water contamination:

- ► consider using header tiles and fewer outlets when upgrading drainage systems – this can help reduce ditchbank erosion
- ► install non-perforated rigid pipe (minimum length – 10 ft.) with a rodent gate, filter cloth and rock riprap to prevent or correct ditchbank erosion problems
- ► check the condition of the outlet pipe, rodent gate and riprap – especially in the spring
- ► check outlet effluent to ensure liquid manure, sediment or other contaminants are not getting into watercourses.

Drop Structures

Check with your local drainage superintendent and Conservation Authority before taking any action around municipal drains.

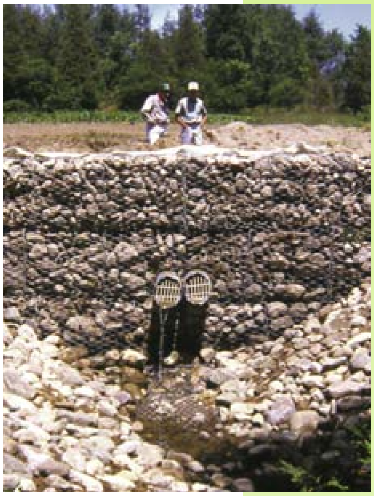
One of the major causes of ditchbank failure and washouts is from concentrated surface flow entering the ditch over the bank. Here are three common methods to control this problem.

ROCK CHUTE SPILLWAYS

These spillways are sloped riprap structures placed at points of entry for surface runoff from cropland that's level or gently sloping. They have to be wide and deep enough to adequately carry the surface flow and should extend from well into the field to below the level of flowing water. Rock chute spillways prevent ditchbank failure caused by scouring.

WASCOBS (WATER AND SEDIMENT CONTROL BASINS)

WaSCoBs are earthen berms constructed across a low draw in the field with the function of ponding runoff water. They prevent gully erosion by intercepting concentrated flow and creating temporary ponding conditions behind an earth dam or "berm". Ponded water is slowly released through a drop pipe to a tile outlet. Water is ponded behind the berm for up to 24 hours. Placed at the edge of fields near ditches and other watercourses, drop pipe inlets drop concentrated flow and ponded waters safely to watercourses. Pipe designs can be steel or plastic.



GABION BASKETS

Gabion baskets are systems where the rock materials are held in place with wire cages. Filter cloth must be used underneath the structure. They are suitable in areas with local spots of extreme erosion, used either on their own or in combination with other hard structures such as bridges and crossings. In other situations, gabion baskets may be considered in combination with plant bioengineering.

BMPS FOR DRAIN MAINTENANCE

Check with your local drainage superintendent and Conservation Authority before taking any action around municipal drains.

REVEGETATING BARE BANKS

Bare banks are prone to erosion during high water and any storm event. A vegetative cover will protect the soil material and provide important wildlife habitat. Ground-nesting birds prefer native grasses. The grasses can be more difficult to establish, but will persist longer. Tame forage grasses and legumes are easier to establish, but are less preferred as habitat. Use cover crops, nurse crops or mulches to aid establishment. Consider planting trees or shrubs on one side of the drain.

DRAIN MAINTENANCE – TIMING AND TECHNIQUE (BOTTOM CLEANOUT)

Sediment and woody debris at the bottom of the drain may obstruct flow excessively. Remove it during the early part of the growing season (June) where possible to minimize disturbance. Bottom cleanouts will restrict destruction of the vegetation to the channel area only. Bank stability is not affected. Removed sediment should be spread well back from the top of the ditchbank. Spread it on the buffer – or truck it away.

Vegetation can block the flow of draining water during times of high flow. Removing obstructions can stabilize the banks. This involves the judicious removal of woody vegetation by trimming, pruning and thinning, or mowing only heavily grassed areas. Removal from the channel bottom or only one side of the ditchbank may be all that's necessary.

SHORELINES

Ditchbanks and shorelines are quite different. With banks, water flows in a channel along the toe of the banks. The sediment from eroding banks is carried downstream and sorted as the flow changes. By contrast, lake waters move cyclically in waves directly at the beach. Coarser sediment is deposited at the shore to form beaches. Finer particles (silt and clays) are carried out by near-shore currents to be deposited in deeper waters.

There are several types of shorelines: bluffs, points, bays, deltas and wetlands.

BLUFFS

Bluffs are shores with a vertical or near-to-vertical elevation drop from the land to the water. Bluffs consist of layered soil materials or exposed bedrock – often lacking vegetation due to erosion or lack of topsoil. Bluff erosion is most severe where there are exposed clayey and silty soil materials, and when these materials cause piping (significant subsurface flow). Erosion can also be severe when land use (e.g., buildings) has put undue pressure on the bluff.

POINTS

Points are shores where the land juts into the lake like a peninsula. Points can be formed of most soil types, but are often naturally protected by coarser materials such as stones, cobbles and boulders. Waves and off-shore currents are the main erosive forces affecting points.

BAYS

Bays are shore areas where the land is "indented." Sandy beaches form where the bay is sharply indented between two points. The dynamic nature of the wave action sorts the sand and gravels on the beach and carries finer materials to deeper waters. Shoals or flag beaches are usually less indented, near exposed bedrock, and subjected to high wave energy.

DELTAS

Deltas are shore areas where major watercourses enter a lake. The energy of flowing water interacts with the energy of lake water (e.g., Grand River and Lake Erie). Fine sands and silts are deposited nearby and are constantly cut into new channels. Like bluffs, deltas are unstable and should be left in a natural condition.

LAKESHORE WETLANDS

Lakeshore wetlands are usually marshes and are most often formed in bays or near deltas. These marshes trap sediment, utilize excess nutrients, and create habitat for fish, songbirds, waterfowl and many other wildlife species.

BMPS FOR LAKESHORES

Shoreline erosion is often caused by other disturbances, e.g., the removal of vegetation or shoreline wetlands, or by the installation of a new structure. Check with authorities to ensure you understand the source of the problem.

The goals of BMPs around lakeshores are to:

- prevent and control shoreline erosion, as well as erosion from adjacent land use
- prevent contamination from crop nutrients, bacteria, and pesticides, and
- conserve fish and wildlife habitat.

BMPs involve structural work and maintenance.

Shoreline erosion is a natural process, but can be greatly accelerated by human activities.

Structural

Structural BMPs for shores can use "hard" materials (e.g., rock) or "soft" materials (e.g., soil bioengineering and other uses of vegetation).

Shoreline erosion is a natural process, but can be greatly accelerated by human activities.

Hard Structures

In areas of severe erosion or where bioengineering techniques are ineffective, always use properly designed, hard erosion control structures. Poorly designed structures often fail, in part because there was not a thorough site assessment before project planning and construction.

A professional engineer should assess the site to:

- determine the limits of shoreline reach
- assess local erosion types
- document the sorting, redistribution and direction of movement of near-shore sediment, and
- check for subsurface flow (piping).

Permission and approvals must be obtained for all lakeshore structures.

CRIB WALLS

Crib walls are soil-retaining walls designed to resist current and wave action. Avoid treated wood. Crib walls act as a bulkhead to protect shorelines, but can cause off-site erosion problems down-current from the structure. Stone aprons can limit this negative effect.

REVETMENTS

Revetments are stone retaining walls containing quarry stone of various sizes. The stones are arranged for maximum strength by wedging the smaller, angular pieces between larger, angular boulder-size rocks. Gabion baskets, filter cloths and stone aprons are sometimes used to ensure stability.

GROYNS

Groyns are protective barriers that are constructed at right angles from the shore to deter erosion from near-shore currents and to trap sand. If these structures trap too much sand, they can cause severe erosion at "sand-starved" shores down-current from the structure.

Hard structures require expert design and construction supervision to be effective and to reduce the risk of off-site damage. They're often expensive. By comparison, soil bioengineering and other vegetative techniques also need expert design, but may be less expensive and more sustainable. Soft structures will strengthen over time as vegetation establishes.

Soft Structures (Bioengineering)

While these BMPs may be less costly than structural changes, due care must be taken in the design and selection of plant materials to guarantee long-term success. Here are some possibilities.

BMP	SUITABLE FOR	TECHNIQUES	BENEFITS
BRUSH MATTRESSES 	• lake shoreline protection	• small depression in bank is excavated • bundled branch cuttings are set as mat layer and staked with live and dead wood • bundle is covered with soil and watered regularly until vegetation establishes	• lake shoreline protection
BRUSH LAYERING	• bluffs	• live branch cuttings are placed on 1-metre-wide terraces (benches) to form terraces perpendicular to the slope	• alternative to bulkhead or gabion baskets
JOINT PLANTING (VEGETATED RIPRAP)	• high and low-relief bluffs	• live cuttings are placed between riprap rocks on slope face	• has strength of hard feature plus longevity of natural technique
RECREATE WETLAND	• filled-in beaches • former wetlands	• revetment boulders are placed at or just above water level, 5–10 metres (16–33 ft.) from shore of shallow bay to form a protected near-shore (“littoral”) zone	• will reduce erosion of beach area and provide high quality habitat
LIVE CRIBWALL	• exposed shorelines, points, etc.	• boxlike interlocking arrangement of untreated wood/timber filled with backfill and live cuttings • rootings establish and vegetation takes over	• where wall is required to provide stability at toe of slope to reduce slope steepness

Lakeshore Maintenance

Not all BMPs for shores are intended to control erosion. Runoff control, pollution control and habitat management should be part of a comprehensive shoreline conservation effort too. Here are some BMPs that will help you conserve and maintain shores.

- Establish buffer strips between the water body and cropland to prevent erosion and bank faulting.
- Exclude or deter livestock access where grazing intensity is high or where impact is noticeable.
- Follow separation distance guidelines for the application of crop nutrients and pesticides.
- Use water diversion structures to prevent gully formation and to control surface runoff.
- Ensure your septic system is properly installed, especially if you have a dwelling near a shore. Ensure that the tank and leaching bed systems are suited to the local soil conditions and sufficiently set back from the shore.
- Maintain your septic system through water conservation, system inspections, and regular cleanouts.
- Don’t remove shoreline vegetation, i.e., trees, shrubs and wetland vegetation.
- Don’t plant invasive plant species adjacent to shore area. Appropriate native plants will have the best survival rate.
- Reduce the amount of lawn cover and reintroduce natural vegetation.
- Restrict intensive water recreation activities (e.g., water skiing, boating) to designated areas and protect sensitive zones from traffic.

RULE OF THUMB –
"Don't make soft shores hard or hard shores soft."

At the time of settlement, farms were established near watercourses and lakes. Today the challenge for these operations is to eliminate runoff from nutrient sources.