Constructed Ditch
FACTSHEET

BRITISH COLUMBIA
Ministry of Agriculture, Food and Fisheries

Drainage Management Guide - No. 10 in series

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DITCH BANK STABILIZATION TECHNIQUES

It is important to maintain ditches using practices that ensure ditch banks remain stable and do not slough in over time. Soil that collapses into a ditch disrupts water flows causing sediment to be deposited and increases scouring of the banks. Eventually the ditch fills in again and requires further maintenance. Proper bank stabilization can reduce the need for maintenance and extend the life of the ditch.

In low gradient ditches, the soil structure is the most important aspect of the stability. Sands, peat, and loose loam ditches often have bank wall failures. The banks of a ditch should be generally sloped between 2H:1V to 4H:1V, horizontal to vertical ratio. Gently sloped banks will help to maintain bank stability and will prevent slumping and infilling of the ditch due to erosion.

Over excavation also de-stabilizes existing slopes, increasing slope failures and causing infilling of the cleaned out ditch.

Bank stabilization techniques should be chosen to address the site conditions, cause of failure and take into account future maintenance needs. Figure 1 can be used to determine the stabilization technique appropriate for general situations. Soil type and the ditch water velocities may also be a factor in determining which technique to use.

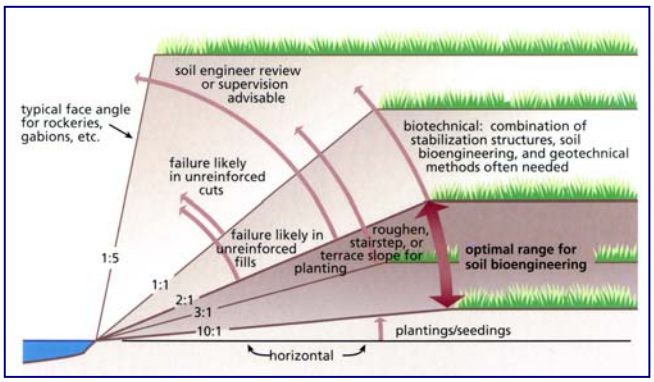


Figure 1 Determining the Appropriate Technique for the Bank Slope (Stream Corridor Restoration)

Protecting the toe of the slope is key to bank stabilization. If there is any erosion/undercutting of the toe occurring, this must be addressed first before the upper slope is considered. The following factsheets in this guide provide additional information.

Factsheet No. 11 *Bank Re-Vegetation for Agricultural Land*

Factsheet No. 12 *Rock Revetments for Constructed Ditches*

Factsheet No. 13 *Bio-Engineering Techniques*

The guidelines provided are for bank stabilization techniques on small ditches only. They are not intended to provide advice for slopes requiring engineered techniques for stabilization. If slope failure is extensive contact Fisheries and Oceans Canada (DFO). Table 1 describes the notification or approval requirements for various situations when work is done in the timing window.

Table 1 Notification requirements for Work In Constructed Ditches

Description	No Agency Contact	Ditch Maintenance Form*
Bank stabilization by planting vegetation and seeding with a native grass mixture	X	
Bank stabilization or repair through bio-engineering techniques, using rock or other 'hard' engineering works		X

* See *Agency Contact Requirements for Constructed Ditch Maintenance,* Factsheet No. 3 in this series.

To provide an estimate of costs for each technique, relative capital **(C) costs** and **maintenance (M)** costs are shown in the small tables.

Bank Re-Vegetation

The planting of cuttings or seedlings along the banks and adjacent to a ditch can significantly reduce the erosive capability of water flow and stabilize stream banks in a natural way.

Bank re-vegetation on agricultural lands can also provide economic benefits. It is important to determine the objectives of the planting before selecting the plants. The objectives may be to stabilize the banks, enhance fish habitat, create a windbreak, create shade, or may other reasons. Once the objective of the planting has been determined, the plants and method of planting can be selected. Plants along the ditch edge may also be able to provide an economic benefit to the farm.

It is important to get expert advice on the types of plant species that will survive in specific conditions and the initial planting and maintenance required to ensure the plants will thrive.

Planting techniques are briefly described below. More detailed information on re-vegetation of banks can be found in *Bank Re-vegetation for Agricultural Land,* Factsheet No. 11 in this series.

Live Staking

Live staking involves the insertion of dormant wood cuttings into the ground. The stakes create a root mass that stabilizes the bank by binding soil particles together. Live staking is used in many bio-engineering practices to stabilize soil or stake other materials in place. Live staking on its own does not solve immediate erosion problems and is usually used as a long term re-vegetation technique.

	C	M
4		
3		
2		
1		

This technique is suitable to solve simple erosion problems and prevent bank scour. Live staking is relatively inexpensive provided there is source material nearby.

Container or Root Stock Planting

Container and root stock are more expensive than other planting techniques but have the advantage of bypassing the germination period for seeds or root developments for cuttings.

	C	M
4		
3		
2		
1		

This technique can be used in conjunction with other planting techniques to create variety in the plant type and establishment time of coverage.

Seeding

Seeding is good for immediate protection of the soil surface and prevents erosion from runoff and wind. It is usually used in conjunction with other planting techniques. Seeding can be quickly applied to slopes and is inexpensive.

	C	M
4		
3		
2		
1		

However, seeding is not adequate to be used alone for erosion control in areas where the bank is unstable.

Streamside Fencing

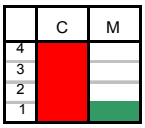
Streamside fencing is particularly useful in areas where cattle have unrestricted access to a ditch for grazing. The construction of fences adjacent to a ditch helps to protect the bank, natural vegetation as well as the ditch itself. By restricting access of animals and people, vegetation will re-establish along the banks, thereby limiting erosion. It also can improve downstream water quality by reducing inputs of sediment and other animal and agricultural wastes.

More fencing information and construction details can be found in the Agricultural Fencing Manual available from the Ministry of Agriculture, Food and Fisheries.

Rock Revetments

Rock revetments may be required where banks are subjected to high velocity flows or the bank toes need to be stabilized. More detailed information can be found in *Rock Revetments for Constructed Ditches,* Factsheet No. 12 in this series.

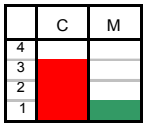
Rip Rap



Riprap is the placement of angular rocks of various sizes along the stream banks. The rocks lock together to help to stabilize the banks thus providing a hard layer of protection outside of the softer, easily erodible stream bank materials like sand or fine sediments. It works best where stream banks are less than 1.5H:1V horizontal to vertical and where water velocities are less than 4.0 m/sec

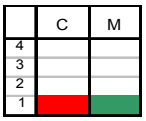
The advantage of riprap is that it remains stable at most flow levels, it is durable, easy to install and easy to maintain. However, large projects can be costly, it restricts natural channel movement, it looks unnatural and can cause other erosion problems upstream and downstream of where it is placed.

Rock Toe Keys



Rock toe keys are the bottom half of the riprap structure. These are used in conjunction with other bio-engineering techniques which protect the upper bank. The rock toe keys stabilize the toe and are installed up to the normal water level.

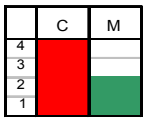
Joint Plantings



Joint plantings incorporate riprap and live stakings to produce a vegetated armored bank. These are effective in areas where the banks require more protection than vegetation alone can provide and require some vegetation for habitat creation. The vegetation and root structure will bind the riprap to the slope and create more natural looking bank.

Establishing vegetation in riprap can be tricky and requires monitoring and irrigation during the first years to ensure survival of the plants. The cost estimates do not include the riprap placement.

Gabions and Vegetated Gabions



Gabions are wire mesh rectangular baskets filled with rock and soil. Gabions may be an option where side slopes are too steep for riprap or where large rocks for riprap are not readily available locally. Vegetation should be planted above the gabion structure to stabilize exposed soil.

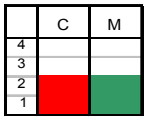
Vegetated gabions are gabion structures that have branches layered between the gabions. This vegetation creates a more natural look and provides additional stability once the root system is established.

Bio-Engineering

Bio-engineering techniques for bank stabilization incorporate the use of riparian vegetation and wood cuttings that are installed in the bank to provide structural stability. This is often done in conjunction with other stabilization techniques, such as riprap. Bio-engineering techniques are used to enhance slope stability, control sediment generation and maintain bio-diversity.

A brief description of these techniques is provided below. More detailed information can be found in *Bio-engineering Techniques,* Factsheet No. 13 in this series.

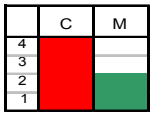
Wattles (Fascines)



Wattles (or fascines) are bundles of live cuttings that are staked into trenches. The wattle placement breaks up the slope by creating terraces with shallower slopes than the original bank. As the cuttings take root, the root system binds the soil together helping to stabilize the bank.

Wattles are useful in areas of general scour and to protect the bank from runoff. They also provide slope stabilization and sediment control. They are not appropriate for areas undergoing mass movement. Wattles can be installed on slopes up to 1.5H:1V. Wattles are used from the normal water level to the top of the bank. Wattles planted below the water level may still provide some erosion protection of the toe of the slope, but the plants will not grow.

Brush Mattress

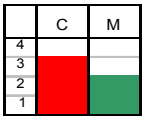


A brush mattress is an interlaced layer of live branches placed on the bank and held in place with untreated twine and live or dead stakes.

This technique is useful where high flows may erode exposed banks before vegetation is established

The mattresses are limited to slopes 3H:1V or shallower and should be installed above the normal water level of the ditch. A large amount of live material is required to cover the bank. Pre-vegetated mats are a similar specialty product where live plants are grown on movable mats of organic material generally 1.2-2.4 m in size. The mat material degrades while the plant material takes root in the banks.

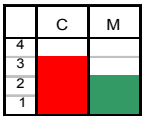
Brush Layers



Brush layers are horizontal alternating layers of soil and live branches. This creates a continuous reinforced bench within the bank. This technique is useful in projects that require cut and fill, where there are large quantities of loosened soil on the slope, or where the bank is slumping. This technique can be used on slopes up to 1.5H:1V in areas of seriously eroded and slumping banks. Installation is best during low flow conditions. Brush layers are typically not effective in slump areas greater than 1.2m deep or 1.2m wide

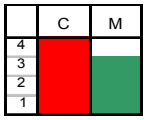
Brush layers should be done in conjunction with techniques that protect the toe of the slope from undercutting such as wattles, tree or rock revetments. This will provide better long-term bank stabilization.

Branch Packing



This technique is a modification of brush layering. Branch packing uses layers of compacted fill and branches secured with live and wooden stakes to fix slumps or holes in stream banks. The stakes and eventual root structure will strengthen the bank while the exposed branches and vegetation will filter sediments and protect the bank surface from erosion. This technique should not be used on slope failures larger than 1.2m x 1.2m or on slopes steeper then 2H:1V.

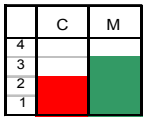
Vegetated Geogrids



Vegetated geogrids are similar to brush layers except natural or synthetic geotextiles are wrapped around the exposed soil between brush layers, anchoring the ends of the geotextile in the fill material.

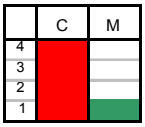
Vegetated geogrids are appropriate for steeper slopes that have limited room for bank shaping. This technique is used to reinforce the area of toe erosion and for projects that require filling or rehabilitation of seriously eroding and slumping banks. Typically this technique is not effective in slump areas greater than 1.2 m deep or 1.2 m wide.

Tree Revetments



Tree revetments involve the grading of a slope to 2H:1V then cabling durable green coniferous trees, such as cedar or pine into the bank slope. The trees should have a diameter of 50-100 mm. The branches of the trees will dissipate water velocities and the stream's energy. Sediment settles out behind the branches and can help to rebuild an eroded bank. This technique is most effective when used in locations where ditch banks are rapidly eroding and require protection from toe erosion and bank scouring. Other bio-engineering or planting is recommended to protect the upper bank.

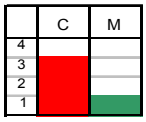
Cribwall



A log crib is basically a 'live' log wall, built crib-style, to protect eroding banks. Vegetation is planted between the logs used to build the wall. This reduces the water velocity and provides shelter for fish.

This technique is useful when slopes cannot be cut back or to prevent toe erosion in large areas of scour. Crib walls do not need to be built up the entire bank, wattles, or brush layers may be installed on the upper bank. Crib heights are limited to 2m or less.

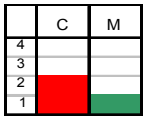
Log Bank Cover (Lunker)



A log bank cover is like a shelf built into the stream bank, which is covered with topsoil and native riparian grasses and vegetation. They are also often referred to as 'undercut bank' structures. They provide some bank protection benefits. However, they are most often built to provide complexity in watercourses where fish are present and little cover or shelter exists for fish.

Fiber / Vegetated Roll

Vegetated rolls are usually made of coconut fiber bound together with twine. However, these rolls may also be made of other materials that provide the same effect. The rolls are flexible and able to mold to existing curves. Therefore, little site disturbance occurs during installation.



This technique is useful for providing temporary toe protection of slopes while vegetation establishes. It is not effective for permanent toe protection.

Conditions Specified for Bank Stabilization for Constructed Ditches

- Bank stabilization using 'soft' engineering techniques, such as planting and/or seeding, may be undertaken at any time of year without notification or approval.
- Bank stabilization using any form of 'hard' engineering technique, such as bio-engineering or riprap placement, must be undertaken during the Timing Window for your area. DFO authorization may be required if the watercourse has fish habitat. For further details see *Fishery Timing Windows for Maintenance Work in Constructed Ditches*, Factsheet No. 4 in this series.
- All works must be conducted during favourable weather and low water conditions.
- If the constructed ditch has fish present, a fish and amphibian salvage must be undertaken by persons who have been trained to complete this type of work. Fish collection permits must be obtained from DFO prior to the commencement of the works. For further details see *Fish Salvage*, Factsheet No. 17 in this series.
- Works must be conducted in isolation of flowing water. The method chosen should be appropriate for the amount of flowing water in the ditch. For further details see *Sediment Control*, Factsheet No. 8 in this series.
- Work must be undertaken in a manner as to prevent the release of silt, sediment or sediment-laden water, raw concrete or concrete leachate, or any other deleterious substance. For further details see *Sediment Control*, Factsheet No. 8 in this series.
- Re-release of water into the ditch and/or culvert should be conducted to allow for a gradual release. Removal of sediment control devices should be undertaken once the sediments have settled out of the water and the water has cleared.
- Machinery is to work from the top of bank and not from within the watercourse.

Contact Information

Agency Contacts, Factsheet No. 19 in this series contains a list of local agency contacts and other organizations that may be able to provide some assistance.

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