Constructed Ditch
FACTSHEET

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ROCK REVETMENTS
For Constructed Ditches

Rock revetments are used to stabilize banks in areas of high water velocities and/or where bank erosion can't be corrected with other bank stabilization techniques. Typical rock revetments that may be used in small channels such as ditches are rip rap and rock gabions. These techniques are also used to stabilize slope toes up to the normal water level when other bio-engineering techniques are used to stabilize the banks farther up the slopes.

Vegetation may be used in conjunction with rock structures to provide additional structural support and create a more natural looking bank and enhance fish habitat.

See Factsheet No. 13 *Bio-Engineering Techniques*

Riprap

Rock riprap is the placement of angular rocks of various sizes along the streambanks. The rocks lock together to help to stabilize the banks thus providing a hard layer of protection outside of the softer, easily erodible bank materials, such as sand or fine sediments. It works best where banks are less than 2H:1V (2 horizontal lengths for 1 vertical length) and where water velocities are less than 4.0 m/sec. A geotextile or gravel filter layer between the riprap and bank is recommended to prevent the bank material from being drawn out through the riprap.

This technique is useful to stabilize areas on slopes with poor soil structure or bank seepage. Riprap is useful on banks where there are high water velocities or the stream bank is often submerged and vegetation cannot be established. It is often used to prevent the undercutting of bank (stabilize the toe slope) in conjunction with other bio-engineering techniques that support vegetation growth.

If water velocities are 2 m/sec or greater on a constructed ditch advice from an engineering consultant will be necessary.

Advantages

Riprap remains stable at most flow levels, it is durable, easy to install and easy to maintain.

Disadvantages

Large projects can be costly and the riprap restricts natural channel movement. The site may also look unnatural and may cause other erosion problems upstream and downstream of where the rock revetment is placed. Large projects eliminate riparian vegetation, a key component of fish habitat. They may result in a HADD and require an Authorization from DFO.

Figure 1 Riprap Placement on a Constructed Ditch

Rock Toe Keys

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

Riprap Placement

The following briefly outlines the installation of riprap on a constructed ditch. However, it is advisable to obtain professional expertise to ensure works will be stable and functional.

Riprap, placed within the average high water mark of the ditch, must be free of silt, debris or other substances harmful to aquatic life.

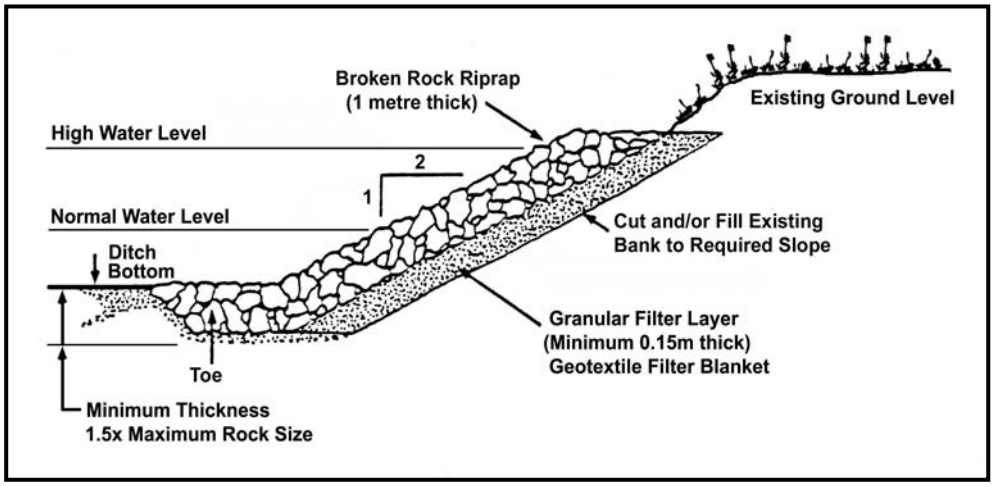

Figure 2 Typical Riprap Cross Section

Rock used as riprap must be durable, and suitably graded and sized to resist movement, see Rock Gradation below. Do not use broken concrete slabs as these can erode over time resulting in fine material accumulating downstream and harming fish habitat.

Start at the toe of the slope just above the eroded areas.

Plan a side slope between 2H:1V and 4H:1V (horizontal to vertical distance ratio). Mechanically shape the wall as closely to this slope as possible*.

Dig a toe wedge to stabilize riprap at the base line of the slope, see Figure 2.

Riprap should be hand-placed or machine-placed individually.

Place larger pieces of riprap at the toe of slope and work upwards to the erosion line (or average high water mark) with smaller riprap materials. Ensure however, that riprap is of a size large enough that it will not be transported downstream during flood events.

Pack the shale or riprap with the back of the excavator bucket.

Cover the rock above the high water mark with topsoil or material excavated from the ditch after it has drained. Seed the topsoil with a fast-growing native grass seed mixture. Immediate seeding with native grasses will help to prevent colonization of the area by weeds.

*Where water velocities are above 2 m/sec on a constructed ditch, it may be necessary to install erosion control blankets or turf reinforcement mats under the riprap to ensure stability. Figure 3 provides information on installation of riprap and filter blankets for the stabilization of ditch banks.

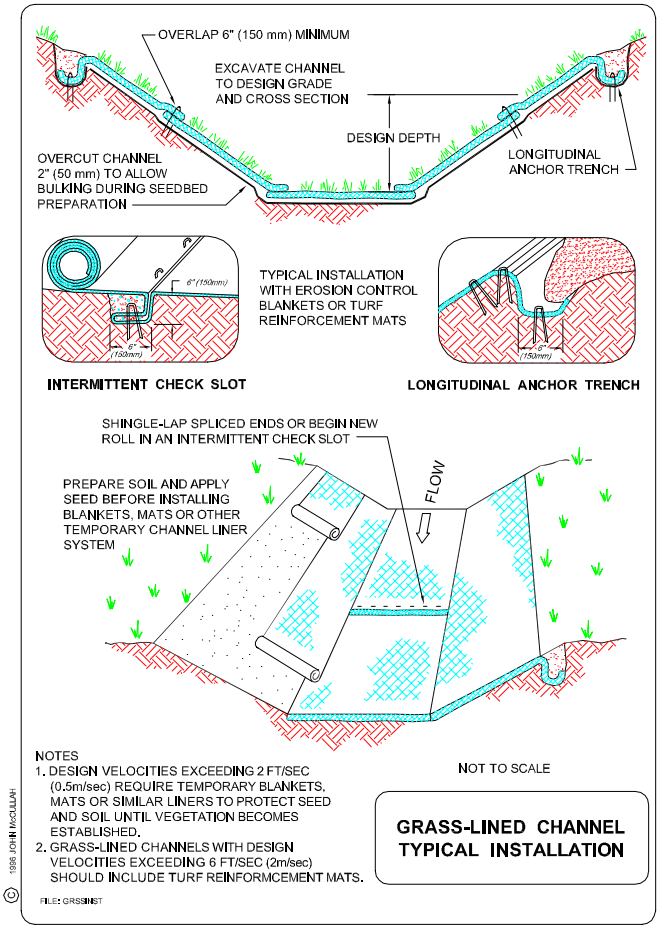

Figure 3 Channel Stabilization with Filter Blanket (Erosion Draw)

Sediment control measures must be installed or the works should be conducted in isolation by diverting water flows.

Rock Gradation

Gradation is extremely important to ensure the riprap will function properly. Varying rock sizes allows the rock to interlock and minimizes voids in the structure. Gaps in gradation may cause structural failure. For velocities not exceeding 2.4 m/s (8 fps) the nominal size is 36 kg. (80 lb.) or 300 mm diameter rock.

Angular rock will lock together better than rounded rock. Rounded river rock is **not** acceptable to be used as riprap.

Rock size grading specifications:

100% smaller than 500 mm (20 in.)
at least 20% larger than 350 mm (14 in.)
at least 50% larger than 300 mm (12 in.)
at least 80% larger than 200 mm (8 in.)

Joint Plantings

A joint planting is basically riprap with live stakes driven in among the rocks. Vegetation on the riprap structure increases bank stability and may also help to minimize the growth of noxious weeds. Shade vegetation significantly reduces the growth of in-stream grasses, which minimizes future maintenance.

Live staking can be done anytime after the rock has been placed, preferably when the plants are dormant. The stakes should be driven completely through the riprap into the bank to allow for rooting, see Figure 4. It may be difficult to established plantings in thick riprap unless special tools are used to create pilot holes. See *Bank Re-vegetation for Agricultural Land*, Factsheet No. 11 in this series for more information on live stakes and planting preparation.

Soil can also be added to the riprap to provide material for roots to grow into. Irrigation is necessary in dry areas for the first few years to ensure the root system establishes.

Advantages

The vegetation provides habitat and will help bind the riprap and bank material together, increasing the stability of the bank. The structure has a more natural appearance.

Disadvantages

The plants require a lot of monitoring and irrigation during the first years to ensure survival. A large plant loss is common with this technique due to damage of the plants during installation and lack of care during establishment.

Live Stake Installation

Create a pilot hole using a steel rod that is the same diameter as the live stakes.

Tamp the live stake into the spaces between the rock in a random pattern. The stakes should be perpendicular to the bank with buds pointing up. The end of the stake must penetrate the bank soil. The top should be slightly above the surface of the riprap.

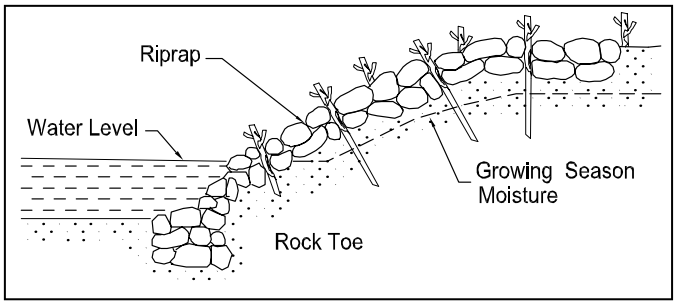

Figure 4 Joint Planting (WTEC)
Live Stakes are driven through riprap

Gabions and Vegetated Gabions

Gabions may be an option where side slopes are too steep for riprap or where large angular rocks used for riprap are not readily available. Gabions are wire mesh rectangular baskets (normally 0.5-1.0 m thick) filled with rock and soil. They are laced together to create a wall. Using vinyl coated or galvanized steel mesh improves the durability of the baskets.

Gabions require a firm stable foundation for placement. These structures are not appropriate if the ditch bottom is eroding and may undercut the gabion.

Gabions can be used to stabilize the toe of the slope while bio-engineering or planting techniques are used to stabilize the upper bank.

Vegetation may be incorporated into the gabion by placing cuttings between the gabion layers. The cuttings will take root in the gabions and the soil behind the structure.

The vegetation provides additional stability once the root structure has developed. There may be a risk of large woody vegetation damaging the baskets as they grow or if they uproot. This risk should be weighed when choosing the vegetation type. Note that the basket must be filled with rock and soil if the plant material is to take root.

Advantages

Gabions require about a third of the thickness compared to riprap designs. Vegetated gabions provide some fish habitat and make the site more attractive.

Disadvantages

The cost of construction and placement can be high. Repairs to the wire mesh basket may be necessary.

Placement of Gabions

Prepare the area by creating the desired final slope of the bank and excavating the toe area. The bottom of the gabion should be partially buried in the ditch bottom, similar to the riprap toe, see Figure 5. Ensure the bottom of the gabion will be below the scour depth, at least 60 cm below ditch bottom. The work should be done with sediment control measures in place or in isolation of flowing water.

Install the filter material, either geotextile or gravel filter. See Figure 5 for techniques on securing a filter blanket.

Assemble the empty gabion baskets into the desired shape and place in their final location. Lace adjacent gabions together to prevent movement. The gabions should be tilted back slightly into the bank.

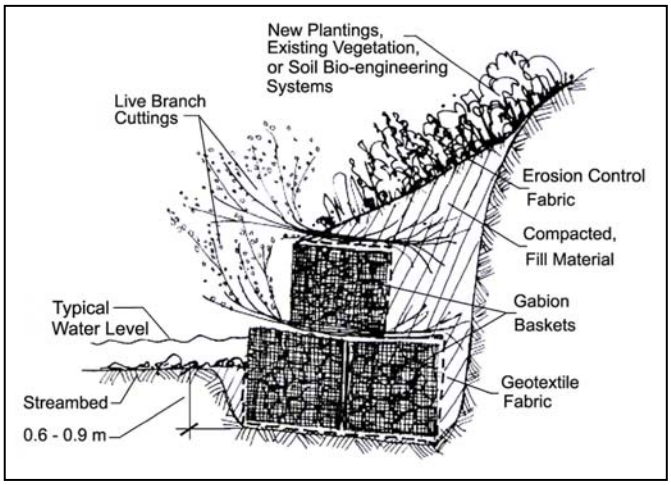

Figure 5 Vegetated Gabion
(Watershed Science institute, NRCS)

Fill the baskets once a number of gabions are in place. Place fill in lifts of 30cm carefully to prevent damage to the baskets. Tie wires or stiffeners from the exposed face across the baskets after each lift to prevent bulging.

To create a vegetated gabion, live branches are placed on top of row of gabions. Pack soil around branches before placing the next layer of gabions. This will ensure good soil-plant contact and a firm base for the next gabions.

Add gabions until the desired height is reached. This should be above the normal water level.

Tie backs must be installed at both the upstream and downstream ends.

Vegetation should be planted above the gabion structure to stabilize exposed soil. Vegetation planted on the banks above the gabions should not affect the basket integrity.

Gabions should be checked regularly for broken wires and repaired if necessary to ensure stone containment.

Conditions Specified for Rock Revetment Bank Stabilization for Constructed Ditches

- 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 ditch 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 ditch

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.