Stream Bank Protection Project

An information source for implementing stream bank protection

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Table of Contents

Introduction

Most farms in Nova Scotia have streams running through the farm land. In the province there is over 50,000 acres of flat agricultural land located along watercourses. This interval land is comprised of approximately 40 cm of sandy loam over gravel and is either a Cumberland or Hebert soil type. The soil has excellent drainage and is one of the best agricultural soils in the province.

Streams tend to meander when the adjacent land is relatively low. Many stream banks along interval land have experienced stream bank erosion or, in some cases, a movement of the stream to a new course which is a loss of productive farm land.

Stream bank erosion impacts water quality and marine habitat. Tonnes of sediment can be deposited in a stream bed when a stream bank is eroded. This affects fish habitat by destroying spawning grounds and the habitat of organisms that fish feed on.

There appears to be more frequent high stream flow events in recent times, which may be due to less water retention in the watershed landscape (i.e. deforestation, urban sprawl) and more intense storms. Higher stream flows can lead to more erosion and thus higher amounts of gravel and debris being deposited in the stream. This decreases the volume a stream channel will handle and diverts the stream flow direction.

Over the years there have been many stream bank protection projects conducted throughout the province. The purpose of this project is to assess the performance of stream bank protection projects and to provide rural property owners, construction contractors and local government with the information required to protect valuable land from being lost due to stream bank erosion.

This project does not apply to shoreline/coastal erosion. It also is not meant to address the issues associated with flooding.

Stream bank protection methods used in Nova Scotia

The Nova Scotia Department of Agriculture and the Nova Scotia Department of Environment conducted various stream bank protection projects during the 1980's and 1990's. A number of stream bank protection methods were reviewed and a number of potential sites for the assessment of the effectiveness of the protection were identified.

A list of stream bank protection methods used in Nova Scotia includes:

- Vegetation
- Deflectors
- Armour rock
- Gabion baskets and mats

- Used tires
- Logs and trees

Generally, the term armour rock is used to refer to all rock larger than one tonne. The term rip rap is used to describe rock that is between 20 and 45 cm. For this report the term armour rock will be used to describe all rock greater than 20 cm.

The size of rock used in gabion baskets is generally between 10 and 20 cm. A lot of field stone picked from farm fields is usually about the size of rock used in gabion baskets.

There are a lot of armour rock stream bank protection projects done all over Nova Scotia. The other methods are not as common in Nova Scotia.

Assessment of the stream bank protection projects

A total of 9 sites were selected for an assessment. The list of sites is as follows:

- Shubenacadie River, Shubenacadie – gabion mats
- Brierly Brook, Antigonish - gabion baskets
- Farnham Brook, Bible Hill – tires
- Middle River, Middle River – armour rock
- Broad Cove – armour rock
- James River - armour rock
- James River by highway – armour rock
- South River – armour rock
- Mill Brook, Earltown - logs

A checklist was developed to determine the performance of the various stream bank protection methods. Each site had its coordinates recorded with GPS and had its characteristics identified. These characteristics included:

- Type of stream bank protection
- Height of stream bank
- Length of protected area
- Whether the area was on a bend or straight stretch
- Stream depth
- Stream flow rate

The sites were assessed for:

- Condition of the stream bank protection structure
- Amount of stream bank protection provided
- Signs of erosion at toe-in
- Signs of erosion downstream of protection
- Signs of erosion across from protection
- Amount of vegetation

Site Assessments

Gabion Baskets and Mats

The site, on the tidal section of the Shubenacadie River in the village of Shubenacadie, is located on a bend in the river and was designed to protect the adjacent road. The site has very little room between the road and the river, thus has a steep bank. The stream bank protection consists of 150 feet of gabion mats with 45 feet of armour rock at each end of the gabions. There is a small amount of armour rock at the bottom of the gabions and the stream bank is approximately 10 feet high. The gabion mats are galvanized wire mats that are 30 meters long by 2 meters wide and 0.23 meters thick. This project was constructed in 2011 but there is no sign of damage to the wires of the gabions from floating logs or ice. The bank is stable and silt from the river is covering most of the gabion mats (Figure 1). A factsheet on the construction and performance of this site is available at the following link http://www.maccaferri.ca/media/om_www/canada/Case%20Histories/CAN_NSTIR_Shubie_Hwy_215.pdf

Figure 1. Gabion baskets covered in silt

The site on the Brierly Brook in the Town of Antigonish is located on a bend in the brook and was designed to protect the adjacent road. The gabion baskets are stacked approximately 20 feet high with armour rock protecting the bottom six feet of the bank (Figure 2). The bank is very steep and the brook does not flow above the armour rock. The site is over twenty years old and has held up well, however, the gabions cannot be evaluated for abuse as the brook flow does not reach the gabions.

Figure 2. Armour rock and gabion baskets on steep slope

Tires

The site is located on a bend in Farnham Brook in Perennia Park (Bible Hill) just upstream from the bridge. The protected area is 40 feet in length and four feet high. This site was constructed in the 1990's. The truck tires were tired together and filled with soil. The tires on the bottom protrude out further into the stream than the tires above them. The bank area is stable and has small trees and grass growing on it (Figure 3).

Figure 3. Vegetation among truck tires

Armour Rock

The site on Middle River protects a large interval field on Bruce MacDonald's farm. Most of the armour rock was installed more than twenty years ago. Although many other areas on Middle River have changed course, the river has not moved along this stretch although there are signs of flow across the interval field. There is a twenty foot riparian area consisting of mature trees along the interval field. There are several large gravel deposits in the river along this stretch which would likely cause bank erosion if not for the armour rock and riparian of large trees (Figure 4).

Figure 4. Gravel bars in Middle River

The site on James River located by the TransCanada Highway is on a fairly straight section of the river. This site was armour rocked over twenty years ago. The section north of the highway has had the channel move approximately 70 feet away from the rocked bank (Figure 5). The section south of the highway has some signs of bank erosion across the stream from where rocks were placed. Another section has bank erosion above where the armour rock was placed.

Figure 5. Armour rock to the right of gravel bar

The site on the James River along Wilfred MacDonald's farm is on a small bend in the river. Approximately twenty years ago the river started to cut across an interval field. The armour rock was placed along the old stream bank and the area behind the rock that had eroded was filled in. The rock and the infilled area have stayed well. The protected stream bank is approximately 100 feet long by five feet high and has a lot of small

trees growing amongst the rocks (Figure 6). This site had some erosion across the stream from the armour rock, which appeared to be caused by a large gravel bar formed in the stream.

Figure 6. Trees on rocked bank

The site on the South River on John Vosman's farm has a gradual bend in the river. This site was just recently completed and had approximately 400 feet of rock that was up to twelve feet high at one end. At this site the lower portion of the bank was being eroded and the trees on the upper portion of the bank were falling into the stream. Some portions of the bank were rocked at a fairly steep slope that was close to a one to one slope (Figure 7). Care must be taken when placing rock on a steep sloped bank

Figure 7. Steep banks along South River

The site at Broad Cove was on a sharp bend in the brook and was designed to protect the bank supporting the adjacent bridge abutment. The rock appeared to be more rounded natural stones than angular quarried rock but there was no evidence of rock movement (see picture on cover).

Logs/Trees

A site is located on the Mill Brook in Earltown at Layton Lynch's farm. The structure has been in place for a few years. Logs placed on their sides on top of one another held in place by several logs on end embedded into the stream bed. This method can be used on steep banks and takes up minimal space in the stream.

Figure 8. Logs along bank of Mill Brook

Another method is spruce trees placed along a stream bank with the butt end pointing downstream. Field stone is dumped over the tree. The upstream facing branches hold the rock in place while the weight of the rock holds the tree in place. This form of stream bank protection works on brooks with low to moderate flows. A site can be seen on the Indian Brook, Victoria County and has been in place for over ten years.

Summary of site assessments

The site assessments showed that the durability of the armour rock method was very good for all sites. Most of the sites assessed were on high flow streams indicating that the size of rock used was large enough to remain stable. There appeared to be no problems with the rounded natural stone used at Broad Cove. This is important because it may allow local natural stone to be used instead of trucking in armour rock which is the costliest part of armour rocking a stream bank. Rounded rock may be less stable.

The positioning of the rock is important for bank stability and for bank erosion potential on the opposite side of the stream. Any misplaced rocks could act as wing deflectors and cause bank erosion on the opposite side of the stream. Rocked banks located on bends in the stream could also cause bank erosion across the stream if the rock work is not feathered out properly or if the rock is directing high flow toward adjacent unprotected stream bank. The banks should be assessed regularly as they might need a little maintenance periodically to work properly.

The gabion mats were holding up well after two years on the Shubenacadie River. This site should be assessed again in a few years to determine its durability. The gabion baskets were very stable after 20 years of supporting the bank above the Brierly Brook in Antigonish.

The bank protected by the tires was in good condition after more than 15 years. The use of trees, logs and tires is best suited to low or medium flow streams.

There were no assessments of stream deflectors for stream bank protection. Deflectors are structures built out from the stream bank that direct stream velocities away from eroding banks. More information on stream bank deflectors is available from Nova Scotia Adopt A Stream.

Guide to implementing stream bank protection

This guide will describe how to assess stream bank erosion problems and how to make repairs.

Step 1. Site assessment

An assessment of the area will determine if stream bank protection is needed and the type of protection that will work. Assessments may determine that no additional protection is needed. Examples of these include:

- Areas in streams where downed trees and logs deflect the stream causing bank erosion. In these areas, if there is a riparian area where there are lots of roots to hold the soil along the stream bank, the removal of the obstructions and a maintenance program which includes regular inspections for downed trees and logs may be all that is needed. These obstructions can be

removed from the stream without NSDE approval provided no machinery enters the stream bed or stream bank and the tree is not embedded into the stream bed or bank.

- An assessment might reveal that fencing livestock from the stream may be enough to allow revegetation of the bank and stop stream bank erosion.
- An assessment might reveal that the removal of a gravel bar would stop further erosion. Contact the Nova Scotia Department of Environment before attempting to alter a gravel bar.

Information acquired from site assessments includes:

- Stream flow velocity
- Access to site
- Steepness and height of bank
- Access to raw materials (distance and availability of rock, field stone, tires)
- Time of year (if work can be conducted between June to September or if frozen soil needed to transport material to site)
- Stability upstream and downstream of site

Once the assessment is completed, the project planning can begin.

Step 2. Determine which method of stream bank protection will work at the site

Using the site assessment information, it can be determined which methods would provide adequate stream bank protection. The information will also determine the costs of the different stream bank protection methods.

This is a list of the advantages and drawbacks of the various stream bank protection methods.

Armour rock

Advantages – able to handle high stream flows, able to protect a large area in a short time

Disadvantages – requires large machinery, may be costly if rock has to be trucked a fair distance

Gabion baskets

Advantages – able to handle high stream flows, can be used on steep banks, wire can last up to 50 years, can be done without large machinery, field stone could be used in gabions

Disadvantages – labour intensive, wire may degrade under abuse from ice and debris, expensive if no local field stone available

Tires

Advantages – can incorporate vegetation, low cost

Disadvantages – labour intensive, hard to get enough tires to protect a large section of bank, tires need to be anchoured to the bank

Logs and trees

Advantages – low cost

Disadvantages – may not work on high flow streams, wood rots over time

Step 3. Resources needed for project

Nova Scotia Department of Environment Requirements

The first step in preparing for a stream bank protection project is acquiring the proper permits from the Nova Scotia Department of Environment. If a contractor is used, they may have a blanket permit for all watercourse alteration work.

The Nova Scotia Department of Environment factsheet on Erosion Protection is on the next two pages. The factsheet addresses the work site procedures for the construction of an armour rock stream bank protection project. The size of rock required for the project is also specified based on stream flow velocity. Stream flow velocity at a particular site increases after a storm as the volume in the stream increases.

The table in the factsheet on size of rip rap required for various stream flow velocities refers to stream velocity measured under storm flow conditions in the middle of the stream channel.

The Canada Department of Fisheries and Oceans has produced a booklet titled **Ecological Restoration of Degraded Aquatic Habitats: A Watershed Approach.** This booklet has fact sheets on various fish habitat restoration techniques including armour rock and deflectors. The link to the booklet is **http://adoptastream.ca/sites/default/files/321286.pdf**

NOVA SCOTIA
Environment

NOVA SCOTIA WATERCOURSE ALTERATION SPECIFICATIONS (2010)

Erosion Protection:

EP1. All work operations shall be conducted in a manner to protect the watercourse from the release of silt and sediment.

EP2. All erosion protection works must be carried out in isolation of the streamflow (in the dry).

EP3. Prior to the placement of erosion protection material, banks are to be graded to a uniform slope not to exceed a 2:1 horizontal to vertical slope. Erosion protection materials must be installed, after preparation of the bank, below the line of scour (deepest channel of flow within the watercourse), sized based on the calculated velocity of the stream (see table 1) and installed to minimum thickness of 1.5 times the maximum stone size. (See Diagram 1)

EP4 Erosion Protection material shall be placed such that it must not encroach upon the channel beyond the thickness of the largest material required, based on velocity of the watercourse.

EP5 The placement of the erosion protection material shall be carried out starting at the upstream end.

EP6 Following installation the erosion protection material shall be checked to ensure that any movement of the material does not result in exposing the slope, increasing the risk of failure.

EP7. The material used for erosion protection works must be clean, durable, non-ore bearing, non-toxic and obtained from a non-watercourse source.

EP8. The following uniformly-graded, stone rip rap material shall be used as armour for erosion protection unless alternate materials have been authorized by the Department.

Table 1: Rip Rap Sizing

Velocity	*A minimum of 70%* **of** *Rip rap size (millimetres)*
Up to 3 meters per second	200 to 450
3 meters per second to 4 meters per second	300 to 760
4 meters per second to 4.5 meters per second	500 to 1200

EP9. Erosion Protection Material must be placed by an excavator, backhoe, or by hand and carefully fitted along the watercourse to prevent scouring and bank failure. No equipment shall be permitted in the watercourse unless otherwise authorized in writing by the Minister or Administrator.

EP10. Erosion Protection material is to be installed to minimum thickness of 1.5 times the maximum stone size.

EP11. All areas of soil exposed as a result of construction must be immediately stabilized to protect the watercourse from the release of silt or sediment.

EP12. All excavated material shall be placed in a location where it will not enter the watercourse.

All debris resulting from construction activities shall be disposed of at a facility which is Approved to accept the specific material. Any material not regulated by the Department shall be removed to an area where flood water will not come in contact with the debris and excavated material must be removed from the areas adjacent to the watercourse and be disposed of in a manner acceptable to the Department.

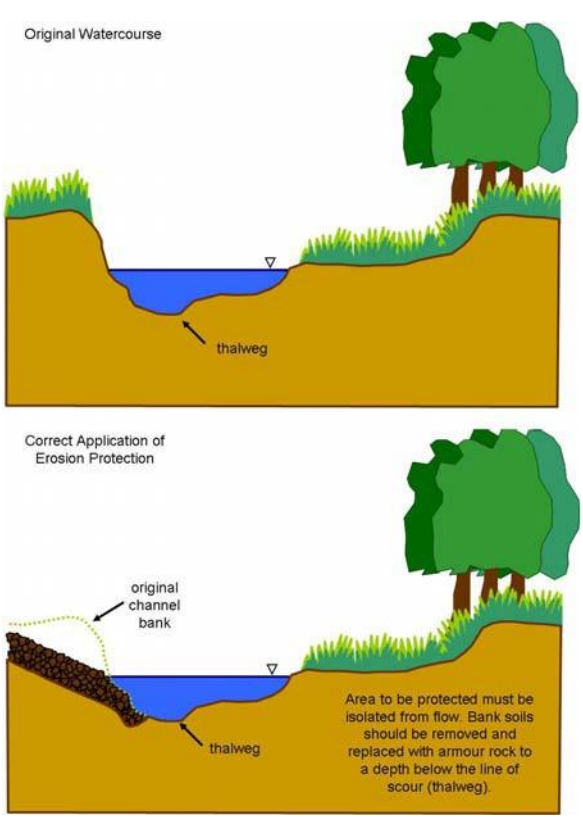

Diagram 1: Example of Correct Erosion Protection Installation

Source of materials

Source of rock

- Lafarge - Folly Lake
- Conrad Bros. Ltd. – Dartmouth
- S. W. Weeks Construction – Mt Thom and Troy
- Spicer Construction – Paradise
- Bilcon – Digby
- Dexter – Bridgewater
- Martin Marietta Materials – Aulds Cove
- Alva Construction - Georgeville, Whycocomaugh

The Nova Scotia Department of Environment may have a more comprehensive list of rock quarries.

Source of gabion baskets

- **Maccaferri Canada Ltd.**
  201 Brownlow Ave. Ste. 44
  Dartmouth B3B 1J4
  Phone: (902) 468-8615

- **Eastern Fence**
  47 Troop Ave.
  Dartmouth, N.S. B3B 2A7
  Phone: 1-800-563-2455

Costs of materials

Purchasing rock – the price of armour rock can range from $9 to 13/Tonne depending on if the contractor loads the rock or the rock is loaded by the quarry

Trucking rock – The Nova Scotia Department of Transportation and Infrastructure Renewal has rates for trucking gravel (Tonnes/Km). Extra charges may include approximately 10% for trucking rock and approximately 10% for fuel surcharge. The rates are available at the following link:

http://www.novascotia.ca/tran/publications/asphalt/TruckRates-April2013.pdf

Placing rock – an excavator can place approximately 500 Tonnes per day. An excavator can cost about $140 per hour. It is important to get enough trucks to haul rock to keep the excavator busy. It may be helpful to have rock trucked in before hiring an excavator.

You need to figure out your volume of rock (height x thickness x length) in cubic meters and multiple it by 2.5 to get approximate tonnes. Since the rock will be on a 1:1 or greater slope to be stable, you will need to take into account the effect the slope has on the "height" of the rock. Generally speaking, a meter length of bank, a meter high will require approximately 1.5 Tonne of rock.

Gabion baskets

- Cost of a 2m x 1m x 1m gabion basket is about $150
- Cost of a 3m x 1m x 1m gabion basket is about $200

A farm tractor with a front end loader can be used to fill the gabion baskets with stones.

Tires

Include the cost of soil or gravel that is required to fill the voids in the tires

Maintaining or establishing a riparian area after stabilizing the stream bank is recommended. More information on riparian and buffer strips is available in *Beneficial Management Practices for Riparian Zones in Atlantic Canada* at: http://www.nr.gov.nl.ca/nr/publications/agrifoods/beneficial.pdf

Possible sources of funding

There is funding available for stream bank protection through the following agencies:

1. The Nova Scotia Department of Agriculture offers 60% funding on stream bank rocking through the Homegrown Success Program. The program typically opens in the spring to all registered farmers. View the following link for more information. http://www.novascotia.ca/agri/programs-and-services/financial-funding/growing-forward2/

2. The Nova Scotia Adopt A Stream program offers 50% funding on stream conservation projects. View the following link for more information. http://www.adoptastream.ca/?q=project-resources

3. The Federal Department of Fisheries and Oceans has a new program called Recreational Fisheries Conservation Partnerships Program. The goal of the project is to restore, rebuild and rehabilitate recreational fisheries habitat. This program matches funds (up to 50%) with the applicant. The applicant can either provide cash or in-kind work. The in-kind work could consist of supplying rock or an excavator for placing the rock. Applications for the 2014 season have to be submitted between November 4 and December 19, 2013. It is recommended that the application be made through the local stream conservation club. There are approximately 25 stream conservation clubs in the province. For a list of stream conservation clubs in please contact Amy Weston of Adopt A Stream at (902) 644-1276 (amyweston@adoptastream.ca). View the following link for more information. http://www.dfo-mpo.gc.ca/habitat/rfcpp-ppcpr/index-eng.asp

The following is an incomplete list of some of the groups that conduct stream conservation work:

Habitat Unlimited
Antigonish, Nova Scotia
Canada
Phone: 863-6364
Fax: 867-2389
habitat.unlimited@gmail.com

Nova Scotia Sportfish Habitat Fund
Nova Scotia Department of Fisheries and Aquaculture
6th floor (Suite 605), WTCC
Halifax, Nova Scotia
B3J 3N8
Phone: (902) 424-4560
Fax: (902) 424-4671

Nova Scotia Salmon Association
P.O. Box 396, Chester,
Nova Scotia, B0J 1J0
e-mail : info@nssalmon.ca
www.nssalmon.ca/

NSLC Adopt A Stream Program
581 Stanburne Road, R.R. 2
Barss Corner NS B0R 1A0
Tel: (902) 644-1276
Fax: (902) 644-1279
e-mail: amyweston@adoptastream.ca

Nova Scotia Department of Agriculture Homegrown Success Program
Programs and Business Risk Management (PBRM)
60 Research Drive, Suite A
Nova Scotia B6L 2R2
Phone: 902-893-6510
Toll free: 1-866-844-4276
Fax: 902-893-7579
Email: prm@gov.ns.ca
www.novascotia.ca/agri/prm/

Emergency Management Office – replacement of infrastructure (old armour rock)
E-Mail: emo@gov.ns.ca
Phone: (902) 424-5620
http://emo.gov.ns.ca/

The Atlantic Salmon Conservation Foundation
480 rue Queen Street, Suite 200
Fredericton, NB E3B 1B6
Phone: (506) 455-9900
Fax: (506) 455-9905
admin@salmonconservation.ca
www.salmonconservation.ca/

Clean Nova Scotia – N.S. Fish Habitat Assessment protocol
John-William Brunner
Phone: 902-420-7961
Fax: 902-982-6768
Email: jwbrunner@clean.ns.ca
http://clean.ns.ca/programs/water/nsfhap/

Clean Annapolis River Project
314 St. George Street,
P.O. Box 395, Annapolis Royal
Nova Scotia, Canada
B0S 1A0
Toll Free: 1.888.547.4344
Tel: 902.532.7533
Fax: 902.532.3038
E-mail us at carp@annapolisriver.ca
http://www.annapolisriver.ca/

Cheticamp River Salmon Association
René Aucoin
Association President
Email: rene.aucoin@usainteanne.ca
http://cheticampsalmon.com/

St. Mary's River Association
8404 #7 Highway
PO Box 179, Sherbrooke
Nova Scotia, B0J 3C0
Telephone: (902) 522-2099
Fax: (902) 522-2241
Email**:** stmarysriver@ns.sympatico.ca
http://stmarysriverassociation.com/

Cobequid Salmon Association
P.O. Box 1874
Truro, N.S.
B2N 6C7
www.**cobequidsalmonassociation**.ca/

The Cornwallis Headwaters Society
P. O. Box 66
Berwick, NS
B0P 1E0
Email Address:
information@cornwallisheadwaterssociety.ca
http://www.cornwallisheadwaterssociety.ca/

Margaree Salmon Association
P.O. Box 108.
Margaree Centre Nova Scotia.
B0E 1Z0
Tel.: (902) 248-2578
http://margareesalmon.ca/

The Pictou County Rivers Association
PO Box 586
Westville, NS
B0K 2A0
http://www.pictoucountyrivers.com/

Bluenose Coastal Action Foundation
Cpt. Angus Walters House
37 Tannery Road
PO Box 730
Lunenburg, NS
B0J 2C0
Tel: 902-634-9977
Fax: 902-634-9979
www.coastalaction.org