Certification Manual

For Aquatic Habitat Restoration Installers

2021

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Nova Scotia Environment would like to acknowledge the following organization for its contribution to the Nova Scotia Watercourse Alteration Certification Manual for Aquatic Habitat Restoration Installers.

- Nova Scotia Salmon Association's Adopt A Stream Program for revising the Nova Scotia Watercourse Alteration Installers Manual for use by those undertaking Aquatic Habitat Restoration.

1 INTRODUCTION

1.1 Objective - NSE

The objective of the watercourse alteration program is to promote environmental protection measures for activities potentially impacting watercourses in an effort to preserve watercourses and protect their aquatic habitats.

The purpose of the watercourse alteration certification training manual for installers of culverts, bridges and other instream structures is to provide practical information that focuses on environmental protection. For this certification course in **aquatic habitat restoration,** the focus is on improving the aquatic habitats for fish, wildlife and esthetic values. This includes, but is not limited to, planning, installation, construction, replacement and decommissioning of habitat restoration structures if they are found to be not working properly, including remediation of crossing structures to improve fish passage.

The goals of this training program are:

- To train people on how to interact with watercourses in a positive way for the aquatic ecosystem.
- To improve the level of compliance with watercourse alteration regulations through education of regulations and standards.
- To provide a better understanding of the importance of environmental protection, aquatic habitat restoration, the Nova Scotia Environment Act and the Federal *Fisheries Act*.
- To inform people on the watercourse alterations approval and notification processes.

1.2 Limitations of the Certification Manual for Watercourse Alteration Installers

The following limitations are placed on the use of this training manual:

- Certification through this training satisfies Nova Scotia Environment requirements for Watercourse Alteration (Fish Habitat Improvement) Certified Installers only. It **does not** provide certification or approval for work designed or funded in part or in whole by the Nova Scotia Salmon Association's Adopt A Stream Program (AAS). That approval will be provided by the Adopt A Stream Program and will normally require in-field training on the specific techniques used in the project within 24 months of the instream work or direct supervision.
- The manual does not cover every aquatic habitat restoration technique but attempts to provide general guidance for some of the most common types of techniques and recommendations which would be applicable to most, but not all, works or activities. Specific conditions pertaining to

individual restoration activities will vary with each project. In some cases, supplemental measures are necessary to resolve site-specific problems.

- The manual does not cover alterations to wetlands and does not cover activities in tidal sections of watercourses or coastal areas. The Adopt A Stream Program may undertake this work, but it requires other permitting and training than presented in this course.

- The manual is not a regulation, and the manual is not to be interpreted as a method of design or a design code except for the step-by-step instructions for the installation specific structures, which must be followed unless you have written permission to do the work in another way.

- Following this manual does not exempt a person from liability for any damage resulting from the alteration of a watercourse, or from the requirement to obtain an approval or provide notification as stipulated in the *Activities Designation Regulations*.

- Following this manual places no liability for the design, planning or construction of any watercourse alteration on the Minister and/or Nova Scotia Environment or the Nova Scotia Salmon Association or its Adopt A Stream Program. This liability rests with the designer and installer of the structures.

- Following this guide does not exempt a person from adhering to any legislation, regulations, bylaws and other requirements, including regulations and requirements mentioned in the guide.

1.3 Regulations

The following information describes the current regulations, standards, and the approval and notification process for Nova Scotia. While many of the regulations and standards presented in the rest of this chapter may not apply to aquatic habitat restoration, it is important that certified installers understand them to be able to determine if other types of watercourse alterations are being done correctly.

Government Departments & Agencies involved in watercourse alterations

Nova Scotia Environment (NSE)

Nova Scotia Environment (NSE) has been designated as the lead provincial agency to take such measures as are reasonable to promote sustainable management of water resources and to promote the health and integrity of aquatic ecosystems, to protect habitats for animals and plants (Environment Act, clauses 104 (a) and (d)). The Act further authorizes the making of regulations and standards to implement and enforce this mandate.

NSE is responsible for the processing of notifications and the processing and issuing of all watercourse alteration approvals as stated in the **Activities Designation Regulations** under the ***Environment Act*** (1995), amended June 14, 2016. https://novascotia.ca/just/regulations/regs/envactiv.htm

Fisheries and Oceans Canada (DFO)

Under the Constitution the federal government has the exclusive legislative authority for all matters relating to "Sea Coast and Inland Fisheries"; the federal *Fisheries Act* gives the Minister of Fisheries and Oceans the authority to manage and protect the resource, to provide access to the resource, and to impose appropriate conditions on harvesting. The Department administers and enforces the federal *Fisheries Act* and the *Species at Risk Act* (aquatic species only).

Transport Canada – Navigation Protection Program

Transport Canada administers the Navigation Protection Act through the review and authorization of works in navigable waters. The majority of work in this area involves evaluating impacts to navigation and acting to minimize risks to navigation through decisions and compliance activities. Navigable fresh waters covered by this Act in Nova Scotia only include LaHave River (from the rapids in Bridgewater to the Atlantic Ocean) and for greater certainty the brackish water of the Bras D'Or Lakes and Great Bras D'Or. There is still a prohibition against throwing or depositing materials in waters that flow into navigable waters. See www.tc.gc.ca/eng/programs-632.html. The general "right to navigation" is included in the Canadian Constitution and governed by common law within the Province. Approval for works in fresh water can be obtained from Transport Canada if you wish to have certainty your work will not interfere with navigation.

Department of Natural Resources (DNR)

DNR administers the Wildlife Habitat and Watercourse Protection regulations, which protect water quality and maintain various elements of wildlife habitat on all forest harvest sites (on all lands; private, industrial and Crown). The regulations restrict tree and vegetation removal in areas next to watercourses for forestry operations.

Many species at risk are associated with watercourses, wetlands, or lands adjacent to watercourses and wetlands. They are found throughout the province but in rare and site-specific locations. Species at risk are listed and afforded protection, so it is critical to ensure work in or near watercourses and wetlands does not disrupt these rare plants and animals and their habitat. Refer to guidance at www.speciesatrisk.ca to assist you with the identification of species and their habitats and check with Regional Biologists at Nova Scotia Department of Natural Resources.
Also see http://novascotia.ca/natr/wildlife/biodiversity/species-list.asp

Municipalities

Some Municipalities have by-laws, plans, or policy that restrict or guide activity within areas next to watercourses. For example, the Halifax Regional Municipality requires a buffer of vegetation be maintained next to watercourses (the buffer zone is at least 20 meters wide).

Definitions

The following definitions are included in *Environment Act* (1995) making them legally binding.

- A **watercourse** is the bed and shore of every river, stream, lake, creek, pond, spring, lagoon, or other natural body of water, and the water therein, within the jurisdiction of the province, whether it contains water or not. This also includes all ground water.

- A **Water Resource** is all fresh and marine waters comprising all surface water, groundwater, and coastal water.

- A **Wetland** means any lands commonly referred to as marshes, swamps, fens, bogs and shallow water areas that are saturated with water long enough to promote wetland or aquatic processes which are indicated by poorly drained soil, vegetation and various kinds of biological activity which are adapted to a wet environment and includes fresh and saltwater marshes.

The following definitions are included in the *Activities Designation Regulations* making them legally binding:

- A **bank** is the portion of a watercourse between the ordinary high water mark and the boundary of the watercourse in its fullest natural state but does not include any area of overflow onto a flood plain.

- A **bed** is the portion of a watercourse that is commonly submerged in water during the one-in-two year mean daily flow level.

- The **ordinary high water mark** is the limit or edge of the bed of a body of water where the land has been covered by water so long as to wrest it from vegetation or as to mark a distinct character on the vegetation where it extends into the water or on the soil itself (normally the one in two year mean daily flow level).

A **watercourse alteration** is any temporary or permanent change made to a watercourse or to water flow in a watercourse.

- Any change made to existing structures in a watercourse including repairs, modifications or removal whether water flow in the watercourse is altered or not.

- Any deposit or removal of sand, gravel, rock, topsoil or other material.

Other constraints placed on projects through legislation are those relating to the design or construction or the carrying out of a watercourse alteration by specific clauses in various Acts and Regulations of the Legislature of Nova Scotia and the Parliament of Canada (see Table 1-1).

Governing Acts and Regulations

Environment Act

The designating of watercourse alteration activities for approval or notification is in the Activities Designation Regulations. The approval and notification processes are regulated in the Approval and Notification Procedure Regulations pursuant to the Nova Scotia *Environment Act* (1995).

Fisheries Act

In addition, watercourse alterations must comply with the "Fish and Fish Habitat Protection and Pollution Prevention" provisions of the Federal *Fisheries Act* and the General Prohibitions of the *Species at Risk Act*. Fish Habitat is defined in the *Fisheries Act* as "*fish habitat* means water frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes, including spawning grounds and nursery, rearing, food supply and migration areas; (habitat)"

Section 35 (1) of the *Fisheries Act* states "No person shall carry on any work, undertaking or activity that results in the harmful alteration, disruption or destruction of fish habitat" unless it is approved by the Minister. Relationships between typical project impacts (e.g., temperature change, sedimentation, infilling, reduction of nutrients and food supply, etc.) and the consequences to fish or fish habitat are described in the Pathways of Effects at http://www.dfo-mpo.gc.ca/pnw-ppe/pathways-sequences/index-eng.html . Also see the codes of practice which are being developed for common low impact work, undertakings or activities at https://www.dfo-mpo.gc.ca/pnw-ppe/practice-practique-eng.html .

Also see other prohibitions, required approvals and duties.

34.4 (1) No person shall carry on any work, undertaking or activity, other than fishing, that results in the death of fish.

34.3 Management or control of obstructions & Obstruction of free passage of fish

38. (4 to 7)
Duty to notify — death of fish; harmful alteration, disruption or destruction of fish habitat;
Every person shall without delay notify an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations of .. the death of fish, a harmful alteration, disruption, or destruction of fish habitat, that is not authorized under this Act, or of a serious and imminent danger of such occurrence, if the person at any material time

- (a) owns or has the charge, management or control of the work, undertaking or activity that resulted in the occurrence or the danger of the occurrence; or a deposit of a deleterious substance in water frequented by fish or if there is a serious and imminent danger of such an occurrence, and detriment to fish habitat or fish
- (b) causes or contributes to the occurrence or the danger of the occurrence.

Duty to take corrective measures
Any person described above shall, as soon as feasible, take all reasonable measures consistent with public safety and with the conservation and protection of fish and fish habitat to prevent the occurrence or to counteract, mitigate or remedy any adverse effects that result from the occurrence or might reasonably be expected to result from it.

Report
As soon as feasible after the occurrence or after learning of the danger of the occurrence, the person shall provide an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations with a written report on the occurrence or danger of the occurrence.

Table 1-1 Provincial and Federal Acts and associated regulations or sections applicable to the watercourse alteration program.
Please note: It is the applicant's responsibility to ensure compliance with the Acts listed in this table and any other applicable Acts of the Legislature of Nova Scotia and the Parliament of Canada.

PROVINCIAL	
NS Environment Act (1995)	Nova Scotia Environment
Activities Designation Regulations	Nova Scotia Environment
Approvals and Notification Procedures Regulations	Nova Scotia Environment
Nova Scotia Watercourse Alterations Standard	Nova Scotia Environment
Environmental Emergency Regulations	Nova Scotia Environment
Environmental Assessment Regulations	Nova Scotia Environment
Petroleum Management Regulations	Nova Scotia Environment
Sulphide Bearing Material Disposal Regulations	Nova Scotia Environment
Nova Scotia Endangered Species Act	NS Department of Natural Resources
Nova Scotia's Wildlife Habitat and Watercourse Protection Regulations	NS Department of Natural Resources
Nova Scotia Wildlife Act and General Wildlife Regulations	NS Department of Natural Resources
FEDERAL	
Fisheries Act	Fishways (Sec. 20, 21); Fisheries Protection, including fish habitat protection and Pollution Prevention (Sec. 35, 36, 37, 38); Regulations (Sec. 43)
Species at Risk Act	General Prohibitions and Protection of Critical Habitat (Sec. 32, 33, 58)
Canadian Environmental Assessment Act	Purpose (Sec.4); Environmental Assessment of Projects (Sec.5); General (Sec. 14, 15, 16, 17)
Canadian Environmental Protection Act	Objectives, Guidelines and Codes of Practice (Sec.54)
Navigation Protection Act	Transport Canada

1.4 Approvals and Notifications

The *Activities Designation Regulations* prescribe the activities which require a notification, those watercourse alterations that require an approval, and exemptions for submission requirements. The document titled "Changes to the Watercourse Alteration Program: What are the New Regulatory Submission Requirements?" provides some guidance on what types of instream work requires a notification, an application for approval, or does not require any submission to Nova Scotia Environment. (The document is only guidance; refer to the *Activities Designation Regulations* for legal purposes.)

The watercourse alteration program includes the following types of submissions:

1. Approvals
2. Notifications

See Nova Scotia Environment's website for more information: http://novascotia.ca/nse/watercourse-alteration/

Approvals

- **Approvals** authorize work on a single watercourse alteration within a specific time period and with specific terms and conditions. A fee per alteration is applicable. Approvals are required for alterations that are typically higher risk, including alterations that do not meet the eligibility criteria for notifications.

- **Amendments** are used for alterations that have an existing approval, have not yet commenced or finished and require a change to the alteration originally applied for. A fee per amended alteration applies.

- **Renewals** are used for alterations that have existing approvals, have not yet commenced or finished and require an extension to the approval expiry date in order to complete the work. Renewals must be requested prior to the expiry date of the existing approval.

Application for Approval Process
Applications for approval are reviewed by NS Environment. Complete applications will be processed within 60 days. Work cannot begin until an approval has been received. All terms and conditions in the approval must be followed.

a) Information accompanying the application shall include all items listed on the "Submission Checklist for Watercourse Alterations". Please refer to the checklist.

b) Information as to the location of any work **in progress,** or work **completed,** must be made readily available, upon request, to any Inspector of NS Environment and should be provided

to any Inspector of the Department of Natural Resources, or any Fisheries Officer of the Federal Department of Fisheries and Oceans for auditing or inspection purposes.

c) The approval application will be reviewed by NS Environment. Copies of the application and site locations will be forwarded to DFO for comment.

d) Approval for alterations within a designated watershed will require prior written approval from the Municipality responsible for the designated watershed.

e) A single approval may be issued to the applicant containing the conditions required to ensure proper execution of the activity.

Note: In some cases, approvals may not be granted for the watercourse alteration being proposed. For example, infilling or dredging.

Note: Most aquatic habitat restoration work done under the Nova Scotia Salmon Association's Adopt A Stream Program can be included in the Program's "multi-site permit". Reviewed and approved project site details, including starting date are provided by the NSSA Adopt a Stream Program in an annual application to NSE.

Notifications

- **Notification**s are notices that work on a watercourse alteration activity is about to commence. The process is a streamlined way to inform NSE you are carrying out a watercourse alteration activity.

- **Revision (amended) Notifications** are used when a previous notification has been submitted and the notifier wishes to change the details of the activity beyond what was indicated on the notification receipt. All revisions to a notification must still be eligible for notification, as is stated in the Activities Designation Regulations. For watercourse alteration notifications, the renewal will be granted for the next year's summer window (between June 1 and September 30). No work outside of the summer window may take place under a notification.

Notification Process

Nova Scotia Environment must receive a complete notification a minimum of 5 calendar days in advance of the proposed commencement of an activity. NSE does not review your submission - if the notification is complete and eligible according to the requirements in the Activities Designation Regulations, a notification receipt will be issued to the notifier. If the notification is incomplete, then an incomplete letter will be sent to the notifier. You must receive a receipt from NSE indicating the department has received your completed notification before you can start work.

The person who completes the notification form is referred to as the notifier. Certified watercourse alteration sizers or installers can be notifiers. The notifier must understand the regulatory obligations that apply to the activity and must ensure the activity is carried out in accordance with requirements.

For aquatic habitat restoration the designer/sizers will be Adopt A Stream personnel or other recognized individuals who are listed on the http://adoptastream.ca/training/watercourse-installers-certification-for-aquatic-restoration web page.

- All activities taking place under a notification must comply with the **Nova Scotia Watercourse Alterations Standard.**

The notifier would complete and sign the notification form for the alteration. If your client is signing the form, you may need to provide information concerning the activity details (Section 5 of the form). Activity details include information about the watercourse and information about the construction/structure.

Notification for aquatic habitat work is limited to small projects such as a culvert baffles or small bank stabilization under 15m in stream length. Notifications cannot be strung together to cover longer restoration projects even though each site is less than the 15m of stream length.

Notification may be used for making repairs to existing (previously installed under an Approval) habitat restoration structures and devices. For this activity, indicate "Maintenance of structure in watercourse" and not "Work to improve fish habitat" in the notification form.

Please refer to Appendix A for guidance on how to complete the notification form.
You may be required to provide information about the watercourse alteration for an audit being conducted by NS Environment (see Section 4.0 Auditing). Similarly, Nova Scotia watercourse alteration designer/sizers need to keep calculations and other information used to determine the type and size of structures.

Please note:
Blanket approvals have not been issued after October 1, 2014. A notification form must be provided for every eligible alteration. For those activities that do not qualify for notification, an application for approval must be submitted.

1.5 Nova Scotia Watercourse Alterations Standard

The NS Watercourse Alterations Standard contains the minimum requirements that apply to watercourse alteration activities for which notification is required to be provided under the *Activities Designation Regulations* made under the *Environment Act* (1995).

The Standard can be found on the Nova Scotia Environment website.
http://novascotia.ca/nse/watercourse-alteration/docs/Watercourse-Alterations-Standard.pdf

Some or all of the requirements in this document may become conditions of an approval for a watercourse alteration. There are no standards specific to habitat restoration but many of the standards for general activity do apply.

1.6 Certification and Qualification Requirements

The watercourse alteration program includes a number of requirements for the involvement in certified and/or qualified professionals in the planning, design and installation of watercourse alterations.

Note: Those trained under the culvert, bridges and other instream structures course will be certified to install those structures. Certification under this course will be for aquatic habitat restoration only.

As of October 2016, certified Watercourse Alteration Installers or aquatic habitat restoration installers depending on the work type will be required to carry-out the installation of watercourse alterations or directly supervise the work for:

- All watercourse alterations taking place under a notification.
- All watercourse alterations taking place in a watercourse under an approval as per section 5a(2)(a) of the activities designation regulations.
    - For example, alterations that do not meet the notification conditions, most fish habitat restoration, dredging, and permanently diverting a watercourse from its natural channel.
    - Note: an installer certification is not required for wetland alterations, water withdrawals, or dams (unless required in the terms and conditions of the approval). There is different approval process for these types of alterations.

For the non-restoration works, a certified watercourse alterations culvert and bridges sizer or a professional engineer is required to size structures under the following notification categories in the activities designation regulations:

- The construction or modification of a single culvert or other single closed-bottom structure for the purpose of a road, railbed, trail or footpath crossing, if the following conditions are met:
    - The length of the culvert is 25 m or less;
    - The watercourse slope is less than or equal to 0.5%*;
    - The watershed of the watercourse crossing does not exceed 20 km^2; and
    - The work begins on or after June 1 and ends on or before September 30.

*note: a professional engineer may design culverts on watercourse slopes up to 8% under a notification, provided they follow the ***DFO guidelines for the design of fish passage for culverts in Nova Scotia****, Fisheries and Oceans Canada, Fisheries Protection Program, Maritimes Region, January 2015* (http://www.dfo-mpo.gc.ca/library/353873.pdf) and meet the other notification conditions above.

- The construction or modification of a bridge or other open-bottom structure for the purpose of a road, railbed, trail or footpath crossing, if the following conditions are met:
    - The bed of the watercourse is not altered;
    - The bank of the watercourse is altered;
    - The span is a maximum of 15 m for a bridge or 3600 mm for a structural plate arch or other open-bottom structure;
    - Any structural plate arch installed is 25 m long or less; and
    - Work that alters the shore of the watercourse begins on or after June 1 and ends on or before September 30.

Although not required, certified culvert and bridge installers may sometimes be involved in applications for approval since installers have some knowledge of watercourse hydraulics and importance of aquatic ecosystems. An installer may assist in the development of some of the accompanying documentation for an application for approval.

Completion of Training Program

Individuals successfully completing this Certification program will be recognized by Nova Scotia Environment as having been trained for undertaking aquatic habitat restoration in watercourses and for altering watercourses, in accordance with requirements in the Nova Scotia Watercourse Alterations Standard in the case of restoration activities eligible for Notification or in accordance with the terms and conditions of an approval. This manual and accompanying training provide information on planning considerations and construction methods for some of the most common restoration techniques. It also provides general principles and cautions that can be applied to any alteration or work around a watercourse.

Training of installers does not extend to alterations proposed for wetlands areas. Any developments in or near wetlands are regulated by Nova Scotia Environment and are subject to a separate review process involving other government agencies. A list of Wetland Professional Resources in Nova Scotia can be found at www.novascotia.ca/nse/wetland.

This training does not extend to the design of restoration projects including the sizing, layout and structure or technique selection. Those approved to do this work under the AAS Program can be found on the AAS web page. http://adoptastream.ca. Others may be approved by NSE for work not under this AAS Program.

Responsibilities of Certified Installers

It is a certified installer's responsibility to be in compliance with all relevant acts and regulations, standards, approval or notification conditions and all requirements of the application process. Nova Scotia Environment encourages certified watercourse restoration installers to promote their authorization to restore watercourse structure and productivity and also to promote their ability to follow best environmental practices.

The responsibilities of certified restoration installers doing watercourse alterations or directly supervising watercourse alterations include, but are not limited to, the following:

- Know, understand, comply with all relevant acts, regulations, and standards, and any guidelines, and policies of NS Environment.
- Ensure consideration of best practices for environmental protection for all watercourse alteration sites and land next to the watercourse. Best practices include proper planning and consideration of alterations.
- Understand the Nova Scotia Watercourse Alterations Standard for notifications and the terms and conditions of water approvals before starting work and complying with the requirements.
- Plan to install/construct restoration projects in accordance with training provided for qualifying watercourse restoration installers.
- Be able to recognize and correct problems during work on a watercourse (such as, identifying issues prior to problems occurring and making appropriate adjustments).
- Provide their name, phone number and certification number as an installer on a notification form.
- If acting as a notifier for a watercourse alteration, comply with the responsibilities of a notifier as per the Approval and Notification Procedure Regulations.
- Assist property owners and others to complete notification and application forms for watercourse alterations.
- Provide information to Nova Scotia Environment in a timely manner when requested related to projects which you are or were involved.
- Provide updated contact information to Nova Scotia Environment in a timely manner so contact lists may be updated.
- Communicate with other professionals working on the project and seek assistance from others when needed.

1.7 Failure to Comply

Failure to comply with requirements in the Environment Act, the Activities Designation Regulations, the Approval and Notification Procedures Regulations, the Nova Scotia Watercourse Alterations Standard and other regulated requirements may result in prosecution. Failure to comply with regulated requirements may result in suspension or cancellation of the certificate of qualification.

2 POSSIBLE IMPACTS OF WATERCOURSE ALTERATIONS

Nova Scotia has over 6,700 lakes, 1000s of named rivers and many more that are unnamed, as well as numerous smaller watercourses. Healthy communities and healthy aquatic ecosystems rely on the sustainable use of water resources and watercourse protection. Sustainable use of water resources supports economic development, recreational activities, and the health and quality of life of Nova Scotians.

Any alteration at, near, or in a watercourse, or of its flow, has the potential to damage the aquatic ecosystem. The aquatic ecosystem is the interactive community of living things (plants, animals, insects and microbes) and their physical setting. Damage can result from such things as erosion, sedimentation, stream blockages, poorly designed crossings, degraded water quality, and habitat loss.

Nova Scotia Environment requires people to take great care when working in and near watercourses. The goal of having requirements and restrictions for watercourse alterations is to protect surface water resources and ensure sustainable use for all beneficial uses, including drinking water supplies, habitat for aquatic life, and recreational, agricultural and industrial uses. Requirements are also in place to mitigate flooding and scouring of the watercourse channel leading to impacts on ecosystems and on property.

Restoring and protecting our watercourses means:

- Restoring and maintaining water quality.
- Restoring and maintaining channel and flood plain capacity and flow.
- Restoring and maintaining stable banks and riparian vegetation. and,
- Restoring, maintaining and promoting the health and productivity of the aquatic habitat.

Any alteration done at, near, or in a watercourse or to the flow in it can result in a negative impact to the watercourse and its aquatic habitat. Careful planning must be employed. The following information describes potential negative impacts and their effect on the aquatic environment.

2.1 Erosion

Erosion is the detachment of soil particles and loss of material from the earth's surface by the action of gravity, ice, water, wind, or as a result of other natural occurrences or man-induced events. Although erosion is a natural process, in undisturbed environments, it is a slow one. During a watercourse alteration, an increase in soil exposure may accelerate the rate of erosion if protective measures are not properly executed.

If erosion does occur at an alteration site, it will have a negative impact on the aquatic ecosystem.

2.2 Sedimentation

Sedimentation is the deposition of fine particles, such as sand, silt and clay, which have been eroded from exposed soils and transported by water. Under natural conditions this is a slow process and only occurs under high flow conditions. When this is the result of erosion accelerated due to land use or watercourse alteration, it can have a potentially serious impact on the aquatic ecosystem. Sedimentation is divided into two categories determined by the mode of transportation by which it moves through a watercourse.

- **Suspended sediments** are soil particles suspended or mixed in the water column. Suspension is dependent on particle size and water velocity, turbulence and sometimes electrical charge on very fine particles.

- **Bedload sediments** are soil particles that slide, roll or bounce along the bed of the watercourse. These sediment particles are either too heavy to be suspended in the water column or the water velocity is too slow to suspend them.

If sediment, suspended or bedload, is present in a watercourse, it will have the following impacts on aquatic habitats:

Ecological Impacts of Silt and Sand

Sedimentation is a common occurrence in our streams due to changes in land use. The result is heavily embedded, or another term is grouted, watercourse beds that just do not have the ability to restore themselves through natural processes. These are watercourses where the gravel, cobble and boulder substrates are too large for the watercourse to move, especially when grouted, which decreases the ability of natural flows to clean the substrate by up to 10 times.

Restoration techniques such as digger logs and deflectors do not remove all the excess sand and silt in streams, especially those with angular or large rock forming the beds. These techniques will restore pools, insect habitats and fish spawning and rearing areas in gravel cobble pool-riffle watercourses,

moving some of the sand and silt onto the riparian areas or point bars during bank full flows. It is also possible to remove the sand and silt directly using SandWand technology in certain substrate types. There are also several erosion control and bank stabilization techniques that help prevent direct sedimentation, as well as some which directly remove the sand and silt in cobble and gravel streams but techniques are still limited when trying to fully restore the streams with large or angular rock. A strong focus on **prevention of sedimentation is critical**, but when this doesn't work, or there is an accident, the productivity of the habitat is lost and requires costly works to restore or they may never to return to pre-impact conditions.

When the stream sediments or silts in:

- The watercourse over widens usually by about 20% in Nova Scotia. This widening brings in more silt and sand creating a shallow stream, causing it to lose its productive pool-riffle or step-pool – run structure, therefore turning the streams into all run with no thalweg. The loss of stream structure resulting in long shallow runs creates a partial-and even full-migration barrier for fish. The water just isn't deep enough with suitable velocities between resting pools to allow them to make the trip. This also takes away the pools used by Trout and large Salmon parr, including critical Salmon pre-smolt over-wintering habitat and almost all the fish refuge habitat during low flow periods. In severe cases, or in bad sections, the streams build thick ice in the winter and the ice freezes to the bottom in shallow areas with no thalweg. This ice scours the bed and banks during the thaw, resulting in the majority of the bank erosion, second only to that caused by stream crossings. This has serious impacts on the fish, but the loss of structure also means the streams completely freeze over in the winter, depriving other wildlife critical access to open water to drink.

- There is no flow or critically reduced flow through the streambed. This greatly reduces the thermal capacity of the watercourse, so the water heats up faster, creating greater daily temperature fluctuations. Temperatures normally closely track air temperature in these streams. This combined with the over-widening that increases the surface area to water volume ratio in contact with the air, results in loss of habitat due to warm water. Trout population drops quickly above 16 °C, and they all move to seek colder water above 20 °C, and Salmon populations drop above 20 °C. Even if you have shade from the riparian area, the water gets too warm.

- Instream cover is lost for juvenile fish, resulting in high predation rates.

- Over-wintering habitat under the rocks disappears, reducing over-wintering survival.

- Spawning beds have flows reduced or stopped through them, so the fish either do not spawn or dig shallow redds that are subject to ice scour and washout. Where the flow through the spawning beds is just reduced, the eggs will survive, but the big loss is the inability of the alevin

to get out of the egg coating and later make it to the surface as emergent fry. This can result in no egg-to-fry survival.

- Instream food from vegetation declines. Most of our streams are naturally nutrient poor and depend on organic material from the riparian areas to support the food web. This means the leaves, grasses, etc. have to stay in the stream system to be decomposed by bacteria and shredder insects. When the interstitial spaces between the rocks are filled with sand, this organic material washes through and the food supply can be reduced by as much as 90% within the stream environment. Conversely, increased loading of ponds, lakes and estuaries with these organics often results in reduced oxygen levels in these habitats.

- Invertebrate habitat is greatly reduced because they live only on the back of surface rocks that have been washed clean. The shredder insect populations in particular are greatly reduced, and there is insect production on only a few centimeters of substrate depth versus up to 35cm in a clean stream. Diversity of insect species and sub-species is reduced, so adult stages are present for just short periods, and so are not available to the fish and nesting birds which depend on them through their breeding season. Therefore, there is no food and no habitat for the insects that are key in the food web for fish and birds.

In short, it is an ecological disaster that in many cases has reduced Trout and Salmon populations to small remnants of their potential. AAS projects have shown that we can get 120 to 150 salmon/100 m^2 where the restoration work has been able to do a good job of sorting the sand and silt out of the substrate using our current restoration techniques, compared to the Nova Scotia average that is running in the range of 8 to 14 Salmon parr/100 m^2 where there is good water quality.

“Sand and silt will wash from riffles and pools will clean out on a 1 in 2-year storm.” This fact is sometimes quoted to say the river will fix itself quickly and we should just wait for nature to do the cleanup. But these freshets do not clean out the stream bed, just wash away the surface sand and silt, so do not reduce the impacts listed above.

Natural meander migration will clean the sand and silt out of gravel cobble bed watercourses. However, the natural Nova Scotia river meander migration rate in gravel cobble bed stream is approximately 2cm/year, so, for a 5m wide stream it will take 1500 years for nature to clean sediments out of a gravel bed stream. In many of our streams with heavy substrates, there is no meander migration rate, so they will never recover without a major change in the drainage pattern that comes in geological time frames.

Suspended Silt and Clays

Most fish are sight feeders, including salmon and trout, which means that they can’t see the food if the water is too turbid. The reduction in feeding begins when the water contains just 20 ppm of suspended silt. This is the major impact of suspended silt, and the longer this persists over the growing season, the greater the impact. The silt also coats the surface algae, making it hard for insects to hang on the rocks and they tend to drift away with the flow, reducing the onsite population and food supply. The

suspended particles can cause physical gill damage to fish and damage to aquatic insects. In severe cases, the gills of fish may become plugged, and pollutants attached to the silt are more easily transferred to their blood stream. The fines may deposit in the bottom of the stream, embedding the substrate, and completely sealing off the flow to fish eggs in the redds.

Suspended sediment can result in warmer water due to the absorption of the sun's warmth by the darker color of the water.

Other users of the watercourse experience:

- Decreased water quality due to suspended sediment in water being used for private, commercial, industrial, or municipal use and as drinking water for wildlife.
- Impacted water quality affecting recreational use of watercourse.

Any activity which disturbs soil has the potential to damage aquatic habitat.

2.3 Water Quality

In addition to siltation of the watercourse, water quality is very important for the health of the aquatic habitats. Water temperature, pH, conductivity, oxygen and metal levels, particularly aluminum, are all critical elements affecting aquatic life. Wet concrete, petroleum products for vehicles and equipment, and preservatives in some wood products are just a few of the many examples of substances that can impact water quality.

The NSSA's AAS Program has prepared a water quality guide "WALKING THE RIVER" A Citizen's Guide to Interpreting Water Quality Data. That is available at http://www.adoptastream.ca/project-design/interpreting-water-quality . This guide also provides information on the design of water sampling programs to define the health of lakes and streams and to support the design of water quality restoration projects.

2.4 Riparian Zone

To protect important natural ecosystems, we need to protect more than just the watercourse itself. Riparian zones are those areas of land immediately adjacent to watercourses, including the banks of the watercourse. Riparian zones are ecologically diverse, provide a buffer that protects the watercourse from impacts of agriculture, forestry and development, and reduce the severity of flooding. Some benefits of stable vegetated riparian zones include:

- Travel corridors for wildlife along the watercourse and providing access to watercourses for wildlife requiring both terrestrial and aquatic habitat (e.g., mammals such as moose and mink).

- Providing shade, reducing the water temperature in watercourses.

- Contributing insects and detritus such as leaf litter into the watercourse, which act as a basis for the food web.

- Providing shelter - Riparian vegetation, in the form of tall grasses, shrubs and trees, protects fish from predators.

- Providing natural erosion control - The root system of vegetation contributes to bank stability, stabilizes the flood plain and intercepts and slows runoff which limits erosion and sedimentation, helping to protect the aquatic habitat from the harmful effects of sedimentation.

- Providing natural filtration - Vegetation and root systems can act to filter out small amounts of pollutants such as pesticides, bacteria, fertilizers, heavy metals, sediment, and hydrocarbon

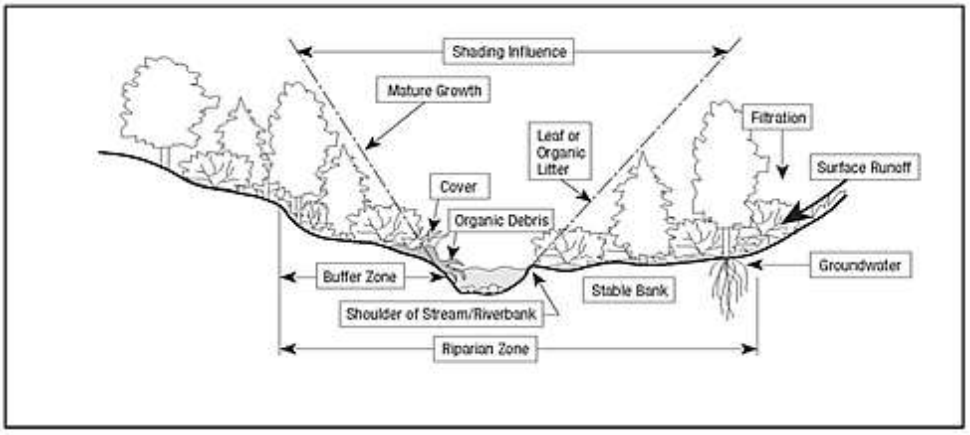

Figure 2-1 Importance of Riparian Zone to Aquatic Habitat

2.5 Alteration of Bank and Bed of a Watercourse

The improper alteration of the bank or bed of a watercourse can have a direct impact on habitat for aquatic life. Altering stream channels or altering water flow will also affect flow dynamics, changing the stream's morphology, and can create unstable channel conditions leading to erosion, changes in meander pattern, and increased potential for flooding and bed material transport. **It is very important that the restoration work be properly designed, laid out and installed to ensure a positive effect on the aquatic ecosystem.**

Flow velocity can be decreased in some areas of the channel and increased in others. If not done following a proper design, these changes can result in severe scouring of banks and undesirable changes to pools and shallow areas in the watercourse. In some cases, the impact is deposition of material in places which harm the aquatic ecosystem and stream function. This harmful deposit of sediment can have an impact on fish migration and important aquatic habitat downstream. It can also impact property owners if flooding occurs. These changes can impact both large and small watercourses, which all contribute to productive aquatic ecosystems.

These changes will affect aquatic habitat in the immediate area but can also have an impact upstream and downstream of the alteration site. Changes to the flow dynamic and the features of the watercourse may also result in the damage of property adjacent to the watercourse.

Littoral Zone of Watercourse

The shallow water areas of watercourses, lakes and ponds (called littoral zones) where light penetrates to the bottom of the water body, are highly productive for aquatic life. Through complex food chains, virtually all aquatic organisms are dependent upon these rocky, silty, or sandy bottomed areas during at least one stage of their life cycle. The penetration of light allows plant organisms to grow, creating part of the essential interconnections between living organisms and their habitat.

For example, hard-bottomed areas and vegetation are ideal for spawning and nursery areas for some fish species with ideal hiding areas and sources of food. Disturbance of this area and of the riparian zone can impact waterfowl nesting areas and habitat for amphibians, aquatic insects, and other organisms.

2.6 Other Impacts

Improperly designed and installed structures such as bridges or culverts, which are incapable of passing high water flows, can cause upstream flooding and high downstream velocities can result in property and watercourse damage downstream.

Improperly constructed or designed structures could fail, resulting in large amounts of material infilling the watercourse below, flooding, property damage, or even loss of life. Alterations may also cause substantial changes in the availability of water suitable for domestic and industrial consumption, as well as for a number of other uses including agriculture, forestry, fishing, mineral development, tourism, outdoor recreation, and power production.

2.7 Method of Defense

For work in and around the vicinity of watercourses, the best method of defense is to ensure that all protective measures are planned before beginning work and properly utilized and adjusted (if needed) during the restoration work. Consider the planning aspects outlined in Section 3.0, Construction Requirements for all watercourse Alterations and the Appendix for specific types of work. As part of the planning process, it is necessary to also anticipate problems and prepare a contingency plan and have required materials on site.

3 PLANNING WATERCOURSE ALTERATIONS

Comprehensive planning is essential during the pre-construction phase of proposed aquatic habitat restoration, and for the maintenance and modification of existing restoration in watercourses. Careful planning and design will prove to be cost effective to the restoration work and to the long-term maintenance of structures.

The NSSA's AAS Program has a habitat quality survey methodology to assess the quality of stream habitats for Trout and Salmon and to identify parameters that are limiting productivity. These parameters such as substrate quality, stream structure, shade, bank stability, and basic water quality will help in the selection and design of the restoration project techniques. The survey also shows the improvement in the habitat quality following restoration works. Training in this survey technique is available through the NSSA AAS Program.

Please ensure all other approvals that are required are obtained. For example, work in streams running through Crown Lands require approval through the Nova Scotia Department of Natural Resources.

3.1 Proposed Watercourse Alteration Location

Use of topographic mapping, geology mapping, ortho-photo mapping and/or aerial photos, digital mapping geographic information systems (GIS) for planning watercourse alterations is useful and in some cases is essential. These maps and photos often identify natural areas such as wetlands and manmade features and may identify other users of the watercourse. The restoration Biologist involved in the design of the restoration work may have already viewed the mapping for the area.

Areas requiring special consideration

Prior to deciding on a watercourse alteration, it is important to identify and outline all sensitive and unique areas or habitats such as:

- Ecological reserves, game management areas, protected areas, historic sites or areas of significant archaeological significance.
- Sensitive areas such as deer wintering areas, salmon spawning and rearing areas and waterfowl breeding areas.

Protected Areas

In Nova Scotia there are 60 Protected Areas which are divided into 37 wilderness areas, 21 nature reserves, and two heritage rivers. Alterations of watercourses flowing into nature reserves or activities in the watersheds above nature reserves must be completed with extreme care in order to preserve the ecosystems found within the protected area.

Nature Reserves

Nature reserves protect unique, rare, outstanding or representative natural ecosystems, and the habitats of rare or endangered species.

Wilderness Areas

Wilderness areas protect representative examples of Nova Scotia's natural landscapes, biological diversity, and wilderness recreation opportunities.

Canadian Heritage Rivers

Canadian Heritage Rivers recognize and promote the of the best examples of Canada's river heritage

For more information on protected areas please visit the protected areas website at: http://www.novascotia.ca/nse/protectedareas/

- Nova Scotia Protected Areas including Nature Reserves and Wilderness Areas. Additional precaution may be needed for in watersheds shared with protected areas. See http://novascotia.ca/nse/protectedareas.

- Habitat for species at risk. Endangered and vulnerable wildlife and plant species are protected under the *NS Endangered Species Act.* Contact the Wildlife Division at NS Natural Resources and see their website: http://novascotia.ca/natr/biodiversity. Also see www.speciesatrisk.ca.

- All wetland areas including, but not limited to, those designated as Provincially Significant.

- Protected water supply areas designated in provincial regulations. http://novascotia.ca/nse/protectedareas/map.asp

- Any critical habitat identified for a wildlife species that is classified as endangered, threatened or of special concern as part of a Recovery Strategy, Action Plan or Management Plan under the federal *Species at Risk Act (*SARA). Restoration of habitats is normally included in the plans but check for specific requirements. See the *Species at Risk Act* Public Registry at www.sararegistry.gc.ca. For a non-exhaustive list of Aquatic Species at Risk found in Canadian waters see http://www.dfo-mpo.gc.ca/species-especes/listing-eng.htm.

Drinking Water Supply Areas

Be aware that many Nova Scotians rely on surface water resources for potable water, agricultural practices, and commercial and industrial use. Watercourse alteration projects must take this into consideration and ensure water flow and water quality is maintained so that other users are not affected.

If you are planning any activity within one of these water supply areas you should contact the municipality that oversees the protection of the watershed

In Nova Scotia, 25 Protected Water Areas designated in Provincial regulations provide drinking water to communities. More requirements may need to be followed as prescribed in the regulations.

Protected water supply areas designated in provincial regulations are listed below and provide drinking water to communities. Please note, this list is subject to change as Regulations come into effect or are cancelled. See http://novascotia.ca/just/regulations/rxaa-l.htm#env for the Regulations in effect.

The Regulations place restrictions on land and water uses within the water supply area. If you are planning any activity within one of these areas you should contact the municipality that oversees the protection of the water supply.

A map of the protected water areas may be found on th Nova Scotia Environment website at the link provided below: https://www.novascotia.ca/nse/water/docs/Protected.Water.Areas.Map.pdf

For more information contact Fisheries and Oceans Canada, Species at Risk Coordination Office at http://www.dfo-mpo.gc.ca/speciesespeces/regions/ Maritimes/maritimes-contact-eng.htm.

It should be noted that although not all sensitive and unique areas are identified on maps or photos, they must still be given special consideration. It is good practice to contact provincial or federal government agencies to ensure that all significant areas are addressed in planning. These agencies may include, but are not limited to, Nova Scotia Environment, the Nova Scotia Department of Natural Resources, Fisheries and Oceans Canada, and Environment Canada.

3.2 Field Inspection

A field inspection of the proposed restoration work location is essential in identifying any limiting environmental factors not apparent during the planning process. The field inspection may result in the need to make adjustments to the planned location or the type of structure and restoration methods.

Scheduling the Field Inspection

- Schedule field inspections during low water when potential problems and opportunities would be evident. These would include springs, seeps, wet areas, etc., which are not always visible during high flows or on a map or photo.
- Field inspections should be completed on foot to be most effective.

Information to gather during the field inspection

Information about the selected watercourse alteration site should be recorded and maintained (some of this information may have already been gathered by the restoration Biologist).

- Location of watercourse alteration (UTM coordinates: northing and easting- see Appendix A for instructions on identifying UTM coordinates).
- Photos of the watercourse where the alteration will occur and photos of the watercourse upstream and downstream of the proposed alteration.
- An account of why the site was selected for the watercourse alteration or why a modification to an existing alteration is needed.
- Features of watercourse at site, including bed material, bank material, width and depth of channel (if flowing watercourse).
- Description of the riparian zone (land next to watercourse).
- General topography and soil type of the area.
- Description of flood plain.
- Areas requiring special consideration (e.g., wetlands, steep slopes, sensitive or critical habitats).

Some of this information will be required on the notification form or the submissions with an application for approval. The information will also be helpful when determining the best type of structure or alteration, the most appropriate water control method and the plan for erosion and sedimentation controls.

TIPS ON IDENTIFYING WATERCOURSES

See definitions of watercourse, bank and bed in Section 1.2.2. Further guidance on identifying watercourses:

- if a watercourse is drawn on a National Topographic Series (NTS) map it is considered a watercourse by NS Environment
- if air photos less than 40 years old show evidence of a watercourse, then it may be a watercourse. Evidence would include visible water, visible stream channel (riffles, eroded areas, bars, rapids, pools, etc.) and vegetation which indicate a watercourse.
- Visit the site. Look for a clearly defined stream channel. Is there a mineral soil in the channel including sand, gravel and/or cobbles in a continuous pattern over a continuous length, with little to no vegetation? Is there an indication that water has flowed in a path or channel for a length of time and at a rate sufficient to erode a channel or pathway? Is there water flowing in this channel? Are there pools, riffles, steps or rapids? Are there aquatic animals, insects or fish? Are there aquatic plants? If two or more of these characteristics are present than it is a watercourse unless otherwise determined by NS Environment.

Be aware it is possible for a watercourse to disappear underground for a certain distance and re-appear elsewhere. Some small streams may course through, or turn into, wetland in places. You will need to walk some distance up and downstream to view conditions as part of a determination and not be confined to evidence at one location.

Does the watercourse now exist in its present channel as a result of developments in the past, and has the watercourse established itself as habitat for aquatic plants and animals? There are lakes for example in the province that have been created or enhanced by man-made impoundments. If a watercourse has been altered by ditching, dredging or other types of development, such as a stream that has been dredged or straightened, it is still a watercourse. If a channel has been diverted and the original channel is gone or dried up, the existing channel is a watercourse nonetheless.

A watercourse does not include non-natural bodies of water. A ditch for a highway, forestry road and agricultural drainage ditch or ponds created by humans are not on watercourses.

TIPS ON HOW TO IDENTIFY/MEASURE:

WIDTH – the width of the channel at the bank full height.
The bank full width can be measured as follows:
- Find the bank full height by observing the points of vegetation change on the banks of the watercourse, where algae does not grow on the boulders, where sediment texture changes abruptly, or where tree roots have been exposed.
-Collect at least three to six bank full width measurements along the channel where the proposed work is to be located, noting both pool, riffle–run, and narrow sections.
- For permitting purposes, average the measurements to get the bank full width.

DEPTH – The depth is the height of the watercourse channel from the stream bed to the bank full height. The depth of the channel can be measured as follows:

- The depth is measured from the bank full width height to the bed of the watercourse.
- Measure the depth of the channel three to six times along the channel.
- The depth measurements should be averaged to get the watercourse channel depth at the work location.

THALWEG - The line joining the lowest points lengthwise of the bed of the watercourse defining its deepest channel. The lowest /deepest channel of flow within a watercourse, "the current".

RIFFLE - shallow water extending across the bed of a flowing watercourse with rapid current and with surface flow broken into waves by submerged obstructions such as gravel and cobble. The water flow is rapid and usually shallower than sections above and below. Natural watercourses often consist of a succession of pools and riffles.

Run – lower slope than a riffle and deeper water and are usually between step- pool sections or between riffles and pools. Degraded watercourses that do not have clear riffles, steps or pools may be entirely run.

Steps – These are ridges of large cobble, boulder or bed rock that form a ridge over which the water drops usually into a pool although the pools may be filled in degraded habitat and appear as runs.

POOL - A deep, slow moving, quiet portion of a watercourse with no slope.

3.3 Timing of an Alteration

All watercourse alterations involving instream work should be carried out during the low flow period between **June 1st and September 30th** of the same construction season. Carrying out instream work at low flows is intended to minimize any potential negative impacts to aquatic ecosystem and to other users of the watercourse (such as for recreational or commercial use) resulting from erosion and sedimentation. Working during the summer season minimizes potential impacts by:

- Avoiding sensitive periods in the life cycle of fish such as during migration, spawning, over wintering, and when eggs and alevins are in the gravel.

- Facilitating dam and pump systems, diversion ditches, cofferdams, or other in isolation of water flow construction techniques. It is easier to isolate low flows in order to work in isolation of flowing water. Isolating high flows could lead to flooding and increase the risk of introducing sediment into the watercourse.

- Providing a period of adequately warm weather after the alternation period to re-establish vegetation on the disturbed footprint bordering the construction site. Providing the opportunity for vegetation to become established immediately after the completion of the project.

- Making it easier and less expensive to move and stabilize soil, since soils are often either frozen or saturated at other times of the year, making them more difficult and costly to move.

- In order to minimize environmental impacts caused by suspended sedimentation, the length of time it takes to carry out the permitted alterations must be minimized and planned so as not to coincide with periods of increased sensitivity for fish, such as spawning and egg incubation periods.

Specific conditions will vary for different areas throughout the province depending on the number and species of fish involved and the timing of flows and water temperatures that trigger migration and spawning activities of the various species.

All notifications will be valid from June 1st to September 30th. Be aware that when a notification is submitted to Nova Scotia Environment the expiration date will automatically be set to the next September 30th. Notifications cannot be extended beyond September 30th. If works are anticipated to extend beyond the September 30th expiry date, a standard approval will be required to continue the work.

Temporary Bridges (portable bridges) may be installed year-round when construction and operation/use is completed in a manner that avoids altering the watercourse and does not cause sedimentation to the watercourse. Nova Scotia Environment does not require a submission to install or remove a temporary crossing provided an alteration to the watercourse or the water flow does not occur.

3.4 Selecting the Watercourse Alteration with the Least Risk to the Environment

All watercourse alterations impact the environment to some degree. Careful planning, selection of type of work, and proper construction/installation methods can minimize this impact. Nova Scotia Environment encourages discussion with certified installers and/or sizers or restoration Biologists prior to the submission of a notification form or application for approval.

Some basic principles to determine the type of structure or method that has the most benefit to the aquatic ecosystem include the following:

- Understanding the objective of the project.

- Choosing methods and structures which cause the most benefit the watercourse. Avoid unnecessary disturbance of the bed of the watercourse and minimize disturbance of the bank of the watercourse. Do not use structures which negatively alter the flow of the watercourse.

- Involving certified watercourse restoration sizers, and restoration Biologists, or other professionals when required and when appropriate to ensure proper sizing and design of restoration works. For work under the AAS Program this is a requirement.

These basic principles can be explained to others so they understand you are trying to find the best way to achieve their objective. Structures with lower environmental risk often have lower maintenance and replacement costs. Structures which maintain the natural bank and bed and the natural flow and stream morphology have the most positive effect on aquatic ecosystems. The structures typically also require less maintenance because blockages and scouring do not occur as frequently.

All watercourse crossings should be designed to minimize any alteration of the flow in the watercourse, to retain natural stream morphology, and to preserve fish habitat and fish passage. Poorly designed crossings can result in inadequate capacity, leading to increased velocity or blockage followed by flooding, erosion, changes in meander pattern, stream bed down cutting and washouts, which damage aquatic habitat and physical property, endanger human life, and prevent the utilization of upstream habitat.

3.5 Seek Additional Guidance

As a certified installer you may encounter difficult projects or encounter situations where you are uncertain how to proceed. The watercourse alteration training for installers and the general recommendations for more common alterations provided in this training manual may not provide sufficient guidance for all projects.

For AAS Program works you must contact the Program Manager for direction.

If you encounter these types of situations when working outside the AAS program, you may wish to:

- Seek advice or assistance from other installers who have knowledge in the type of alteration;

- Seek out specific expertise in areas such as fish habitat restoration, hydrology of watercourse, engineering and geotechnical, etc.;

- Ensure you understand the terms and conditions of the water approval or the Nova Scotia Watercourse Alterations Standard; and

- Arrange a meeting with NSE to discuss the project, mitigation measures, and contingency plan prior to starting work.

3.6 Planning Watercourse Alterations – Existing Construction

Where there is already an existing structure, an alteration to that structure may be considered to be either a modification or maintenance. The distinction is made by the type of work being proposed. Depending on whether the work is maintenance or modification, there are different regulatory requirements which must be met.

When approaching an existing structure for repair or replacement, consideration should be made to the current condition of the watercourse and the functionality of the crossing structure. If the structure is not functioning properly (i.e. causing a barrier to fish passage, causing flooding, dewatering the watercourse, over/undersized, etc.), replacing the structure with the same type of structure may not be appropriate or acceptable to Nova Scotia Environment. The type of work proposed to an existing structure must ensure that the structure functions properly to not impede water flow in the watercourse and be able to pass fish.

Maintenance

When approaching an existing structure for maintenance, consideration must be given to the functionality of the structure.

Maintenance to a structure can be done at any time of the year without the need of obtaining an approval or notification receipt if:

- The work is restricted to restoring the structure back to its original or near original condition, and
- All the work takes place above the ordinary high water mark.

Maintenance to a structure requires notification if:

- The work is restricted to preserving the alteration or structure in a state as close as possible to the state it was in when it was installed,
- The work is done below the ordinary high water mark, and
- The work begins on or after June 1 and ends on or before September 30.

NOTE: Maintenance work is restricted to the original structure's foot-print. If the maintenance work proposed will extend, minimize, or otherwise change the size of the structure, the work is considered to be modification.

Restoring a non-functional structure to its original condition may not be appropriate if the restoration does not alleviate on-going water conveyance problems or fish passage issues. Prior to initiating maintenance on an existing crossing structure, a site survey should be conducted to identify any surrounding issues that the structure may be causing. For example, during a site survey the following watercourse features should be reviewed:

- Up/down stream bank stability;
- Pool/riffle – step/pool sequence up and downstream;
- Structure's ability to pass fish (i.e. is the culvert "hanging", is the depth of water in the culvert too shallow, etc.);
- Scouring or erosion around rip rap, abutments or structures that is not planned;
- Scouring of banks/energy dissipation pool at culvert outlet;
- Structure's ability to pass high water flows (i.e. is there obvious signs of upstream flooding)

If some or all of these issues are observed, then maintenance may not be appropriate, and a replacement may be required.

Modification

Modification is defined as "a change to a watercourse alteration including, but not limited to, the replacement, removal, expansion or reduction of the alteration." The same careful planning is required when modifying a structure, crossing, or other alteration. If the modification is such that is alters the capacity of the structure, new sizing calculations are required.

If a replacement is occurring because the previous structure was deemed to be inadequate, or "failing" to function properly, then extra consideration must be given to how a new structure can remediate the watercourse. An approval may be required in situations where additional work is required to repair the watercourse up and downstream of the location.

3.7 The Next Step

During the planning process, watercourse alteration sites are identified, and the most appropriate type of alteration is chosen. The most appropriate alteration is one which meets the objective and is the lowest risk best improvement to the environment. The Nova Scotia Watercourse Alterations Standard, the watercourse alteration guide, and this manual have been developed to promote environmentally acceptable methods of alteration, structure selection, construction, installation, stabilization and maintenance.

4 AUDITING

All watercourse alterations are subject to audit at any time.

Audits will be undertaken by inspectors representing Nova Scotia Environment, Fisheries and Oceans Canada, Environment Canada and Adopt A Stream for projects under their program. Audits may be completed before, during, or after installation.

Inspectors will be auditing all aspects of a watercourse alteration including, but not limited to, installation, stabilization and maintenance follow-up. Inspectors will also be auditing the planning and design of restoration work.

It is important for notifiers and/or designers to maintain all paperwork pertaining to the planning and design of the restoration work. Keeping documents that show you have followed the Nova Scotia Watercourse Alterations Standard and the restoration fact sheets is important. If an audit is conducted, a notifier may be required to provide this information to an inspector with Nova Scotia Environment. Documents to be kept include, but are not limited to, the following:

- calculations used to determine the type and size of crossing
- structure location and types approved

Failure to comply with regulated requirements may result in an investigation and possible prosecution, a directive or order to complete mitigation, or may result in suspension or cancellation of a certificate of qualification or current and future funding under the Adopt A Stream Program.

Regulated requirements include:

- *Environment Act;*
- Activities Designation Regulations;
- Approval and Notification Procedure Regulations; and,
- Nova Scotia Watercourse Alterations Standard

5 GENERAL REQUIREMENTS FOR ALL WATERCOURSE ALTERATIONS

5.1 Water Control Measures When Working in a Watercourse (How to Work in Isolation of Flowing Water)

All work in a watercourse must be completed in a way avoid siltation/sedimentation of the watercourse.

Activities within and immediately adjacent to the channel or a watercourse must be conducted in a way to reduce the impact of sand, silt and fines on water quality affecting aquatic life and other users. Water control measures are to be used when necessary to allow the work to proceed while minimizing impacts to the aquatic environment.

If you need to pump water around the worksite then you must minimize the area that becomes dry and use proper screening on the intake to prevent entrainment of fish.
See http://www.dfo-mpo.gc.ca/Library/223669.pdf and fish rescue guidelines at http://www.dfo-mpo.gc.ca/Library/353873.pdf

Additional Requirement

All work should be done during low and moderate flows. All work must be stable and secure at the end of the workday to withstand higher flows.

Any work in or adjacent to the watercourse must not increase the concentration of suspended solids in the watercourse more than 25 mg/liter above background levels.

5.2 Erosion and Sedimentation Control

Any soil exposure/disturbance, big or small, and especially near water can cause major environmental issues.

Environmental Considerations

Defined in basic terms, erosion is the wearing away of an exposed surface, and sedimentation is the deposition of eroded particles. When erosion is minimized, the amount of sediment is reduced.

In nature, a balance exists between erosion and deposition. For example:

- A section of land erodes and the eroded particles are deposited downstream.
- Deposition occurs during a low flow period followed by erosion at the same location when high flows occur the following season.

Any activity involving soil disturbance can accelerate the rate of erosion and a vast quantity of sediment can make its way to watercourses. The consequences are degradation or destruction of fish and wildlife habitat, and water being less useful for fresh water supplies, navigation and recreation.

Sedimentation of watercourses is destructive to the aquatic habitat whether the sediment remains suspended in the water or settles out.

Directly or indirectly, sediment can affect all aspects of the aquatic environment. For example, some of the basic requirements common to many salmonids that can be affected by suspended or settled out

sediment include:

- Water clarity is essential for fish to find food, for the production of food sources. A maximum of 25mg/L over background levels is considered acceptable during a watercourse alteration for a 24-hour period and only 5mg/L for a longer duration.

- Dissolved oxygen needs to remain high to meet the required levels for survival, to promote fish health and to provide optimal conditions during egg incubation, hatching and in the first few weeks of life.

- Water temperature needs to remain cool (14 to 16° C), which is the preferred temperature range for Trout and Salmon. Warmer temperatures result in decreased dissolved oxygen content.

- Gravel substrate needs to remain clean for spawning, rearing, escape cover and overwintering.

- Fish passage needs to remain unobstructed for successful migration to occur throughout the watercourse.

Planning Considerations

One of the mandates of the Watercourse Alteration Program is to avoid sedimentation of watercourses, thereby requiring preventative measures be taken during the construction phases of the project.

Although construction outside the bed and bank of a watercourse does not require notification or approval, the impact of this activity should be minimized or avoided through proper planning and the implementation of preventative measures.

Even small projects that expose soil to rain (and ice and snow melt) can cause erosion and sedimentation to watercourses. For example, soil disturbance from a landscaping project or the tracks from a machine can be enough to cause sedimentation to a watercourse during the next rain storm.

Construction activities and large earth-moving projects accelerate erosion dramatically, mainly by exposing large areas of soil to rain and running water. If erosion is not prevented and runoff is not properly treated, the result is often serious siltation/sedimentation of nearby watercourses.

Therefore, general design principles should be used for any project (see All Sites: Preventing Problems) and a detailed plan needs to be developed for larger projects.

For more information refer to Nova Scotia Environment's Erosion and Sedimentation Control Handbook for Construction Sites at
http://www.novascotia.ca/nse/surface.water/docs/erosionsedimentcontrolhandbook.construction.pdf.

All Sites: Preventing Problems

If basic principles for prevention of surface erosion and sedimentation are considered at the design stages of the project, potential problems will be minimized. These principles are as follows:

1) Limit the size of the disturbed area. Retain existing vegetation wherever feasible. Erosion is minimal on a surface covered with natural vegetation.

2) Limit the time the disturbed area is exposed.

3) Establish permanent vegetation and surface cover as soon as possible. **During work:** At a minimum, all exposed soils must be covered with plastic or tarps when rain is expected during the work and grass seed and mulch (such as straw, wood chips) or with permanent surface cover such as gravel as soon as the exposed area or soils are no longer in use. For larger projects, keep soil covered as much as possible with temporary or permanent vegetation or with various mulch materials.

4) Ditches and swales may need to be lined with gravel, rock or rip-rap to prevent erosion and scour of the soil. The size of material is dependent on the volume and velocity of the water flow during storm events.

5) Land next to watercourses should be replanted with native species to establish natural habitat.

6) Keep clean water clean by diverting upland surface runoff away from exposed areas. Dykes and constructed swales may be used to divert runoff.

7) Keep the velocity of surface runoff low. This can be accomplished by limiting the slope and gradient of disturbed areas and constructing check dams or similar devices in constructed swales and ditches.

8) Plan construction to coincide with the low flow period from June 1 to September 30 of any year.

9) All stockpiled soil should be covered with polyethylene (sheeting or tarps) or, contain stockpiles with a sediment control fence or mulch the stockpile as a temporary solution.

10) Exposed soils must be managed until all erodible soils are permanently re-vegetated or stabilized with geotextile or rock.

11) Silt-laden water must not be pumped directly into a watercourse. It must be pumped into a settling pond, behind a silt filtering medium, or onto an adjacent vegetated area sufficient in size to filter any water returning to the watercourse, such that the concentration of suspended solids in the watercourse does not increase more than 25 mg/L above background levels.

12) Monitor weather forecasts and ensure the erosion and sedimentation controls are maintained and ready for any rainfall events. Keep additional materials and equipment on site in order to troubleshoot any issues that may arise.

For Larger Projects: Erosion and Sedimentation Control Plans

For restoration projects this section applies mainly to temporary access roads or trails used to access the sites with materials.

Before construction begins, erosion and sediment control plans need to be developed especially for larger or more complex projects. Complex projects may involve sites with difficult terrain or sites with soils especially susceptible to erosion, such as clay soils.

The plan should be guided by the following basic approach: site evaluation, erosion control planning incorporated into the work schedule, sediment control and site management.

It is essential to plan and place sediment control devices before the construction phase of a watercourse alteration begins in order to intercept and trap sediment before it reaches the watercourse. These devices must remain in place until permanent vegetation has been established or the site is otherwise stabilized.

PREVENTING PROBLEMS:

- Expose the smallest amount of soil possible for the shortest amount of time.
- Retain existing vegetation wherever possible.
- Smooth grade any disturbed soil to a uniform slope.
- Re-vegetate and/or cover soil where possible.
- Divert surface water away from exposed soil.
- Maintain low runoff velocities.
- Trap sediment before it can cause any damage.
- Maintain the onsite erosion and sediment controls.

SEDIMENT CONTROL MEASURES

STOP IT BEFORE IT STARTS

In practicing these guidelines, keep in mind that sedimentation can be reduced simply by controlling erosion at its source.

The following provides information on specific sediment control measures which can be employed at or near the work site.

The objective of this section is to provide some guidelines on preventing and controlling surface erosion and sedimentation with respect to road construction and maintenance activities.

Sedimentation and the Environment

Use the following guidelines when planning for erosion and sedimentation control.

Drainage Control – Directing Runoff

Runoff is defined as the portion of precipitation on a drainage area that runs along the surface of the ground and is discharged into streams and waterways.

Runoff transports suspended sediment and needs to be directed away from areas of exposed soil. The following information provides techniques on runoff diversion in relation to road building. In most cases, these techniques are installed in conjunction with road construction, not after.

Stable non-erodible surfaces

The best way to prevent the movement of sediment is to cover it with non-erodible materials. For roadbeds and trails, rock and gravel the surface. Follow the contours and direct runoff into vegetated areas as often as possible. This will cover most erodible soils on access roads and trail used for large restoration projects.

Check Dams

Check dams are temporary structures made from stones, straw bales, sandbags or logs constructed across ditches and drainage routes. Check dams are used to reduce the velocity of the concentrated flow and thereby the potential for erosion until permanent stabilization of the disturbed area has been established.

Check dams must be constructed using the following procedure:

- Embed check dams in the bottom and the bank of the ditch by digging a trench at least 25 cm (10 in) deep across the width of the ditch. This will help to prevent undercutting and runaround.
- Place dam material over the trench area until a height of 20 cm (8 in) below the roadbed is reached.
- Construct check dams with the center at least 15 cm (6 in) lower than the ends of the dam. This notch in the center enables any accumulated water to flow over the dam rather than around the ends, while sediment settles out on the upstream side of the dam.
- Stabilize by backfilling and compacting the soil against the dam.
- Place check dams between 15 to 200 m (50 to 670 feet) apart depending on the slope of the ditch (see Figure 5-1).

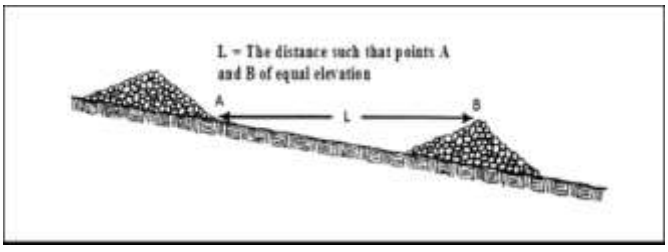

Figure 5-1 Measuring the Placement of Check Dam

- Inspect check dams regularly and after each runoff event to ensure that sediment does not accumulate to an elevation more than half of the height of the dam. If so, remove all accumulated sediment and dispose of in an area where it will not re-enter the watercourse.

Straw Bale and Silt Fence Sediment Barriers

Straw bales and silt fences are temporary structures which function as sediment barriers. These sediment barriers are placed around the downslope perimeter of a disturbed area or along the top of the bank of a watercourse, in order to intercept runoff and trap sediment before it reaches the watercourse. See Figure 5-2.

- Sediment barriers must be erected prior to any soil disturbance of the upland area.
- The gradient of the upslope of the barrier should be no steeper than 2:1 (horizontal to vertical).
- Sediment barriers should be checked regularly and immediately after each rainfall event for repair or replacement.
- On the downhill side, backfill should be built level to the ground.
- On the uphill side, build the backfill up approximately 10 cm (4 in) above the ground.
- Remove the barrier once site is stable.

Straw Bale Barrier Construction

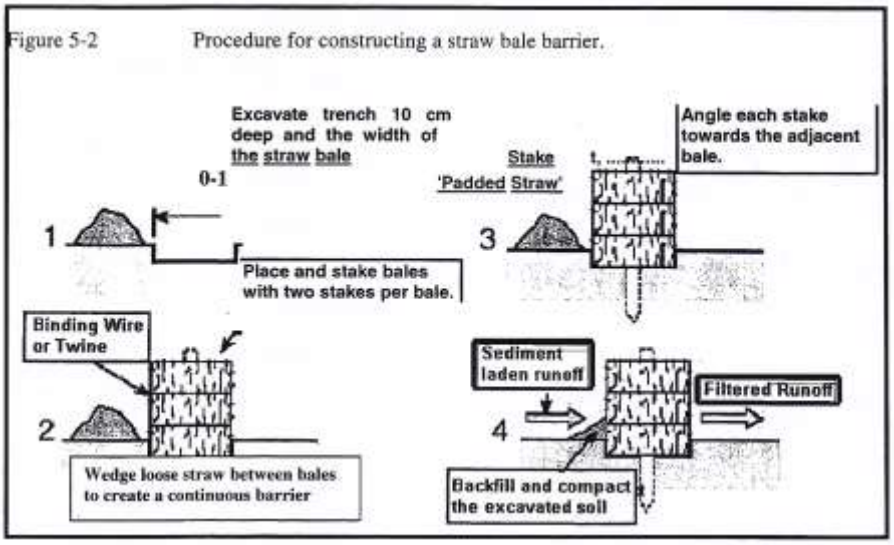

Figure 5-2 Procedures for Constructing Straw Bale Barrier

Silt Fence Construction

Construct a silt fence using the following procedure (see Figure 5-3):

- Silt fences should be limited to situations in which only sheet flow or overland flows are expected, not concentrated flow.
- Set wooden or steel posts a minimum of 3 m (10 ft.) apart and drive into the ground a minimum of 30 cm (12 in). Wooden posts should be 150 cm (60 in) in length and at least 10 cm (4 in) in diameter.
- Excavate a trench, approximately 15 cm (6 in) deep up-slope from and along the line of the posts.
- Attach filter fabric to the posts on the uphill side and extend into the trench approximately 15 to 20 cm (6 to 8 in).
- Fence height should not exceed 90 cm (36 in).
- Silt fences normally last up to 6 months before requiring removal or replacement.

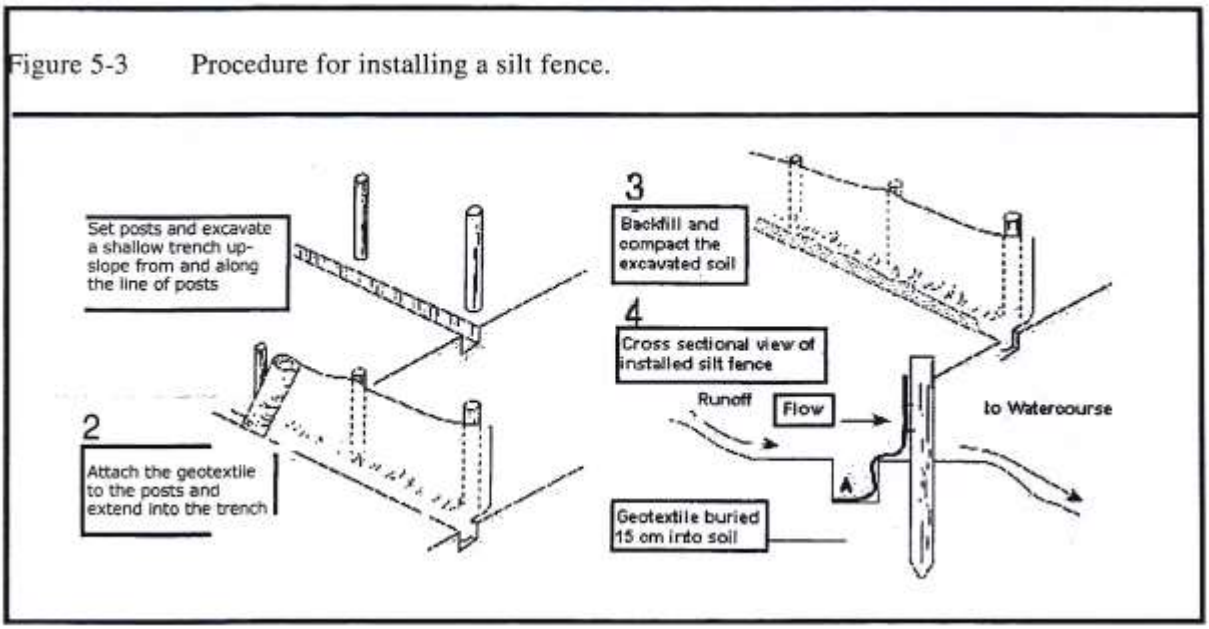

Figure 5-3 Procedures for Constructing a Silt Fence

Settling Pond (or Sediment Trap)

Settling ponds or sediment traps (Figure 5-4) are used to intercept and retain sediment laden runoff. These ponds are usually located at the end of a ditch.

Sediment ponds are most often used when space is limited or the road gradient is steep.

- Locate ponds a minimum of 30 m (100 ft.) from any watercourse.
- Settling ponds must have a volume of at least 190 m^3 for every hectare of disturbed soil. (100 yd./ac)

Construct a settling pond (or sediment trap) using the following procedure.

- Excavate the designated area to a minimum depth of 1.2 m (4 ft) with the average length at least twice the average width.
- Construct the sides of the pond at a slope of 4:1.
- Line the outlet of the settling pond with rip-rap to prevent scouring and re-introduction of suspended sediment into the runoff. The area below the outlet should be stable and well vegetated.
- Maintain the area to ensure that the elevation of the sediment in the pond is 30 cm (12 in) below the lip of the outlet. When this is the case, remove sediment from the pond to a disposal area well away from any watercourse.

Off-Take Ditches

Off-take ditches are used to transport concentrated runoff into well-vegetated areas in an effort to filter out sediment before runoff enters any watercourse. When constructing off-take ditches, practice the following.

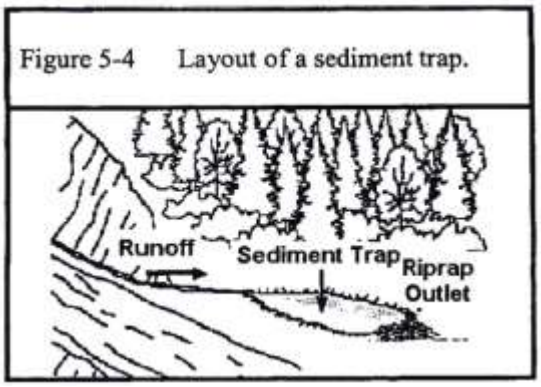

Figure 5-4 Layout of a sediment trap.

- Locate off-take ditches a minimum of 30 m (100 ft.) away from any watercourse. If the topography permits, construct off-take ditches on both sides of the road adjacent to a watercourse.
- Space off-take ditches to accommodate the ditch gradient. Use the following formula:

Spacing (m) = $\frac{500\ m}{\%\ \text{ditch grade}}$ Spacing (ft.) = $\frac{1640\ ft}{\%\ \text{ditch grade}}$

- Spacing may be disrupted in areas of unsuitable conditions such as bedrock substrate. Where this occurs, use the closest location available and resume construction.

- Extend off-take ditches into well-vegetated areas beyond the treed buffer. A suggested distance is 7.6 m (25 ft) into the vegetated or wooded area.

Example: Calculating Off-take Ditch Spacing

How far apart should off-take ditches be placed with a ditch gradient of 15%?

Spacing (m) = 500 m / 15% = 33 m

Or 1640 ft / 15% = 109 ft.

Space off-take ditches 33 m (109 ft apart)

Permanent Re-Vegetation

Re-vegetation is a long-term surface water control method. Re-vegetation of disturbed areas in and around the worksite should be done immediately after the final grade is established.

- Prepare the site by:
  - Using effective erosion and sediment control techniques where needed.
  - Grading the disturbed area at a uniform slope.
  - Removing stones or debris.
  - Loosening the soil by hand raking.
  - Fertilizing where necessary.

- Plant during suitable temperature and moisture conditions to promote plant growth. If planting after September 1st, soils will also require a heavy layer of mulch.

- Use mulch to improve the odds of successful re-vegetation as it conserves moisture, modifies soil temperatures, and prevents soil compaction.

- Choose a low maintenance seed mixture that is adapted to the local climate and soil conditions. Choose fast growing and easy to plant mixtures.

- If possible, spray hydroseed over the disturbed soil area. This mixture is comprised of a slurry of seed, fertilizer, wood fiber, mulch and water that take hold quickly and effectively.

- Maintain the area by watering and fertilizing (where necessary).

5.3 Maintenance of Vehicles (Including Machinery and Equipment) and Handheld Equipment

Machinery and equipment should be regularly maintained to prevent leaks of hydraulic fluids, cooling system liquids, and other fluids. Machinery and equipment should be inspected for leaks regularly.

Fuel in a secure area away from any watercourses or anywhere that surface water could become contaminated.

A fire extinguisher suited for extinguishing fires ignited from fuels should be on site at all times.

Machinery and equipment must never be cleaned in or near a watercourse. This is not limited to the alteration site, but anywhere that surface water could become contaminated and seep into a watercourse or groundwater. Machinery should be washed in a designated maintenance area.

Fuel Handling and Transfer

All fueling, maintenance or repair of equipment must be performed at least 30 m (100 ft.) from any watercourse.

When servicing equipment, dispose of all containers, cartridges, filters, used oil and other refuse away from any watercourses at a recognized disposal site in accordance with Nova Scotia Environment.

Clean-up Material

Keep spill clean-up kits on site at all times. These kits are designed specifically for the various types of hazardous products which may be used. Each kit often designates a limit for the maximum quantity of spilled product that the kit is able to absorb/contain.

Keep sorbent materials, suited to contain and/or absorb spilled products, on site at all times.

Storage

All petroleum storage tank systems must be in compliance with the ***Petroleum Management Regulations - Environment Act***. Above ground storage tank systems with a total capacity of 4000 liters or greater must meet the requirements of the Petroleum Management Regulations and must be registered. The Regulations also require registration of underground petroleum tanks.

Store all petroleum products/lubricants and other hazardous materials at least 30 m (100 ft.) from any watercourse. The storage area must be above the high water mark.

Ensure that fuel storage containers, drums or tanks are in good condition and clearly marked. Storage tanks shall be inspected regularly.

Reporting Procedure

Depending on the substance released there are a number of reporting requirements found in the Nova Scotia Environment Act and regulations. The majority of reporting requirements are based on "volume of substance released" and can be found in the Environmental Emergency Regulations: http://novascotia.ca/just/regulations/regs/envemerg.htm.

In the case of petroleum products the reportable volume for a release is 100 liters. However, there is also a requirement to report a lesser volume of a substance released if it has the potential to cause an adverse effect pursuant to the Environment Act - Part VI Release of Substance. http://nslegislature.ca/legc/statutes/environment.pdf

When contamination is discovered the Contaminated Site Regulations also require reporting to the Department and along with the contaminated site protocols mandate a variety of remediation requirements: http://www.gov.ns.ca/nse/contaminatedsites/

To report environmental emergencies 24 hours a day phone 1-800-565-1633 or phone your local NS Environment office during normal business hours 8:30 – 4:30 at 1-877-936-8476. A list of local NS Environment offices is also available at http://www.gov.ns.ca/nse/dept/division.emc.asp

Fisheries Act

Section 38 (4) Every person shall without delay notify an inspector, a fishery officer or an authority prescribed by the regulations of an occurrence that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery, that is not authorized under this Act, or of a serious and imminent danger of such an occurrence, if the person at any material time

- (a) owns or has the charge, management or control of the work, undertaking or activity that resulted in the occurrence or the danger of the occurrence; or
- (b) causes or contributes to the occurrence or the danger of the occurrence.

(6) Any person described in paragraph (4)(a) or (b) .. shall, as soon as feasible, take all reasonable measures consistent with public safety and with the conservation and protection of fish and fish habitat to prevent the occurrence or to counteract, mitigate or remedy any adverse effects that result from the occurrence or might reasonably be expected to result from it.

Clean-up Procedure

The area affected by the spill must be cleaned to the satisfaction of Nova Scotia Environment.

If clean-up can be done safely, apply some or all of the following techniques as well as other techniques as required:

- When a limited spill occurs on level land, use spill clean-up kits and sorbent material to clean up/absorb the spill.
- Excavate any affected soil and place in a temporary container.
- When possible, pool spilled product and pump the product into a temporary container. Excavate any affected soil and place in a temporary container.
- When a spill occurs on a side hill or slope, construct a barrier of mounded soil downhill from the spill area to intercept spill product(s). Excavate any affected soil and place in a temporary container.
- Dispose of absorbent material and contaminated soil at a recognized disposal site. A list of disposal sites may be obtained from the Nova Scotia Environment.

If spill product(s) reaches a watercourse, attempt to prevent the material from spreading by using the following.

- On small watercourses, a weir(s) made of plywood, sheets, logs or any other available material. Place weir(s) in watercourse, allowing water to flow underneath while trapping oil on water surface.
- On larger watercourses (1 m deep), a fence-type structure may be used. Stake and brace a snow fence in the watercourse. Line the fence upstream using straw bales and / or commercially available booms (adsorbent pads).
- Sorbent booms may be used alone to intercept spill products by installing the boom across the full width of the watercourse. These booms may be commercially purchased.

5.4 Materials used for structures in watercourses

Only materials which will not negatively impact water quality may be used in watercourses or in close proximity to watercourses.

Rock material

Rock material used in a watercourse or next to a watercourse must be clean, coarse, granular aggregate material, durable, non-ore-bearing, non-watercourse derived and non-toxic to aquatic life.

In some cases there may be a requirement for a mixture of rock with a percentage of fines (20 %, with no clays) when constructing an energy dissipation pool for culvert installations. This rock mixture is to be "washed" thoroughly prior to releasing the watercourse into the energy dissipation pool or channel.

Rock must not be sulphide bearing aggregate. Some rock, commonly referred to as slate or shale, can be sulphide bearing and can be acid generating if disturbed and exposed to air and water. Slate and shale rock can be tested to determine its acid producing potential.

Wood

The following wood materials can be used below the ordinary high water mark of a watercourse:

- untreated rot-resistant timber, such as hemlock, tamarack, juniper, or cedar; any natural logs.

- pressure treated Alkaline Copper Quaternary (ACQ) or Chromated Copper Arsenate (CCA) treated wood, if treated in accordance with CAN/CSA-O80 SERIES-08 (R2012) and as described in the Wood Preservation Specification Guide (Ottawa, ON. Wood Preservation Canada, 2014) (as updated from time to time). See http://www.woodpreservation.ca/index.php/en/specifiers-guide **However: It is recommended to avoid the use of wood pressure treated with chromated copper arsenate (CCA) (i.e. wolmanized) below the ordinary high water mark of watercourses.**

Some treated wood (wood containing preservatives) cannot be used in watercourses:

- Lumber treated with creosote or pentachlorophenol (PCP) must NOT be used in the construction, modification, or maintenance of any part of a structure.

Concrete: Fresh concrete can be toxic to aquatic life:

- Fresh/wet/uncured concrete must not come into contact with water flow in the watercourse or in contact with water that will flow into a watercourse.
- Concrete used in a watercourse that has not been isolated from water flow must be pre-cast and cured away from the watercourse. Concrete blocks must be cured for at least one week before using at a crossing site.
- Concrete used in a watercourse that has been isolated from water flow must be permitted to cure long enough prior to releasing water flow so that it does not contaminate the water after the flow is released.
- Concrete must be cured for at least one week prior to form removal.
- Excess, unused concrete must not be permitted to enter a watercourse.
- Wash water contaminated with concrete must not enter a watercourse.

6 WATERCOURSE ALTERATIONS – AQUATIC HABITAT RESTORATION

6.1 Environmental Considerations

See Section 2 for general environmental considerations associated with alterations to the bank, bed and riparian areas of watercourses.

6.2 Removal of Material from Watercourse

The removal of material from a watercourse may be any of the following:

No submission *	Notification is required if,	Approval required if,
If there is no alteration or disturbance to watercourse, especially if material has been recently deposited. **Example**: if the material is removed by hand or with grapples	No option.	Removal will result in disturbance to bed or bank of watercourse **Example**: if machinery is used to dig out material embedded in watercourse

- Removal of foreign material which is embedded in the natural material of the watercourse, such as garbage (old vehicles, fridges, shopping carts etc.) where silt, gravel, etc. has been deposited by water flow around or over the material.

- Removal of foreign material which is not embedded in the natural material of the watercourse, such as recently deposited garbage)

Requirement for Submission to Nova Scotia Environment

***Note**: certified watercourse alteration installer is not required for "No Submission" projects.

6.3 Aquatic Habitat (Fish Habitat) Improvement Structures

Aquatic habitat (Fish habitat) improvement works are activities and structures utilized in watercourses with the objective of improving and enhancing the aquatic ecosystem. Structures can be used to reduce erosion rates, provide cover and habitat for fish and/or assist in natural channel formation.

Requirement for Submission to Nova Scotia Environment

No submission	Notification is required if,	Approval required if,
No option	Work is being completed by hand (or with hand-held equipment) and does not extend more than **15 meters along the length of watercourse** (bed and bank), and work is completed between June 1 and September 30.	Conditions of notification are exceeded. Example: vehicles, including machinery, are used, length of project at the site extends to more than 15m of stream length

6.4 Aquatic Habitat Restoration Methods

Seek out and involve specialists in aquatic ecology. For works designed or fully or partially funded by the NSSA's Adopt A Stream Program, contact (www.adoptastream.ca) to attain expert assistance. For projects not part of the Program, expert advice and design services can be obtained through the Program. A fee for services may apply.

Resources include:
The Nova Scotia Adopt a Stream Manual: A Watershed Approach to Community-Based Stewardship
http://www.adoptastream.ca/project-design/nova-scotia-adopt-stream-manual

Up to date technique facts sheets available at
http://www.adoptastream.ca/project-design/habitat-restoration-methods

6.5 Construction

Follow the Nova Scotia Watercourse Alterations Standard and the fact sheets on the website whether the work is done without notification, under notification process, or under an approval. If the work is completed under an approval, check for specific terms and conditions of the approval including those added by the NSSA's Adopt A Stream Program.

Key considerations

Carefully follow the plan and design of structure(s) completed by qualified, experienced and knowledgeable individuals. Attention to detail is required to ensure proper restoration (e.g., the location

of structures in the stream in relation to the stream structure; the elevations and orientation of the structure; etc.).

Types of habitat improvement works include but are not limited to those in the fact sheets.

6.6 Aquatic Habitat Restoration Introduction

For aquatic habitat restoration to be effective it must be designed properly.
The identification of limiting factors on productivity and locations of instream problems is the first step in restoration of aquatic habitats, and then the proper techniques must be applied to reduce the limiting factors. If migration habitat is limiting due to hung culverts, improperly designed or installed culverts, dams, debris barriers and long reaches without suitable resting and holding pools for fish etc., then these restrictions on productivity have to be fixed first. It is most important the fish are able to reach all the habitats they require in their life cycle and that the habitats are suitable due to seasonal changes like water temperature. Spawning habitat quality is critical to the survival of eggs, alevins and fry and must have the proper form and flows through the gravel for the species inhabiting the watercourse. Pools must be available for all age classes of fish during low flows and for winter survival. Abundant cover (overhanging vegetation, undercut banks, and interstitial spaces free of sand and silt) must be available to hide from predators. Water quality (including temperature, turbidity, pH, and pollutants) must stay in suitable ranges. Water quantity has to provide suitable water depths and velocities for the various species and life stages. All of these and more can be limiting factors on the survival of instream insects and fish.

The aquatic habitat restoration plan has to be done or approved by trained specialists to be effective. All projects with Adopt A Stream Program funding must have the layout and sizing of instream structures approved by Program staff.

Structures placed or sized incorrectly will not work. Stream restoration projects throughout the world have been criticized for the high failure rate due mainly to the placement and sizing of structures without proper consideration of the natural processes that form and maintain stream structure. A very common mistake is not identifying the location of the thalweg and meander pattern the flows are trying to create and working with it. If the flow pattern isn't considered, the structures will be destroyed, and the habitat will not be restored.

The physics of stream formation

There are some basic physical processes within a watershed that are responsible for giving a stream or river its shape. The force of gravity pulls the water downhill and the flowing water shapes the sediments, gravel, cobble, and small boulders, forming a watercourse channel with defined size and

characteristics. Gravity is an accelerating force and would make the water flow faster and faster as it moves downhill, but it is slowed by drag on the rocks on the bottom, instream woody debris, and the banks of the channel. As the flow increases, the significance of the drag decreases because the water is flowing over water. When the water reaches this stage, its internal strength (it is hard to pull water apart) causes the water to slosh from side to side. This can be demonstrated by watching increasing water flow down a chute. Low flows go down the center of the chute, but as the flow increases the water sloshes higher and higher up the sides of the chute. In a stream as water sloshes to the left side, its level is higher on the left bank than on the right bank. The water on the high side falls under the flow and digs a pool on the left side of the stream, sorting the cobble, gravel, sands, and silts; forming a point bar on the right, and building the crest of a riffle downstream of the pool. The water then flows down the riffle/run, sloshes up on the opposite side, and digs a pool on the right side. The water's digging action places a pool at approximately 5 to 7 channel widths on alternate sides and forms what is known as the meander pattern (Figure 1). The flow that forms the channel is the mean daily flow that occurs 66% of the time. This is known as the 1:2 year flood. There is a direct relationship between the flows, the channel width, and the meander length.

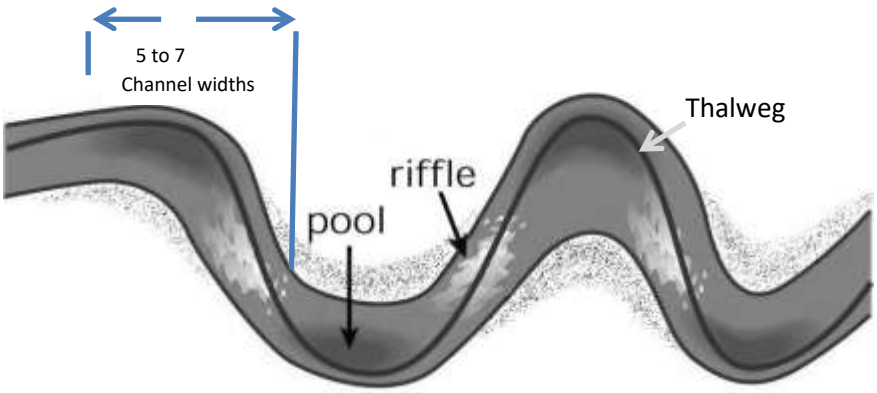

Figure 6-1 Pool-riffle sequence and erosional and depositional features in meandering streams (modified from FISRWG, 1999).

In designing habitat restoration, the 1:2 year mean daily flow has to be calculated for the reach being restored. This is done by taking into consideration the land use, watershed slope and rainfall in the watershed upstream. This calculation of stream width and bank height is then ground-truthed on site, and the location of the meander pattern the flow is trying to establish is found and used to site and size the instream structures.

The pattern is established by the physics of flowing water and can be calculated. From that the stream width can be calculated, and in turn the meander length. However, the instream flow will encounter resistance from geological formations (bedrock or constrained valleys, boulders too big for the flow to

move, etc.), as well as man-made structures like culverts, bridges, and dams forcing it to readjust or restart the meander pattern. This has to be taken into consideration.

Vegetation also plays a role in channel development. Grasses, shrubs and trees grow along the edges of the channel in areas that are dry during most of the summer months. The roots of the plants help bind the soils and the tops of grasses and some shrubs lie down during high flows to prevent erosion. Fall and spring high flows are slowed as they pass through the vegetation and drop silt, sand and gravels they are carrying. This helps build and maintain the banks. These higher stable banks contain the 1:2 year daily mean flows and allow the water to create deeper pools, clean the bottom of sands and silts, and provide more diversity of stream habitats.

Branches, roots and trees (Large Woody Debris, LWD) that grow or fall into the river in random locations, also play an important part in building the structure of the stream and its habitats. In gravel and cobble bedded rivers, the LWD is moved by flows. The logs moved by the flows are embedded where the bottom currents are slow at the head of the pools. Logs embedded at the head of the pools establish the toe of the riffle/run areas, allowing them to build stable slopes without the gravel being washed into the pools. The small branches lying in the pools provide habitat diversity and cover for all aquatic species. Roots hold soils on the banks and permit undercuts, important for cover in medium to large rivers.

Many watercourses in Nova Scotia take a step/pool/run form that is dictated by geology. Where the watercourse has formed ridges of large cobble, boulder, or bedrock these are called steps. The water may drop up to 50 cm on a step but is usually in the 10 to 20 cm range. The steps drop into a pool with water level controlled by the next downstream step. These watercourses still have the 5 to 7 channel width pattern that must be considered but with 1, 3 or 5 steps alternating in a right left pattern within the six channel width reach. Many watercourses have a combination of step pool run sections and pool riffle sections. Step pool run sections can form in watercourses with any slope but generally they appear when slopes are over 1%, and by slope of 4% and above they are all step pool.

Streams develop many forms and they can exhibit different flow patterns. Rosgen (1994) developed a stream classification system which is widely used today and which helps explain the varying characteristics of watercourses (Figure 2). Various stream types can be observed in a single watershed (i.e. A-type in the headwaters, to C-type in the mid reaches, and to E-type in bogs or meadows). Generally, as a river flows downstream, it progresses from streams with coarse substrate (>2 % slope) to gently sloping streams and rivers (< 2%) with finer cobble-gravel substrate and low gradient rivers (< 0.2%) with fine gravels sands and silt substrates. In Nova Scotia, many streams are B & C types, they are sinuous, moderately entrenched, and gently sloping. However, other stream types are also found.

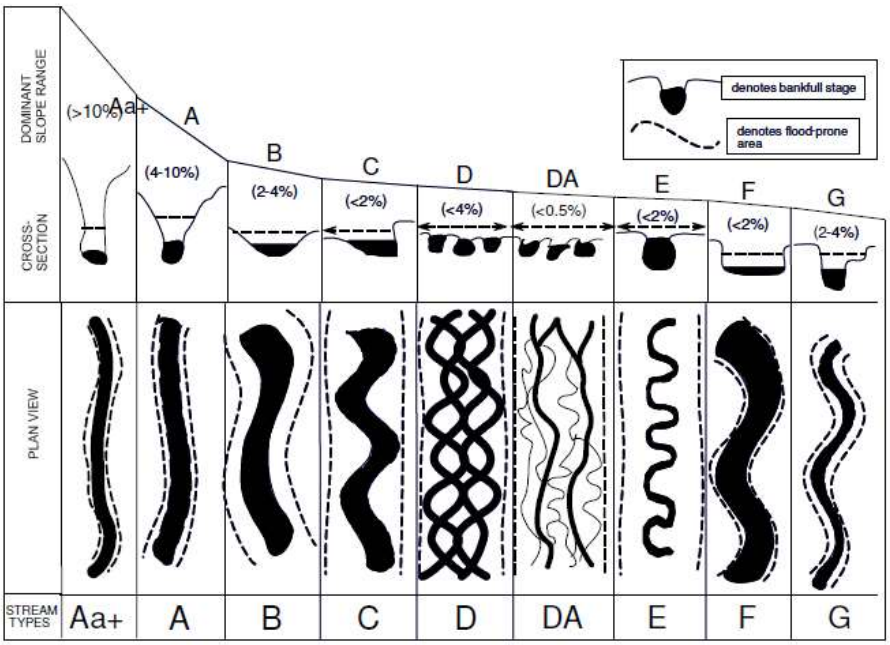

Figure 6-2: A stream classification system based on morphological features (Rosgen, 1994)

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7 FISH HABITAT RESTORATION METHODS CONCEPT SPECIFICATION

All stream restoration projects under the NSSA Adopt A Stream Program have to be designed by our trained and experienced staff to ensure the restoration objectives of the Program are met. We have several project types, including instream restoration of gravel and cobble bed streams with instream structures, SandWand removal of sand and slit from streams, thalweg and pool development in cobble boulder streams and step pool run streams, and culvert fish passage remediation. All require a high degree of design but are easily implemented by community groups once the plan is in place and they have received training on the proper installation/restoration techniques.

The Fish Habitat Restoration Methods Concept Specification fact sheets found at (http://www.adoptastream.ca/project-design/habitat-restoration-methods) are to be used by groups doing general project planning and proposal applications. Typical and commonly used techniques are in appendix D.

The instream locations and sizing must be determined by trained and experienced individuals and approved by AAS staff if the work is funded under the Adopt A Stream Program or done under the Program" general permit.

8 All WATERCOURSE ALTERATIONS

8.1 General Principles

The following are some general principles that can be applied all work sites near watercourses, many of which have been covered in other sections of the manual:

- Give special consideration to environmentally sensitive areas.
- Minimize the work-site footprint; only clear to the extent necessary.
- Choose most beneficial alteration by minimizing the footprint of work on the banks or bed of the watercourse.
- Cover excavated and exposed surfaces, including stockpiled materials.
- Control for erosion and sedimentation by managing sediment-laden runoff.
- Install silt fences and other prevention measures where prevention of erosion is insufficient.
- Avoid exposing or scraping down to mineral soil.

- Re-vegetate disturbed surfaces as soon as possible.

- When clearing vegetation, only cut down to ground level, leaving rootstock in place. This will greatly reduce erosion and sedimentation and will promote more rapid re-vegetation.

- Equipment should be refueled and serviced more than 30m from a water body such that no deleterious substance enters any water body; all equipment must be clean and free of deleterious substances and invasive plant species before working in or near a water body.

- Never pump silt laden water directly into a natural water body. Normally, it is pumped to a vegetated depression, sump or sediment trap to remove sediment and avoid erosion of the natural water body.

8.2 More Complex Watercourse Alterations

More complex watercourse alterations will typically require an approval. More complex work includes construction of dams or other water impoundment structures, bridges with piers in the watercourse, extensive bank stabilization in flowing watercourses, dredging, etc. Some types of alterations will only be approved by Nova Scotia Environment in exceptional circumstances, such as infilling, causeways, or beach construction below ordinary high water mark.

The planning and design of complex projects will often require the expertise of professional engineers, hydrologists, ecologists or others. The terms and conditions of the approval may refer to engineer drawings or other detailed documents describing the work and mitigation measures specific to the site.

This course does not cover instruction on more complex alterations, as site specific considerations would be unique to each alteration. As a certified Aquatic Habitat Restoration installer, it is important that you understand and feel comfortable with the terms and conditions of the approval including all submission documents referred to in the approval.

9 GLOSSARY OF TERMS

Abutment: A wall or mass supporting the end of a bridge, arch or span, and sustaining the pressure of the abutting width.

Backfill: Fill used to replace material removed during construction of a structure such as a bridge or culvert.

Buffer Zone: A natural boundary of standing timber and/or vegetation left between watercourses and road right-of-ways or harvest block boundaries.

Cofferdam: A temporary water barrier constructed around an excavation to exclude water so that work in or adjacent to a watercourse can be carried out in the dry.

Design Flow: The discharge which a structure is designed to accommodate without exceeding the adopted design constraints

Discharge: The flow rate of a fluid at a given point in time expressed as volume per unit of time, such as cubic meters per second, gallons per minute, etc.

Dissolved Oxygen: The concentration of oxygen dissolved in the water, expressed as mg/L or the percent saturation, where saturation is the maximum amount of oxygen that can theoretically be dissolved in water at a given altitude and temperature.

Drainage Area: The area of land draining to the point along the watercourse where the proposed crossing is to take place.

Dyke: An impervious bank of earth constructed to confine water or another liquid from entering or leaving an area of land.

Erodible: Susceptible to erosion.

Erosion: The detachment of soil particles and loss of surface material from the earth's surface by the action of gravity, ice, water, wind or as a result of other natural occurrences or man-induced events.

Fish Screen: A screen set across a water intake, outlet or pipe to prevent the entrance or exit of fish.

Foreslope: The side of a ditch which is part of the roadbed.

Grade: The slope of a roadway, ditch or bed of a watercourse expressed as a function of the amount of vertical drop over a given distance or to prepare roadway or other land surface of uniform slope.

Grubbing: Removing and disposing of all stumps, roots, un-merchantable trees and overburden material from the road right-of-way.

Hydraulic: Pertaining to fluid in motion and the mechanics of that motion.

In the Dry: Separated from the wetted portion of the channel.

Interstitial: Small narrow spaces between substrate.

Littoral Zone: The littoral zone is the near shore section of water where light penetrates to the bottom. These zones are highly productive areas for aquatic life. Through complex food chains, virtually all aquatic organisms are dependent upon these rocky, silty, or sandy bottomed areas during at least one stage of their life cycle. The penetration of light allows plant organisms to grow, creating part of the essential interconnections between living organisms and their habitat. For example, these areas are ideal for spawning and nursery areas for many fish species with ideal hiding areas and sources of food.

Obstruction: Those watercourse alterations which involve the construction of structures on the watercourse which impede or prevent the flow of water and/or fish migration.

Pier: On bridges of more than one span, the intermediate supports between abutments; a structure extending out into a body of water from shore used as a landing place for boats.

Piling: A columnar timber, steel or reinforced concrete post that has been driven or jacked into the ground or bed of a watercourse to support a load or resist lateral pressure.

Pool: A deep, slow moving, quiet portion of a watercourse.

Riffle: Shallow water extending across the bed of a flowing watercourse with rapid current and with surface flow broken into waves by submerged obstructions such as gravel and cobble. (A section of watercourse in which the water flow is rapid and usually shallower than sections upstream or downstream. Natural watercourses often consist of a succession of pool and riffles (or steps).)

Rise: The distance from the bed of the watercourse to the underside of the stringers of a bridge, or the vertical dimension of an arched pipe.

Salmonid: Of or relating to the salmonid family of fishes, including salmon, trout and char.

Sedimentation: The deposition of fine particles, such as sand, silt and clay, which have been eroded from exposed soils and transported by water.

Seeps: A place where ground water flows slowly to the surface and often forms a saturated soil area; a small spring.

Settling Pond: Artificial ponds designed to collect suspended sediment and separate suspended particles from water by gravity settling.

Silt Fence: Specially designed synthetic fabrics fastened on supporting posts which are designed to efficiently control and trap sediment runoff from construction sites.

Sorbent Material: A material that has the capacity to absorb another substance.

Span: The horizontal distance between the abutments or supports of a bridge.

Spring: Any place where a concentrated, natural discharge of groundwater issues forth as a definite flow onto the surface of the land or into a body of water.

Stream: A body of running water moving under the influence of gravity to lower levels in a narrow, clearly defined channel.

Stream or watercourse morphology: Characteristics of a stream or watercourse.

Thalweg: The line defining the lowest points along the length of a river bed or valley. The lowest channel of flow within a watercourse, "the current".

Upstream: Towards the sources or against the current of a watercourse.

Watercourse: The bed and shore of every river, stream, lake, creek, pond, spring, lagoon, or other natural body of water – whether it contains water or not – and the water therein, within the jurisdiction of the province. It also includes all groundwater.

Watercourse Alteration Approval: An approval signed by the Minister of the Department of Environment or an administrator and issued according to the Activities Designation Regulations.

Waterway Opening: The cross-sectional area under a bridge available for the passage of water.

Wetland: any lands commonly referred to as marshes, swamps, fens, bogs and shallow water areas that are saturated with water long enough to promote wetland or aquatic processes which are indicated by poorly drained soil, vegetation and various kinds of biological activity which are adapted to a wet environment and includes fresh and saltwater marshes.

10 REFERENCE DOCUMENTS

See web links to references and further information throughout the document.

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Maine Department of Environmental Protection. March 1991. *Maine Erosion and Sediment Control Handbook for Construction: Best Management Practices.*

New Brunswick Department of Transportation. January 2010. *Environmental Management Manual for New Brunswick Department of Transportation.*

11 CONTACTS

Nova Scotia Environment – Compliance Division

Western Region	
Area	Contact
Kentville Office: Kings & Annapolis Counties	136 Exhibition Street Kentville, NS B4N 4E5 Phone: 902-679-6086 Fax: 902-679-6186
Bridgewater Office: Lunenburg & Queens Counties	60 Logan Road Bridgewater, NS B4V 3J8 Phone: 902-543-4685 Fax: 902-527-5480
Yarmouth Office: Digby, Yarmouth & Shelburne Counties	55 Starrs Rd. Unit 5 Yarmouth, NS B5A 2T2 Phone: 902-742-8985 Fax: 902-742-7796
Central Region	
Area	Contact
Bedford Office: HRM, East Hants, West Hants	30 Damascus Road, Suite 115 Bedford Commons, Bedford NS B4A 0C1 Phone: 902-424-7773 Fax: 902-424-0597
Northern Region	
Area	Contact
Amherst Office: Cumberland County	71 East Victoria St. Amherst, NS B4H 1X7 Phone: 902-667-6205 Fax: 902-667-6214
Antigonish Office: Antigonish & Guysborough Counties	155 Main Street, Suite 205 Antigonish, NS B2G 2B6 Phone: 902-863-7389 Fax: 902-863-7411
Truro Office: Colchester County	36 Inglis Place Truro, NS B2N 4B4 Phone: 902-893-5880 Fax: 902-893-0282

Pictou Office: Pictou County	20 Pumphouse Road R. R. #3 New Glasgow, Nova Scotia B2H 5C6 Phone: 902-396-4194 Fax: 902-396-4765
Eastern Region	
Port Hawkesbury Office: Richmond Co. Southern Inverness Town of Mulgrave Community of Auld's Cove	218 MacSween Street, Suite 12 Port Hawkesbury, NS B9A 2J9 Phone: 902-625-0791 Fax: 902-625-3722
Sydney Office: CBRM Victoria Co. Northern Inverness	1030 Upper Prince Street, Suite 2 Sydney, NS B1P 5P6 Phone: 902-563-2100 Fax: 902-563-2387

Fisheries and Oceans Canada	
Area	Contact
Nova Scotia	Fisheries and Oceans Canada Fisheries Protection Program Maritimes Region Attention: Referrals Secretariat P.O. Box 1006 Dartmouth, Nova Scotia B2Y 4A2 Report a fish habitat violation Phone: 902-426-3909 Fax: 902-426-7174 E-mail: ReferralsMaritimes@dfo-mpo.gc.ca

APPENDICES

11.1 APPENDIX A Calculating Watershed Area

The Atlas of Canada: Toporama
Find interactive topographic map at http://atlas.gc.ca/site/english/toporama/index.html. The dynamic map viewer makes it easy to find your site and its watershed area.

Other resources
Wet Area Mapping http://novascotia.ca/natr/forestry/gis/wamdownload.asp To use this you will have to install "ARC Explorer") as the viewer which is available on the web site or ESRI ARCGIS https://www.arcgis.com/home/item.html?id=c74acddfcb1844eb90f8f9d40be2c823

Nova Scotia Topographic Database WMS
https://www.novascotia.ca/geonova/services/nstdb_wms.asp

Garmin MapSource or Base Camp with topo Canada. Use the track tool to delineate the watershed and it will give you the enclosed area in square kilometers.

Watershed delineation is the mapping of land that drains to a point on the watercourse. The watershed area the size of the basin) where water drains to that point on a watercourse and is the area inside the delineation. It involves tracing the boundary around a watershed and then measuring the area of the polygon. The unit typically used to calculate this value is Square Kilometers (km^2). This calculation is used for restoration design, culvert and bridge sizing, flood management, project reporting, and among others.

Calculating Watershed Drainage Area

1. The first step to delineate the boundary of the watershed starting at the point where you are going to work. Find this point on a topographic map in either paper or electronic format. You can use the GPS reading taken during the site field visit. For a restoration site this point would be the downstream end of the section of stream you plan to work on.

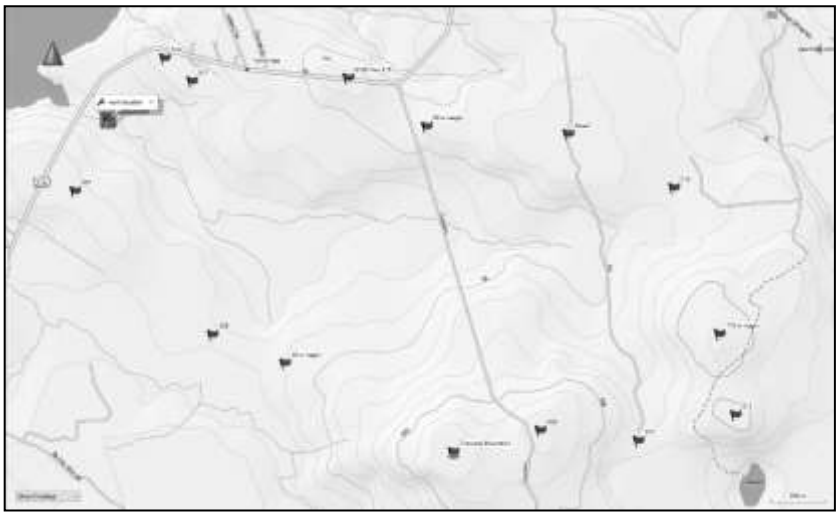
2. Once the point is identified, mark it on the map as shown in Figure 1. When first learning watershed delineation it may help to highlight the watercourse upstream of the point including all of its tributaries. The contour lines on your topographic map will usually form a "v" where the stream crosses them. The "v" always points upstream.

3. It helps to mark the high points surrounding the watercourse. An example of this is shown in Figure 2. High points are denoted by a closed contour line with no other contour lines within it. Your marks should be placed in the center of these closed contours. These points denote the tops of hills.

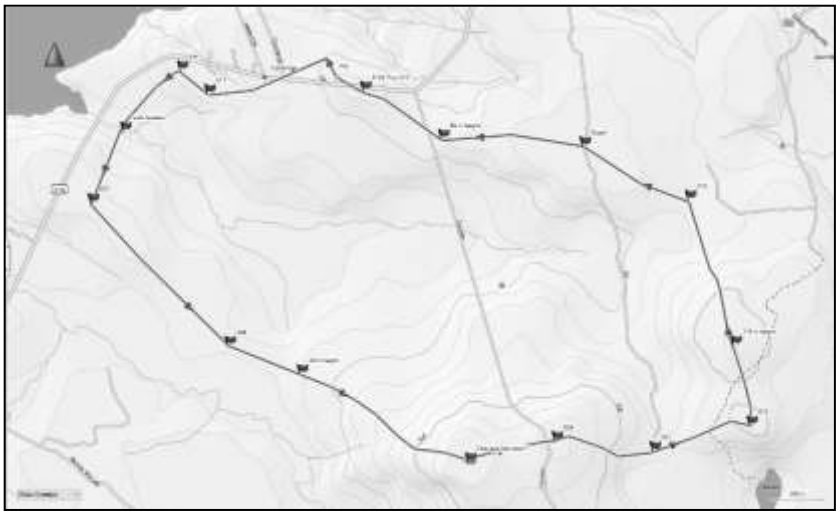
4. Beginning at the proposed work site, connect the dots on the high points around the watershed. The line will not be straight. Try to cross the contour lines at right angles as much as possible. The line

should never cross a watercourse. It may help to visualize water flow as you draw the line. On one side of your line water is going to flow one way towards the watercourse where you are going to work. On the other side of the line water is going to flow in the opposite direction away from your watercourse and into another watershed.

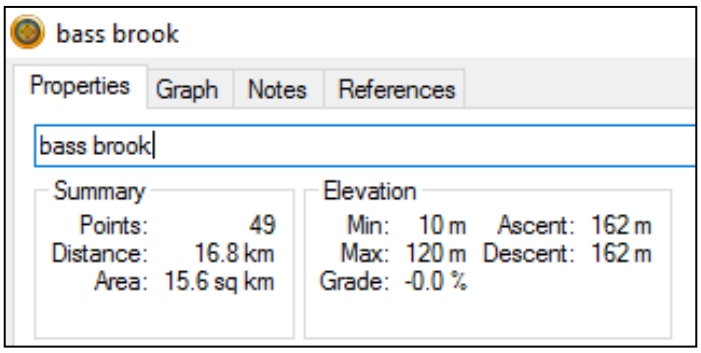
5. If you are using electronic mapping software, then the software will calculate the area automatically. If you are using a paper map, then use a planimeter or dot grid to calculate the enclosed area in Square Kilometers.



Watershed Delineation: Work site and high points



Watershed Delineation: Outline



Example: Bass Brook watershed properties, distance around, area, elevation difference for flow calcultions.

11.2 APPENDIX B UTM (Universal Transverse Mercator) location

UTM is an acronym for *universal transverse mercator*. It is a projected coordinate system that divides the world into 60 zones that are 6 degrees wide running from north and south. Nova Scotia lies within 3 UTM zones. Zone 19, 20, and 21. Almost all of Nova Scotia falls into Zone 20. Zone 19 is a small area close to Yarmouth and Zone 21 is a small area close to Glace Bay on Cape Breton Island (see zones map below). The X and Y values for UTM coordinates are called Northing and Easting. Northing is a 6 digit number and Easting is a 7 digit number. Northing and Easting are sometimes followed by decimals as well for increased precision (cm).

http://www.cccmaps.com/gps.html

There are two easy ways to collect UTM coordinates, you can use a GPS unit or computer software such as Google Earth, Garmin Basecamp, Toporama etc. There are also many ways to convert other coordinate formats, such as latitude and longitude, to UTM available on the internet (www.Earthpoint.us) or computer software such as Garmin Basecamp. If converting to UTM from latitude and longitude, it is important to understand latitude and longitude formats to input them into conversion software correctly. Latitude and longitude formats include decimal degrees (DD.DDDD), decimal minutes (DD MM.MM), and decimal seconds (DD MM SS.SS). It is also important to remember to include the hemisphere designation for both coordinates (ie. **N** and **W** or **+** and **-**) before the coordinate value for latitude and longitude coordinates. Not remembering this could place your coordinate on the opposite side of the hemisphere.

Example of a UTM coordinate for Citadel Hill, NS: 20 T 453975m E 4943911m N

LatitudeZoneNumber	LongitudeBandNumber (optional)	Easting	Northing
20	T	453975m E	4943911m N

GPS Collection:

To collect coordinates on a GPS unit in UTMs, you must adjust the unit's settings. Use your supplied user's manual to accomplish this. As an example, most Garmin GPS units will follow the following procedure (varies slightly based on model):

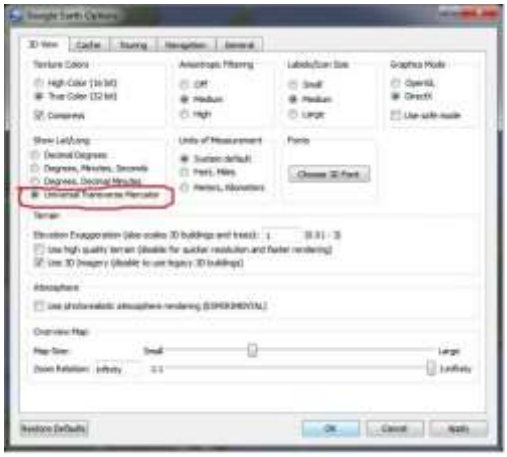
Main Menu > Setup > Scroll down to the Position Format > Scroll down to UTM Grid > select UTM UPS > Map Datum NAD83

Always take note of what zone you are collecting in and write that information down

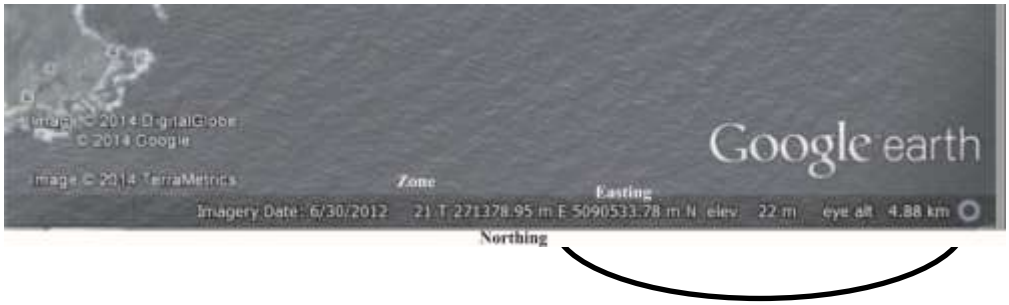
Google Earth:

Install Google Earth on your machine if you do not have it.

Click on the "Tools" dropdown menu and select "Options" The following window will open:



Change the default setting of Degrees, Min, Seconds to Universal Transverse Mercator in the Show Lat/Long section of the options box (see graphic) Then click "OK".
Depending on where you move the cursor the UTM Zone and coordinates (northing and easting) will be displayed in the lower right hand corner of the google earth screen.



11.3 Appendix C Watercourse Alteration Application and Notification forms.

For the most up to date forms check the NSE web site. https://novascotia.ca/nse/watercourse-alteration

Out of date forms will not be accepted.

Forms

- Notification Form (PDF:298k)
- How to Complete a Notification Form (PDF:910k)
- Water Approval Application (PDF:402k)
- Submission Checklist for Watercourse Alteration (PDF:477k)
- Certified Individuals - form to update your information with NSE (PDF:686k)

The sections of the forms that need to be filled out for Aquatic/ Fish Habitat Restoration will be highlighted during the certification training course.

PID property numbers can be found on http://www.viewpoint.ca just login for free and select the property you are interested in.

11.4 Appendix D: Typical and Commonly Used Restoration Structures.

The full set of up to date techniques can be found at http://www.adoptastream.ca/project-design/habitat-restoration-methods . The following are examples in each category. All structures have to be the right size and location in the watercourse pattern, so it is essential that you follow the designer's instructions.

Restoration of meander pattern

Digger Logs

Purpose: To support the bottom of a riffle or run upstream of the log and create a pool downstream to enhance trout and salmon spawning, rearing and migration habitats and develop aquatic habitat diversity.

Conditions Where Applicable:

- Instream location and sizing must be approved by an Adopt A Stream Biologist.
- In a stream with low to moderate grade (up to 3%), with gravel-cobble substrate, and where natural flows and currents can be allowed to shape the streambed.
- The log acts as a gradient control holding the riffle/run substrate from washing into the pool. They are not intended to create a significant head difference or plunge pool.

Habitats Created:

- Pool habitats are ideally 45 cm deep or more in low flow but can be up to 20% of the design width deep including instream cover.
- Instream cover under the log.
- Sorted substrates in the pool bottom and slope up to the riffle crest removing sands and silt to point bars and flood plain.
- Sorted substrate and pools capture leaf litter and organics, supports larger insect populations for food, provides better spawning gravels and juvenile escape cover, and over-wintering habitats.
- Encourages the development of the thalweg between pools.
- Imitates natural digger log processes in streams.

Advantages:

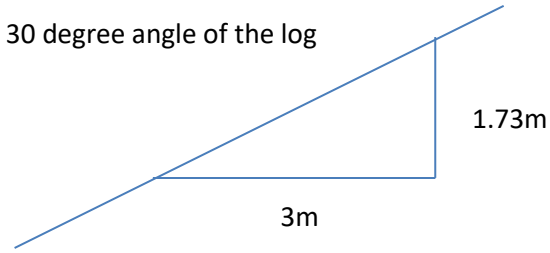
- If positioned correctly, a digger log will create a pool that will not fill in.
- Creates overhead instream cover and helps develop a proper riffle/pool ratio and sorted gravels in disturbed streams.
- Can be built with on-site materials in remote or poorly accessible forested areas.

Disadvantages:

- If not positioned/anchored correctly, digger logs may wash away, do nothing or be buried.
- Can be labour intensive to install.
- Structure must be checked regularly to make sure it is still functioning correctly.

Design Criteria:

- The digger log should be placed at the head of a natural pool or at the location the restoration design determines a pool should be developed. These pools are very close to six channel widths apart based on the channel width of a 1:2 year mean daily flow channel and are on alternating sides of the stream.
- Proper placement is critical to their success in creating habitat diversity. They must be placed at locations where the existing flow is establishing a pool. Proper siting in this pattern is critical and must be determined or checked by AAS staff.
- Logs are most effective in streams under 6 m (20 ft) wide.
- The log diameter for a particular site will be specified by the AAS staff as the diameter changes based on the stream width and bank heights. Log diameter is typically 15 cm (6 in.) to 25cm (8 in.) on the small end with a minimum of taper from one end to the other.
- The digger log must be firmly anchored to the substrate.
- It should be placed on a 30° angle from straight across the stream and, when looking downstream, turned toward the side the pool is on. To calculate the angle measure the bank to bank width and divide by 1.73, this distance will be how far up the upstream end of the log is along the bank. Or if calculating the angle when in mid-stream measure 3m toward the bank then 1.73 upstream and join the two points.



- The upstream end of the log should be set at least 15cm lower than the rest of the log to concentrate low flows on the pool side of the stream. Wherever possible the slope on the log should be 3cm to 5cm /meter of log length within the design width of the stream.
- The ends of the log must fit tightly to the banks and be well rocked in place to prevent erosion of the banks. Some fact sheets call for the ends of the log to be set up to 1 m into the bank. This is not necessary in most Maritime streams unless the log is in a gravel bar or other soft bank material.
- A rock ramp should be built, sloping the streambed up to the log. Typically, this means a 1 - 3 m (3 - 10 ft) long ramp on the upstream side.
- Cobble and large rocks armouring the surface should be removed from the pool area to assist the scour by the flows.
- The thalweg location for digger logs is the low end of the log.
- Digger logs can be used in combination with deflectors in over widened watercourses. The digger log is an extension of the downstream end of a deflector.
- Logs work with the stream flows to sort gravel and shape pools, riffle and thalweg. This typically takes two to three years to fully form.
- Logs and ramps need periodic maintenance until the stream has achieved its new form and vegetation has stabilized the new banks.
- The logs work with the flows to create the habitats. The substrate that is scoured from the pool area is needed to build the point bar and shape the channel.
- When the pool has formed, the cobble and large rocks that were removed initially may be

replaced to provide juvenile instream cover as needed.

Digger Log with Deflector:

- The deflector is typically installed on the downstream end of the digger log. In some cases deflectors may be placed on both ends of the log.
- Its tip is at the edge of the channel design and all dimensions, angles and form are the same as described on the deflector fact sheet.
- The deflector will help dig a longer pool and speed the narrowing of the over-widened stream.
- This combination gives the benefits of both structures.

Implementation Steps:

- Follow the design for location and layout provided or approved by the AAS staff.
- Preferably use hardwood logs of appropriate size because they withstand scour with fine gravels and sand bedload better than softwoods.
- Place digger log into stream, firmly anchoring it to the substrate with re-bar.
- Build a good rock ramp on the upstream side. Remember that the log will undercut so the rock against the log must be large enough not to fall through. If large rock is not available, lay another log along the top side and set below the digger log making the structure two logs wide to provide a wider area for the undercut and then smaller rock can be used for the ramp. It is not acceptable to use fencing or geotextiles in stream for this purpose as they plug with sand and silt preventing the ramp from being used as a spawning area.

References:

DFO fact sheets (1994).

Thaumas Environmental Consultants Ltd. 2005.

Adapted from Ecological Restoration of Degraded Aquatic Habitat: A Watershed Approach 2006 Published by Fisheries and Oceans Canada Oceans and Science Branch Gulf Region ISBN: 0-662-42818-8 Cat. Number: Fs104-4/2006E

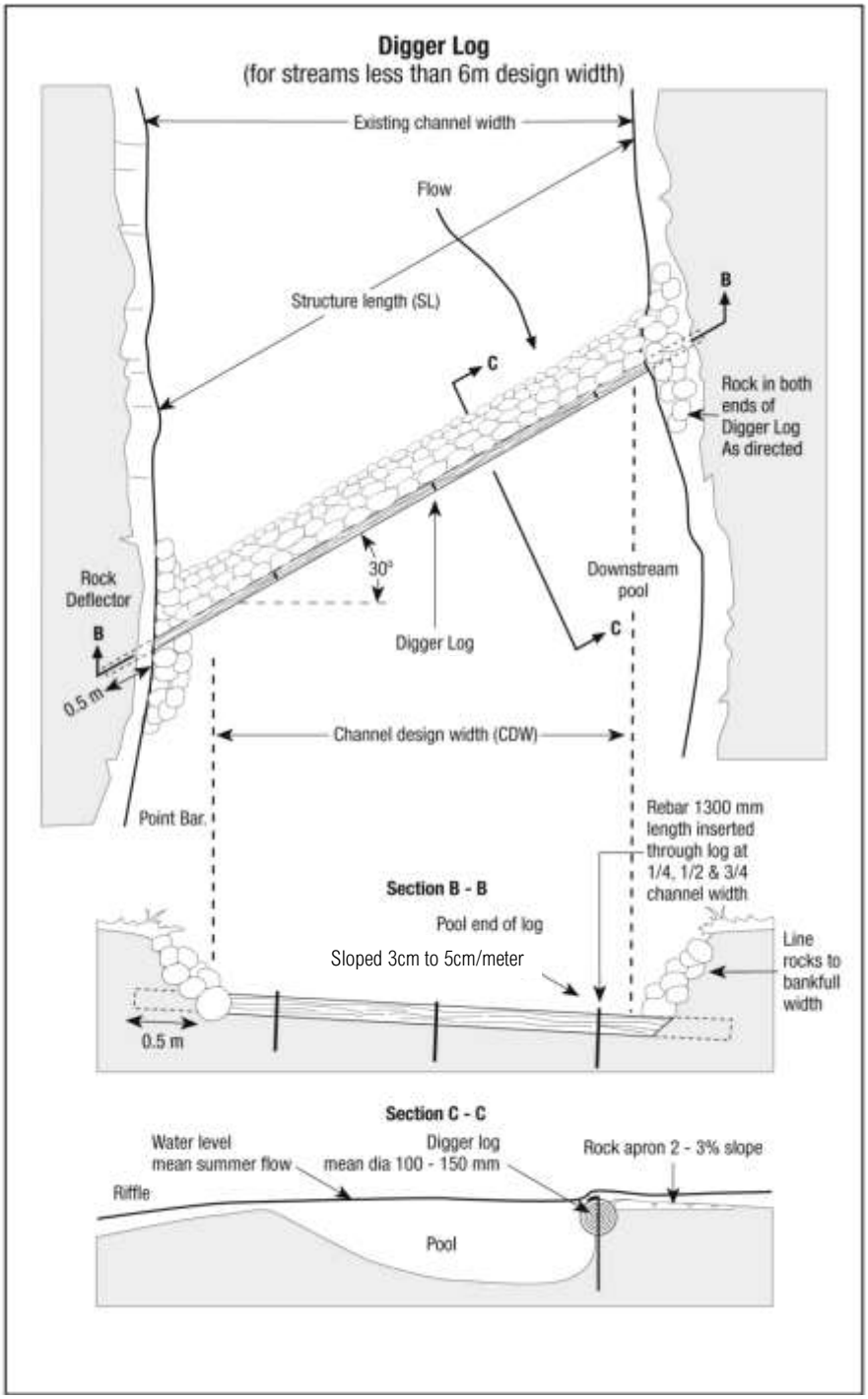


Figure 1: Conceptual drawing of a digger log (Thaumas Environmental Consultants Ltd.).

Deflectors

Purpose:

- To provide rearing habitat for juvenile and adult salmonids by developing a narrower, deeper channel and/or a pool area.
- To flush silt from a stream reach.
- To create a point bar and allow silts to redeposit alongside the bank.
- Acts as the upstream end of a point bar.

Conditions Where Applicable:

- Instream location must be approved by an Adopt A Stream Biologist.
- Deflectors are typically used in low gradient (up to 2 %), sections of streams. Deflectors should not be used where there is an unstable flood plain or other unstable reaches of the stream without additional stabilization works.
- Deflectors can be installed as single structures or in pairs. As single structures they are installed in a staggered fashion on alternate banks. Twin deflectors can be installed as a single unit opposite each other for central pools or shifted as they would have been placed along a digger log or rock sill.

Single Deflectors:

- Used to concentrate flow, narrow and deepen the channel.
- The use of several of these structures in an alternating fashion encourages meandering of the stream by deflecting the main current (thalweg) toward the center of the stream.
- Single deflectors are placed 6 stream widths apart based on the channel design width which is the 1:2 year mean daily flow channel width.

Twin Deflectors:

- Often used in watercourses that are very over widened to locate the thalweg (deepest part of the channel) in the proper meander location.
- In very over widened watercourses two deflectors uses less materials than a large single deflector and is usually preferred if they fit with the meander pattern.
- Commonly used on the ends of digger logs or rock sills or on their own in the same shifted pattern in over widened channels.
- Normally used staggered as if they were on the ends of a digger log but may be used to narrow the watercourse toward the center of the channel as shown in the drawing below.

Habitats Created:

- Used to develop the thalweg and pools.
- Will develop pools on the opposite side of the stream and just downstream of the deflector.
- Create the upstream end of a point bar.
- Twinned deflectors narrow and by using different sizes on are used to place the design channel width in over-widened sections.
- Enhance fish habitat for juvenile and adult fish rearing and migration.

Advantages:

Aid in stabilizing stream banks and consequently controlling erosion.

- Accentuate the stream flow, keeping downstream reaches of the stream clean of sediment deposits.
- Tree deflectors are easy to build by hand.

Disadvantages:

- Those constructed with boulders or log cribs may require equipment to install and consequently require additional considerations to prevent any adverse effects caused by the construction equipment.
- If materials need to be brought in or machinery is required, costs may be high.
- Deflectors must be located properly in the meander pattern or they can cause watercourse instability.
- Single deflectors may require some bank stabilization work downstream on the opposite bank.
- If trees are used, they need to be freshly-cut to provide adequate bed load retention.

Design Criteria:

- Since deflectors are used to concentrate and redirect the stream flow, the developing pattern of stream flow needs to be determined before attempting any work.
- Single deflectors should be placed upstream and on the opposite side of a natural pool location.
- Use materials that will withstand flood conditions (e.g. trees or log riprap in low flood- prone areas, rock in moderate flood prone areas, and riprap mixtures with large median size and cribbing in severe flood prone areas).
- Normally used in long runs.
- A series of single deflectors alternating from bank to bank each 6 channel widths will assist in developing a natural meander pattern.
- Deflectors should be sized to leave the design width of the watercourse open. The tips of the deflector(s) must not narrow the stream to a width less than the design 1:2 year flood channel width.
- Deflectors are intended to guide the water.
- They should have no protrusions on which drifting debris can accumulate.
- Deflectors should be triangular in shape (i.e. 30^{o} on the bank at the upstream tip, 90^{o} at the tip out in the stream and 60^{o} at the downstream bank. The 30^{O} angle guides the current toward the center of the stream rather than the opposite bank and therefore will not cause erosion downstream. If downstream erosion does result from your work then some bank protection work may be necessary.
- To check the size and angles, the long edge from the tip out in the stream to the upstream connection to the bank is twice as long as the downstream edge from the tip out in the stream to the bank. Or as flagged by the designer.
- The downstream edge of the deflector should be at an angle of 90° to the upstream edge. This will allow floodwaters that overtop the deflector to leave at an angle away from the bank.
- The deflector should be at bank height where it meets the bank and slope down to approximately ½ the bank height at the outer tip.
- If using a single deflector and the opposite bank is eroding, it should be stabilized by

rocking or another suitable method.

- Re-vegetate any exposed soil as soon as possible after work is completed.

Implementation

Installation Steps:

Deflectors can be constructed using four different materials: trees, rock riprap, log riprap, and log crib and rock. The designer will determine suitable locations so that the downstream end is just above the upstream end of a pool and will sake or flag out the location and size (area to be covered) by the deflector.

Tree Deflector:

- Use thick, freshly cut coniferous trees like balsam fir or various spruce species.
- Determine suitable locations so that the downstream end of the tree (i.e. the tip of the tree) is just beside the design location of a pool so it collects gravels to form a point bar.
- Anchor the tree butt to the top of the stream bank with rebar, or secure to a tree stump with rope or galvanized wire. Also, anchor the tip of the tree onto the stream bed with re-bar.
- Do not anchor to a living tree.
- Tree deflectors can also be used along eroding banks to reduce velocities and provide cover.

Rock Deflector:

- Rock deflectors should be built at sites where rock is plentiful or can be delivered to the site.
- At base of the structure, use large rocks 36 - 38 cm (14 - 15 in) to construct outside edge or rocks 1.5 times the size of the largest rock in the river whichever is larger. The largest rocks should be placed on the upstream side and near the bottom. Fit the largest rock at the apex of the deflector. Use double rows of rocks in the upstream side of deflector. First row of rocks should be fitted into streambed. When fitting, lay rocks masonry style (i.e. with joints staggered).
- Slope deflector up to the bank from the tip to the top of the bank forming a shape like the corner of a pyramid using the large rock. Fill in center of deflector with smaller stone. If the bank is high, the deflector should be sloped up to a height that exceeds the 1:2 year storm flow or the height of the flood plain on the opposite bank if it is lower.
- To prevent rock from rolling or moving, use angular rock and chink in smaller rock in open spaces along upstream face.
- Upstream and downstream ends of the deflector should be protected with rock to prevent the river from washing around ends.
- Anchoring the structure by vegetating top of structure with grasses or shrubs may be desirable. Flooding characteristics will determine which plant type is most suitable.
- The bank opposite the deflector should be stable or may have to be protected to prevent erosion.

Log Riprap Deflector:

- Build on sites where quality wood is available or can be delivered.
- Obtain necessary materials: No.9 gauge galvanized wire, 20-30 cm (8-12 in) angular rock, 3.0-6.1 m (10-20 ft) logs and prepared brush bundles. Materials and methods for construction are similar to those used in the Log Riprap bank stabilization technique.
- Cut and place first log along upstream side then along downstream side. Continue

placing logs on top building in the pyramid fashion.

- Fill in center of deflector with brush bundles, rock, etc. When top of deflector is reached logs can be placed over top and wired down to prevent smaller rock and brush mats from washing out.
- Key in upstream and downstream of structure. Place in angular rock at the base of the deflector.
- When gravel bar develops downstream, stabilize by planting.

Log Crib Deflector:

- Build at sites where rock and logs are plentiful or can be delivered.
- Estimate and obtain the required materials. Materials and methods used in this technique are similar to those in the Log Crib Structure technique.
- The proportion of the total log to be anchored into the bank is dependent on the following: the amount of log protruding into the main stream, amount of ice movement, volume of water and the type and amount of debris, including logs and limbs which may impact the structure as they are transported downstream. Logs may be set tight to a stable bank or may be embedded up to 1 m (3 ft) into the bank.
- The downstream log of the crib frame must butt to and behind the upstream log at the tip out in the stream of the deflector.
- Secure logs to streambed by drilling through logs and driving in reinforcing rods through logs into streambed. Further anchoring may be obtained by driving T-bars (possibly cut in half) into the streambed adjacent to and on the inside of the deflector. Secure T-bars to log with galvanized wire. T-bars should extend only to top of log.
- NOTE: A frame is generally only required when the materials used (rocks, gravel, rubble) are not of sufficient size to withstand stream flows or depth of water. If all wood components can be submerged the life expectancy will be increased. If logs are exposed to air they should be peeled.
- If the structure is greater than one log high, secure logs together with dock spikes or rebar. Before using dock spikes or rebar, pre-drill holes slightly smaller than the spike or rebar diameter.
    - Cross brace logs can be added to increase strength of the structure.
    - Rocks and rock rubble are placed within the frame.
    - Where frequent flows are not expected to overtop the deflector, soil may be used to cover the rocks and then seeded with grass. Both grass and shrubs will add shade, cover and improve aesthetics.

References:

Melanson T., S. LeBlanc, M. Goguen, and N. LeBlanc. 1999. Enhancement of Regional Sport Fisheries Through River Restoration: Case Studies for Shediac, Cocagne, Bouctouche, and Kouchibouguacis Watersheds. Southeastern Anglers Association 1996- 1998 Progress Report. 78 p.

Ministry of Natural Resources of Ontario “Community Fisheries Involvement Program: Field Manual”. 1982.

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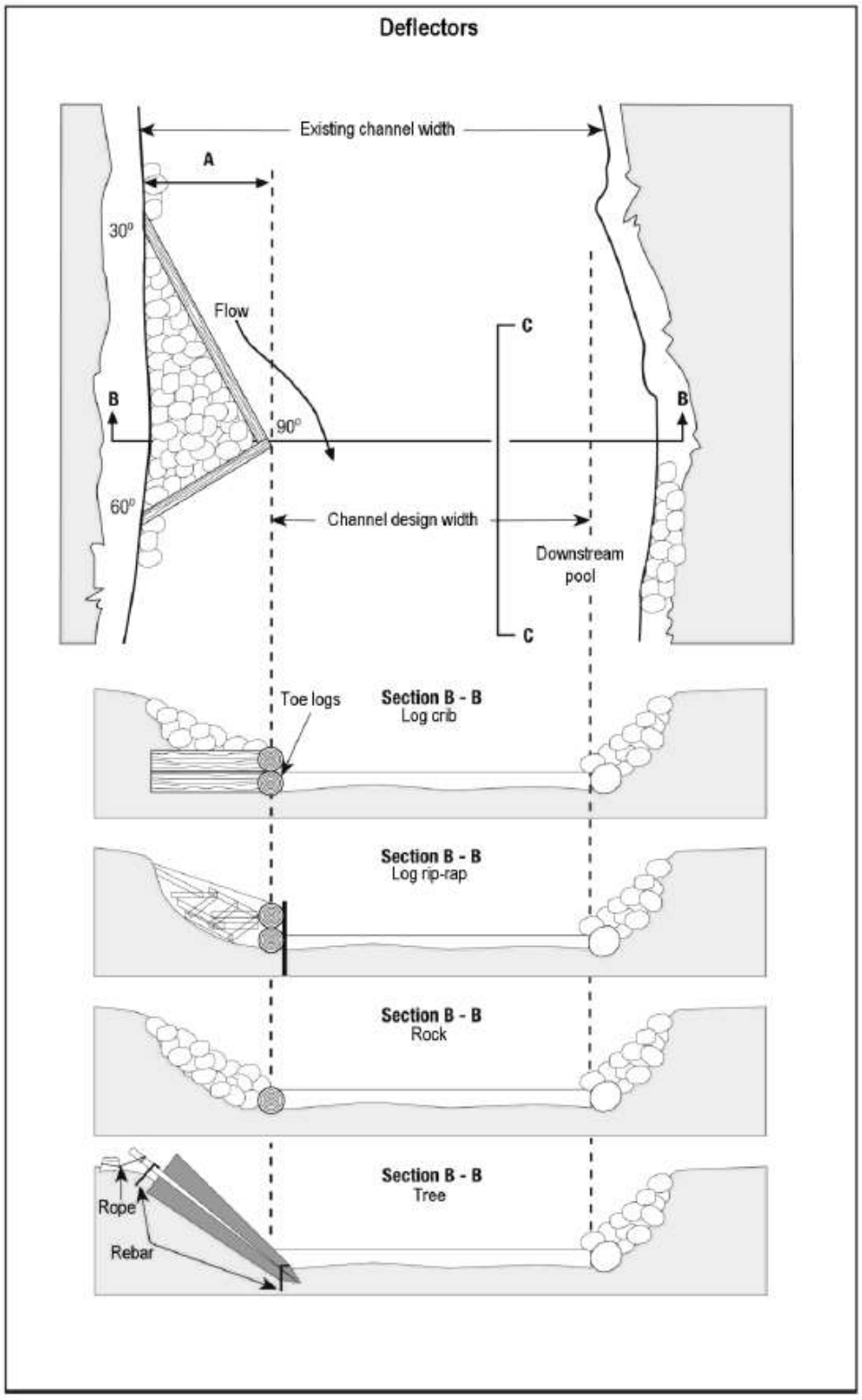

Figure 2: Deflector types

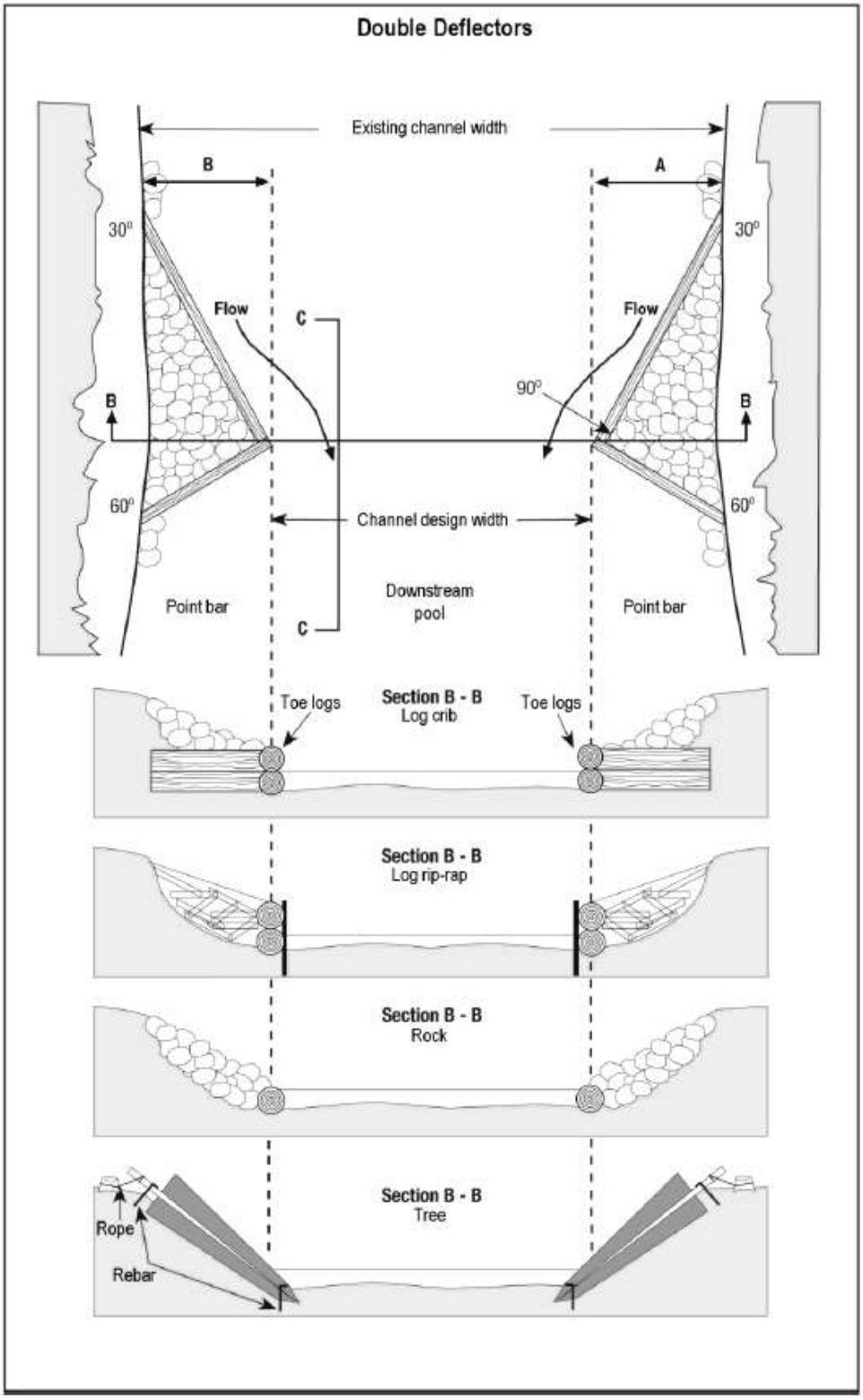

Figure 3: Double Delflectors

Bank Stabilization Structures

Combination of RipRap and Vegetation

Purpose:

- To stabilize banks and further improve habitat by providing shade, cover, and leaf fall.

Conditions Where Applicable:

- Instream location must be approved by an Adopt A Stream biologist.
- Where erosive forces are too strong for vegetative methods alone.

Advantages:

- Improves bank protection by forming a root mat under the rock.
- Increases deposition of sediments.
- Little maintenance.
- Improved aesthetics.

Disadvantages:

- Cuttings can be damaged by the rock placement.
- Cuttings have to be driven well into the soil.

Design Criteria:

- Design the bank as described in the riprap bank stabilization fact sheet.
- Plant live stakes of shrubs in the soil under the rocks so that the stake protrudes between the rocks.
- Planting can be done during or after placing riprap on the banks.
- Fascines can be planted in the rock work as it is being built.
- Care must be taken to avoid damaging the plants when placing the rock.
- The toe of the bank can be covered with riprap up to the ordinary high water level and vegetative methods can be used on the bank above the rock.
- These methods can be adapted for use with any of the constructed bank stabilization methods.

Implementation Steps:

- Implement the work as outlined on bank stabilization fact sheet for riprap.
- Construct the toe of the riprap to the low water mark.
- Plant shrubs, stakes, and fascines in the soil and riprap around them.
- If the layer of riprap is not too thick, it is possible to drive the stakes or live posts between the rocks and well into the soil.

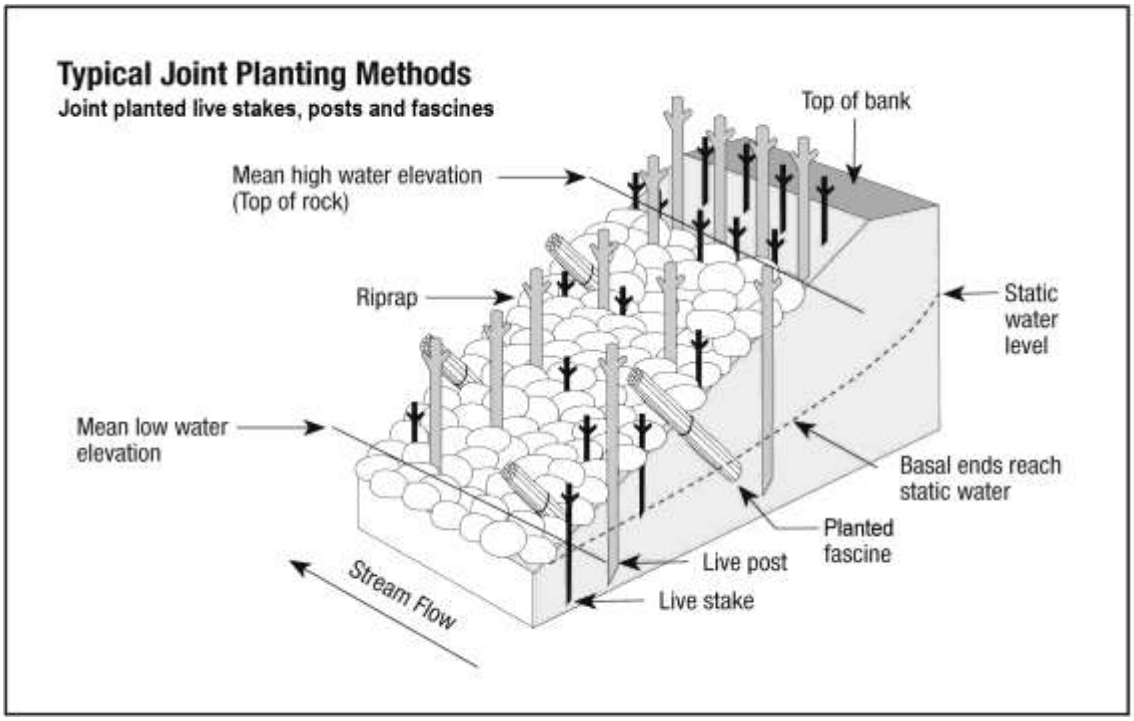

Figure 4: Conceptual drawing of joint plantings to reduce stream bank erosion (B.C. Ministry of Environment, Lands, and Parks and Ministry of Forestry, 1997).

References:

Federal Interagency Stream Restoration Working Group (FISRWG). 1998. Stream Corridor Restoration: Principles, Processes and Practices.

British Columbia Ministry of Environment, Lands, and Parks and Ministry of Forestry. 1997. Fish Habitat Rehabilitation Procedures, Watershed Restoration Technical Bulletin No. 9.

Schiechtl, Hugo. 1980. Bioengineering for Land Reclamation and Conservation. University of Alberta Press.

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Instream Debris and Barrier Removal

Woody Debris Jams

Purpose:

- To remove excess branches, logs, and fallen trees that are hindering fish passage or altering the stream's hydrology.

Conditions Where Applicable:

- Removal must be approved by an Adopt A Stream biologist.
- **Large woody debris (LWD) plays a role in the development of fish habitat and provides instream cover.** Only excessive amounts of LWD should be removed because it may:
  - Become a barrier to fish migration.
  - Lower the water's oxygen content through decay.
  - Trap silt, creating build-ups leading to decreased flow or upstream flooding.
  - Cover and destroy clean gravel substrate.
  - Cause bank erosion.
  - Flood adjacent lands.

Advantages:

- Aesthetically pleasing.
- Can remove contaminants.
- Can prevent bank erosion.
- Can permit fish passage.

Disadvantages:

- Can remove important cover.
- Removal of large woody debris can destabilize the stream and lower the productivity of the fish habitat.

Design Criteria:

- Debris jams should be assessed by a habitat biologist for removal advice.
- Generally, debris jams, which are not causing bank erosion and backup less than 40 cm of water, should be left.
- If the debris has remained in the watercourse for a long period of time, it may have become so deeply embedded that removing it would cause more damage than leaving it in place. Disturbing firmly embedded logs, branches, or other debris not only releases sediment into the water but may disrupt the fish habitat of which they have become a part.
- Accumulations of sand, silt, or gravel are not considered to be debris, even if they originate from an upstream location in the watercourse or built up due to the debris jam.
- Consideration should be given to the consequences of removing uprooted trees, which are securely fastened to the banks of a watercourse. The root systems may be preventing erosion of the bank.

Implementation Steps:

- With the landowner's permission, woody debris may be placed in the riparian zone where it will not be washed back into the stream.
- Badly damaged or dead trees, which could fall into the watercourse, should be removed, but trees containing active nest cavities should be left.
- Trees leaning over the water such that the trunk is at an angle of 30^{o} or less, measured from the water surface, may be removed if they are likely to fall in the stream or catch debris.
- Branches from overhanging trees which would catch debris floating in the watercourse should be trimmed.

References:

N.B.Department of Environment and Local Government. Watercourse Alterations Technical Guidelines.

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Cover structures

Artificial Undercut Banks (Lunkers)

Purpose:

- To provide hiding and escape cover for both juvenile and adult fish.

Conditions Where Applicable:

- Instream location must be approved by an Adopt A Stream Biologist.
- In streams where cover may be limited for juvenile and adult fish.
- In streams of width greater than 3m.
- In streams exhibiting low to moderate flooding.
- In streams where ice damage is not severe.

Habitats created:

- Juvenile and adult cover and overwinter areas.
- Adult cover during spawning.

Advantages:

- Provides an abundance of hiding places for fish.
- Can protect stream banks from further scour or erosion.
- Provides a good use for dead wood and stumps, if these are available nearby.

Disadvantages:

- Can catch debris and ice if not placed properly.
- If not properly sized can constrict flow and cause damage downstream.
- If not constructed properly may have a damming effect.
- May require annual maintenance.

Design Criteria:

- Build during the summer low flow period.
- The structure can be built along an eroding bank either on the outside of a bend or along a run where the low water depth is 0.3 m - 1.2 m (1- 4 ft).
- It can also be built out from a natural "dead water" bay along the shore.
- The structure width can extend out to the edge of the current/eddy interface, but it should not extend into the main current more than ¼ of the way across the stream.
- The structure should protrude no more than 30 cm (1 ft.) above the water surface at the front, but slope up gradually to meet the low water level at the bank behind.
    - No material should protrude out beyond the outer surface edge of the structure.
    - Both ends of the structure should taper into the stream bank. Depending on the amount of flooding and erosion, both ends may require stabilization with riprap.
    - Length of structure is variable depending on local conditions i.e., size of stream, flooding, availability of wood.
    - Typically wood logs and stumps must be readily available near the work site.
    - In the absence of wooden logs and stumps, concrete slabs may be used for building the platform. A habitat restoration Biologist must be consulted before undertaking such work.

Implementation steps:

- Determine location. As mentioned above, the structure can be built along an eroding bank either on the outside bend, along a straight stretch of deep water, or built to fill in a backwater area.
- If an existing natural debris jam is to be enhanced, then the following approach should be used:
  1. Add or remove material to obtain desired shape which conforms to design criteria.
  2. Spike green logs along outside edge of structure. Spikes are 20 - 25 cm (8 -10 in). Use larger dock spikes if they are necessary. Logs are placed slightly under the water surface.
  3. Logs must run parallel to the main current; then the structure is tapered at both ends and keyed into the stream bank.
  4. Remaining material on jam is spiked together forming a complete unit.
  5. In addition, posts can be dug into the substrate and spiked to the outer perimeter of logs for added stabilization and anchoring.
  6. If work is beginning at a location where there is not an existing debris collection area, then the following approach should be followed:
     a. Determine location conforming to design criteria.
     b. Outline area with stakes.
     c. Construct outer shell using green logs.
     d. Add stumps and logs as required and secure.
     e. If additional bank stabilization is required, more material is used along the bank to form a dense barrier to the current flow within the structure.
     f. In most cases of newly constructed sites the bank above the structure can be planted

References:

Federal Interagency Stream Restoration Working Group (FISRWG). 1998. Stream corridor restoration: principles, processes and practices.

Ministry of Natural Resources of Ontario. Community fisheries involvement program: field manual.

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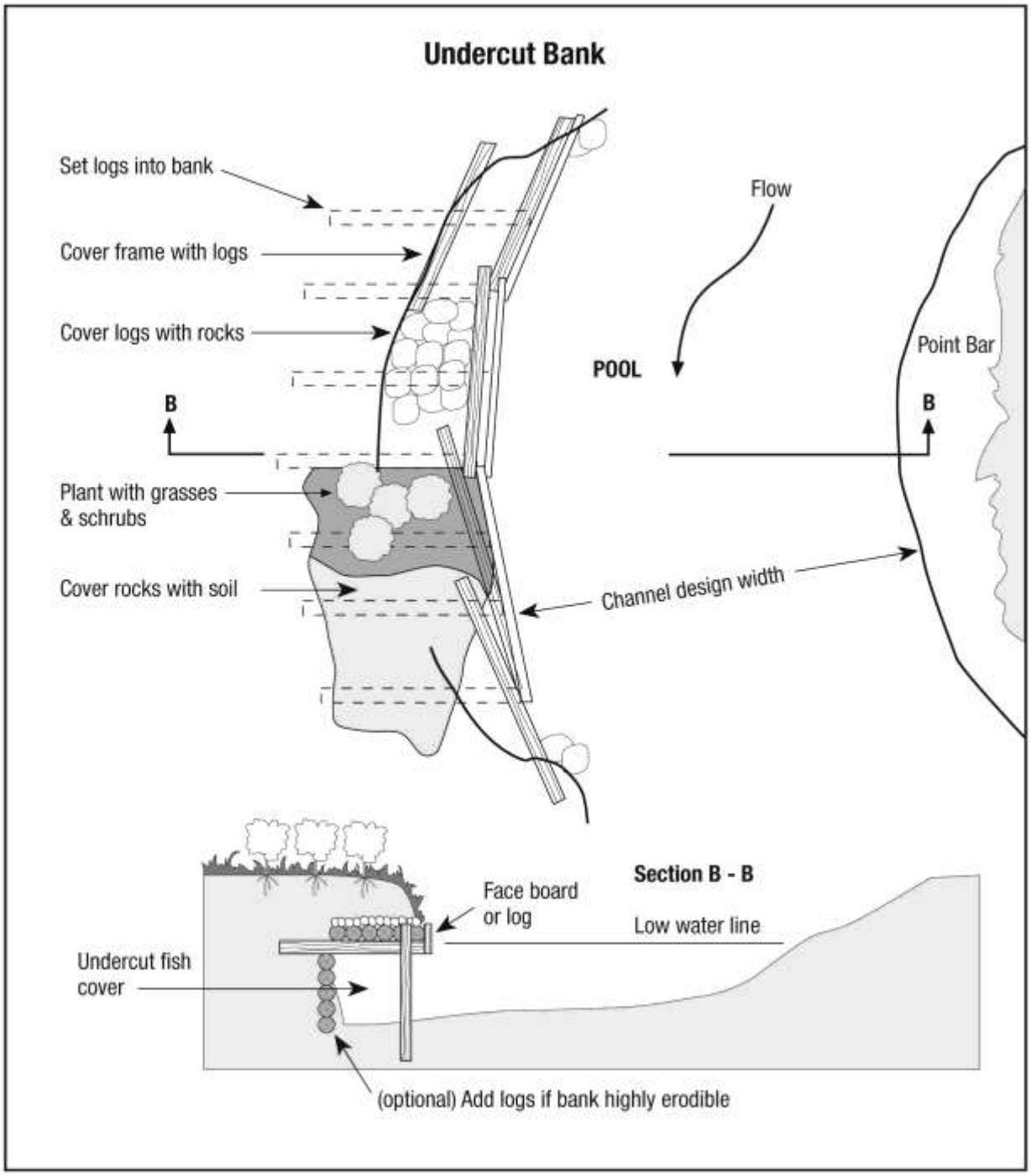

Figure 5: Conceptual drawing of an artificial undercut bank (Thaumas Environmental Consultants Ltd.).

Gravel cleaning: SandWand

Purpose:

- To remove sand and silt from gravel-cobble bed streams

Conditions Where Applicable:

- Instream location and cleaning design must be approved by an Adopt A Stream Biologist.
- Sites where the sand and silt content of the stream bed exceeds 10%.

Advantages:

- Removes sand and silt for the stream substrate with minimal impact of invertebrates and no impact on resident fish.
- Allows natural flows to reform meander pattern and riffle pool pattern reducing stress on stream banks.
- Brings stream habitat substrate to optimum condition for spawning, rearing and migration of stream fish.
- There are no instream structures and can be done in remote sites.
- Aesthetically pleasing.
- No maintenance requirement.

Disadvantages:

- Can increase substrate permeability drying up stream sections during low flow if not properly done.

Design Criteria:

- At least one staff that has received training will be in charge and on site at all times the equipment is in use.
- A minimum of two people will be on site during operations, one to work the wand and the other to tend the pumps and the discharge hose.
- Each proposed restoration site will be assessed and the work laid out/flagged on site by a AAS habitat restoration staff at the start of the work.
- The pools and spawning areas are to be cleaned deeply up to 40cm down to provide cover for all life stages and species of fish and insects and to clean spawning gravels for salmonids.
- No cleaning at crest of riffles to ensure low flows continue to maintain pool water levels
- Light clean of riffle areas to increase insect habitat and cover for salmon juveniles.

Implementation:

- Sand and silt disposal will be in the riparian zone with the landowner's permission. Sand and silt deposition in riparian areas is a natural occurrence for the sediment flushed through by flood flows. Deposition of sediment in the stream bed has been found to be mainly sand and outflow water turbidity was low and the sand settled out immediately in the riparian area.
- The outlet hose is to be moved frequently to prevent a buildup of sand greater than 2 cm deep. This will ensure the vegetation will grow up through it.
- Other silt control techniques will be used to contain the sand and silt if disposal in the riparian area is not possible or effective. These are to include but not limited to the use of silt fences, straw

bales, silt bags, sand bag filters. Techniques to contain the sand and recycle the wash water will be used in cases where we need to remove the sand from the site and have limited flows.

- Pumps in operation will be placed 3m + from the watercourse and set in containment trays to catch any oil or gas leakage or spill during refueling and water leaking from the pumps.
- The system needs 15cm + of water depth to operate. In some cases a water dam or sand bags filled with pea stone and covered with plastic will be used to temporarily raise the water over the work area.
- All the water returns to the stream quickly through the riparian areas and discharge hoses are to be placed in the riparian area upstream of the work site if possible so that water will return to the stream upstream of the work site. This also allows continuous monitoring of the return flow to ensure it is not turbid above guideline levels.
- The water returning to the watercourse will be monitored to ensure it does not exceed the CCME guidelines for aquatic life. The objective is to achieve no increase in suspended sediments or turbidity above background levels due to the cleaning operation and no bed load size input of sediment. Adjustments should be made to the silt control techniques if the returning water is turbid. Adjustments must be made to the silt control if the levels approach the following levels. All operation must stop if proper silt levels are not achieved.

Suspended sediments.

- Clear flow; Maximum increase of 25 mg/L from background levels for any short-term exposure (e.g., 24-h period). Maximum average increase of 5 mg/L from background levels for longer-term exposures (e.g., inputs lasting between 24 h and 30 d).
- High flow; Maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L. Should not increase more than 10% of background levels when background is >250 mg/L.

Turbidity

- Clear flow; Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g., 24-h period). Maximum average increase of 2 NTUs from background levels for a longer-term exposure (e.g., 30-d period).
- High flow; or turbid waters Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs. Should not increase more than 10% of background levels when background is >80 NTUs.

Deposited bed load sediment

- No sediment of bed load size is permitted back into the stream

References:

Irish Cove Nova Scotia, habitat restoration research project. Nova Scotia Salmon Association Adopt A Stream Program 2011.