Certification Manual

For Watercourse Alteration Installers

January 2015

NOVA SCOTIA

Contents

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1 INTRODUCTION

1.1 OBJECTIVE

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 is to provide practical information that focuses on environmental protection. These stages include, but are not limited to, planning, installation, construction, replacement and decommissioning of watercourse alterations, including watercourse alteration crossing structures.

The goals of this training program are:

- to train people on how to interact with watercourses in a less impactful manner

- 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 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:

- The manual does not cover every type of watercourse alteration type, but attempts to provide general guidance for some of the most common types of alterations and recommendations which would be applicable to most alterations, but not all. Specific conditions pertaining to individual watercourse alterations will vary with each project. In some cases, supplemental mitigation measures are necessary to resolve site specific problems.
- The manual does not cover alterations to wetlands and does not cover activities in tidal watercourses or coastal areas.
- The manual is not a regulation and the manual is not to be interpreted as a method of design or a design code.
- 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.
- 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.

1.3.1 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.

Nova Scotia Environment 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).

Fisheries and Oceans Canada (DFO)
DFO has the lead federal role in managing Canada's fisheries and safeguarding its waters. 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 in Nova Scotia include Bras d'Or Lakes, Great Bras d'Or, and Lahave River (from rapids in Bridgewater to the Atlantic Ocean). See www.tc.gc.ca/eng/programs-632.html

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 metres wide).

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

- **bank** means that 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.

- **bed** means that portion of a watercourse that is commonly submerged in water.

- **ordinary high water mark** means 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.

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).

1.3.3 Governing Acts and Regulations

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). In addition, watercourse alterations must comply with the Fisheries 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 "spawning grounds and any other areas, including nursery, rearing, food supply and migration areas, on which fish depend directly or indirectly in order to carry out their life processes." Section 35 (1) of the *Fisheries Act* prohibits any person from carrying on "any work, undertaking or activity 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". Section 35 (2) of the *Fisheries Act* provides exceptions to Section 35(1) where work may be carried out without contravening subsection (1). Section 36 of the *Fisheries Act* prohibits anyone from depositing a deleterious substance of any type in water frequented by fish. This section is administered by Environment Canada for most substances.

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.

<u>PROVINCIAL</u>	
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
<u>FEDERAL</u>	
Fisheries Act	Fishways (Sec. 20, 21); Fisheries 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 crossings require 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/

1.4.1 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.

1.4.2 Notifications

- **Notifications** 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.

- **Revised (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.

- **Renewed Notifications** are used when a previous notification has been submitted and the notifier wishes to continue the work beyond the time period specified on the notification receipt. 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.

- <u>All</u> 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.

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 sizers need to keep calculations and other information used to determine the type and size of crossing structures.

> **Please note:**
> **Blanket approvals will not be issued after October 1, 2014. A notification form must be provided for every eligible alteration. For those activities that do not qualify for notification or no submission, an application for approval must be submitted.**

1.5 <u>NOVA SCOTIA WATERCOURSE ALTERATIONS STANDARD</u>

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.

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.

As of October 2016, certified Watercourse Alteration Installers 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 under an approval as per section 5A(2)(a) of the Activities Designation Regulations.
  - for example, alterations that do not meet the notification conditions; dredging, 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).

A certified Watercourse Alterations 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 ***Guidelines for the design of fish passage for culverts in Nova Scotia***, *Fisheries and Oceans Canada, Fisheries Protection Program, Maritimes Region* (as updated from time to time) (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 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.

1.6.1 Completion of Training Program

Individuals successfully completing this Certification program will be recognized by Nova Scotia Environment as having been trained for installing structures in watercourses and for altering watercourses, in accordance with requirements in the Nova Scotia Watercourse Alterations Standard in the case of 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 watercourse alterations. 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.

1.6.2 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 Alteration Installers to promote their authorization to install watercourse crossings and do other watercourse alterations under a streamlined notification process and also to promote your ability to follow best environmental practices.

The responsibilities of certified 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 lower risk alterations such as floating docks and open bottom crossing structures.
- Understand the Nova Scotia Watercourse Alterations Standard for notifications and the terms of conditions of water approvals before starting work and complying with the requirements.
- Plan and install/construct watercourse crossing sites in accordance with training provided for qualifying Watercourse Alteration Installers. Efforts should include planning and construction of entire road system or project and not just individual crossing sites.
- Be able to recognize and correct problems during work on a watercourse alteration (such as, identifying issues prior to problems occurring and making appropriate adjustments).
- Provide your 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. A notifier is the person who signs and submits a notification form to Nova Scotia Environment.

- Assist property owners and others 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 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, and 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 its flow, has the potential to damage the aquatic ecosystem. The aquatic ecosystem is the interactive community of living things (plants, animals, microbes) and their physical setting. Damage can result from such things as erosion, sedimentation, stream blockages, degraded water quality, and habitat loss.

Nova Scotia Environment requires Nova Scotians 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.

Protecting our watercourses means:

- Maintaining water quality;
- Maintaining channel capacity and flow;
- Maintaining stable banks and riparian vegetation; and,
- Maintaining and promoting 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 <u>EROSION</u>

Erosion is 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. 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 may have the following impacts on:

Fish / Fish Habitat

- Disruption of migration patterns due to large amounts of erodible material blocking upstream / downstream reaches.
- Reduction in the food supply as a result of a loss of vegetation along the banks and adjacent areas.
- Reduction in vegetated areas, which give shelter to small fish.
- Destruction of rearing pools / holding areas by sediment deposition.

Water Quality

- Increases in water temperature and decreases in hiding cover, shade and fish food supply due to the loss of vegetation along the banks and adjacent areas and / or to the widening of the watercourse.

- Changes in the water chemistry and possibly species composition in response to increased levels of nutrients such as nitrogen and phosphorus.

While the above focuses on fish and fish habitat, erosion affects other aquatic life, such as aquatic insects and amphibians.

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. It is a natural, but potentially serious, consequence of erosion which may be accelerated by a watercourse alteration. Sedimentation is divided into two categories determined by the mode of transportation by which it moves through a watercourse.

- **Suspended sediment** are soil particles suspended or mixed in the water column. Suspension is dependent on particle size.

- **Bedload sediment** 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.

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

Fish / Fish Habitat

- Suffocation of fish due to the clogging of the gill surface membranes. Suffocation of fish eggs and young fry due to sediment filling the interstitial spaces in the gravel.

- Hyperventilation in response to extreme stress that causes an increase in mucous production.

- Abrasion or scraping of gill membranes and fish scales.

- Disruption of spawning activities due to stress.

- Changes in feeding efficiency in response to decreased visibility.

- Reduction in food supply due to a decrease in photosynthesis affecting algae and other aquatic plants.

- Reduction in food supply due to a decrease in aquatic invertebrate populations.

- Reduction in suitable spawning areas due to the interstitial spaces between rocks, rubble and gravel being filled.

Water Quality

- Increased water temperature and decreased oxygen levels due to changes in water depth as a result of sediment deposition.

- Decreased visibility as water clarity diminishes in response to increased turbidity.

Other users of the watercourse

- Decreased water quality due to suspended sediment in water being used for commercial, industrial, or municipal use.

- Impacted water quality affecting recreational use of watercourse.

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

2.3 WATER QUALITY

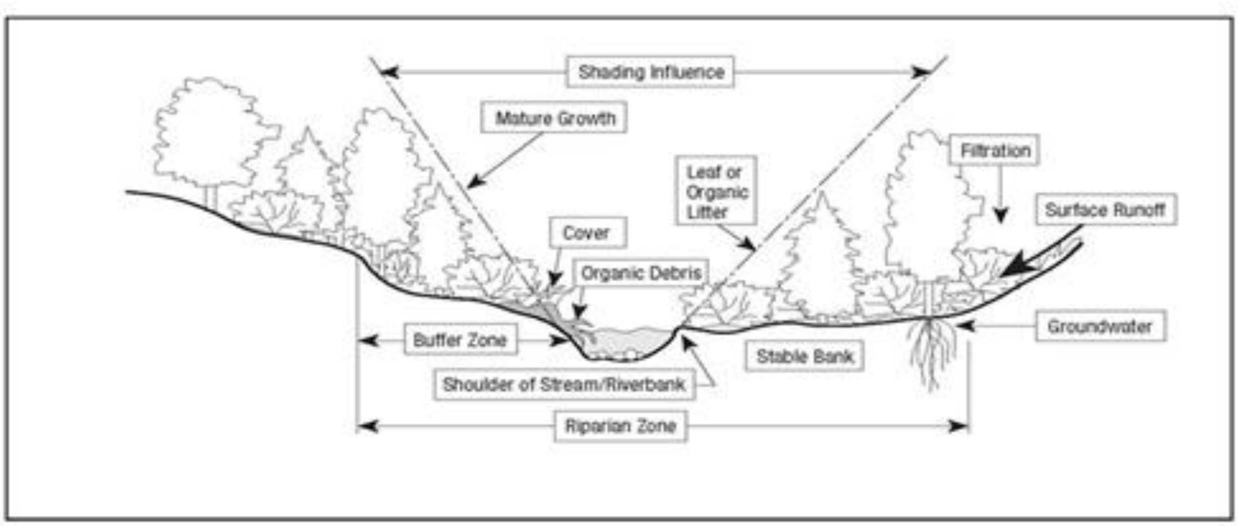
In addition to siltation of the watercourse, water quality can be affected by construction materials on site. For example the lime in concrete can create very alkaline conditions in a watercourse that is toxic to aquatic life. Petroleum products for vehicles and equipment, preservatives in wood products are other examples of substances that can impact water quality.

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 reduces severity of flooding. Some benefits of riparian zones include:

- Travel corridors for wildlife along the watercourse and provides access to watercourses for wildlife requiring both terrestrial and aquatic habitat (eg., mammals such as moose and mink)
- Provide shade, reducing water temperature in watercourses
- Contribute insects and detritus such as leaf litter into the watercourse which act as food sources for the fish
- Provides shelter - Riparian vegetation, in the form of tall grasses, shrubs and trees, protects fish from predators.
- Provides natural erosion control - The root system of vegetation contributes to bank stability and intercepts runoff which limits erosion and sedimentation, protecting fish habitat from harmful effects of sedimentation
- Provides natural filtration - Vegetation and root systems act to filter out pollutants such as pesticides, bacteria, fertilizers, heavy metals, sediment, and hydrocarbons.

Figure 2-1 Importance of Riparian Zone to Aquatic Habitat



2.5 ALTERATION OF BANK AND BED OF WATERCOURSE

The alteration of the bank or bed of a watercourse can directly impact habitat for aquatic life. Altering stream channels or altering water flow will also affect flow dynamics and change the stream's morphology and can create unstable channel conditions leading to erosion, meandering, and increased potential for flooding and bed material transport.

Flow velocity can be decreased in some areas of the channel and increased in others. These changes can result in severe scouring of banks and changes to pools and shallow areas in the watercourse. In some cases the impact is deposition of material. This deposit of sediment can impact important aquatic habitat downstream and 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 property damage adjacent to the watercourse.

2.5.1 Littoral Zone of Watercourse

The shallow water areas of watercourses (called littoral zones) where light penetrates to the bottom of the water body are often 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, these areas are ideal for spawning and nursery areas for many 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 flooding and result in property and watercourse damage downstream.

Improperly constructed or designed structures could fail, resulting in 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

Whenever possible, avoid working in and around watercourses. For work in and in 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 alteration. The first step of planning is to choose an appropriate work site. Consider the planning aspects outlined in Section 3.0, Construction Requirements for all watercourse Alterations and the Sections 5.0 through 17.0 for specific types of work. As part of the planning process, you should also anticipate problems and prepare a contingency plan.

3 PLANNING WATERCOURSE ALTERATIONS

Comprehensive planning is essential during the preconstruction phase of proposed watercourse alteration and for the maintenance and modification of existing watercourse crossings or other structures in watercourses. Environmental impacts such as erosion and sedimentation can be minimized through careful planning and design. Careful planning and design will prove to be cost effective to the construction and to the long-term maintenance of structures and alterations.

Please ensure all other approvals that are required are obtained. For example, for forestry operations, all roads to be constructed on Crown Land require a pre-approved road plan through the Nova Scotia Department of Natural Resources.

3.1 PROPOSED WATERCOURSE ALTERATION LOCATION

Use of topographic mapping, geology mapping, orthophoto mapping and / or aerial photos for planning watercourse alterations is useful and in some cases is essential. The usefulness is dependent on the type and extent of watercourse alteration. These maps and photos often identify natural and manmade features such as wetland areas and may identify other users of the watercourse. For example these maps are essential if laying out a new road with watercourse crossings. The certified watercourse alteration sizer or professional engineer involved in the design of crossings may have already viewed the mapping for the area.

3.1.1 Areas to Avoid

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

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/

- 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/water/docs/Protected.Water.Areas.Map.pdf).

- 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). 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.
  For more information contact Fisheries and Oceans Canada, Species at Risk Coordination Office at http://www.dfo-mpo.gc.ca/species-especes/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 avoided. 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.

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 the Nova Scotia Environment website at the link provided below:
https://www.novascotia.ca/nse/water/docs/Protected.Water.Areas.Map.pdf

3.2 FIELD INSPECTION

A field inspection of the proposed alteration 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 of watercourse alteration or the type of alteration and methods.

3.2.1 Scheduling the Field Inspection

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

3.2.2 Choosing a Watercourse Crossing Location

- Establish and clearly mark minimum buffer zone of 30 m (100 ft) between the edge of the proposed road and the watercourse.
- Align the crossing structure to cross the watercourse at right angles to prevent any redirection of the flow in the watercourse.
- Road approaches should be stable with the minimum slope possible for a distance of 30 m (100 ft) on either side of the watercourse crossing.
- Whenever possible avoid crossing watercourses at locations where valuable fish habitat (pools, spawning riffles) or critical habitat for endangered species is present. If these features are present, move the crossing location upstream or downstream.
- Location of the crossing should be a straight and relatively narrow section of the watercourse, with no braiding or obstructions.
- Crossing should be located in a section of the stream with zero or near zero gradient and a constant water velocity.
- Avoid sections of watercourse that have tidal influence.
- Avoid crossings of watercourses at the outlet of lakes, ponds or wetlands.
- Stream bottom should be stable with a rocky or hard, non-erodible bottom.
- Stream banks should have steep slopes with stable soil conditions and abundant vegetation.
- Stream flow must not be altered or watercourse channels diverted to facilitate a watercourse alteration.

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 channel? Is there sand, gravel and/or cobbles evident 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 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 watercourses.

3.2.3 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 a sizer or a professional engineer in the case of watercourse crossings):

- 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

- Identify areas to avoid (eg., wetlands, steep slopes, sensitive or critical habitats).

- Geotechnical information may be required at some locations. For example for bridge abutments, footings for open-bottom structures or for boring or directional drilling under a watercourse.

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 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 has been scoured from 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 crossing structure is to be located.
-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 crossing location.

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

RIFFL - 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 (or steps).

POOL - A deep, slow moving, quiet portion of a watercourse.

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 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 between June 1 and September 30 minimizes potential impacts by:

- Avoiding sensitive periods in the life cycle of fish such as during migration or spawning.
- Facilitating dam & 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 water flow. Isolating high flows could lead to flooding and increase the risk of introducing sediment into the watercourse.

- There should be adequate warm weather after this 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.

- It is easier and less expensive to move and stabilize soil during this period. Soils are often either frozen or saturated at other times of the year making them more difficult and costly to move.

- To minimize environmental impacts caused by erosion and 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.

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 LEAST RISK TO 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 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 least impact on the aquatic ecosystem include the following:

- Understand the objective of the project. Can the objective of the project be achieved without altering the watercourse?

- Choose methods and structures which cause the least impact on the watercourse. Avoid disturbance of the bed of the watercourse and minimize disturbance of the bank of the watercourse. Avoid structures which alter the flow of the watercourse.

- Involve certified watercourse alteration sizers, professional engineers, or other professionals when required and when appropriate to ensure proper sizing and design of alterations.

These basic principles can be explained to your client so they understand you are trying to find the least impactful way to achieve their objective. Structures with lower environmental risk often have lower maintenance and replacement costs. For example, bridges and open-bottom structures are preferred over closed-bottom structures, such as pipe culverts. Bridges and open-bottom culverts have less impact on aquatic habitat than culverts and are the preferred method for providing access across a watercourse. Structures which maintain the natural bank and bed and the natural flow and stream morphology have the least impact on aquatic ecosystems. The structures typically also require less maintenance because blockages and scour does 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 and washouts, which could damage aquatic habitat and physical property, endanger human life, and prevent the utilization of upstream habitat.

For additional guidance see the planning considerations included in sections 5 to 17 for specific alteration types. Be aware there are some alterations which are of such high risk, that the department may not approve the work.

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.
If you encounter these types of situations, 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 meeting to discuss the project, mitigative 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 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.) then 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.

3.6.1 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 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 structures 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 sequence up and downstream of crossing;
- 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 or abutments;
- Scouring of banks/ energy dissipation pool at culvert outlet; and,
- 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.

3.6.2 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 to ensure that the new structure dimensions will be able to meet the 1:100 year storm flow.

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 crossing 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 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 or structure selection, construction and 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 and Environment Canada. Audits may be completed before, during or after installation/construction.

Inspectors will be auditing all aspects of a watercourse alteration including, but not limited to, installation / construction, stabilization and maintenance follow-up. Inspectors will also be auditing the planning and design of crossing structures and other watercourse alterations.

It is important for notifiers to maintain all paperwork pertaining to the planning and design of crossing structures and other watercourse alterations. Keeping documents that show you have followed the Nova Scotia Watercourse Alterations Standard 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:

- determination of drainage areas for crossing sites such as culverts and bridges;
- calculations used to determine the type and size of crossing structure;
- for professional engineers, design of culvert crossing showing it conforms with the ***Guidelines for the design of fish passage for culverts in Nova Scotia****, Fisheries and Oceans Canada, Fisheries Protection Program, Maritimes Region,* (as updated from time to time) for culverts in a watercourse with slope greater than 0.5% but less than 8%.

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. 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 WATER FLOW)

All work in a watercourse must be completed in isolation of water flow to avoid sedimentation of the watercourse. Keeping the work area isolated from water flow also creates a work area where excavation and construction can be completed properly.

Construction activities within and immediately adjacent to the channel or a watercourse must be isolated from water flow in an effort to reduce the impact of silt and fines on water quality affecting aquatic life and other users. Water control measures are to be temporary to allow the work to proceed while minimizing impacts to the aquatic environment. This can be done with the use of cofferdams, temporary diversions and dam and pump around techniques.

5.1.1 Sizing Requirement

Cofferdams must be of sufficient height and strength to hold back the bank full velocity of a 1:2 year rainfall event.

The design and construction of temporary diversions and dam and pump methods should also withstand 1:2 year return flow and velocity. Additional equipment (eg., pumps) and materials should be kept on site so you are prepared for higher flows in the watercourse occurring after rainfall events. Weather forecasts should be monitored and work in watercourses should be avoided during times of peak flows if possible.

5.1.2 Cofferdams

When cofferdams are used to isolate the work area from flowing water (see figure 5-1):

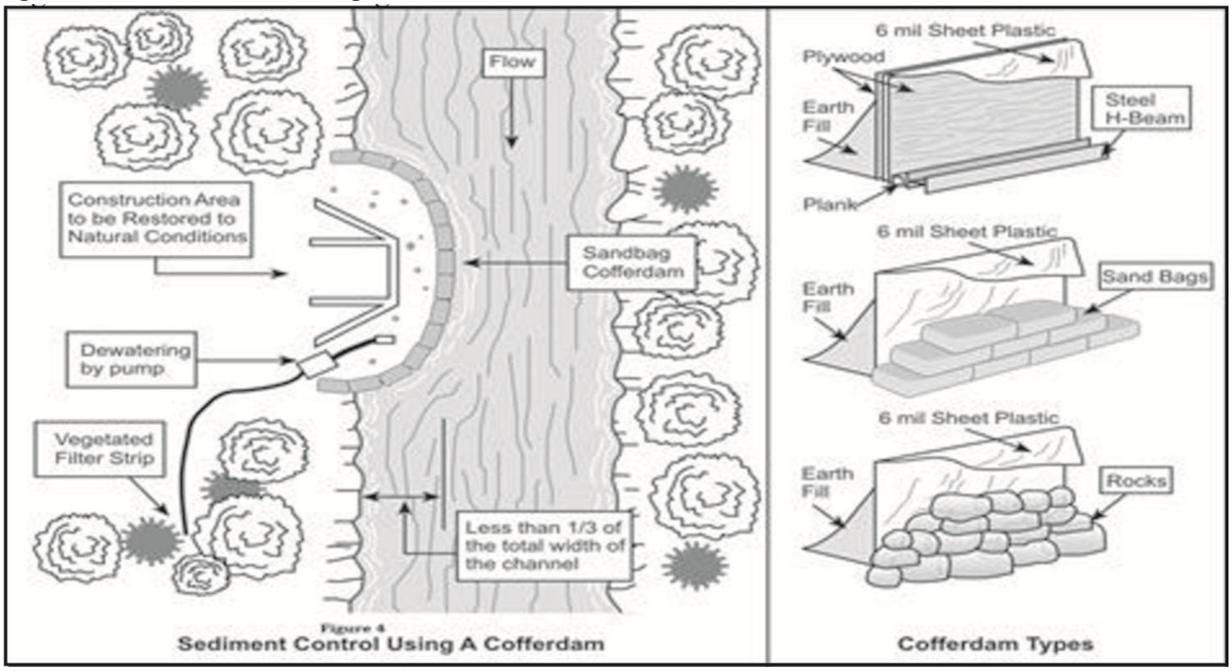
1. As much of the channel as possible should remain open at all times to allow unrestricted water flow and fish passage. At least one-third of the cross-sectional area of the channel must remain open at all times.

2. Cofferdams should be constructed of non-erodible material to prevent washout of the structure which may result in downstream deposition and siltation.

3. Cofferdams should be of sufficient height and strength to prevent overtopping or collapse as a result of sudden increases in water levels.

4. They must be constructed tightly to prevent or reduce the amount of seepage into the work area.

Figure 5-1 Water Control using Cofferdam



5. Cofferdams should consist of: sheet piling or a layer of 6 mil plastic sandwiched between an inner wall of in situ earth fill and an outer wall of either rocks, sandbags, or a steel H-beam attached to the bottom of a sheet of plywood. Sheet metal or wood panel cofferdams are preferred to construction with till or pit run material as they can provide a tighter structure and do not create problems of siltation and erosion. Sandbags filled with peastone are also preferred as they can be removed easily.

6. No excavation may be carried out inside the cofferdam or sediment filtering curtain until the cofferdam/curtain is completely closed.

7. Water pumped from inside the cofferdam should 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/litre above background levels.

8. The cofferdam material must be completely removed immediately upon completion of all work in the wetted portion of the watercourse and the watercourse substrate shall be restored to closely resemble pre-installation grades and profiles.

9. If pier(s) are constructed in the wetted portion of the watercourse where it is not possible to build a cofferdam, a floating sediment barrier anchored to the bottom with a medium that readily conforms to the substrate profile, should be placed around the work area.

5.1.3 Temporary Diversions

When constructing a temporary plastic or rock lined diversion:

1. Design to accommodate the peak seasonal flows for the time period the diversion will be in place.

2. The diversion channel must not be any longer than absolutely necessary to efficiently

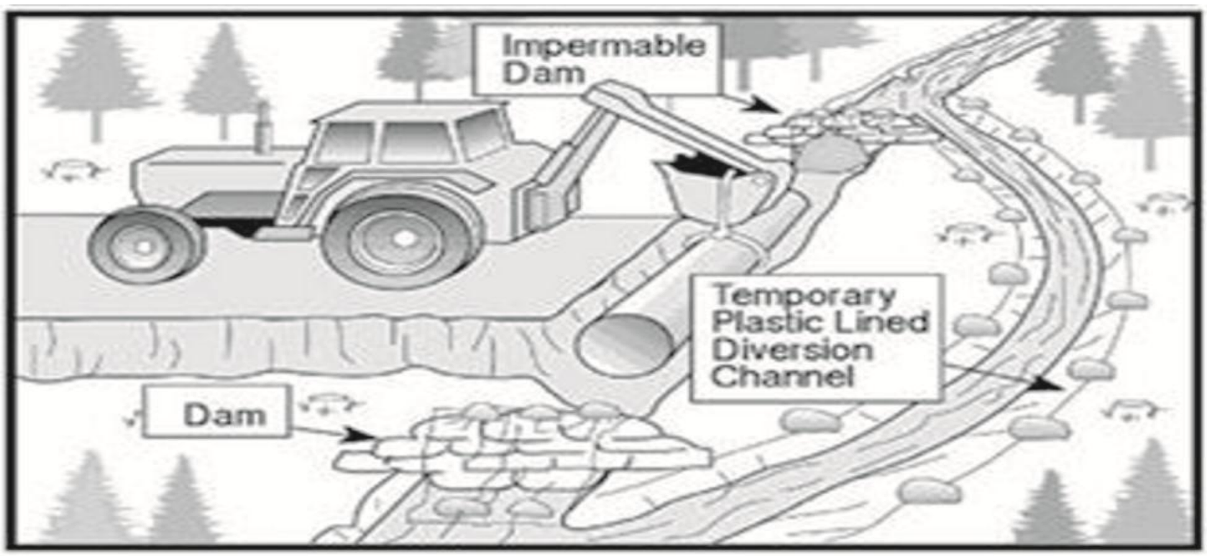
accomplish the planned project and shall be excavated from the downstream end in isolation of water flow, see figure 5-2.

3. Excavate a temporary channel parallel to, and as close as possible, the existing stream channel working from the downstream end to the upstream point of diversion.

4. Line the temporary channel with plastic and secure with rock. Stake the plastic into place at the top of the channel side slopes, stabilization, remove first the downstream then the upstream cofferdam from the watercourse.

5. The diversion channel should be restored as closely as possible to pre-project conditions

Figure 5-2 Water Control using Temporary Diversion



5.1.4 Dam and Pump

Stemming the flow upstream of the in-channel work area and pumping the flow around the site to a point immediately downstream of the work area (see figure 5-3):

1. An impermeable cofferdam must be constructed to block the flow upstream and downstream, if necessary to prevent back flooding, of the construction site.

2. Arrangements must be made to ensure the flow is constantly pumped around the site until the installation is completed.

3. Fill used in construction of a cofferdam shall consist of only clean, sediment free materials.

4. Cofferdams should be of sufficient height and strength to prevent overtopping or collapse as a result of sudden increases in water levels.

5. Establish a water pumping system to transfer the natural water flow directly downstream of the work site.

6. Upstream of the installation site, locate the intake pipe where stream elevation is lowest. Movement of substrate material in the streambed to accommodate the placement of the intake pipe shall be done by hand.

7. The use of the pump should be done so that it avoids the killing of fish. The pump must be screened to prevent the entrainment of fish (fish is drawn into a water intake) and the screen must be carefully monitored for

impinged fish (fish is held in contact with the intake screen). The pump might need to be temporarily turned off long enough to allow fish to free themselves from impingement on the screen. See figure 5-4 for temporary screening.

8. The discharge hose should be located in areas with stable streambed conditions. Use material such as plywood, sandbags or rock to stabilize the area where stable streambed conditions are not available. Stabilization of the discharge area will prevent unnecessary scouring and erosion problems as a result of increased water volume and velocity.

9. On the downstream side of the work site, construct a second cofferdam above the discharge area. This cofferdam is intended to prevent the movement of sediment from the work site into the watercourse.

10. Remove any fish trapped in the isolated area of the existing stream and relocate migrating fish upstream of the cofferdam and non-migrating fish downstream of the cofferdam. A license to collect and move fish may be obtained from DFO prior to the fish rescue. Please contact DFO through the National Online Licensing System at http://www.dfo-mpo.gc.ca/index-eng.htm.

11. Pump any residual water from the isolated area of the stream channel into a designated treatment area such as a settling pond behind filter fabric dam or into a vegetated area. Once filtered, the water can be released downstream of the lower cofferdam.

Figure 5-3 Water Control using Dam and Pump

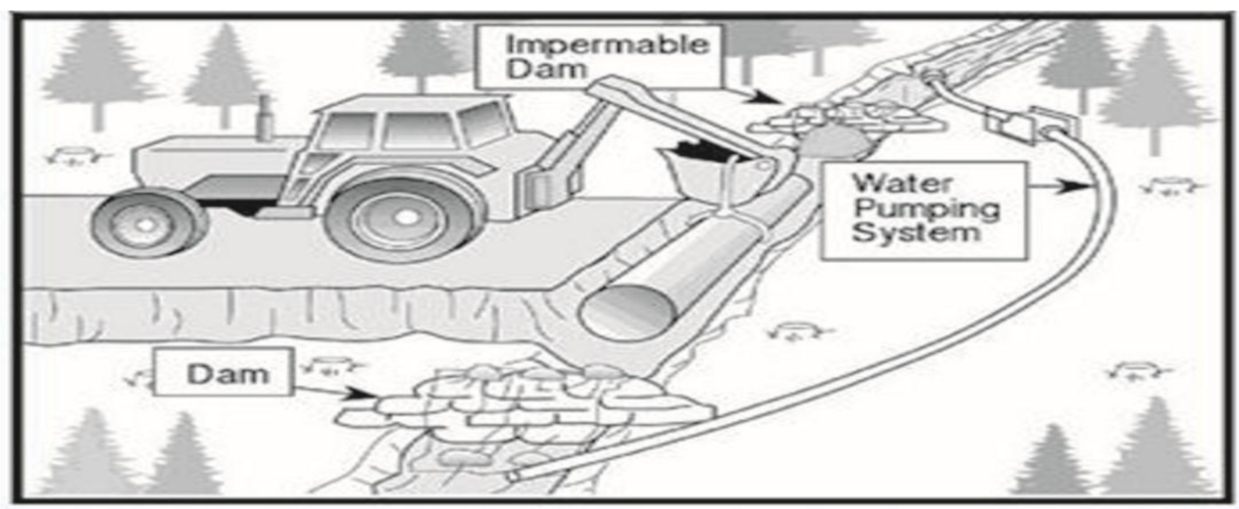
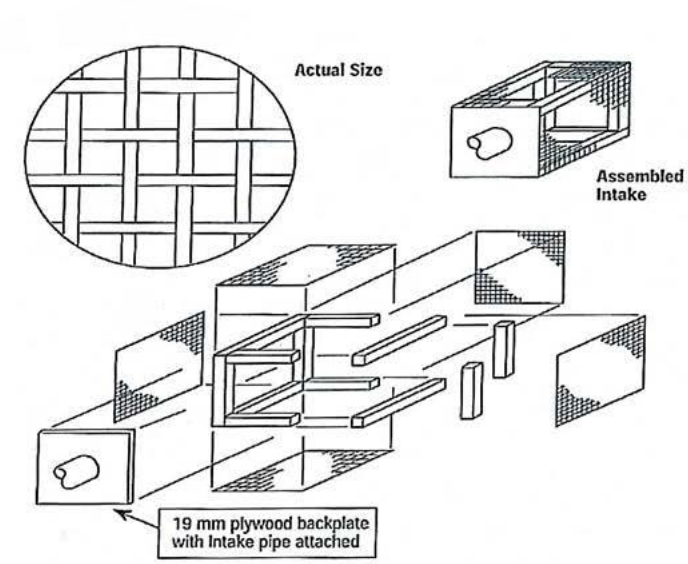


Figure 5-4 Temporary intake screen

Temporary Intake Screens



1 Dimensions of the assembled structure will vary according to the rate of intake.

2 1 square metre of open area of screen is required for each 0.15 cubic metres per second of water extracted.

3 Velocity through the screen must not exceed 15 centimetres per second.

4 Wire mesh with a horizontal distance between the openings of no greater than 7.5 millimetres is attached to the wooden frame using steel staples.

5 Treated wood must be completely dry before being immersed in water.

6 Attatch intake pipe to backplate.

7 Intake must be elevated to allow flow through screen bottom or other dimensions must be increased to ensure that sufficient screen is available.

Fisheries and Oceans Canada. 1985. Technical Advice for Temporary Fish Screens

12. Following culvert installation, remove first the downstream then the upstream cofferdam from the watercourse. Restore / stabilize any soil disturbance along the stream banks or within the work area.

13. The water pumping system must be continuous whenever there is sufficient water to facilitate pumping until the installation is complete. This system must never be left unattended.

14. A complete back-up system should be kept on-site at all times to accommodate any increases in water flow and as a precautionary measure in case of breakdowns.

15. After completion of instream work, all materials must be removed from the watercourse.

Official Version of Regulations

Refer to the most current and official version of the Nova Scotia Watercourse Alterations Standard posted on the Nova Scotia Environment website: www.novascotia.ca/nse/watercourse-alteration

Also refer to the official versions of any legislation or regulation on the Nova Scotia Justice website, such as:

- *Environment Act;*
- Activities Designation Regulations; and,
- Nova Scotia Watercourse Alterations Standard.

5.2 EROSION AND SEDIMENTATION CONTROL

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

5.2.1 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, for fishes breathing processes and migration patterns.
- 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 (12 to 14° C) which is the preferred temperature range. Warmer temperatures result in decreased dissolved oxygen content.
- Gravel substrate needs to remain clean for spawning.
- Fish passage needs to remain unobstructed for successful migration to occur throughout the watercourse.

5.2.2 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 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.

5.2.3 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. At a minimum, all exposed soils must be covered with grass seed and mulch (such as straw, wood chips) or with permanent surface cover such as gravel. 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 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/litre 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.

5.2.4 For Larger Projects: Erosion and Sedimentation Control Plans

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
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.

IT'S A FACT

The major cause of soil erosion and sedimentation in any projects is caused by road construction, not land clearing.

5.2.5 Sedimentation and the Environment

Use the following guidelines when building erosion and sedimentation.

STOP IT BEFORE IT STARTS

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

5.2.5.1 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.

5.2.5.2 Road Crowning

Road crowning is done by making the center of the road higher than the outer edges. Crowning is used to encourage water to drain into adjacent ditches to reduce rutting and the need for road maintenance. The average slope of the crown should be 3%.

5.2.5.3 Roadside Ditches

Roadside ditches are used to intercept and carry runoff to locations where the concentrated water flow can be safely carried downslope using drainage control structures such as off-take ditching or cross- drainage culverts.

- End ditches a minimum of 30 m (100 ft) away from any watercourse. Ditches must never discharge directly into any watercourse.
- Roadways located on fairly level ground (low gradient) should have ditches constructed on both sides.
- Roadways located on steep terrains or hillsides should have ditches constructed on only the uphill side to intercept seepage and runoff.
- Design roadside ditches to promote proper water flow management as follows:
- Design the ditch to adequately handle the expected peak flow runoff.
- Maintain a minimum ditch gradient of 2%. Where possible, ditches should maintain the same slope as the roadway.
- Ditch gradients less than 2% can be effective; however, a more frequent inspection and maintenance regime must be undertaken. Slopes at this level have the potential to pond water which may saturate the subgrade.
- Avoid sharp or abrupt changes in the gradient to minimize scouring of the invert of the ditch.
- Extend the ditch beyond areas deemed unsuitable for water dispersal such as sensitive soils, wetlands or cuts.

Construct roadside ditches in the following manner:

- Ditches should be constructed in an uphill direction to prevent trapping of surface runoff.
- Excavate ditches to a minimum depth of 30 cm (12 in).
- Ditches should have a curved or flat bottom with fore and backslopes no steeper than a 2:1 slope.
- Areas that are prone to erosion should be stabilized immediately after excavation. Minimize ditch erosion using the following techniques:
- Line the ditch with non-erodible material such as rock or gravel.
- Construct check dam (s) or sediment barriers within the ditch in an effort to control water velocity and reduce sedimentation (see Sections 5.2.5.4 and 5.2.5.5 on construction procedures). This is a temporary measure until construction is complete and all exposed areas are stabilized.
- Construct settling ponds (or traps) at the end of the ditch in an effort to check the water velocity. The larger particles of sediment suspended in the runoff settle out in the pond / trap. (See Section 6.3.5 on construction procedure).
- Vegetate the ditch cross-section to reduce erosion.
- In areas of highly erodible soils, postpone construction activities until such time as the ground is frozen or weather conditions are dry.

5.2.5.4 Check Dams

Check dams are temporary structures made from stones, straw bales, sandbags or logs constructed across ditches. 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.

Construct a check dam 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.

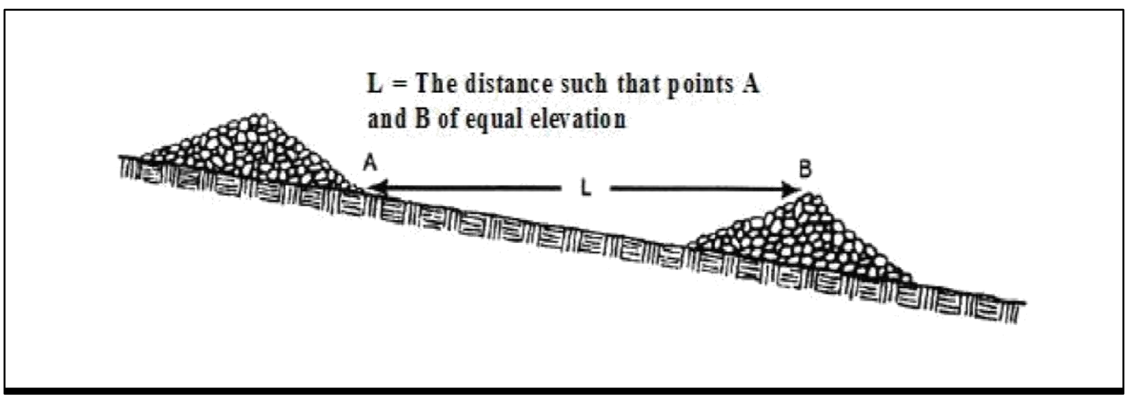
- Construct check dams with the center at least 15 cm (6 in) lower than the ends of the dam. This notch in the center enables any accumulated water to flow over the dam rather than around the ends, while sediment settles out on the upstream side of the dam.

- 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 5-5).

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.

Figure 5-5 Measuring the Placement of Check Dam Distance

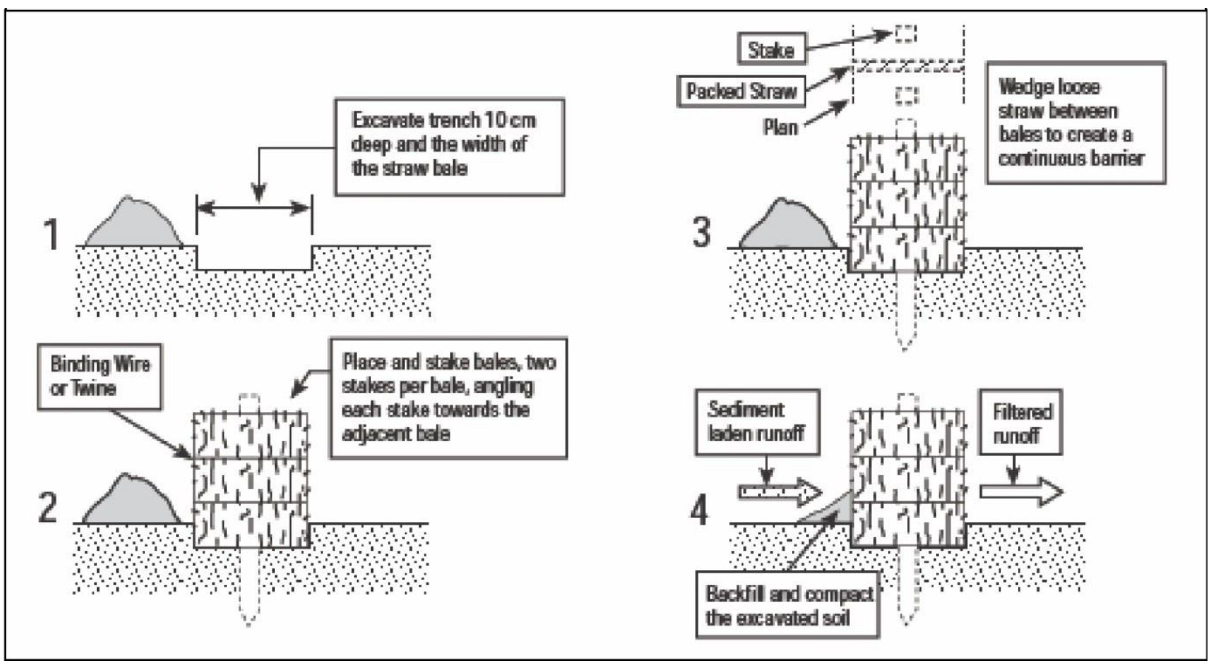


5.2.5.4 Straw Bale Barriers

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 5-6.

- 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 straw bale barrier once site is stable.
- Sediment barriers must be erected prior to any soil disturbance of the upland area.

Figure 5-6 Procedures for Constructing Straw Bale Barrier

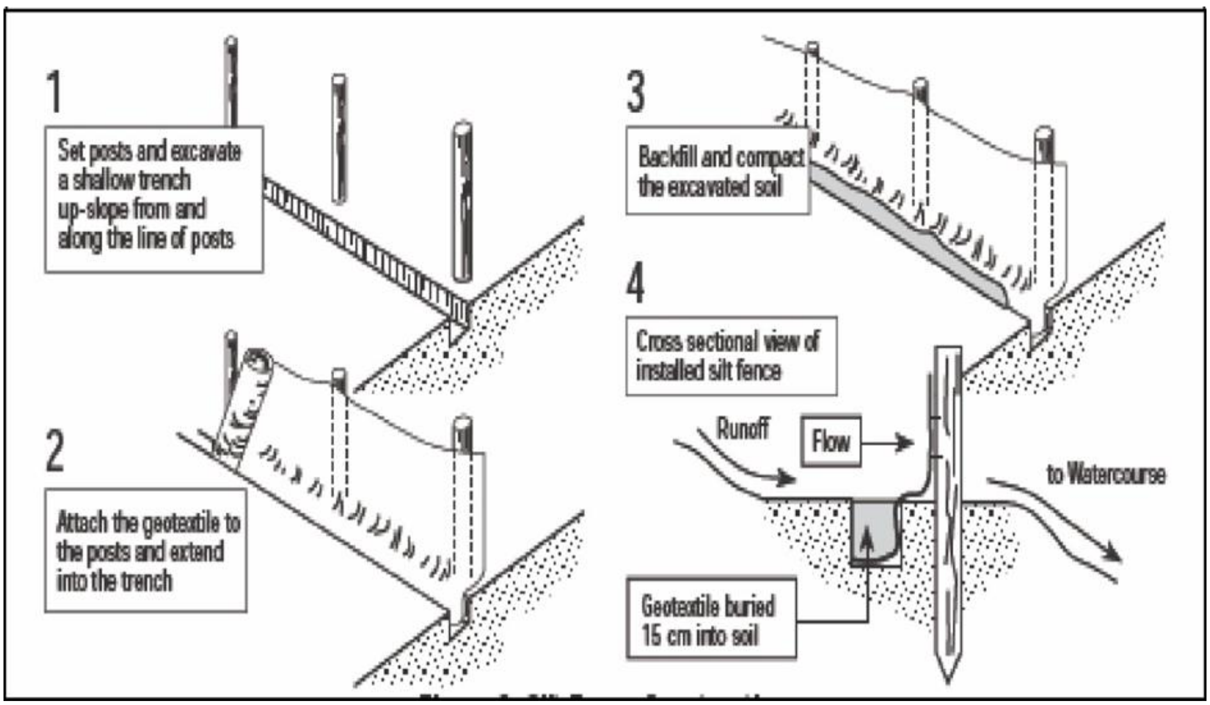


5.2.5.5 Silt Fence Construction

Construct a silt fence using the following procedure (see figure 5-7):

- 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).
- Backfill the trench over the fabric and compact the excavated soil.
- Silt fences normally last up to 6 months before requiring removal or replacement.

Figure 5-7 Procedures for Constructing a Silt Fence



5.2.5.6 Settling Pond (or Sediment Trap)

Settling ponds or sediment traps (see figure 5-8) are used to intercept and retain sediment laden runoff. These ponds are usually located at the end of the ditch.

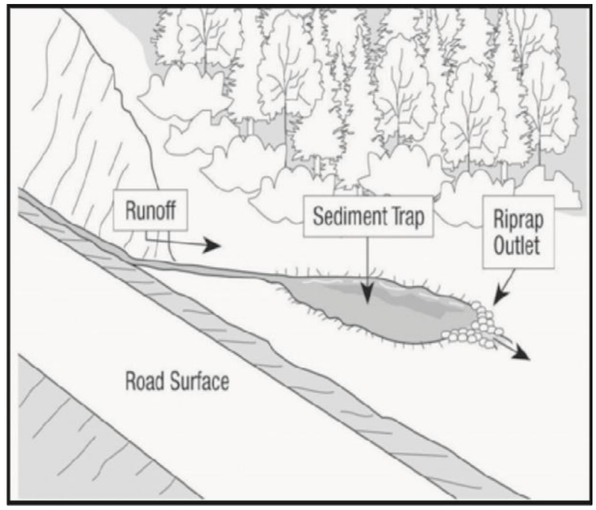
Sediment ponds are most often used when space is limited or the road gradient is steep.

- 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 road under construction. (100 yd / acre)

Construct a settling pond (or sediment trap) using the following procedure. See Figure 5-7.

- 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.

Figure 5-8 Layout of a Sediment Trap



5.2.5.7 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.

- 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:

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

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

Example 5-1

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)

- 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.

5.2.5.8 Cross-Drainage Culverts

Cross- drainage culverts are used to transport runoff from one side of the road to the other at a road junction or under and away from a roadway. Diverting concentrated runoff to the low side of the road should prevent excessive runoff in ditches thus reducing erosion of the roadbed and the potential for siltation.

Install a cross-drainage culvert, using the following procedure:

- Locate cross-drainage culverts a minimum of 30 m (100 ft) from any watercourse.

- The minimum accepted opening of a cross-drainage culvert is 30 cm (12 in).

- If the road is located on a sidehill, ensure a cross-drainage culvert drains runoff to the downhill side of the road.

- Space cross-drainage culverts to accommodate the ditch gradient. Use the following formula:

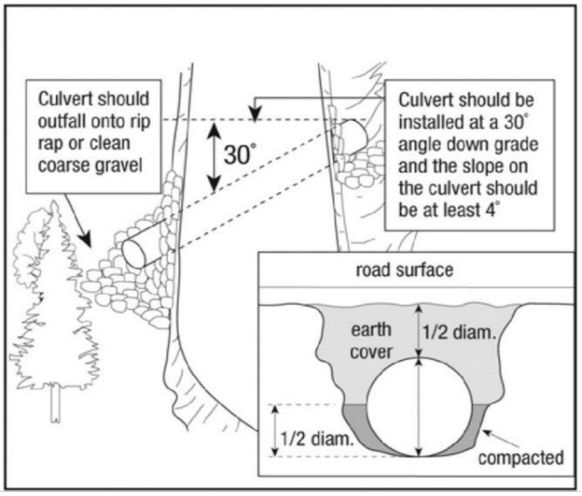
  Spacing (m) = 500 m % Ditch Grade

  Spacing (ft) = 1640 ft % 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 installation of culverts.

- Install cross-drainage culverts at a 30° angle downslope from a line perpendicular to the centerline of the road (see figure 5-8). This allows water to flow easily through the culvert.

Figure 5-8 Installation of Cross Drainage



5.2.5.9 *Temporary Mulching*

Daily maintenance of exposed soil must be practiced when construction lasts more than one day. To stabilize exposed soil at the end of each day:

- Spread mulch evenly over exposed erodible areas. Types of mulch to use include hay, straw, bark, natural vegetation, or mulch from waste-resource material.
    - Hay or straw mulch is normally applied at a rate of one bale per 25 m^2.
- Or place temporary matting such as erosion control blankets over the disturbed area.

5.2.5.10 *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.

- 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 fibre 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.

5.3.1 Fuel Handling and Transfer

- All fuelling, 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.

5.3.2 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.

5.3.3 Storage

All petroleum storage tank systems must be in compliance with the ***Petroleum Management Regulations - Environment Act***. Aboveground storage tank systems with a total capacity of 4000 litres 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.

5.3.4 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 litres. 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

5.3.5 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 watercourse

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

5.4.1 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.

5.4.2 Treated Wood

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.

- The use of wood treated with creosote is not permitted for use in any part of the structure, nor repair of any existing structures. This includes decking and stringers.

- 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;

  - 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

> Note: 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.

Remember, a rainfall event can happen at any time, washing over construction materials and carrying toxic substances to nearby watercourses.

5.4.3 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. Material must not be sulphide bearing aggregate.

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 or a new watercourse channel. This rock mixture is to be "washed" thoroughly prior to releasing the watercourse into the energy dissipation pool or channel. See Section 3.8 (new channel) and 5.6 (energy dissipation pool).

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.

6 WATERCOURSE CROSSINGS – GENERAL

Generally the types of crossing structures used in watercourse crossings include:

- closed bottom culverts, such as box culverts, pipe arch culverts and circular pipe culverts; and,
- open bottom structures, such as bridges, bottomless arch structures, and open bottom box culverts.

6.1 ENVIRONMENTAL CONSIDERATIONS

All watercourse crossings impact the environment to some degree. Careful planning and design can minimize this impact.
All watercourse crossings should be selected and designed to:

- to minimize any change of the flow in the watercourse, and
- to preserve aquatic habitat and fish passage.

A good watercourse crossing, which does not cause impacts up and downstream, is selected and designed to:

- retain natural stream morphology**,** which means a consistent bank-to-bank width, similar substrate material consistent with surroundings and to maintain meander pattern and pool/riffle sequence. Any alteration to these features can cause unintended effects up and downstream.
- retain water depth and water velocity comparable to conditions upstream and downstream.

Poorly selected and designed watercourse crossings can result in inadequate capacity leading to increased velocity or blockage followed by flooding, erosion and washouts which could damage aquatic habitat and physical property, endanger human life, and prevent the utilization of upstream habitat.
Bridges and open-bottom culverts generally have less impact on aquatic habitat than closed bottom culverts and are the preferred method for providing access across a watercourse. Open bottom structures also tend to have fewer issues with blockages reducing maintenance efforts and failures.

Structures selected to maintain the natural bank and bed of a watercourse have the least impact.

6.2 PLANNING

6.2.1 Open Bottom Structures – bridges and open bottom pipe arches

Bridges are the preferred watercourse crossing type from an environmental and fisheries standpoint for the following reasons:

- Bridges retain the natural streambed.
- Bridges help to maintain the cross sectional area of the channel therefore maintaining the flow natural regime.
- Bridge crossings rarely provide a barrier to fish passage.
- Bridge construction requires less instream activity; therefore reduces the environmental impacts.

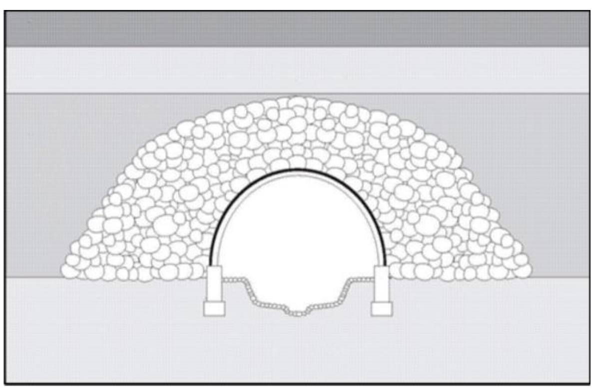
Bridge Crossing Location Considerations

Generally, bridges should be chosen over culverts in areas where any of the following situations are encountered.

- The channel is too wide or water too deep to properly install a culvert.

- The gradient of the streambed is too steep to accommodate an acceptable culvert slope.
- The stream banks are steep requiring a great deal of infilling to properly install a culvert.
- The streambed is soft and unable to support a culvert.
- The crossing site contains valuable fish habitat (pools, spawning riffles, critical habitat).
- The watercourse is subject to rapid runoff, ice blockages or debris dams which may cause structural failure to a culvert and impede fish passage.
- Beaver activity is of significant concern. Beaver dams often block watercourse crossing structures, potentially impeding fish passage and damaging roadways through flooding and erosion.

Open bottom / Bottomless Arch Culvert



Erosion/sedimentation and fish passage are two of the environmental issues that must be addressed with this type of installation. An open-bottom culvert avoids the requirement for fish passage facilities as long as it is installed such that the placement of the structure including the foundation and any associated excavation takes place from the banks of the watercourse and landwards.

Stability of the banks and bed of the watercourse is a concern and must be considered during planning and installation.

This type of structure is less likely to be damned by beavers than circular culverts.

Open bottom culverts are similar to bridges. These culverts are supported by footings situated outside the bankfull limits of the channel. The maximum permissible diameter for an open bottom culvert is 3660 mm (12 ft).

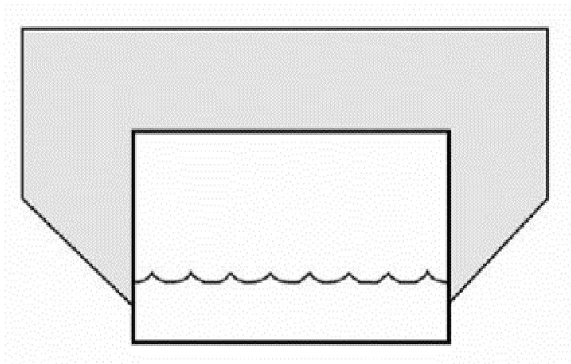
Material: Made from steel or concrete

- Advantages:
  - Natural streambed and slope are maintained if designed and installed appropriately as there is no bottom.
  - Less susceptible to corrosion than steel pipe culverts.
- Disadvantages:
  - Improper installation could result in scouring and erosion if footings are not founded outside the bank full limits of the channel and not buried to a depth below the thalweg.

6.2.2 Closed bottom structures – box culverts, pipe arch culvert, pipe culverts

Closed bottom culverts, when installed properly, are an acceptable method for permanent watercourse crossings. Culverts are used on public roads, forest roads, driveways and in areas where difficult terrain limits where other watercourse crossing options such as bridges are not suitable.

Box Culvert

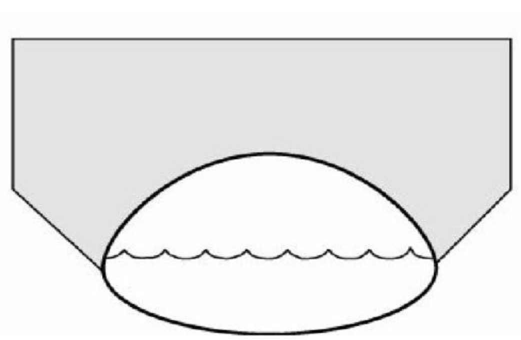


Box culverts in some respects are similar to bridges. For example, their dimensions allow them to be used in areas where fill is limited as they require little backfill or excavation.

Material: Made from wood or concrete.

- Advantages:
  - Maintain natural channel width.
  - Baffles can be easily installed to provide fish passage.
- Disadvantages:
  - The wide, flat bottom may result in reduced water, potentially limiting fish passage.

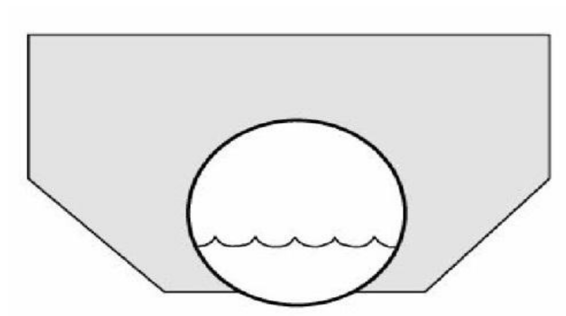
Pipe Arch Culvert



Pipe arch culverts are closed bottom structures embedded into the substrate.
Material: Made from metal or concrete.

- Advantages:
  - Maintains the same slope and allow for retention of bottom substrates.
  - Useful in areas where road fill is limited.
- Disadvantages:
  - The wide, flat bottom may result in reduced water depth, potentially limiting fish passage.

Circular/Pipe Culverts



Material made from metal, plastic and concrete.

- Disadvantages:
  - Reduces the cross sectional area potentially increasing water velocity. This may disrupt fish migration, undermine the inlet or scour the streambed at the outlet.
  - May be susceptible to ice or debris blockage obstructing fish migration and flooding upstream areas.
  - Difficult to install properly in order to maintain fish passage.
  - Concrete and plastic culverts have a much greater velocity potential due to their smoothness and have more potential to result in barriers to fish passage.

> **JUST A REMINDER**
> Choose your watercourse crossing structure carefully. Any structure unsuited to the site or improperly installed can have a *significant* environment impact on aquatic habitat and the fisheries resource, and can result in increased maintenance and replacement costs.

6.3 SIZING OF WATERCOURSE CROSSING STRUCTURES

A properly sized culvert shall have the capacity to accommodate the **peak flow for a 100 year return** period. This means that there is a probability of a peak flow event occurring once in every 100 years. The sizing of crossings under notification must be completed by a certified watercourse alteration sizer or a professional engineer.

6.3.1 Climate Change

We are already feeling the impacts of climate change. Everyone plays a role in helping our generation and future generations mitigate the impacts to the climate system by not only reducing greenhouse gas emissions but also by adapting to the changes in climate.
Some of the impacts we can expect to see in Nova Scotia include wetter summers, coupled with warmer/hotter, drier summers, increased frequency and severity of extreme weather events, changes in precipitation patterns (more flood, more drought), coastal and inland flooding, sea level rise, storm surges, accelerated coastal erosion, loss of sea ice/ice cover, and water availability constraints.
In particular for Nova Scotia, climate change is leading to increased risk of flooding as extreme precipitation events become more frequent, this risk is increased by erosion and sedimentation that affects the watercourse flow. When considering watercourse crossings it is important to design the alteration with climate change in mind. Future climate conditions can have a significant impact on the function, maintenance and longevity of the crossing structure, and can cause serious impacts elsewhere along the watercourse and floodplain if not designed properly.

6.4 Construction

Follow the Nova Scotia Watercourse Alterations Standard if under notification process: General Conditions and sections for culverts and other closed bottom structures, and section for bridges and other open bottom structures.

If work is completed under an approval, follow the terms and conditions of the approval.

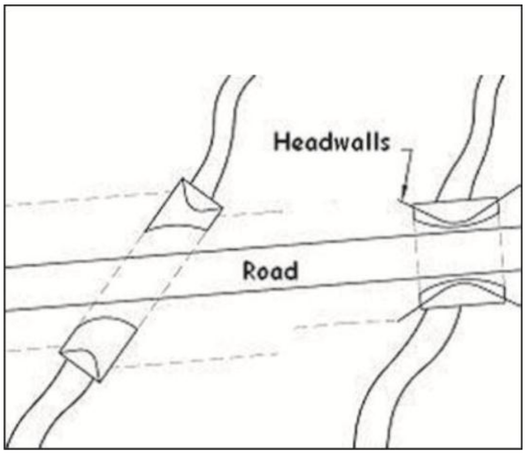
6.4.1 Key considerations

The installation of any watercourse crossing should have minimal impact on the flow of the watercourse, maintain natural stream morphology, preserve fish habitat and provide fish passage.

The alignment of the crossing structure with the watercourse is very important. When the culvert is not properly aligned with the upstream and downstream channel, the hydraulic capacity is reduced and the likelihood of debris clogging is increased. Also when not aligned properly the potential of erosion and scour of the watercourse banks and backfill is greatly increased. See figure 6-1. Watercourses should not be diverted in order to install a crossing.

The next three sections consider the construction and installation of crossing structures in more detail.

Figure 6-1 Examples of Stream Crossings Aligned with Watercourse Channel (Figure from Vermont Stream Crossing Handbook, Vermont Fish and Wildlife Department.)



7 CLOSED BOTTOM CULVERTS (PIPE CULVERTS, BOX CULVERTS, PIPE ARCH CULVERTS)

Using the proper installation techniques is critical to having a good culvert crossing.

Critical areas for attention during installation include:

- invert elevation for the inlet of the culvert;
- invert elevation for the outlet of the culvert;
- erosion protection at ends of culverts; and
- installation of an energy dissipation pool.

7.1 Requirement for submission to NS Environment

No submission	Notification is required if,	Approval required if,
No option	Watercourse has a slope of less than 0.5% and structure is designed by certified sizer, or Watercourse has a slope of less than 8% and structure is designed by professional engineer, and Watershed above crossing site is less than $20km^2$, and Culvert is less than 25 metres long, and Work is completed between June 1 and September 30	conditions of notification are exceeded or wetland is altered

7.2 Environmental Considerations

See environmental and planning considerations in section 6.

Streams provide a means for fish and wildlife to move within a watershed for the purpose of finding food, to reach habitats suitable for reproduction, and to avoid extreme conditions (such as increased water temperature). Migration is essential to the survival of most fish species.

Watercourse crossings if not properly sized and installed can prevent fish passage and create an impediment to other wildlife. Hung or perched culverts have become an issue in many watersheds in Nova Scotia. Culverts with outlets that are elevated above the level of the downstream channel, or perched culverts, are the result of improper installation or scour at the outlet due to increased flow velocity.

Maintaining culverts, such as the removal of blockages, is essential to maintaining the continuity of the watercourse habitat without impediments to movement. Therefore, it is critical that culverts are checked and maintained on a regular basis for the life of the structure and this will ensure that passage is maintained.

Climate change is leading to increased risk of flooding as extreme precipitation events become more frequent, this risk is increased by erosion and sedimentation that affects the watercourse flow. When considering watercourse crossings it is important to design and install the alteration with climate change in mind. Future climate conditions can have a significant impact on the function, maintenance and longevity of the crossing structure, and can cause serious impacts elsewhere along the watercourse and floodplain if not designed properly.

7.3 Planning

A notification may be submitted to NS Environment for a culvert that will be installed in a watercourse with a slope of 8% or less.

A certified sizer or professional engineer needs to select the type of structure and size the culvert, which will be installed in a watercourse slope of 0.5% or less.

A professional engineer must design culvert crossings in watercourses with slopes exceeding 0.5 % (up to 8.0% gradients). The design must follow the ***Guidelines for the design of fish passage for culverts in Nova Scotia***, Fisheries and Oceans Canada, Fisheries Protection Program, Maritimes Region (as updated from time to time).

Ask the certified sizer or professional engineer working on the project for the following information as appropriate for the project:

- Type of structure to be installed, including:
    - size of structure – diameter in the case of circular pipe culvert; height and width for box culverts, bridges and arch culverts; and,
    - type of material.
- Watercourse profile diagram for pipe culverts and other closed bottom structures that includes:
    - Location of inlet and outlet of structures;
    - Elevations of inverts of the inlet and outlet;
    - Size, location, dimensions of the energy dissipation pool (EDP);
    - Elevation and location of the downstream control (the downstream control as a natural riffle that is not to be disturbed);
    - Showing the natural streambed between the EDP and the natural downstream control riffle being undisturbed; and
    - Location of survey benchmark.
- Type and size of erosion protection at inlet and outlet of structure: headwall or rip-rap; wingwalls or rip-rap.
- Size of EDP and size of rip rap for the pool including the material to be used for scour protection (to withstand 1:100 year flood event) in the downstream end of the pool (the area from the bottom of the outlet of the pool up to the natural streambed).
- Recommended type of water control (coffer dam, diversion, dam and pump) and dimensions. The type of water control may be determined with the certified watercourse alteration installer.

> BE SMART, BE PREPARED
> In the event something goes wrong before, during or after construction, have a backup plan for water control and remedial material on site. Remedial material would include sandbags, rip-rap, sediment, fencing, pumps, hoses, etc.

7.4 Construction

Follow the Nova Scotia Watercourse Alterations Standard if under notification process: General Conditions and Culvert sections. Also follow the design and sizing provided by the certified sizer and/or professional engineer involved in the project.

If work is completed under an approval, follow the terms and conditions of the approval.

7.4.1 Culverts: Single culvert or other single closed-bottom crossing structure installed with a watercourse slope less than or equal to 0.5%

In order to install a culvert properly, the elevation of the inlet and outlet of the culvert must be considered carefully. The elevations are important to ensure fish passage and to prevent hung culverts (perched culverts) where the culvert outlet creates a "waterfall".

The elevation of the culvert inlet invert must be set equal to the thalweg of watercourse elevation at the inlet location.

- The elevation of the culvert inlet invert must be set equal to the thalweg of the watercourse elevation at the inlet location.
    - The invert is the floor or bottom of a culvert.
    - The thalweg is the deepest/lowest channel in a watercourse. The elevation of the thalweg is the line joining the lowest points lengthwise of the bed of a watercourse defining its deepest channel.
- The culvert outlet invert elevation must be set at a depth equal to 20% of the culvert diameter/height, to a maximum of 0.4m, below the downstream control thalweg elevation.
    - The downstream control elevation is the first natural undisturbed riffle downstream. This first downstream riffle is a natural, undisturbed riffle that does not get altered.
    - A riffle is shallow water extending across the bed of a flowing watercourse with rapid current and with surface flow broken into waves by gravel and cobble.

Important notes:
If the culvert has an apron, the downstream end of the apron must be embedded at a depth equal to 20% of the culvert diameter/height, to a maximum of 0.4 m, below the downstream control thalweg elevation.

While watercourse alteration sizers will provide this information to installers, installers should confirm elevations in the field prior to placement of the culvert. Elevations should be confirmed before disturbing the watercourse and after preparing the foundation for the culvert.

See figure 7-1 titled Watercourse Profile Section View for a depiction of elevations in the watercourse.

See figure 7-2 for a general description of proper installation of a culvert without fish baffles in a watercourse with a slope of 0.5% or less.

NOTE: Culverts may be designed to be installed at greater than 0.5% slope. The notification criteria require that the watercourse slope not exceed 0.5%, but to accommodate a proper culvert installation the culvert may require a greater or lesser slope

Figure 7-1 Example of watercourse profile diagram .

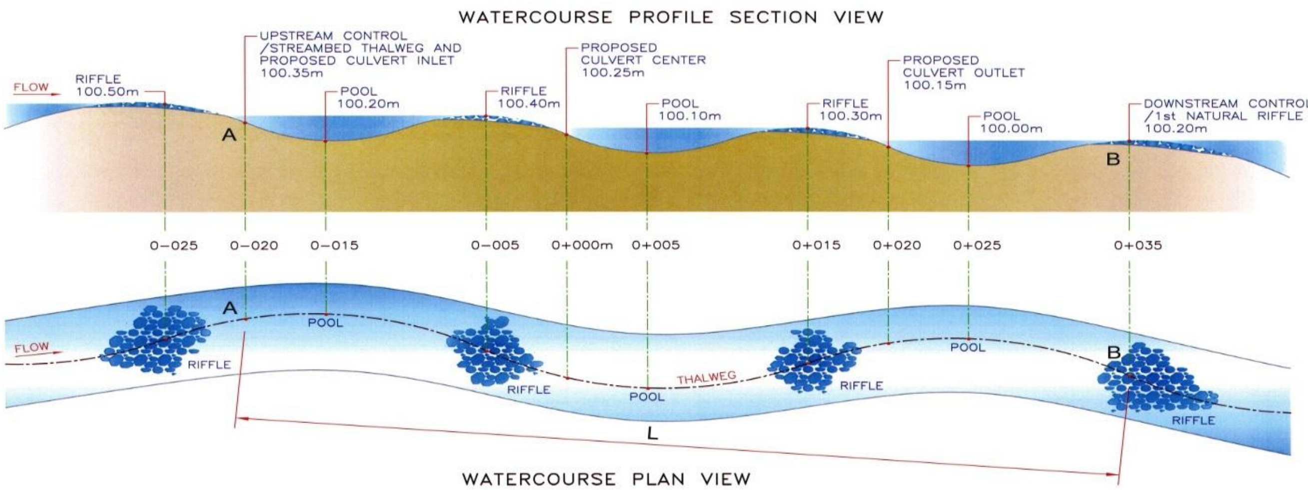
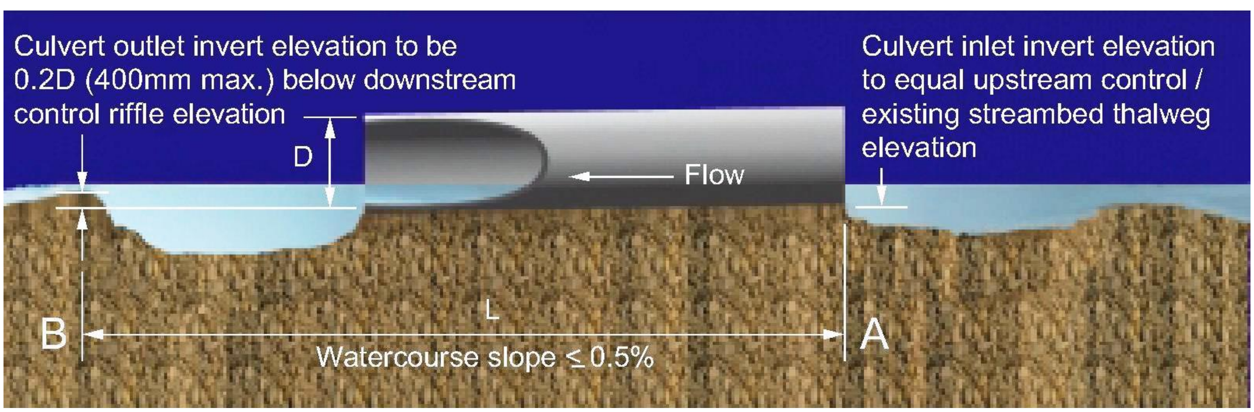


Figure 7-2 Culvert installation when watercourse slope is 0.5% or less



7.4.2 Single culvert or other single closed-bottom crossing structure installed with a watercourse slope greater than 0.5% but less than 8.0%

Closed bottom culverts installed in watercourses with a gradient exceeding 0.5% require engineering and must adhere to the ***Guidelines for the design of fish passage for culverts in Nova Scotia***, *Fisheries and Oceans Canada, Fisheries Protection Program, Maritimes Region,* (as updated from time to time)**.**

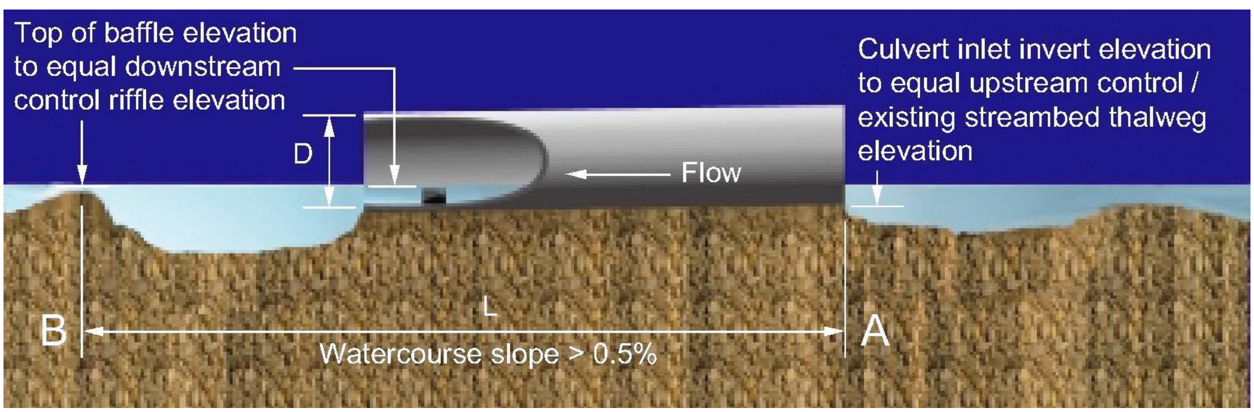
Follow the instructions from the professional engineer for:

- Embedded culvert greater than 4000 mm in diameter, or,
- Culvert with baffles

See figure 7-3 for general description of proper installation of a culvert with fish baffles.

The engineering requirement for fish passage in closed bottom culverts can be avoided by choosing to install an open bottom structure (such as pipe arches) or a bridge. In areas where the stream slope is in excess of 0.5 %, installing an open bottom structure, such as an arch culvert or a bridge, may be the best option for maintaining natural watercourse morphology which is best for aquatic life and fish passage.

Figure 7-3 Culvert installation when fish baffles are needed



7.4.3 Multiple culverts

A single culvert crossing is preferred over multiple culvert installations. When a single pipe culvert is not applicable than an open bottom crossing structure should be considered as an alternative. Multiple culverts are not recommended for fish-bearing streams because they are more likely to become blocked than a single large culvert. Debris blocking multiple culvert installations can often lead to flooding and may compromise the structure integrity. Fish passage is also problematic when multiple culverts become blocked.

In the rare instance that a multiple culvert installation is approved by Nova Scotia Environment the conditions would have to be shown such that the installation is the only engineering solution for a low cover situation, for a wide channel, or for a high outlet velocity situation. The design would have to be approved by NSE and there is no option for a Notification.
If you are hired to install a multiple culvert crossing some key installation features should be kept in mind:

- Minimizing the space between the culverts to reduce the amount of granular material and clay seals is desirable.

- Horizontal space between two adjacent culverts should be 1 culvert diameter/span or 1.0 m, whichever is the greater.

- One pipe must be designed to pass higher flood flows and the other, main pipe must be installed as the primary fish passage structure.

- The pipe dedicated to fish passage must be installed lower than the flood culvert(s) (i.e. the "overflow culvert") to ensure low flows are not split, which might otherwise provide insufficient flows or depth for fish passage.

7.4.4 All culverts

The steps for installing a culvert have been separated into the following categories:

- Installation
- Backfilling
- Stabilization
- Energy dissipation pool

7.4.4.1 Installation

Employ appropriate water control method prior to any culvert installation. Consider stream conditions such as bank slope, stream gradient or water flow in making the decision.

Streambed Foundation

Install the culverts on a firm and level foundation providing proper support to prevent sagging. The extent of excavation of the streambed and preparation of the culvert foundation will differ depending on the natural material in the streambed.

When preparing the foundation ensure that the elevations of the finished foundation at the culvert inlet and outlet locations are in accordance with the instruction from the watercourse alteration sizer or engineer.

<u>Solid Streambed Foundation</u>:

- Where the streambed is solid and level (e.g., gravel, cobble), apply a thin layer of clean gravel.

- Where the streambed contains protruding rocks that may damage the culvert, the rocks should be removed and a layer of clean gravel should be applied.

<u>Soft Streambed Foundation:</u>

- Where the streambed is soft (e.g., mud or silt), excavate to firm ground and apply a layer of clean gravel.

- Excavation of the streambed should be kept to the absolute minimum area necessary to install the culvert.

Do not compact the streambed foundation material.

Do not install a camber under the pipe. Always set the pipe on a solid foundation.

After placing the foundation, check elevations at the inlet and outlet locations.

Align culverts as closely as possible with the stream channel. See figure 6-1.

Backfilling

Once the culvert is situated properly on the streambed, begin the process of backfilling. When properly placed, backfill should provide even support to both sides of the culvert and be compacted well enough to prevent culvert washouts. The following guidelines suggest what material to use and how to place it.

Backfill Material:

- Backfill material should be composed of clean, well-graded pit run gravel less than 5 cm (2 in) in diameter or coarse sand. Clay may also be used if compaction is done properly.

- Backfill material should not consist of mud, fine sand or silt as these substrates may contribute to culvert washouts and sedimentation.

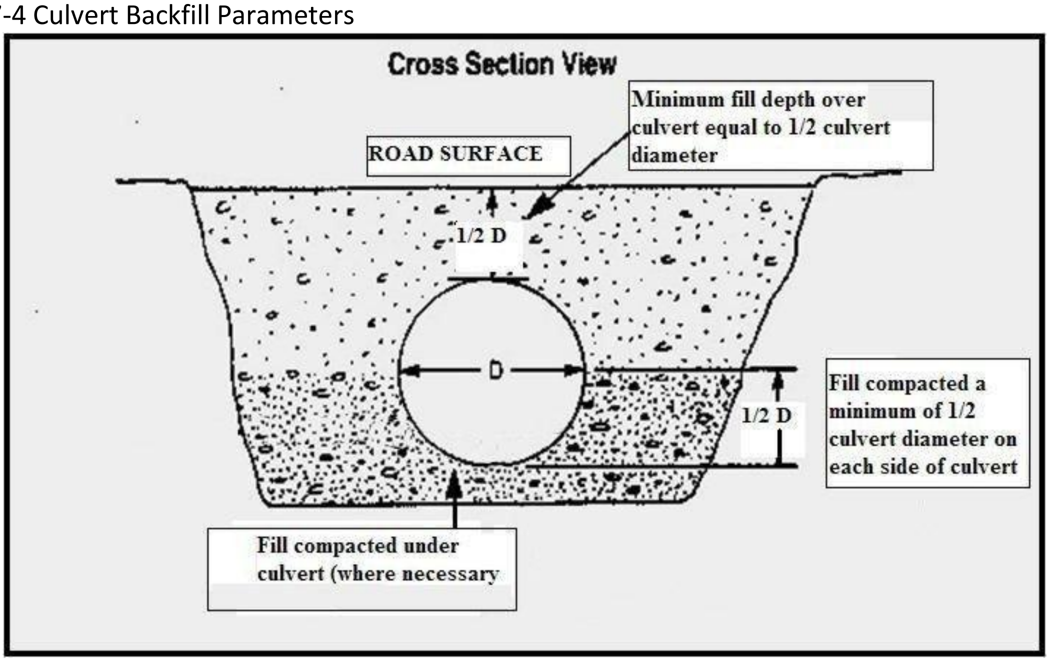
Backfill Equipment:

- Compaction can be completed using hand tampers or mechanical equipment, tamping rollers or vibrating compactors.

Backfill Placement (see figure 7-4)

- Compact backfill evenly on each side in layers of 15 cm (6 in) thick. Balance the layers on both sides to prevent the culvert from bending out of shape.

Figure 7-4 Culvert Backfill Parameters



- For pipe arch culverts, it is necessary to place and compact layers of backfill in the middle of the culvert first to maintain the shape of the arch.

- Compact backfill by hand along the haunches, the crevices formed where the culvert meets the streambed. This will help to avoid any unnecessary shifting or lifting of the culvert. At this time, also ensure that there are no voids or soft spots left between the culvert and the streambed surface.

- When compacting along the haunches, do not push backfill under the culvert.

- Compact backfill material up to the top of the culvert.

- Backfill should be placed a minimum depth of one-half the culvert diameter above the culvert and extended one culvert diameter on each side.

Stabilization

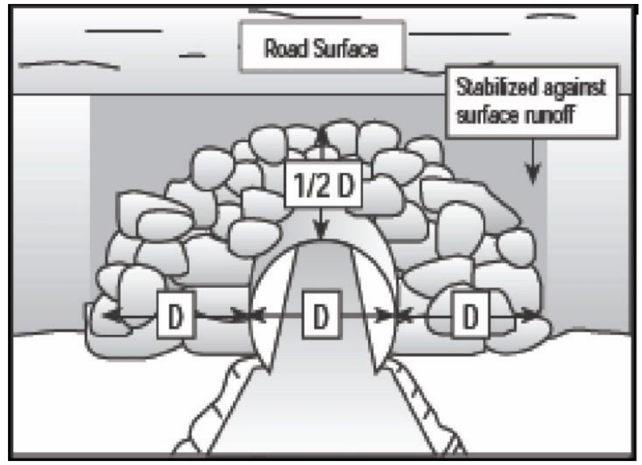
The inlet and outlet ends of a culvert can be stabilized using rip-rap, headwalls or wingwalls. These structures protect the culvert ends against scouring and erosion. The general standards for use of these structures are as follows:

- The standard placement of these structures is one-half the culvert diameter above and a minimum of one culvert diameter to each side of the culvert (figures 7-5 and 7-6).

- Place these structures immediately upon completion of the installation.

- Stabilize the area above rip-rap, headwalls or wingwalls with vegetation for a distance of 0.5 m (1.6 ft).

Figure 7-5 Culvert end Stabilization



The following information is specific to each structure type.

Rip-rap

Proper stabilization requires the placement of rip-rap or headwalls and wingwalls at both ends of a culvert to an elevation of at least one-half of the culvert diameter/height above the top of the pipe and a minimum of one culvert diameter/height on each side of the culvert.

- If rip-rap is used, the foreslopes shall not be any steeper than 2 horizontal to 1 vertical.

- Rip-rap sizing must follow the chart in Table 1. The proper size of rip-rap should be provided by the certified sizer or engineer working on the project. (Calculations to determine the correct size of rock (Class 1, 2 or 3) are included in Appendix D of the manual)

Table 1: Rip-rap stone size chart.

Class 1 1:100 year flow velocity up to and including 3 m per second	Class 1 At least 70% of the rip-rap must be between 0.3 m and 0.45 m
Class 2 1:100 year flow velocity greater than 3 m per second and up to 4 m per second	Class 2 At least 70% of the rip-rap must be between 0.3 m and 0.75m
Class 3 1:100 year flow velocity above and including 4 m per second	Class 3 At least 70% of the rip-rap must be between 0.5m and 1.2m

- "rip-rap" means rock, cobbles, boulders, or broken stone placed along the bank or bed of a watercourse as protection against erosion by water or the elements. Rip-rap must be a well-graded mixture that consists of clean, hard, sound, durable rock.

- Rip-rap should be clean, inorganic, non-ore-bearing, non-toxic material from a non-watercourse source. It should be hard, resistant to weathering, angular in shape.

- Place rip-rap around both ends of the culvert using the following procedure:

    - Grade the fill slope to a 2:1 slope (horizontal:vertical).

    - Place a layer of filter fabric or a thin layer of gravel over the graded area to prevent the soils underlying the rip-rap from washing out. Filter fabric should not be used in-water, below the ordinary high water mark, only above the high water mark.

    - When placing rip-rap in an area close to a watercourse or along the bank of a watercourse, place the rip-rap by hand or using machinery capable of controlling the drop of a rock rather than dumping it over the exposed area. Dumping of rock can result in infilling of the watercourse and encroaching on the water channel. This can lead to restricted flow area, altered flow patterns and scouring of the bank of the watercourse.

    - Maintain a minimum thickness layer of 1.5 times the maximum rock size.

Headwalls

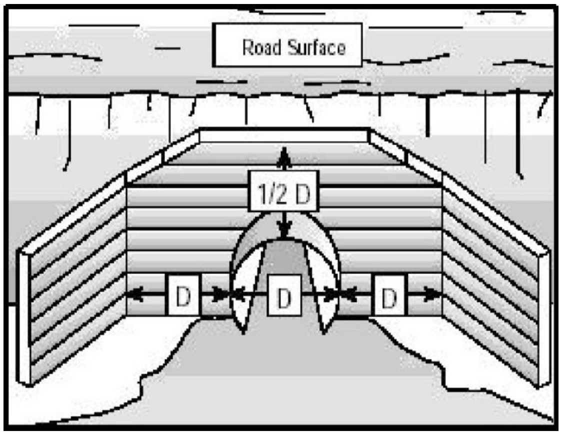
Headwalls are vertical walls that parallel the roadway. They are placed around the end of the culvert and extend back into the slopes of the road embankment. Headwalls may be used alone or in conjunction with rip-rap.

Headwalls are generally installed to:

- Retain the roadway embankment preventing fill materials from entering the watercourse.

- Anchor the culvert against buoyancy uplifting potentially caused by debris or ice damage.

Figure 7-6 Culvert End Stabilization



Provide support to the culvert inlet allowing for the shape and waterway opening of the culvert to be maintained.

- Improve water handling capacity of the culvert by directing water flow.

- Prevent seepage through the backfill and into the watercourse.

When constructing headwalls:

- Excavate the location for the headwalls below the thalweg depth.

- Use squared timber, concrete, gabion, etc. to build the structure.

- Anchor headwalls into the bank for stability.

Wingwalls

Wingwalls are lateral walls similar to headwall except that they extend out from the road embankment at the inlet and outlet ends of a culvert at an angle.

Information listed in the Headwalls section also applies to the purpose for and construction of wing walls.

KEEP IN MIND
Use of headwalls and wingwalls will reduce overall culvert lengths because it eliminates the need for a 2:1 slope on each end.

7.4.5 Energy Dissipation Pool

Energy dissipation pools should be constructed at the outlet of all culverts, both culverts with baffles and those without baffles. The use of an energy dissipation pool serves two purposes:

- to dissipate the extra energy of the water resulting from the culvert placement and to prevent watercourse destabilization resulting in a perched culvert outlet; and

- to provide a resting area for migrating fish before using prolonged swimming speeds to swim through the culvert

The following criteria must be followed during construction:

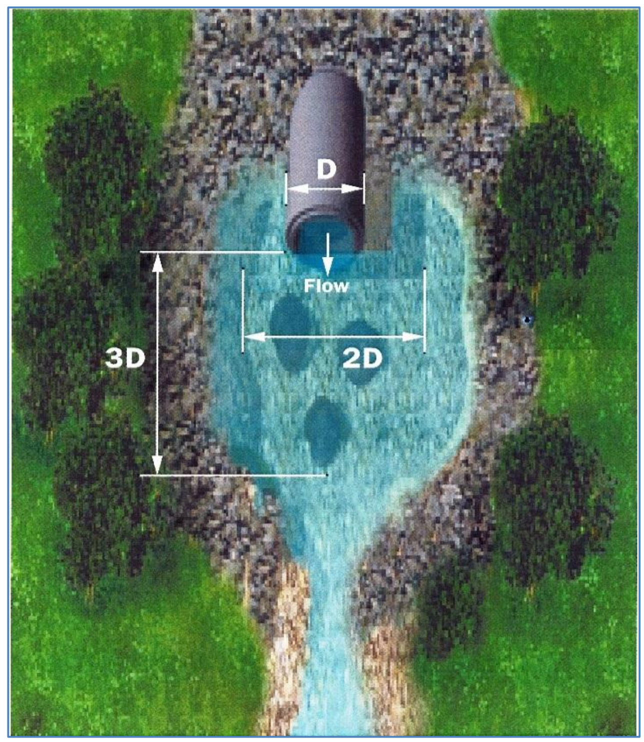
- The energy dissipation pool should be stabilized to prevent scour and erosion. The size of rip-rap stone in the dissipation pool by the 1:100 year flood event.

- A filtration layer of gravel (i.e., Gravel Type 2) should be placed under the rip-rap to prevent erosion.

- Three boulders should be placed in the pool in a triangle pattern (refer to figure 7-7) in order to further dissipate energy and provide fish habitat. For culverts equal to or less than 1.5 m the diameter of the boulders should be approximately 0.75 m. For culverts greater than 1.5 m the boulder diameter should be approximately 1m.

- No filter fabric is to be used in the construction of the pool.
- The average depth of the pool must be a minimum of 1m. See figure 7-8.
- The width at the bottom of the dissipation pool is to be 2 times the culvert diameter (D) or the box width (W).
- The length at the bottom of the dissipation pool is to be 3 times D or W.
- At the downstream end of the dissipation pool (at 3D/W), the slope up to the existing elevation of the natural stream is to be constructed at no more than 1:2 (vertical: horizontal). This area of the pool is to have rip-rap scour protection to withstand a 1:100 year flood event. See figure 7-8.
- An appropriate amount of fine granular material, gravel borrow or pit run material (20% fines, does not include clays) should be mixed with the rock mixture to ensure that the interstitial spaces are filled so that water is not lost. When completed properly and to ensure fish passage, water should flow over the rip rap and not completely disappear.
- To avoid sedimentation of the watercourse downstream, the newly constructed energy dissipation pool should be "washed" thoroughly to dislodge any fine material. The wash water should be pumped away from the watercourse to prevent sedimentation of the watercourse. Once the wash water is running clean then the permanent watercourse can then be re-directed through the culvert

Figure 7-7
Energy Dissipation Pool Dimensions



Important Elevations

The elevation of the first natural riffle downstream (downstream control) of the energy dissipation pool is important to ensure proper backwatering into the culvert and to prevent a perched culvert.

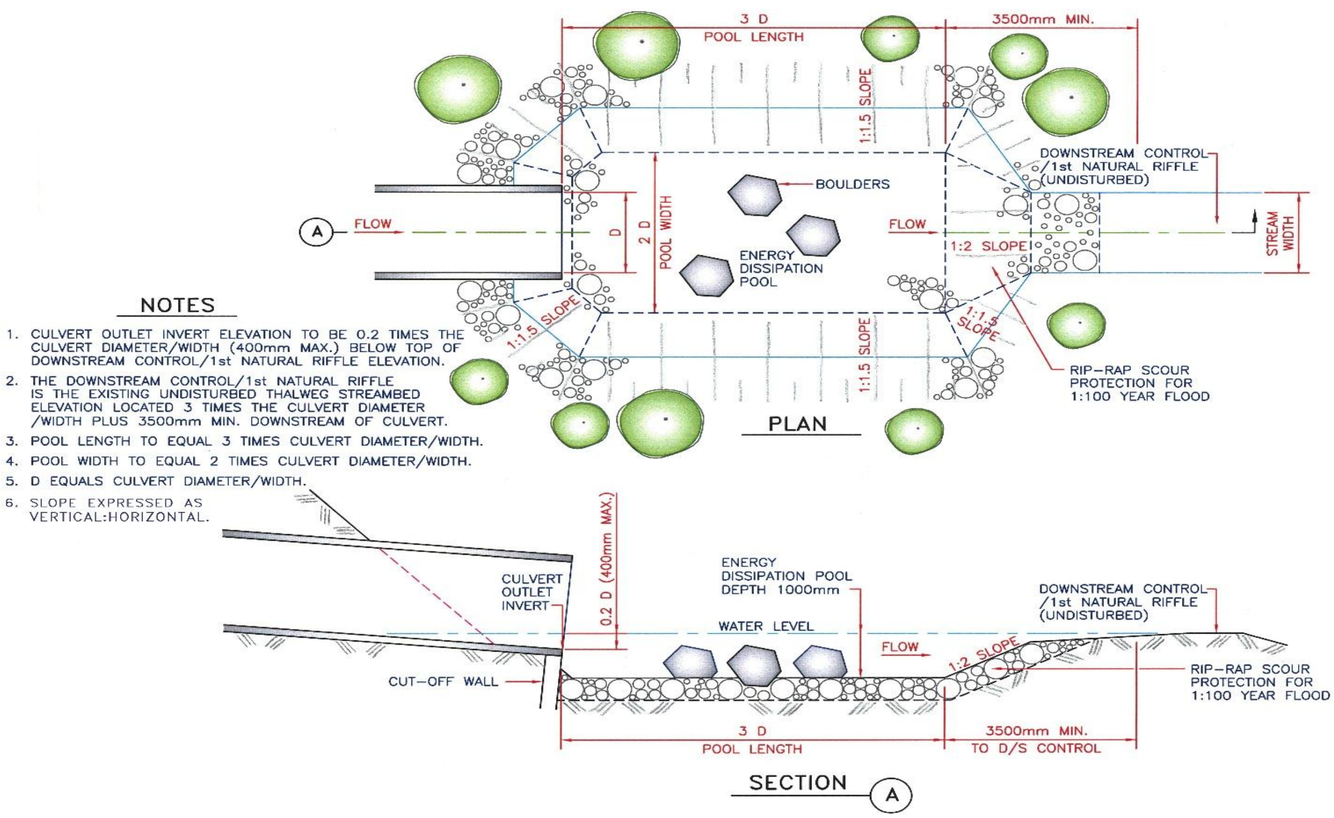
The downstream control is a natural, undisturbed riffle that does not get altered. The downstream control is the thalweg elevation of the streambed at the first natural undisturbed riffle / step located at a distance of 3 times the culvert diameter plus a minimum of 3.5 metres downstream of the culvert.

If the first downstream control riffle/step falls within the location of the proposed energy dissipation pool the design must use the next downstream riffle/step in the design and calculations.

The elevation of the first natural riffle downstream (downstream control) should be included on the stream profile diagram from the designer or engineer working on the project.

If the culvert does not have baffles (in a watercourse with a slope of 0.5% or less), the elevation of the culvert outlet invert is 0.2 times the diameter(D) below (or up to a maximum of 400mm) the downstream control riffle elevation (the first natural riffle located downstream). Or in other words, the natural riffle elevation should be 0.2 times D higher than the culverts outlet invert elevation. See figure 7-8.

Figure 7-8 Energy Dissipation Pool for Culverts in watercourses with a slope of 0.5% or less.



If the culvert has baffles, the elevation of the first natural riffle downstream must be the same as the top elevation of the last baffle in the culvert. This elevation should be provided by the engineer working on the project. See figure 7-9.

Figure 7-9 Energy Dissipation Pool for Baffled Culverts

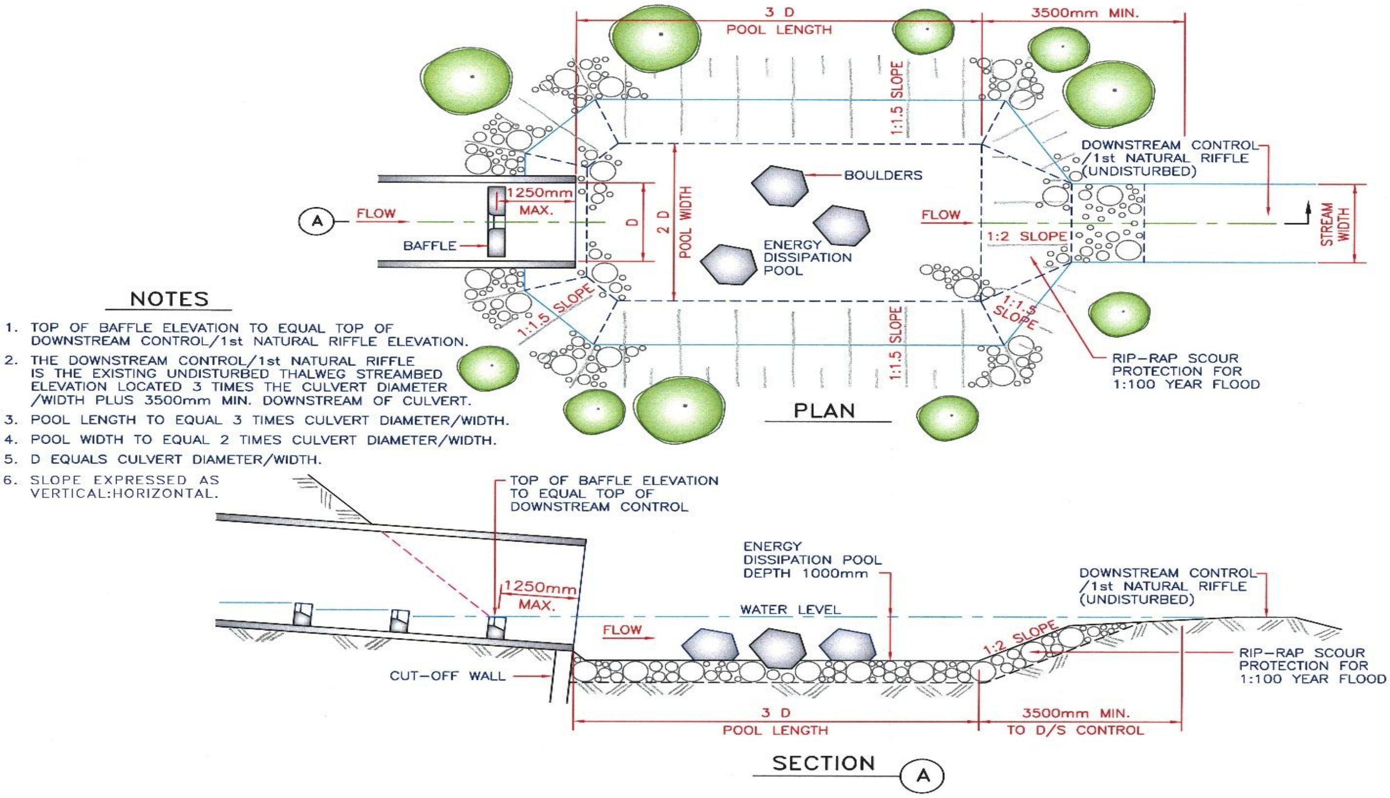
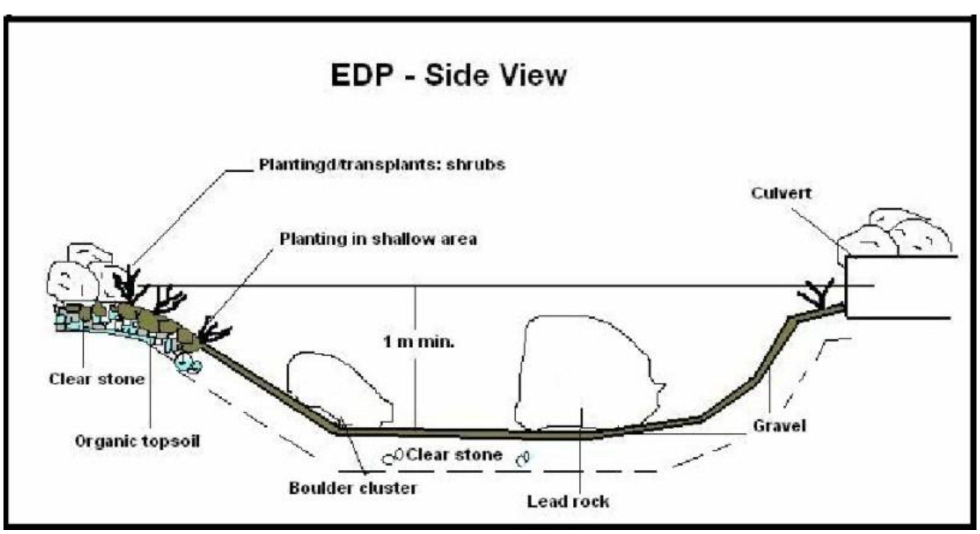


Figure 7-10 Energy Dissipation Pool – side view



Vegetation

Following completion of the energy dissipation pool, plant shrubs, bushes/or trees, interspersed with willow, dogwood or alder live stakes, at 1 m (40 in) spacing along the sides of the energy dissipation pool. These will be planted within the 3 m (10 ft) wide zone bordering the shoulder of the pool. See figure 7-10.

7.4.6 SITE CLEAN UP

Remove all material from the site upon completion of the installation and dispose of it away from the watercourse. Materials may include excavated soil, wood debris, excess rip-rap, etc. A good clean-up results in the site being returned as close as possible to its original condition.

Do's and Don'ts of Culvert Installation

Be Organized

DO!

Have all materials and equipment at site.

Have a contingency plan.

Watch the weather.

Address:

- Erosion and sediment control,
- Fish habitat and passage concerns,
- Control of beaver problems, and
- Work safely.

Installation

DO!

Shape foundation and form haunches.

Use compactable material.

Place backfill in layers 150-300 mm thick material.

Compact within one (1) dia. each side of pipe.

Keep fill depth same both sides; max vertical difference 400 mm.

Use hand compaction equipment within 300 mm of pipe; limit cobbles to 75 mm.

Compact at optimum water content.

Monitor shape and grade control.

Add cover for protection.

DO NOT!

Use frozen material.

Use very dry or very wet material.

End-dump or doze against culvert.

Let heavy equipment within 3 metres of construction site.

7.4.7 REPLACING CULVERTS

The same standards and guidelines for new culvert installation apply to replacement of existing culverts. Any structure on existing roads that is crossing a wetland will require an approval for installation or repair.

7.4.7.1 Replacement of Closed Bottom Structure with another Closed Bottom Structure

For a replacement culvert, sizing and application requirements will be the same as for a new culvert installation. The replacement culvert can be sized by a Certified Sizer or professional engineer and submitted under notification if the following conditions are met:

- the length of the culvert or structure is 25 m or less;
- the watercourse slope is 0.5% or less;
- the watershed of the watercourse crossing is 20 km^2 or less in area; and,
- the work begins on or after June 1 and ends on or before September 30.

Excavated materials associated with the structure being replaced are generally at least partially saturated and should not be used to backfill around the new culvert. Excavated materials should be removed and replaced with imported clean, dry backfill material suitable for compacting.

7.4.7.2 Replacement of a Closed Bottom Structure with an Open Bottom Structure

Closed-bottom culverts can be replaced with open-bottom culverts. In certain instances, it may be appropriate to replace a closed-bottom with an open-bottom culvert due to their ease of installation or to re-establish a natural channel or to improve fish passage.

The utilization of open-bottom culverts in watercourses is a feasible means of conveying water flow under a roadbed in many situations. Open-bottom culverts should not be used at sites where soils are unstable or incapable of supporting the structure. **Erosion** of the banks and streambed of the newly constructed structure is of concern and must be considered during planning. If in-situ soft, organic bed material is exposed when the existing culvert is removed, the site may not provide adequate support for the new structure and may be susceptible to erosion. An open-bottom culvert may not be the most appropriate structure to use at this location and geotechnical investigations may be required.

The removal of a closed-bottom culvert or other structure requires careful planning to ensure that the removal does not impact on the watercourse. The use of open-bottom culverts as a replacement requires the re-establishment of the watercourse channel. Ensuring the channel is properly sized and constructed is of the utmost importance.

- The culvert shall be designed such that after it is installed, the end area available is adequate to ensure that the stream flow velocity does not exceed 1.8 m/s during a 1 in 100 year discharge event.

Downstream sedimentation, **proper design and construction of a new stream channel**, **erosion**, and **fish passage** are four environmental concerns that must be addressed for this type of installation.

Downstream sedimentation can occur if proper controls are not in place during the removal of the existing structure. A dam and pump-around or temporary diversion are two of the techniques that can be utilized to perform work in isolation of the stream flow and to ensure the natural flow of water downstream is uninterrupted and its quality maintained.

The **new channel** under the open-bottom culvert shall be constructed with a depth and width similar to the existing natural channel in the vicinity of the crossing. The channel size, width and depth, can be determined by averaging five measurements upstream of the proposed site. These measurements should be made in a reach of channel that was not altered as a result of the installation of the existing structure. (See section 3.2.3 for tips on how to identify/measure channel width and depth.)

Fish passage facilities are not required if the open-bottom culvert meets the following design criteria together with the "Construction" guidelines below:

- a maximum length of 25 metres;
- the span of an open-bottom culvert is no greater than 3600 mm;
- the new open-bottom culvert is installed along the same alignment as the culvert it replaced; and
- a low flow thalweg (channel) is created to provide fish passage. It should match the natural watercourse so that the water is concentrated during periods of low flow.

The new defined channel shall be lined and the banks stabilized with clean rock to provide stability during a 1:100 year storm. The channel must be lined in a manner so water does not disappear into the interstitial spaces between the rocks. An appropriate amount of fine granular material, gravel borrow or pit run material (20% fines, does not include clays) should be mixed with the rock mixture to ensure that the interstitial spaces are filled so that water is not lost. When completed properly and to ensure fish passage, the water should flow over the rip rap and not completely disappear.

If the natural stream bottom has boulders then the new channel should mimic the original channel by adding boulders 1.5 times the maximum size found in the original stream and include embedding 30 % of their diameter and place them every 5-10 m in an alternating pattern.

To avoid sedimentation of the watercourse downstream, the newly constructed channel should be "washed" thoroughly to dislodge any fine material. The wash water should be pumped away from the watercourse to prevent sedimentation of the watercourse. Once the wash water runs clean then the permanent watercourse can then be re-directed through the culvert.

This type of replacement structure is less likely to be dammed by beavers compared to closed-bottom culverts.

The removal of a closed-bottom culvert or other structure requires careful planning to ensure that the removal does not impact on the watercourse. The use of open-bottom culverts as a replacement requires the re-establishment of the watercourse channel. Ensuring the channel is properly sized is of the utmost importance.
The open bottom structure shall be designed such that after it is installed, the end area available is adequate to ensure that the stream flow velocity does not exceed 1.8 m/s during a 1 in 100 year discharge event.

Open-bottom structures should not be used at sites where soils are unstable or incapable of supporting the structure.

7.4.8 Culvert Lining

Culvert lining is the re-enforcing of a closed-bottom culvert necessitated by a failure of the structural integrity of the structure. This would include replacing the bottom of corroded steel culverts with concrete or other material or inserting sleeves inside weakened or deformed culverts.

Culvert lining is considered to be a modification to an alteration or structure. The work can be done under Notification so long as the reduced capacity of the culvert meets the regulatory requirement of having a capacity to accommodate the peak flow for a 100 year return period (see section 5.3) and meets Fisheries and Oceans fish passage requirements as per the ***Guidelines for the design of fish passage for culverts in Nova Scotia***, **Fisheries and Oceans Canada,** Fisheries Protection Program, Maritimes Region (as updated from time to time).

7.5 DECOMMISSIONING / REMOVAL

Decommissioning or removing a culvert which is no longer in service or needs to be replaced must take place in the dry (a dam and pump procedure). The area of the watercourse where the culvert has been removed must be constructed as per the instruction in section 7.3.7.3 (creating a new watercourse channel).
All materials removed from the watercourse such as the culvert shall be disposed of at an approved facility, and overburden shall be removed a sufficient distance from the watercourse to ensure that the material will not re-enter the watercourse.

8 BRIDGES, PIPE ARCHES AND OTHER OPEN BOTTOM CROSSING STRUCTURES

Open bottom crossing structures include bridges, open bottom arches, and open bottom timber box culverts. Open bottom structures help to maintain the natural features and the cross sectional area of a watercourse channel and therefore aquatic habitat and natural water flow can be maintained.

Open bottom structures which do not encroach on the channel of the watercourse, generally have fewer maintenance issues, such as debris blockage clearing and flooding. This type of structure is less likely to be dammed by beavers than circular culverts.

8.1 Requirement for submission to NS Environment

No submission*	Notification is required if,	Approval required if,
If the bank or bed of watercourse is not altered, and structure and associated works do not disturb watercourse. Example: bridges that entirely span watercourse and their associated works (erosion protection) do not alter the bank or bed of the watercourse.	**Bridge:** span is 15 metres or less, and abutments or associated works disturb the banks of the watercourse, and bed of the watercourse is not altered, and work is completed between June 1 and September 30. (example: single span bridge) **Other open bottom structure:** span is 3600 mm or less, and arch cannot be more than 25 metres long, and bed of the watercourse is not altered, and bank of the watercourse is altered, and work is completed between June 1 and September 30.	conditions of notification are exceeded or the bed of the watercourse is altered, or wetland is altered

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

8.2 Environmental Considerations

Bridges, pipe arches, and other open bottom structures are the preferred crossing structures for aquatic ecosystem protection because the natural features of the watercourse can be maintained. Preserving natural features, helps to maintain the habitat for many species of vertebrates and invertebrates that inhabit the watercourse and areas adjacent to the watercourse. Allowing unrestricted movement through the crossing and within the watercourse and watershed is essential for access to feeding areas and to breeding and spawning areas. Effects of the crossings on riparian lands (for example, flooding and scour) can degrade habitat of riparian plant and animal species.

8.3 Planning

Erosion/sedimentation and fish passage are two of the environmental issues that must be addressed with this type of installation. An open-bottom culvert avoids the requirement for fish passage facilities as long as it is installed such that the placement of the structure including the foundation and any associated excavation takes place from the banks of the watercourse landwards.

The crossing should be installed over a reach of stream channel that is relatively straight and well defined. Aligning the crossing structure to the alignment of the watercourse is necessary in order to avoid scour of the watercourse banks and scour around the structure.

Request information related to the structure (eg. size, type) from the certified watercourse alteration sizer or professional engineer involved in the project.

- Properly sized bridges shall have the capacity to accommodate a 100 year return period of peak water flow. This means that there is a probability of a peak flow event occurring once every 100 years.

- Bridges must be designed to accommodate a maximum flow velocity of less than or equal to 1.8 m / s.

The length of the bridge must be equal to or exceed the width of the watercourse at the crossing site.

Bridge abutments must be placed outside the bank full width of the channel to avoid constriction of the natural flow of water and reduction of the channel cross-section.

It is recommended to use bridges or open bottom structures if:

- Watercourse slope is greater than 0.5 %, or

- if a circular / pipe culverts would need to be greater than 1.8 m (6 feet) in diameter (or equivalent size of pipe arch culverts.

8.4 Construction

Follow the Nova Scotia Watercourse Alterations Standard if under notification process: General Conditions and section for bridges and other open-bottom structures. Also follow the design and sizing provided by the certified sizer or the professional engineer involved in the project.

If work is completed under an approval, follow the terms and conditions of the approval.

8.4.1 Key considerations

8.4.1.1 Excavation

Align abutments with the stream banks so they do not direct the flow into the banks of the watercourse.

Set the base of the abutment below the possible depth of scour to prevent undercutting and scouring beneath the base of the abutment. This will require excavation to properly prepare the base and install the abutment.

Locate the abutments or footings at a minimum elevation below the thalweg of the watercourse as shown in figure 8-1.

In order to avoid disturbing the bed of the watercourse, consider the depth of your excavation for the installation of footings/abutment and ensure you are able to complete the work without excavating the bed of the watercourse. For example, the centre of the footing/abutment may need to be located 1 m (3 ft) back from the shoulder. An approval is required if the bed will be disturbed.

Avoid constricting or blocking water flow.

If the bed of the watercourse is impacted, the terms and conditions in the watercourse alteration approval must be followed. The watercourse must be re-constructed in a manner that allows fish passage and should mimic the morphology or features of the watercourse upstream and downstream of the crossing.

Clearing activities within 30 m (100 ft) of the watercourse should be limited to the absolute minimum required to install the structure and to stabilize the foreslopes. Grubbing should be restricted to that portion of the right-of-way which underlies the actual footprint of the roadbed.

The foundation must be stable or reinforced such that they are capable of supporting the structure and the loads traveling over them. Follow instruction from manufacturers and from professional engineers. The following are guidelines:

- If the foundation is firm, excavate to a minimum depth of 30 cm (12 in) below the streambed level.
- If the foundation material is very soft, excavate to a depth of 60 to 90 cm (24 to 36 in) below the streambed level.
- Where the foundation is not composed of bedrock, level the foundation and place a layer of well compacted gravel 15 cm (6 in) thick. In soft foundation, separate the layers using filter fabric.

8.4.1.2 Placement/construction of structure

Locate the abutments or footings at a minimum elevation below the thalweg of the watercourse as pictured in figure 8-1.

Abutments or footings must be placed outside the bank full width of the channel to avoid constriction of the natural flow of water and reduction of the channel cross-section.

Prefabricated structures shall be installed using machinery that can lift the components into place. Prefabricated structures should not be dragged across a watercourse into position.

There should be no voids between the footings of a prefabricated open-bottom culvert and the bedding material they are founded on.

When installing an open-bottom culvert, the manufacturer’s specifications should be followed. The height of fill and compaction around the structure must be in accordance with the manufacturer’s specifications.

An open-bottom culvert must be founded on continuous footings. These structures may be concrete, wood, steel or other materials which will provide adequate support of the structure.

Use backfill material that is clean, well graded pit run gravel or rock with good compaction.

The area excavated for placement of a footing or abutment shall be backfilled up to the elevation of the bottom of the streambed with unshrinkable fill or clay type material which is to be installed in compacted lifts of not more than 30 cm at a time, to prevent dewatering of the streambed.

Complete construction of one abutment before beginning the second.

See Appendix B for examples of types of bridge abutments.

8.4.1.3 Stabilization

All erodible soil along the banks of the watercourse adjacent to the footings and abutments shall be stabilized. Options for stabilization include rip-rap, wingwalls and/or headwalls.

Abutment face and ends shall be protected from erosion and scour. Erosion protection material shall be installed such that it must not encroach upon the channel beyond the thickness of the largest material required, based on velocity of the watercourse.

If using rip-rap, all erodible soil must be blanketed with rip-rap without constricting the channel width as it exists in the immediate vicinity of the crossing and;

Rip-rap shall be placed around the ends of the footings at all four quadrants of the structure.

- Open bottom culverts, such as pipe arches, must be long enough to allow a stable foreslope no steeper than 2 horizontal to 1 vertical to be developed if rip rap is being used for stabilization.

- Rip-rap material must be placed at a maximum of 2:1 horizontal to vertical slope and is to be sized based on the calculated velocity of the stream (see Table 1 Section 7) and installed to minimum thickness of 1.5 times the maximum stone size.

This area must be stabilized against erosion with rip-rap or other non-erodible material which extends at least 1 span width beyond both sides of the arch and up to the shoulder of the road or at least one half the height of the arch above the structure, whichever is less.

Erosion protection rip rap, wingwalls, and headwalls must be installed below the thalweg (line of scour which is deepest channel of flow within the watercourse).

The upstream and downstream corners of the bridge abutments should be stabilized using either rip-rap or wingwalls to protect the abutment from scouring or undercutting.

Wingwalls are lateral walls that extend obliquely from the upstream and downstream ends of the abutments providing erosion control, bank stabilization and structural integrity.

- Wingwalls may be constructed from squared timber, corrugated steel or aluminum or concrete.

To construct wingwalls:

- Excavate the footprint for the wingwalls below the possible depth of scour, approximately the same depth the base of the abutments are set at.

- Use tie-backs to hold wingwalls in place against the abutments.

- As minimum, wingwalls should be built to the height of the high water mark.

8.4.1.4 Road approach

Road approaches should be straight and stable with minimal slope for a distance of 30 m (100 ft) on either side of the watercourse crossing.

Reduce right-of-way widths at watercourse crossing locations.

The bridge grade should be slightly higher than the road grade to allow flood water to cross over the road rather than damage the bridge.

When possible (for example, forestry roads), create a small dip in the road approximately 30 m (100 ft) away from the watercourse to direct surface water into an ungrubbed area or the roadside ditches.

When possible (for example, forestry roads), ditches should not be located within 30 m (100 ft) of the edge of the banks of a watercourse.

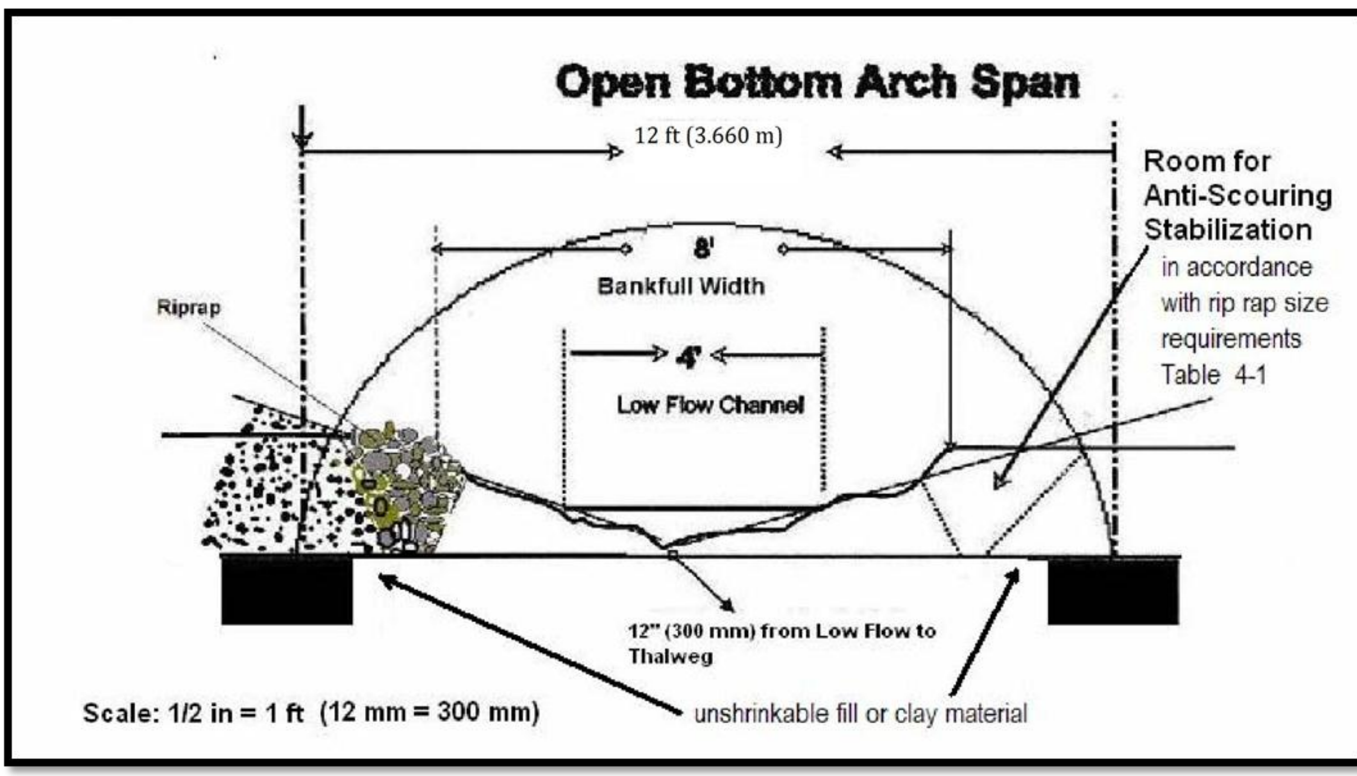
Grubbing within 30 m (100 ft) of the edge of the banks of a watercourse shall be limited to the footprint roadbed only and should begin only once construction of the crossing has begun.

8.4.1.5 Replacing a Bridge

The same guidelines for construction apply when replacing a bridge or other open bottom structure. During a replacement all standard requirements shall be met.

Note: Any structure on existing roads that is crossing a wetland will require standard approval for installation or repair.

Figure 8-1 Open Bottom Arch Span



9 PORTABLE TEMPORARY BRIDGES

Portable bridge structures for temporary crossing of streams can provide an alternative to permanent structures. Portable temporary crossings are constructed or prefabricated structures that provide access across the watercourse for a limited period of time. They are generally used:

- to provide heavy equipment with working access to a crossing under construction;
- to maintain traffic flow for the general public while an existing structure is being repaired or replaced; and,
- to provide temporary access across a watercourse for short term use (avoid fording of watercourses).

9.1 Requirement for submission to Nova Scotia Environment

No submission *	Notification is required if,	Approval required if,
If the bank or bed of watercourse is not altered, and structure and associated works do not disturb watercourse. Example: temporary structures that span the watercourse entirely. The structures need to be constructed in a manner that use does not cause a breakdown of the banks or deposits material into the watercourse and does not alter flow of water in watercourse	span is 15 metres or less, and abutments or associated works disturb the banks of the watercourse, and bed of the watercourse is not altered, and work is completed between June 1 and September 30.	conditions of notification are exceeded or wetland is altered

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

9.2 Environmental Considerations

When completed properly, portable bridges can have minimal environmental impact. Portable bridges should be considered when permanent bridges are not required or in areas shown to be environmentally sensitive which cannot be avoided. A temporary bridge is defined as a portable structure used for watercourse crossings that shall remain in place for a period not to exceed 30 days.

Fording and temporary culverts are not be used because their installation results in impact to aquatic habitat and disturbance to the bed and banks of the watercourse whereas a properly constructed portable bridge will avoid damaging the watercourse.

The temporary crossings and the approaches to the crossing must be stable and be able to withstand the planned use. For example: the approaches must be stabilized to prevent rutting and subsequent sedimentation of the watercourse, and the structure and its supports cannot sink into the bank of the watercourse.

Temporary crossings must be removed so the structure does not become a barrier in the watercourse and cause an impediment to fish passage or scour the watercourse.

9.3 Planning

Temporary bridges should not be left in place long-term because the waterway opening is typically designed to accommodate peak flows, but only those expected to occur during the period the crossing is required which must not include the spring freshet period , and the construction materials may not be appropriate for a permanent crossing. They are often constructed from untreated timbers which may collapse due to deterioration if left in place.

In Nova Scotia temporary crossing can be installed without an Approval or Notification if there is no impact to the watercourse. The following section outlines some of the expected construction methods that are to be met.

9.4 Construction

The conditions placed on construction activities are influenced by the time of year during which the crossing is to be installed and the length of time that the crossing will be in use. The installation and maintenance of the crossing must be given the same environmental considerations as a permanent crossing.

- Hydraulic design for temporary structures is based on the 1:2 year storm event based on the average flows for the period of time that the structure is to be installed; if the minimum criterion outlined below is not sufficient to allow the waters of the 1:2 year rainfall event, then additional clearance will be required between the deck and surface of water.
- The bridge must completely span the watercourse with the sills or abutments placed on firm stable ground back from the top of the bank (minimum of 1 metre) so the bank is not destabilized and impacted.
- The structure shall not touch the water surface during operation.
- If using sill logs, place sill logs parallel to the watercourse, to found the stringers on. Sill logs should be at least 4 m long and have a minimum diameter of 250 mm.
- The deck height shall be a minimum of 250 mm above the bank height and there shall be at least 450 mm between the water surface and the bottom of the bridge at the time of installation.
- Bridges composed of a single sill log on each side of the watercourse must have spacers attached to the underside of the stringers to maintain the span between the sill logs.
- Bridge decks must be fully enclosed and kept free of erodible soil.
- The width of the structure shall not exceed one lane.
- The structure must be lifted in place, rather than dragged, and must be removed in the same manner.
- No disturbance of the bed or banks of the watercourse is to occur.
- The structure shall not touch the water surface during operation and must be designed to carry intended loads.
- Fording is to be avoided.
- Approach roads on both sides of the crossing must be stabilized against erosion by using brush mats or clean granular material unless bedrock is suitable to provide protection from rutting.
- Stabilization shall extend back at least 30 metres (100 ft) on either side of the crossing.
- Structure backfill material and fill for the roadbed is to be clean coarse granular aggregate material, durable, non- ore

bearing, non-watercourse derived and non-toxic to aquatic life. Material must not be sulphide bearing aggregate.

- Erosion and sedimentation control methods must be used to ensure silt or other harmful materials or substances are not discharged into any watercourse.

- No traveling shall be allowed over temporary structures unless approaches to the crossing are stable and the structure has a deck that will prevent debris from falling into the watercourse.

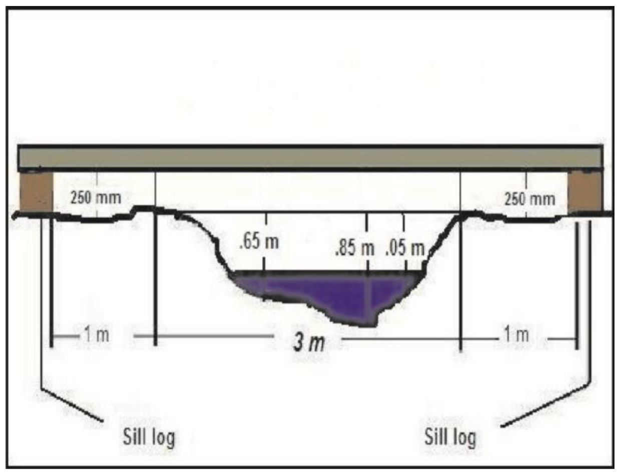
- Bridge decks must be fully enclosed and kept free of erodible soil. Any soil on the deck must be removed in a manner to ensure it will not enter the watercourse. In unstable (muddy) or potentially unstable traction areas, once the support logs are installed across the watercourse, heavy gauge plastic, geotextile, or other suitable material shall be placed on the supports before the decking material is installed to prevent debris and mud from falling between the cracks of the wood (if spacing between decking) into the watercourse as the vehicle crosses.

- Attach decking to make the structure more rigid and to prevent debris generated during travel or maintenance from entering the watercourse.

- Maintain the structure to ensure material does not build up on the runners / decking and the stream banks remain stable.

- For forestry operations, if using a cable skidder or dragging tree length logs via a cable/grapple/clam bunk type system, temporary structures shall have vertical posts along the side of the structure to ensure that trees are not being dragged through the watercourse when crossing.

Figure 9-1 Example of temporary (portable) bridge



9.4.1 Temporary bridge removal

When the temporary structure is no longer needed, the deck of the structure and approach materials must be removed from around the watercourse, such that the riparian area closely resembles its pre-construction cross-section and all exposed erodible soil stabilized against erosion either by rip-rapping, hydro-seeding or seeding by conventional means and blanketing with straw/hay mulch.

- Clean off bridge surface and dispose of material in an area where it will not migrate back to the watercourse.
- Completely remove the deck of the crossing structure and all construction materials from the crossing location, except the sill logs or abutment material.
- Sill logs and any other abutment material shall remain undisturbed during and after removal. The removal of abutments and sill will cause more damage than leaving them embedded.
- Stabilize the approaches and the banks immediately upon removal with rock, erosion control matting, hydro-seeding or seeding and mulch (eg., hay or straw).
- Use sediment and erosion control measures on the approaches.
- If the bed or the bank of the watercourse has been impacted, work must be undertaken to mitigate the impact. Nova Scotia Environment must be informed.

10 WHARVES, DOCKS

Wharves and docks are structures extending into a watercourse. Wharves and docks provide mooring for boats and provide ready access to a watercourse for swimming and other recreational uses. Some wharves on freshwater bodies are used for commercial or public purposes, such as fishing outfitters or boating clubs.

10.1 Requirement for submission to NS Environment

No submission *	Notification is required if,	Approval required if,
if no excavation or disturbance is done to the bed or bank **example:** seasonal wharves that float or are on posts that rest on the bed	there is alteration of the bank and alteration is less than 5 metres along the bank, and work is completed between June 1 and Sept. 30, and the bed is NOT altered	conditions of notification are exceeded **example:** bed of watercourse is disturbed

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

Important Note: Contact NS Department of Natural Resources if planning to construct a wharf in coastal areas.

10.2 Environmental considerations

Structures placed or built in the shallow waters bordering the banks of a watercourse will threaten the sensitive littoral zone of the watercourse. Adding material to or removing material from the bed of a watercourse will damage the littoral zone. The littoral zone is the near shore section of water where light penetrates to the bottom. These zones are often areas of high food productivity.

Absolutely avoid disturbance of areas which are or could be habitat for endangered species of plants and animals. For example, the Blanding's Turtle (*Emydoidea blandingii*). This endangered species is found in central southwest Nova Scotia. One of the major threats to this species is the human alteration of lake shores used for nesting.

Do not use materials that may leach toxics into the watercourse.

10.3 Planning

The best way to prevent harm is to avoid disturbing the bed and bank of the watercourse. This can be accomplished by installing a seasonal floating wharf or seasonal wharf on posts, or a combination of the two.

Seasonal wharves are structures which are removed for the winter season which prevents damage to the structure as well as avoids scouring the bed of the watercourse. A wharf can be anchored to the shore in various ways which do not harm the bank of the watercourse, such as bolting into large rocks or placing anchoring "feet" on the shore. Cantilever and suspension docks are also good options.
Another way to limit disturbance to a watercourse is to share a dock or wharf with a neighbour. Also remember that wharves are not always needed for enjoyment of water front property.

Work that covers or disturbs the bed of a watercourse should be avoided. Work disturbing the bed requires an approval from NS Environment and will only be granted for exceptional circumstances.

Check guide on species at risk and their habitats to ensure protection of endangered species. Species at risk are often associated with watercourses, wetlands, and land next to watercourses. See www.speciesatrisk.ca and contact the Regional Biologist with Nova Scotia Department of Natural Resources.

See the following guide "Healthy Lakes and Wetlands for Tomorrow: A landowner Stewardship Guide for Species at Risk in Nova Scotia" at www.speciesatrisk.ca. The guide contains diagrams of waterfront properties which maintain natural and healthy riparian and aquatic habitat and provide guidance on environmentally responsible dock construction.

10.4 Construction

Follow the Nova Scotia Watercourse Alterations Standard if under notification process: General Conditions and Wharf or Dock. If work is completed under an approval, follow the terms and conditions of the approval.

10.4.1 Key Considerations:

Minimize the size of the wharf or dock structure.

Minimize the amount of disturbance in the riparian zone of the watercourse, including the removal of natural vegetation and excavation. The riparian zone is the land next to the watercourse.

Avoid disturbing areas that is habitat for species at risk. Check guide on species at risk and their habitats to ensure protection of endangered species. Species at risk are often associated with watercourses, wetlands, and land next to watercourses. See www.speciesatrisk.ca and contact the Regional Biologist with Nova Scotia Department of Natural Resources.

Use appropriate materials that will not leach toxic substances in the water and impact water quality (see section 5.4). Try to build with untreated lumber. Do not use paint as it will chip off and contaminate the watercourse.

Avoid using expanded polystyrene which will breakdown over time and contaminate the watercourse. Closed-cell extruded polystyrene is better but should be permanently encased inside structure.

11 BOAT LAUNCHES AND SLIPWAYS

Boat launches and slipways are areas along the bank of watercourses used to load and unload boats from trailers. The objectives are to provide launch areas that have minimal disturbance on the watercourse and are stable to aid in the prevention of siltation entering the watercourse.

11.1 Requirement for submission to NS Environment

No submission	Notification is required if,	Approval required if,
No alteration to the bank or bed of the watercourse.	there is alteration of the bank and alteration is less than 5 metres along the bank, and work completed between June 1 and Sept. 30, and the bed is NOT altered	conditions of notification are exceeded

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

11.2 Environmental considerations

Structures placed or built in the shallow waters bordering the banks of a watercourse will threaten the sensitive littoral zone. Adding material to or removing material from the bed of a watercourse will damage the littoral zone. The littoral zone is the near shore section of water where light penetrates to the bottom. These zones are often areas of high food productivity.

11.3 Planning

The number of boat launches on a lake or other watercourse needs to be minimized to reduce environmental impact.

The following are some suggestions which are preferable to having a boat launch at every property surrounding a lake:

- Community boat launch or launch area open to the public
- Share a launch with a neighbour or several neighbours

Check guide on species at risk and their habitats to ensure protection of endangered species. Species at risk are often associated with watercourses, wetlands, and land next to watercourses. See www.speciesatrisk.ca and contact the Regional Biologist with Nova Scotia Department of Natural Resources.

See the following guide "Healthy Lakes and Wetlands for Tomorrow: A landowner Stewardship Guide for Species at Risk in Nova Scotia" at www.speciesatrisk.ca. The guide contains diagrams of waterfront properties which maintain the natural and healthy riparian and aquatic habitat.

Boat launches and slipways should be located at stable sites along a watercourse to ensure shoreline erosion and sedimentation can be controlled. Approaches should be fairly flat to reduce the chances of vehicles spinning and destabilizing the travel surface and to minimize the excavation of material beside the watercourse and the shore or bank of the watercourse.

The following types of work should be avoided, unless the construction method is required in exceptional circumstances and an approval from Nova Scotia Environment is granted.

- Installing or constructing a structure that covers the bed of the watercourse
- Dredging of the watercourse
- Placement of rock or gravel on the bed of the watercourse

11.4 Construction

Follow the Nova Scotia Watercourse Alterations Standard if under notification process: General Conditions and section titled: Removal of material from the bank for a boat launch or slipway.

If work is completed under an approval, follow the terms and conditions of the approval.

11.4.1 Key considerations

Minimize the amount of disturbance next to watercourses. This will reduce the risk of sediment entering the watercourse. Maintain natural vegetation on the banks and next to the watercourse to maintain habitat for plant and animal life and to maintain wildlife corridors.

Absolutely avoid areas with steep terrain and wet areas.

It is not permitted to place any gravel, concrete or other material in the watercourse except under very exceptional circumstances and only with an approval from NS Environment.

12 WATER INTAKES (including dry hydrants)

A water intake is used to withdraw water from a watercourse for the purpose of irrigation, manufacturing, firefighting, aquaculture facilities, or other uses. The size of intake and extent of work to install varies greatly depending on the project.

Dry Hydrants are water intake structures consisting of a standpipe buried in the bank of a watercourse with a horizontal pipe connected to the bottom end which extends into the watercourse, often installed for water source for firefighting.

The objectives are to minimize disturbance to the bed and banks of the watercourse during installation; to prevent the impingement, entrainment or killing of fish; and the withdrawal of a volume of water from a watercourse while maintaining sufficient flow and depth of water to ensure that fish habitat is protected, and fish passage is maintained and to maintain downstream water quality.

12.1 Requirement for submission to NS Environment

No submission *	Notification is required if,	Approval required if,
If intake is placed on bank or bed of watercourse without any alteration or disturbance	there is alteration of the bank and alteration is less than 5 metres along the bank, and work completed between June 1 and Sept. 30, and the bed is NOT altered **Example**: burying pipe in bank of watercourse	conditions of notification are exceeded **Example**: if the bed of watercourse is disturbed through excavation and/or infilling. An approval is required if greater than 23,000 litres of water is withdrawn per day
	the bed is NOT altered **Example**: burying pipe in bank of watercourse	infilling. An approval is required if greater than 23,000 litres of water is withdrawn per day

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

12.2 Environmental considerations

See section 2 for general environmental considerations.

In addition to the excavation within the watercourse, the withdrawal of water from a watercourse may cause a negative impact:

- The volume of water remaining in the watercourse must be adequate for the maintenance of aquatic life and fish passage. Decreasing the volume of water in the watercourse may result in an increase in temperature, making it intolerable for some species of fish. A decrease in water level or flow can also diminish suitable living space for fish, reduce the habitat and production and delivery of food organisms and accelerate sediment deposition.
- The water withdrawal should not cause issues for other watercourse users downstream such as commercial operations or agricultural users.
- The water withdrawal must not cause any fish or other aquatic life to be removed from their habitat. The intake must not allow fish to be impinged, entrained or killed.
- Water intake structures must be installed so that they do not present an obstruction to migrating fish

12.3 Planning

Minimize the disturbance to the watercourse. If the withdrawal is seasonal and temporary (and in a secure area), you may be able to place the water line over the bank and into the watercourse without any alteration to the watercourse. Or you may only need to trench through the bank of the watercourse if the depth of water at the bank is sufficient to prevent freezing of a permanent waterline or piping in the winter. Trenching the bed of a watercourse or creating a sump in the watercourse should be avoided when possible.

Whether the water is withdrawn from a flowing watercourse such as a stream, creek, river, or brook, or a standing body of water such as a lake or a pond, the following concerns must be addressed before the project begins:

- The water withdrawal must not cause any fish or other aquatic life to be removed from their habitat. The intake must be screened to prevent aquatic life from entering the structure and to avoid the killing of fish. Sufficient screen area must be provided with openings to ensure that approach velocities do not impinge or entrain aquatic life. Refer to Appendix C to calculate the screening requirements that are appropriate for your project.

- The volume of water remaining in the watercourse must be adequate for the maintenance of aquatic life and fish passage.

- Water intake structures must be installed so that they do not present an obstruction to migrating fish.

12.4 Construction

Follow the Nova Scotia Watercourse Alterations Standard if under notification process: General Conditions and Permanent Water Intake or Dry Hydrant.

If work is completed under an approval, follow the terms and conditions of the approval.

12.4.1 Key Considerations:

Minimize the amount of excavation next to the watercourse. This will reduce the risk of sediment entering the watercourse.

Minimize excavation of the bank and bed of the watercourse to only what is absolutely necessary. If trenching is necessary make it as narrow as possible by using a narrow excavator/backhoe bucket.

If the bed or bank of the watercourse has been excavated, areas must be backfilled with clean material and must be protected with rock to prevent erosion. The profile of the backfilled areas must align with the natural bed or bank of the watercourse.

13 UTILITY CROSSING (FOR EXAMPLE, PIPELINES OR CABLE)

Pipeline and cable crossings are locations where distribution or transmission pipelines carrying petroleum products, sewage or water, or where fibre optic or electrical cables cross a watercourse.

The objectives are to place a seamless pipeline or cable across the watercourse without impacting the aquatic ecosystem or release of material, creation of a barrier to fish passage and to prevent the harmful impacts from the installation methodology on fish and fish habitat.

13.1 Requirement for submission to NS Environment

No submission *	Notification is required if,	Approval required if,
If there is no alteration or disturbance to bed or bank Example: aerial utility crossing	there is alteration of the bank and alteration is less than 5 metres along the bank, and work completed between June 1 and Sept. 30, and the bed is NOT altered	conditions of notification are exceeded **Example**: if the bed of watercourse is disturbed

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

13.2 Environmental considerations

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

Additional harmful impacts resulting from constructing a pipeline/cable crossing can be significant. Concerns include:

1. Degradation of water quality – from the release of drilling fluids or sediment during directional drilling and from leaking pipelines or fuel spills.

2. Dewatering of watercourse during directional drilling or boring under watercourse.

3. Release of drilling mud/fluids and other substances into the watercourse due to improper disposal or unexpected release through fractures in substrate. Often referred to as a “frac-out”.

13.3 Planning

There are several categories of pipeline crossing construction methods. The method chosen depends on habitat sensitivity, size of watercourse, approach slopes, channel and flow characteristics. Emphasis should be placed on habitat sensitivity. Highly sensitive areas should not be considered for a crossing site (ie. identified critical habitat). Pipeline characteristics and cost will also influence the method chosen. A brief description of each method and the advantages and disadvantages **from an environmental standpoint** are outlined below.

13.3.1 Trenching and restoring watercourse

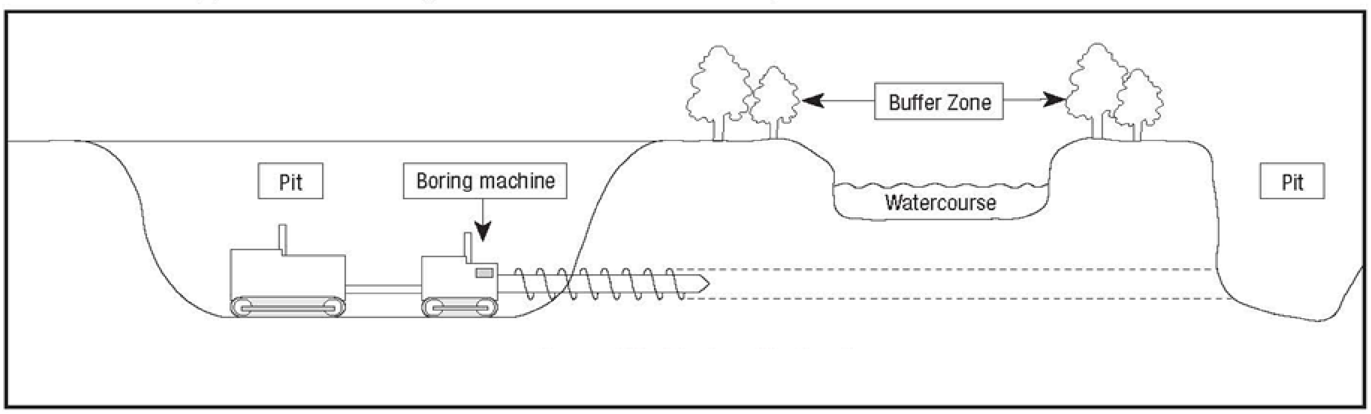
Trenching across a watercourse may be an acceptable method of installing pipelines or cables. Excavation in the watercourse must be isolated from waterflow using methods outlined in section 5.1 (Water Control Measures), namely dam and pump, temporary diversion or cofferdam. Upon completion of the work the watercourse channel must be restored.

13.3.2 Going under or over a watercourse

Boring Method involves boring under the watercourse from a pit on one side of the watercourse to a pit on the other side, with, or without casing. This method is suitable in situations where the bed of the watercourse cannot be disturbed and where the water table is low. See figure 13-1.

Pits may need to be dewatered onto surrounding land. There is a possibility of sump water causing sedimentation of watercourse. Deep pits cause disturbance of approach slopes and there is a possibility of pits caving in.

Figure 13-1 Boring Method

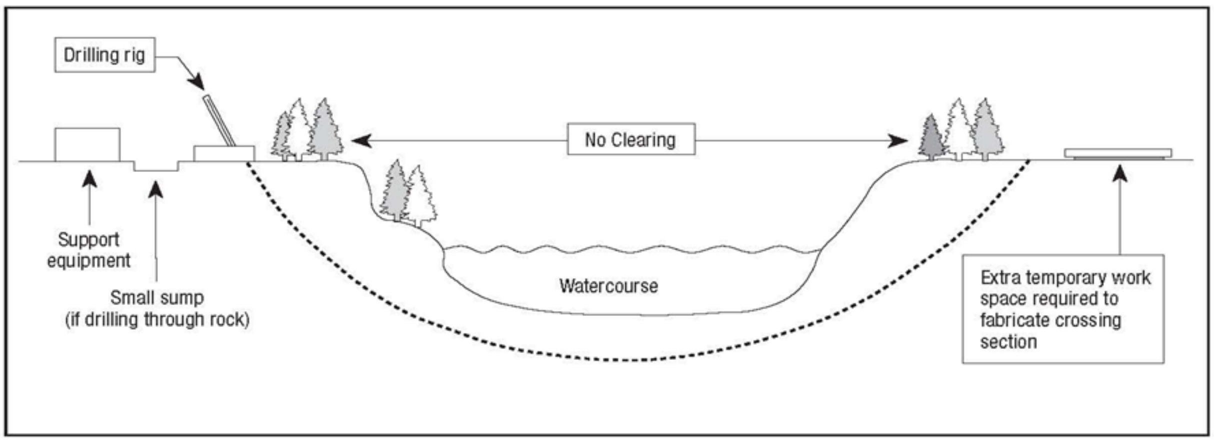


Directional Drilling

Directional drilling is accomplished by setting up a drill rig on one approach slope and drilling to a target on the opposite approach slope. Can be used in large watercourses with sensitive aquatic habitat and where there is no instream activity allowed. See figure 13-2. The substrate material and conditions must be analyzed to determine if drilling fluids could travel through the material under the watercourse and enter the watercourse. Fractures are a route for pressurized drilling fluids to be released into the watercourse.

Drilling fluids must be disposed of properly. Drilling fluids must not enter the watercourse.

Figure 13-2 Directional Drilling Method



Aerial Category

Bridge Attachment Method - involves attaching a line to an existing bridge structure or trestle. This method is used on large watercourses with unstable approach slopes and sensitive habitat where there should be no instream activity. Often used in deep gorges, or canyons or in urban areas where numerous bridges already exist.

Self-Supporting Bridge or Span Method - involves constructing a bridge or abutments to carry line. It is used in large watercourses with sensitive habitat where no instream activity is allowed and or in deep ravines or gorges.

13.4 Construction

Follow the Nova Scotia Watercourse Alterations Standard if under notification process: General Conditions and Utility Crossing.

If work is completed under an approval, follow the terms and conditions of the approval.

13.4.1 Key considerations:

Ensure there is a plan for proper disposal of drilling fluids if using directional drilling method and a contingency plan in case of an emergency such as a “frac-out”.

Has the material under the watercourse been analyzed (i.e., geotechnical investigation) and has it been determined that that pressurized drilling fluids cannot enter the watercourse through fractures in substrate (soil, rock) beside and under the watercourse?

If boring method is used, is the depth and size of the pits on each side of the watercourse reasonable? Are potential problems being created as a result of the size of the pits next to the watercourse. Ensure the pits do not dewater the watercourse. Ensure there is a plan to deal with water which collects in the pits as sediment laden water cannot be pumped directly into the watercourse.

Trenches across a watercourse must be backfilled in such a way that the grade and profile of the natural stream is maintained. Backfill material and erosion protection material must conform to sizing requirements in section 16.

14 REMOVAL OF MATERIAL FROM WATERCOURSE (BEAVERDAMS)

A beaver dam is a barrier across a watercourse constructed by beavers to impound water, control the flow or raise the level of water. This barrier or dam is usually constructed of wood, organic matter, mud, gravel and rocks.

If beaver dam removal is necessary the objectives are to minimize impacts on aquatic habitats when beaver dams are removed and for the protection of infrastructure or property (e.g. roads, septic systems, wells, basements, etc.). The partial or complete removal of beaver dams to allow anadromous fish passage and/or improve fish habitat.

14.1 Requirement for submission to NS Environment

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

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

IMPORTANT NOTE: Nova Scotia Department of Natural Resources must be contacted prior to the removal of beavers or beaver dams. A Nuisance Wildlife Permit is required for the destruction or removal of beavers.

14.2 Environmental considerations

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

Beaver dams are important for providing valuable ecological diversity and are a primary natural method of creating new wetland habitat for a variety of fish and wildlife.
Wetlands constructed by beavers can:

- reduce downstream flooding and sediment loading during storm events by trapping and storing excess water;
- reduce channel scouring and stream bank erosion during high water events;
- form natural lakes and ponds, and maintain existing ponds;
- Provide habitat for some species at risk such as Blanding's Turtle and Eastern Ribbonsnake; and,
- supply summer and winter habitat for fish.

Beaver dams can also disrupt the habitat of other wildlife species, flood upstream property or threaten downstream property.

Beaver dams can:

- reduce spawning habitat;
- create barriers to fish migration;
- increase water temperatures;
- alter riparian vegetation;
- cause contamination of watercourses with Giardia lamblia (“beaver fever”);
- obstruct watercourse crossing structures, which can result in the flooding and erosion of roadways;
- cause flooding which can have a negative impact on landscaping, septic systems, wells, basements and the use of private properties; and
- cause increased erosion, destruction of stream channel and banks due to beaver activity

Uncontrolled beaver dam removal could result in:

- A flush of sediment that can smother downstream habitats and incubating or emerging fish;
- Flooding and erosion of downstream properties;
- A rapid reduction in pond depth, that can result in stranding and killing species of fish, amphibians, birds as well as aquatic and terrestrial plants;
- Scouring and erosion of the downstream channel and banks;
- Rapid changes to downstream water temperatures; and
- Potential contamination of downstream wells.

14.3 Planning

Beaver dams are not to be removed when:

1. Property damage is not demonstrated;
2. The dam is on the outlet of a lake, unless it can be demonstrated that the lower water level will be beneficial to wildlife and all property owners are supportive of the action;
3. The impoundment has established a wetland that is being utilized by breeding waterfowl. Removal can only take place after the waterfowl broods have left; and
4. The “Beaver Dam Removal Guidelines” cannot be met. The guidelines are found in the Beaver Dam Removal Code of Practice.

For more information on the removal of beaver dams please refer to the *Beaver Dam Removal Code of Practice (NSE/ DNR/ DFO)* at: http://www.novascotia.ca/nse/wetland/docs/Beaverdam-Removal-Code-of-Practice.pdf

In areas of recurring problems, use of beaver dam management devices such a pond levellers, culvert screening devices, etc. should be considered. These devices must maintain both water flow and fish passage. The careful selection of a watercourse crossing structure may reduce the occurrence of beaver dam blockages. Bridges and open-bottom culverts are less likely to be dammed as often as circular culverts.

14.4 Construction

Follow the *Beaver Dam Removal Code of Practice (NSE/ DNR/ DFO, 2005)* at http://www.novascotia.ca/nse/wetland/docs/Beaverdam-Removal-Code-of-Practice.pdf

If work is completed under an approval, follow the terms and conditions of the approval.

14.4.1 Key considerations:

Beaver dams can only be removed if the dam and associated flooding is causing damage or is an immediate threat of damage to property or infrastructure.

The beaver must be removed prior to undertaking the removal of the beaver dam. Their removal must be undertaken in compliance with all Acts and Regulations.

Beaver may only be destroyed or removed as authorized under a Nuisance Wildlife Permit issued by Nova Scotia Department of Natural Resources.

Non-mechanical (by hand) removal of beaver dams is the preferred method. This method minimizes disturbances to the bed and banks of the watercourse and should be considered wherever possible.

Removal by hand can include using hand tools and winching the material out. No heavy equipment will be allowed in the water body or on its banks to do work. Material may be cabled or chained out of the channel by machinery or equipment stationed a minimum safe distance of 15 metres from the immediately adjacent stream bank.

Removal of dams during the period from October 1st to May 31st should be avoided in order to reduce the risk of sediment transport downstream when fish eggs and juvenile fish are in the gravel.

The removal of the beaver dam will be limited to the debris used to build the structure. Original watercourse bed and bank material may not be removed or disturbed. If an alteration is planned, a watercourse alteration approval must be obtained from Nova Scotia Environment prior to undertaking the work.
The pond should be drained by pumping down or siphoning. All water should be released in the same watercourse downstream of the dam. This results in a reduced potential for suspended sediments which is important for fish residing in the watercourse. If there is any silt laden water it should be directed away from the watercourse into heavily vegetated areas, settling ponds or other filtering devices for treatment prior to entering any watercourses.

The impounded water should be released over an extended period so as to minimize silt flushing from the impounded area and reduce channel erosion downstream due to the increased discharge and water velocities. The maximum allowable depth of water spilling over the structure at the drainage point is 10 centimetres. The width of the opening created shall be no greater than the width of the watercourse downstream of the dam. It is recommended that it take a minimum of 1 day per 0.5 hectare of ponded surface area to drain the impoundment.

Any fish that become trapped in isolated pools or stranded in newly flooded areas shall be relocated to the main channel of the watercourse. A license to collect and move fish may be required and obtained from DFO prior to the fish rescue. Please contact DFO through the National Online Licensing System at http://www.dfo-mpo.gc.ca/index-eng.htm.

In areas where dams are recurring problems, it is recommended that culvert screens or guards be used.

Debris removed from the beaver dam must be placed above the high water mark and disposed of in such a way so that it does not get washed back into the watercourse by floodwaters.

Once the pond has been drained, the exposed sediment should be seeded and mulched (e.g., blanketed with hay or straw) for stabilization purposes. This will help reduce the amount of sediment washed downstream in subsequent runoff events. Re-vegetation with planting native trees and shrubs are important for restoring riparian areas.

If there is insufficient time in the growing season to germinate seeds, exposed soil must be stabilized to prevent erosion and re-vegetated the following spring.

15 REMOVAL OF MATERIAL FROM WATERCOURSE

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

- 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)
- Dredging, removal or moving natural substrate material in the watercourse

This section does not cover the replacement or decommissioning of bridge or culvert crossing structures which are considered in the crossing sections.

This section does not include the removal of obstructions that impound water, such as dams and causeways. This alteration type may have a significant impact on the aquatic environment and must be considered carefully through the review of an application for approval.

15.1 Requirement for submission to NS Environment

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

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

15.2 Environmental considerations

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

The possible negative consequences of a poorly planned dredging operation can be significant. These operations have the potential to alter and/or destroy fish and fish habitat, negatively affect water quality and to impact private property. Every dredging proposal is unique, and the possible impacts must be carefully considered at the design stage taking into account the potential for environmental impact of the dredging site and the disposal site. Consideration must also be given to neighbouring properties and other activities such as recreational and commercial operations.

Some negative impacts of dredging include:

- Physical Impact to the bottom substrate

Disruption of the benthic habitats caused by excavation or burial can result in a direct loss of fish habitat. Organisms may also become entrapped by the dredging equipment or buried during the operation.

- Turbidity and Sedimentation

This can occur at the dredging site, during transportation to the disposal site, or at the disposal site. Increased levels of suspended sediment can interfere with the necessary functions of aquatic species, such as migration and feeding, and can be lethal, if concentrated.

Disturbance and exposure of anoxic sediments can deplete oxygen from the surrounding waters. The chemical oxidation of metals and other inorganic compounds uses dissolved oxygen present in the water. This process can occur at the dredging site and/or at an underwater disposal site

- Release of toxic substances

Toxic hydrogen sulphide gas is often trapped in sediments and can be released by disturbance to these sediments. In particular, sediments high in organic content such as wood or debris have the potential to promote the formation of hydrogen sulphide and ammonia.

Trace elements, which are often found in association with finer grained sediments, can be introduced into the water when the sediments are dredged, and may be taken up by aquatic organisms.

Dredging of contaminated sediments may release contaminants directly during the dredging process or as a result of runoff, leakage, or leaching from the spoils at the disposal site.

- Disruption of hydraulic regime at the disposal site

Dredged spoils are often disposed of behind a containment dyke at or near the bank of a watercourse. The containment dyke must be capable of retaining the spoils inside the reclamation area.

Introduction of excessive amounts of sediments into the watercourse could affect the existing hydraulic regime.

Sediment may be returned to the watercourse by the erosive action of wind, runoff, and currents or by mass movement or slippage of the material caused by instability of the dumped spoils or the underlying ground.

- Disruption of water current patterns and the natural transportation and deposition of bed material

15.3 <u>Planning</u>

15.3.1 Removing foreign material

If the foreign material has been recently deposited and it is not embedded in the watercourse substrate, the material can be removed. Consideration of the removal technique, depending on the size of the material is important. The material may be lifted out by hand, equipment or machinery. The material is not to be dragged, dredged or scraped out of the watercourse such that the natural watercourse is disturbed. Vehicles, such as excavators or trucks, are not to enter the watercourse.

The removal of major obstructions or foreign material embedded in the watercourse should only be carried out when the benefits of the removal exceed the cumulative effects of the associated environmental impacts. Planning for this type of alteration must not only involve choice of machinery and timing but also an analysis of the positive and negative effects of the removal of the structure on the environment.

15.3.2 Dredging

Dredging is the excavation of material from the bed of a watercourse by mechanical means. Dredging may be considered for a number of reasons including the following:

1. Navigation - To remove accumulated bedload material as a result of high flow events to restore the channel to its natural conditions. For example, to deepen channels, lakes, canals, harbours, or inlets for use by boats.

2. Foundation preparation - to remove unsuitable material at proposed locations for supporting structures such as piers.

3. Environmental - excavation of unwanted or polluted materials such as mine tailings or contaminated sediments.

4. Water reservoir - to increase the size of an existing reservoir or to create a new water reservoir for domestic or firefighting purposes or to remove accumulated sediment in existing reservoirs.

5. Flood prevent - to clear channels or blockages of accumulated bedload material.

If this work is absolutely required, the objectives are to minimize the impact of the dredging operation on fish habitat and fish passage, to minimize sedimentation of the watercourse, to prevent contamination of the water, and to avoid degradation of shorefront properties and disruption of commercial operations such as fisheries and aquaculture operations.

15.4 <u>Construction</u>

Follow the Nova Scotia Watercourse Alterations Standard if under notification process: General Conditions and Removal of Foreign Material.

If work is completed under an approval, follow the terms and conditions of the approval.

16 PLACEMENT OF ROCK OR OTHER EROSION PROTECTION MATERIAL

Erosion protection or bank stabilization is rock (rip-rap), structures and/or vegetation used to stabilize and protect the banks of a watercourse from the scouring and erosive action of water, ice, or floating debris within the watercourse or surface runoff from the land bordering the watercourse. Activities in a watershed like forest harvesting, agriculture, and urban development may increase bank erosion.

The objectives of erosion protection are to prevent further loss of material from unstable banks of the watercourse and property adjacent to the banks of the watercourse, to control channel meander and prevent undermining of a structure and to prevent sedimentation of the watercourse.

16.1 Requirement for submission to NS Environment

No submission	Notification is required if,	Approval required if,
No option	Placing rock or structure to protect the bank of the watercourse, and protection is less than 5 metres along bank, and work is completed between June 1 and Sept. 30.	Erosion protection is more extensive than described under notification conditions. **Example**: if the bank disturbance exceeds 5 metres.

16.2 Environmental considerations

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

Maintaining the natural bank and vegetation along watercourses will in most cases prevent excessive erosion of the bank. When vegetation is removed, the scour and erosive forces can have devastating impacts which can be difficult and expensive to remedy.

Vegetation regulates the water temperature and provides shade, cover, and food for fish and aquatic insects as well as wildlife along the shoreline.

16.3 Planning

If presented with a situation where there is no evidence of erosion, the best course of action is to maintain the natural bank and vegetation along watercourses. This will in most cases prevent excessive erosion of the bank and should not be disturbed.

If erosion is evident, there are a few types of erosion protection:

- Vegetative measures;
- Structural measures such as rip-rap (rock or stone), wire baskets, timber crib, retaining walls; and
- Combination of rip-rap and vegetation

The method used depends on the magnitude of the erosive forces and economic feasibility as well as the availability of materials in the area the erosion is taking place.

16.3.1 Vegetative Measures

Vegetation such as trees, shrubs, vines, grasses, other plants or combinations of different species can be used to stabilize and protect the banks of a watercourse from the erosive action of waves, ice, and debris within the watercourse. Other erosion control measures should be avoided if vegetation can be used or they should be used in combination with vegetation whenever possible.

If the banks are stable and have slopes of 2:1 or flatter, vegetation provides an excellent protection against soil erosion. It also promotes terrestrial or aquatic animal habitat along the banks of the watercourse and in the watercourse. Vegetation is more compatible with the natural watercourse characteristics.

The degree of erosion protection offered by vegetative measures increases as the plants and root system grow and spread.

Vegetative protection is less costly than other measures and requires little or no maintenance once established.

Plants chosen should require little maintenance and be suited for the soil and climate conditions of the site. Conditions may vary greatly across the Province and plans for stabilization must be adapted to each specific site. Plants must be capable of having dense growth and fibrous roots, which provide complete soil cover. The selected species should be easy to plant, fast growing, requiring little or no irrigation, fertilizer or maintenance. Plants should be native to the area and not invasive.

Examples of plants used include: alders, willows, poplars, shrubs, clover, timothy and trefoil.

Mulch is often used as a temporary protection measure to protect sites from erosive action from rainfall until vegetation is established; it will also aid in the growth of vegetation by helping to maintain moisture. It is **not** a permanent solution and should not be used in areas where the water in the watercourse will wash it away. Mulch improves water infiltration, reduces rainfall impact and reduces surface erosion from runoff. Materials commonly used as mulch include: straw, hay, wood, bark chips, nets and erosion control mats.

16.3.2 Combination of vegetation and rip-rap

A combination of rip-rap and vegetation is a good option, especially when immediate protection is needed to reduce erosive action. Vegetation needs time to become established but will provide a more natural bank area than using only rip-rap or other structural methods.

16.3.3 Structural Measures

Structural measures that may be employed include rip-rap, wire baskets, timber cribs, steel or concrete and logs.

Rip-rap means rock, cobbles, boulders, or broken stone placed along the bank or bed of a watercourse as protection against erosion by water or the elements. Rip-rap must be a well-graded mixture that consists of clean, hard, sound, durable rock.

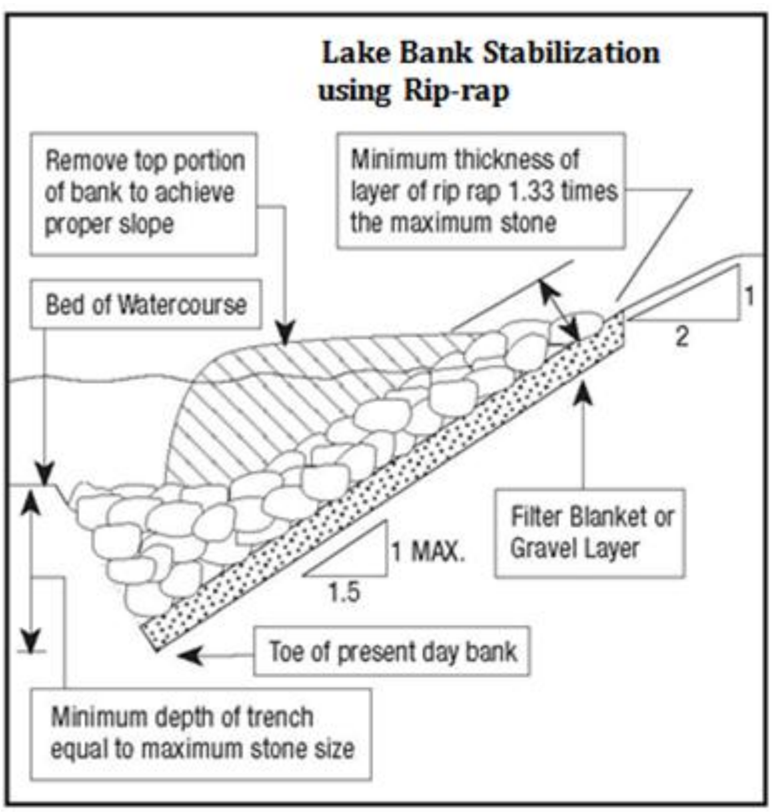
- Rip-rap can be used to prevent erosion on the banks of a watercourse if they are no longer steeper than 2:1 or if the velocity of the flowing water prevents the use of vegetation.
- Rip-rap depends on the soil beneath it for support therefore it **cannot** be used on unstable slopes.
- Follow the rip-rap stone size chart in Table 1. In order to determine the size and

quantity of material required to do bank stabilization with rip-rap or the strength of materials required to build a retaining wall, the velocity of the water must be determined. See Appendix D for method to determine rip-rap size. (You may wish to speak with a certified watercourse alteration sizer or engineer for assistance in determining the water velocity and the size and quantity of rip-rap material for bank stabilization).

Table 1: Rip-rap stone size chart.

Class 1 1:100 year flow velocity up to and including 3 m per second	Class 1 At least 70% of the rip-rap must be between 0.3 m and 0.45 m
Class 2 1:100 year flow velocity greater than 3 m per second and up to 4 m per second	Class 2 At least 70% of the rip-rap must be between 0.3 m and 0.75m
Class 3 1:100 year flow velocity above and including 4 m per second	Class 3 At least 70% of the rip-rap must be between 0.5m and 1.2m

Figure 16-1 Lake Bank Stabilization using Rip-rap



Vegetative measures and rip-rap are usually the least expensive alternative, although they may not be applicable methodologies depending on the slope of banks, excessive wave or ice action.

Wire baskets are heavy gauge wire cages or baskets filled with rock then stacked like a retaining wall to protect the exposed soils. They can be used to armour the eroding of slumping banks of the watercourse or to divert the flow of water away from an eroding channel section.

- Rock filled wire baskets can be used where the velocity of the water is high or where the banks are steeper than 2:1 and the area may not be available to manufacture the slope to a 2:1.

- Rock filled wire baskets, properly installed and using suitable material, can have a life span of 30 to 50 years.

- Steeper slopes, in general, mean increased potential for erosion. Preparation of the banks should take place immediately before placement of the wire baskets.

Retaining walls are walls consisting of timber cribwork, concrete or metal, built to lend stability to the banks of the watercourse. Timber cribs are squared hemlock, tamarack, or lumber may be utilized to protect exposed soils. Retaining walls of concrete or steel may be constructed; see section 5.4 for materials which are not acceptable for use in watercourses. Steel must be appropriately treated for use in the type of water.

- Retaining walls must be soundly engineered by a Professional Engineer licensed to practice in the Province of Nova Scotia. This section is intended to provide guidance to the Recognized Individual to determine if a retaining wall may be the best option for erosion protection at a particular site.

- Retaining walls can be used on steep or vertical banks.

- The retaining wall materials must be designed to withstand water forces from high velocity, wave action and ice movement.

16.4 <u>Construction</u>

Follow the Nova Scotia Watercourse Alterations Standard if under notification process: General Conditions and Erosion Protection of Bank of Watercourse.

If work is completed under an approval, follow the terms and conditions of the approval.

Key considerations:

Erosion protection works should be placed immediately following site preparation.

The sequence for construction includes removal of existing bank material to 1.5 times the thickness of the maximum stone size; grading the surface of the banks; followed by placement of the rip-rap material.

Erosion protection must be keyed into the bed and bank of the watercourse, original bank soils must be excavated to the depth of the erosion protection materials as not to infill the channel of a flowing watercourse or the bed of a lake or pond.

The backfill material behind a retaining wall, wire cage or rip-rap must be compacted to help prevent future washout due to high flows.

Rip-rap should not be “dumped” into the watercourse in the area of erosion. The rock is to be placed by hand or with machinery so the thickness of the layer is appropriate and the watercourse is not infilled and the channel is not encroached upon. The rock must adequately cover the exposed soils as per requirements in the NS Watercourse

Alterations Standard. It should not be placed in layers but in a dense, well graded mass of stone with minimal voids.

Rip-rap shall be installed in a downstream direction.

The ends of the protected area are to be keyed into the natural bank so erosion and scour does not occur at this point.

The slopes where rip-rap is to be placed must be graded to a slope no steeper than 2 horizontal to 1 vertical. A uniform grade should be obtained; all excavated material from the original watercourse bank must be placed in an area where it may not re-enter the watercourse. The base of the trench shall be, at a minimum, the depth of the bottom of the thalweg in flowing watercourses.

Rip-rap used to control erosion along the bank of flowing watercourses must be anchored at the base of the existing bank by placing the bottom row of rock at a minimum, below the depth of the bottom of the thalweg in the case of flowing watercourses. (The thalweg is the deepest depth of the channel and the main current of flow.)

In lakes, the erosion protection material should be keyed in below the bed of the lake by at least the thickness of the maximum rock size or below the anticipated depth of scour.

Woven wire baskets filled with rocks large enough that they will not pass through the openings of the baskets

When more than one tier of wire baskets is required, baskets must be terraced and tied together to add stability to the structure.

The base of baskets must be placed on a bedding layer of crushed stone.

Drainage must be provided for water that will accumulate behind the retaining wall by means of drainage tile behind the wall or a French drain type system.

17 FISH HABITAT IMPROVEMENT STRUCTURES

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

17.1 Requirement for submission to NS 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 metres 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

17.2 Environmental considerations

Careful assessment and planning is needed to ensure that the works are successful and are not creating additional issues for aquatic habitat and other watercourse users. Every watershed has its own features and its own needs.

Identifying the problems or the limiting factors to ecosystem productivity is critical. Without an assessment with the objective of identifying the problems on a watershed basis, the restoration plan created may be targeting the wrong area.

Limiting factors to fish productivity include but are not limited to:

- barriers to fish passage, such as blocked or hung culverts;
- erosion and runoff quality;
- pH, nutrients, chemicals;
- width, depth, shade, organic input;
- temperature of water;
- availability of cover;
- invasive species; and
- availability of spawning habitat.

17.3 Planning

The planning and design of habitat improvement works must be undertaken in consideration of habitat biology, stream hydrology and hydraulics in order to ensure the intended objectives can be met.

Most projects will require a habitat survey to identify limiting or controlling factors, which will need to be addressed. This work needs to be completed by someone who is experienced and knowledgeable in this type of work.

Seek out and involve specialists in aquatic ecology. There are community groups across the province who are already trained to complete assessments and to design habitat restoration projects and structures. Consider contacting Adopt-a-Stream program through the Nova Scotia Salmon Association (www.adoptastream.ca) to attain expert assistance.

Resources include:
The Nova Scotia Adopt a Stream Manual: A Watershed Approach to Community-Based Stewardship http://manual.adoptastream.ca/

Ecological Restoration of Degraded Aquatic Habitats: A Watershed Approach, Fisheries and Oceans Canada, 2006.
http://salmonconservation.ca/images/uploads/Ecological%20Restoration%20of%20Degraded%20Aquatic%20Habitats%20-%20a%20Wat.pdf

17.4 Construction

Follow the Nova Scotia Watercourse Alterations Standard if under notification process. If work is completed under an approval, follow the terms and conditions of the approval.

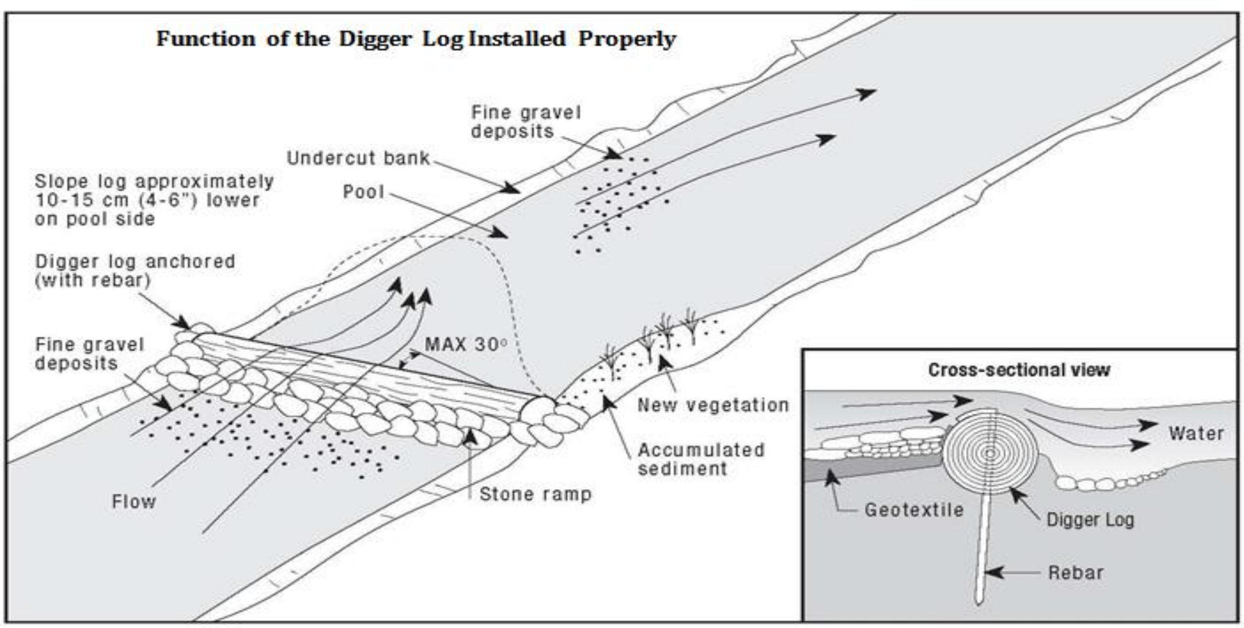
17.4.1 Key considerations

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 (eg., the location of structures in the stream in relation to the pool riffle sequence and meanders; the elevations of the structure; etc.).

Types of habitat improvement works include but are not limited to:

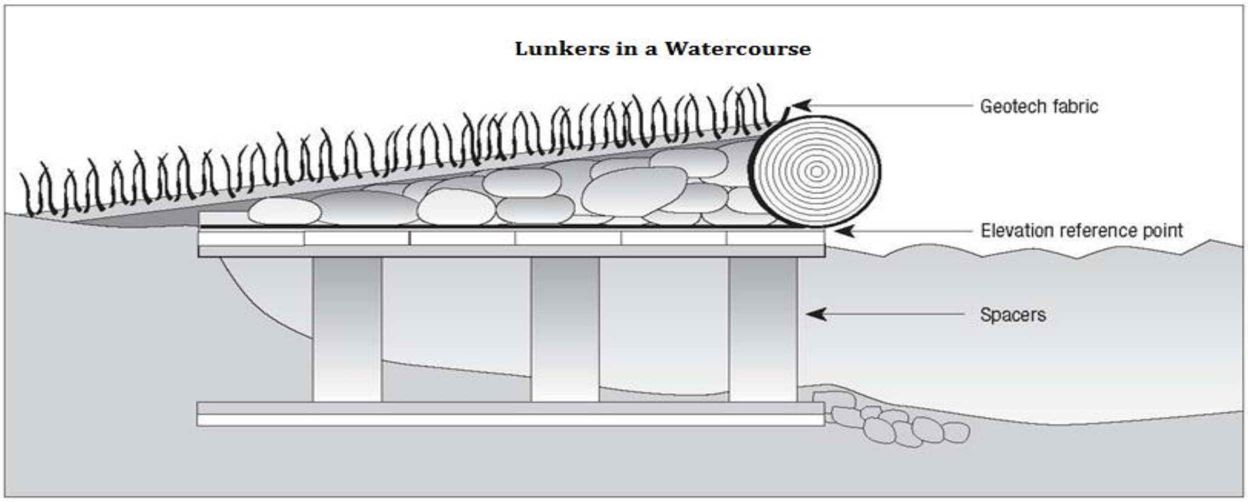
Digger Logs - This common habitat improvement technique has been shown to mimic natural fallen log processes in a stream environment. After assessing the stream and determining their best location, digger logs can utilize the streams energy to create a scour pool for trout rearing and feeding, assist in re-establishing the meander pattern of a watercourse, sorting the streambed material for potential spawning sites and provide oxygen entrapment to improve water quality. See figure 17-1.

Figure 17-1 Function of the Digger Log Installed Properly



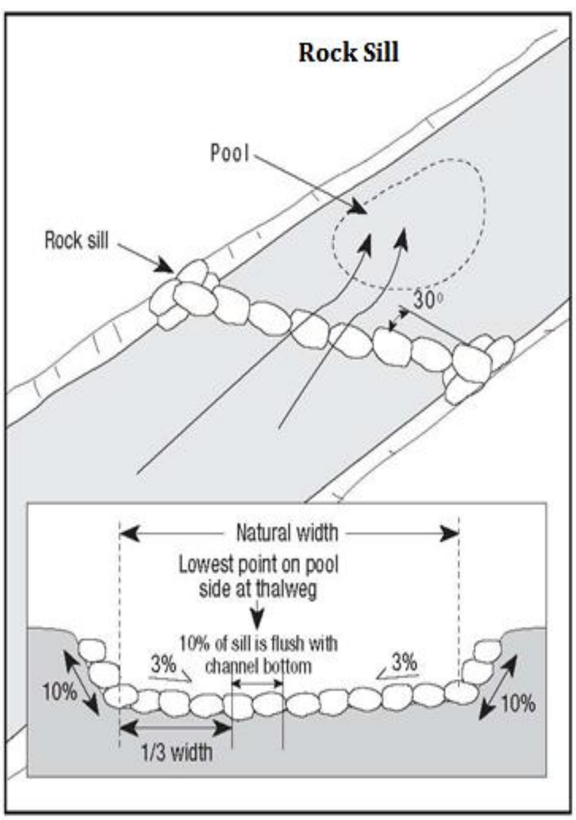
Lunkers - These are wooden structures constructed on the outside of a bend in a watercourse to provide cover and structure. They are used to mimic bank undercutting. See figure 17-2.

Figure 17-2 Lunkers in a watercourse



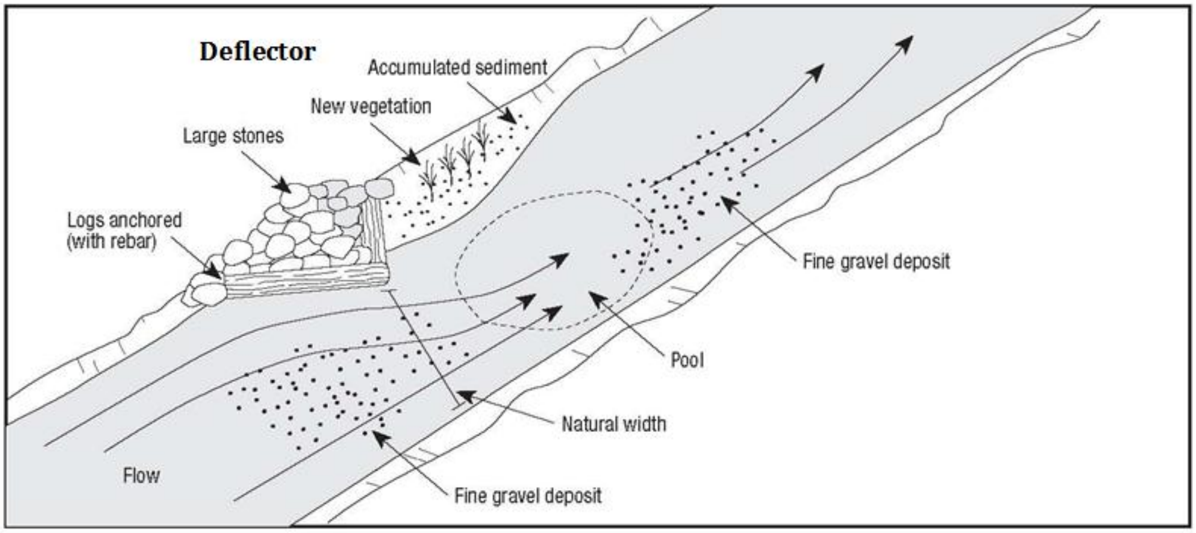
Rock Sills - These structures can provide streambed scour action, grade control and help in the sorting of streambed material. Their use and function are similar to digger logs, but they tend to be used in larger river systems where digger logs would be impractical. See figure 17-3.

Figure 17-3 Rock Sill



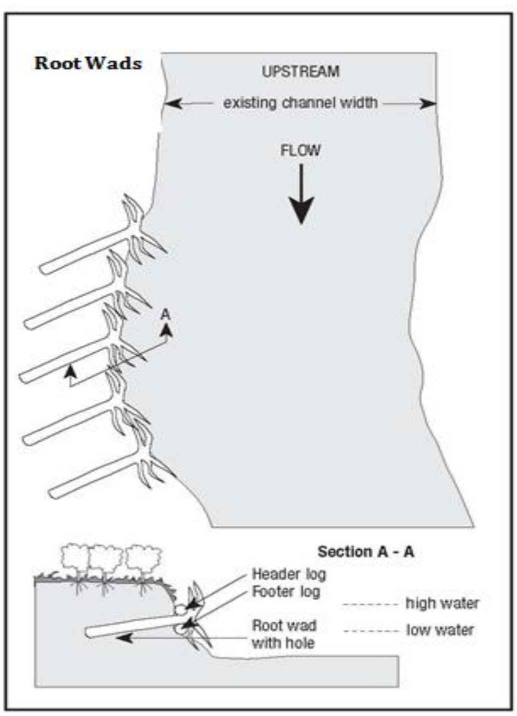
Deflectors - Structures can be built using coniferous trees, logs or rocks secured to the bank to assist in sediment redistribution and deposition, point bar development, bank reformation and assist in re-establishing a natural meander pattern. See figure 17-4.

Figure 17-4 Deflector



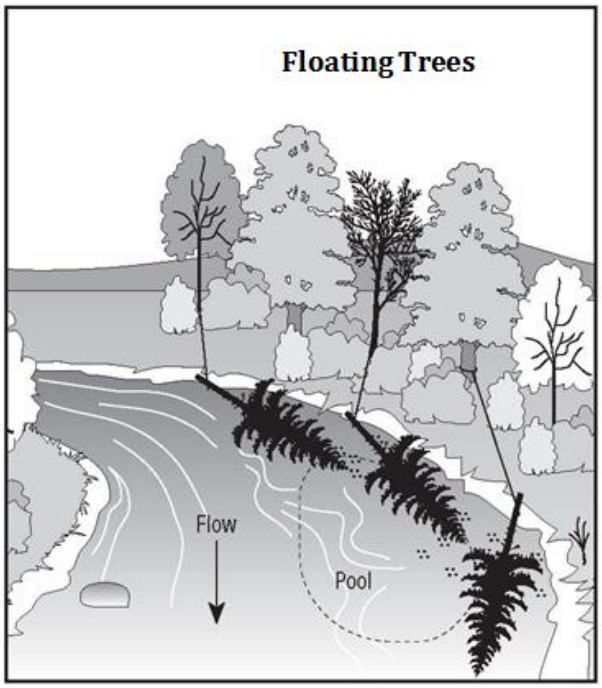
Root Wads - Installed to provide instream cover and bank stabilization. A typical site would use 6 to 9 metre long trees with 2 metres diameter root wads. The tree trunk is buried in the bank or driven into the bank so that the base of the root wad faces the current. See figure 17-5.

Figure 17-5 Root Wads



Floating Trees – Trees oriented with the tops facing downstream can be secured to the bank of the watercourse to provide shade and cover habitat for fish in areas where this is required. See figure 17-6.

Figure 17-6 Floating trees



18 All Watercourse Alterations

18.1 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:

- Avoid environmentally sensitive areas.
- Minimize the work-site footprint; only clear and excavate to the extent necessary.
- Choose least impactful 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.
- Avoid scraping (blading) 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 construction 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.

18.2 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, 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 mitigative 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 watercourse alteration 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.

19 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.

Backslope: The side of a ditch which faces toward the roadbed.

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

Camber: To curve upward or slightly rise near the middle. Culverts are cambered so that upon settlement of the roadbed, they take on a more or less uniform slope.

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.

Frac-out: release of drilling mud/fluids and other substances into the watercourse due to improper disposal or unexpected release through fractures in substrate.

Gabion: Wire baskets filled with coarse gravel or rock used especially to support the bank of a watercourse or an abutment.

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, unmerchantable trees and overburden material from the road right-of-way

Headwall: A retaining wall at the inlet and / or outlet of a culvert serving as protection against scoring and erosion of the foreslope.

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.

Maximum Design Velocity: The maximum flow velocity a bridge or open bottom culvert can withstand and not reduce the life of the structure.

Nomograph: A graph with three lines graduated so a straight line intersecting any two of the lines at their known values intersects the third at the value of the related variable.

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.

Peak: Maximum instantaneous stage or discharge of a watercourse in flood

Peak Flow: The maximum instantaneous value of discharge over a specified period of time.

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 columbar 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 forming 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.

Subgrade: The bed of ground on which the foundations of a road are laid.

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".

Temporary Bridge: a portable structure used for vehicular watercourse crossings that shall remain in place for a limited period of time.

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

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 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.

Wingwall: A lateral wall built onto an abutment serving to retain earth in the embankment

20 REFERENCE DOCUMENTS

Adamson, B. and A. Harris. 1992. *Sediment Control Plans: Reducing Sediment Concerns at Water Crossings.* Northwestern Ontario Forest Technology Development Unit, Tech. Note TN-20.

Ammand, A. and A. L. Stone. 1991. *Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire. Appendix E: Interpretation of Topographic Maps and Watershed Delineation Procedures.* New Hampshire Department of Environmental Services, Concord, NH.

Atlantic Industries Limited. Sales Pamphlets. Corrugated Steel Pipe; Bolt-A-Bin; Bolt-A-Plate.

Atlantic Industries Limited. Personal Communication. Roger Leger, CET, Maritime Sales Manager.

Blinn, C.R., et al. 1998. *Temporary Stream and Wetland Crossing Options for Forest Management.* United States Department of Agriculture Forest Service, North Central Research Station, General Technical Report NC-202.

Braithwaite, G.C., P. Eng. 1992. *Woodlot Roads Stream Crossings.* Cooperation for Forestry Development, Nova Scotia

Caracristi, H., and C. Smith. Fisheries and Oceans Canada. 2015. *Guidelines for the design of fish passage for culverts in Nova Scotia*. Fisheries Protection Program, Maritimes Region.

Douglas, Robert A. *Planning When Constructing Forest Roads and Stream Crossings,* University of New Brunswick. Workshop Proceedings "Maintaining Water Quality in Woodlands Operations". August, 1999. Atlantic Branch of the Canadian Woodlands Forum.

Fisheries and Oceans Canada. 1999. *Fact Sheets Prepared by Habitat.* http://www.nwafc.nf.ca/sealane/References/factsheet index.htm

Fisheries and Oceans Canada. 1985. *Technical Advice for Temporary Fish Screens.*

Fisheries and Oceans Canada. 1994. *Technical Advice for Fish Screens.*

Government of Canada. *Fisheries Act. (R.S.C., 1985, C.F-14)*

Government of Canada*. Species at Risk Act*. (S.C. 2002, C.29.).

Government of British Columbia. October 1996. Forest Practices Code. *Community Watershed Guidebook.* http://www.for.gov.bc.ca/TASB/LEGSREGS/FPC/FPCGUIDE/WATRSHED/watertoc.htm

Government of British Columbia. August 1995. Forest Practices Code: *Forest Road Engineering Guidebook.* http://www.for.gov.bc.ca/tasb/legs regs/fpc/fpcguide/road/FRE-TOC.htm

Government of British Columbia. A Working Draft for 1997 / 1998. Forest Practices Code:

Stream Crossing Guidebook for Fish Streams. http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/stream/str%2Dtoc.htm

Government of Newfoundland and Labrador, Department of Environment. May 1986. Chapter 3: *Environmental Guidelines for Watercourse Crossings.* Water Resources Division, Water Investigations Branch.

Government of Newfoundland and Labrador, Department of Environment and Lands. January 1989. Chapter 4: *Environmental Guidelines for Bridges.* Water Resources Division, Water Investigations Branch.

Government of Yukon, Environment Yukon, Water Resources Branch. May 2011. Best Management Practices for Works Affecting Water in Yukon.

Harland, J.A. and D.H. Waller. 1996. *Planning for Erosion and Sediment Control.* Centre for Water Resources Studies, CWRS Internal Report No. 96-2.

J.D. Irving, Limited. Personal Communication. Mike Boyd.

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

Mead New England Forest Resources Group. *Best Management Practices for Erosion Control & Water Quality Protection in Northern New England Forestry Operations.* Mead, Paper Division, Maine.

New Brunswick Department of the Environment, January 2012. *Watercourse and Wetland Alteration Technical Guidelines.*

New Brunswick Department of Justice and Consumer Affairs. Acts and Regulations. http://www.gnb.ca/0062/acts/index-e.asp

New Brunswick Department of Natural Resources and Energy / Department of Environment and Local Government. December 2001. *Proposed Provincial Wetlands Conservation Policy.*

New Brunswick Department of Natural Resources and Energy. May 1994. *Forest Management Manual for Crown Lands.*

New Brunswick Department of Natural Resources and Energy. July 2000. *Nuisance Wildlife Policy, Appendix B.*

New Brunswick Department of Natural Resources and Energy, Forest Extensions Branch. *Environmental Guidelines Manual for Watercourse Alterations on Private Woodlots.*

New Brunswick Department of Natural Resources and Energy, Forest Extensions Branch. Module 13, *Private Woodlots and the Clean Water Act.*

New Brunswick Department of Transportation, August 1998. *Environmental Field Guide.*

New Brunswick Department of Transportation. May 1998. *Environmental Protection Plan for New Brunswick Department of Transportation.*

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

New Brunswick Department of Transportation. Personal Communication. Phil Hans.

Vermont Stream Crossing Handbook, Vermont Fish and Wildlife Department, Waterbury, Vermont.

21 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	
Area	**Contact**
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

Eastern Region	
Area	**Contact**
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 Phone: 902-426-3909 Fax: 902-426-7174 E-mail: ReferralsMaritimes@dfo-mpo.gc.ca

22 APPENDICES

APPENDIX A

Notification Form Guidance

A**PPENDIX B**

Examples of Bridge Abutments

APPENDIX C

Freshwater Intake Fish Screen Guideline, Fisheries and Oceans Canada

APPENDIX D

Calculating Rip-rap Size for Bank Stabilization

NOVA SCOTIA
Environment

APPENDIX A - NOTIFICATION FORM GUIDANCE

OFFICE USE ONLY		*Application #*
Date Rec'd (yyyy/mm/dd)	*Ext. Ref. #*	*NSE File #*

The notification form must be received by Nova Scotia Environment at least 5 days before work commences. Work may only start after you (the notifier) have received a notification receipt from Nova Scotia Environment.

If you provide your email address and your notification is complete, Nova Scotia Environment will aim to send you the notification receipt by email within 5 days. If there is no email provided, Nova Scotia Environment will aim to put the notification receipt in the mail within 5 days.

PLEASE PRINT OR TYPE. Complete sections 1, 3, 4, applicable parts of 5, and 6 or the notification will not be accepted. Please keep a copy of your notification form. Incomplete forms will not be returned to the notifier.

Type of	New ❑	Renewed ❑	Amended ❑	If this is a renewed or amended notification, provide

For "Type of notification" please check one of the following boxes:

- New: if the notification is for a new activity
- Renewed: if the notification is to renew the notification for an activity that had been submitted in a previous year. If this is the case, please indicate the previous notification number in the box that has "If this is a renewed or amended notification, please provide notification #: _______________"
- Amended: if the notification is to amend the information provided for an activity that had previously been submitted for notification. If this is the case, please indicate the previous notification number in the box that has "If this is a renewed or amended notification, please provide notification #: _______________"
- Note: your previous notification # will be on the Notification Receipt you received.

SECTION 1 – NOTIFIER

This section is mandatory. The notifier is the person who will receive the notification receipt.

Notifier: Are you the owner of the property where the activity will take place ❑ ; the person with primary responsibility for the designated activity, such as a certified watercourse alteration sizer or installer ❑ ; an agent for owner or the person with primary responsibility ❑. Please check one of the boxes to indicate who you are.			
Company/Organization/Municipality			
Business Number (BN) *if applicable*			
Mr. ❑ Ms. ❑ Mrs. ❑ Other:		Professional Designation	
First Name	Middle Initial	Family Name	

Phone	Home ( )	Business ( )	Ext.	Other ( )	Ext.
Fax ( )		E-mail Please provide an email if you would like your receipt sent by email.			
Civic/Street Address					
Mailing Address (if different than Civic)					
County			City/Town		
Province		Postal Code		Country	

SECTION 2 - NOTIFICATION CONTACT (Optional)

This is an optional section and only needs to be completed if you wish someone other than the notifier to receive the official correspondence from NSE.

Company/Organization/Municipality					
Business Number (BN) *if applicable*					
Mr. ❑ Ms. ❑ Mrs. ❑ Other:			Professional Designation		
First Name		Middle Initial	Family Name		
Phone	Home ( )	Business ( ) Ext.		Other ( ) Ext.	
Fax ( )		E-mail [illegible]			
Civic/Street Address					
Mailing Address (if different than Civic)					
County			City/Town		
Province		Postal Code		Country	

SECTION 3 - SITE/LOCATION OF ACTIVITY

This section is mandatory. Please provide all of the information about the location of the activity in the fields below.

Property Identification numbers (PID) are available at Service Nova Scotia.
1:50,000 Topographic Maps (identifying Easting and Northing) are available at Nova Scotia Environment.

Watercourse Name: If there is no watercourse name, please provide the "Tributary to" the watercourse in the field below.

Tributary to:	Watershed name: For help determining the watershed, please refer to https://www.novascotia.ca/nse/water.strategy/docs/WaterStrategy_NSWatershedMap.pdf
Site Name:	
Civic/Street Address	
Property Identification # (PID)	1:50,000 Topographic Map #
Grid Reference Easting (6)	Northing (7)

Please check you have the correct Community to match your PID. If the correct community is not provided, the notification will be considered incomplete. You can find out your community by checking the deed for your property. If you are unsure about the community or if you think your community has changed, please contact the Land Registry Office.

You must provide the Easting and Northing for your alteration. You can find your Easting and Northing with a GPS, Google Earth, or using 1:50,000 topographic map. Please refer to attached document titled UTM (Universal Transverse Mercator) Collection for more guidance on how to find the Easting and Northing.

SECTION 4 – ACTIVITY

This section is mandatory. Please check only one box to indicate the type of watercourse alteration you are doing. Please also check to make sure your project scope falls within the limits of what is eligible for a notification.

Please check (✔) activity that applies. Please refer to Activities Designation Regulations to make sure the activity can be completed under a notification, otherwise an application for approval may be required.

Watercourse alterations (work between June 1 and September 30 only)

- ❑ Bank alteration (restricted to 5 m or less; watercourse bed is not disturbed). **Complete section 5A.**
- ❑ Work to improve fish habitat (not to exceed 15 m; no use of vehicular machinery). **Complete section 5B.**
- ❑ Maintenance of structure in watercourse (does not include removal, replacement, expansion or reductions; work done below the ordinary high water mark). **Complete section 5C**
- ❑ Culvert or closed bottom structure (on watercourse sloped less than 8%; watershed area not exceeding 20 km^2; length of structure 25 m or less). **Complete section 5D.**

Proposed Project Dates (yyyy/mm/dd)
You must provide projected start and end dates for the project. All work taking place under a notification must happen between June 1 and September 30.

Start Construction Date: End/Closure Date:

SECTION 5 - ACTIVITY DETAILS
This section is mandatory. Please complete the section that corresponds with the box checked in Section 4.

5A - All of the following information must be provided for a **bank alteration** in a watercourse or the notification will not be accepted.

Purpose of bank alteration ***(check at least one):***
❑ erosion protection ❑ wharf or boat launch ❑ water intake ❑ other ___________________

Bank Alteration: length _____m (cannot exceed 5 metres*) * if this is exceeded then you must submit an application for approval.
Information for the certified installer will be required as of October 2016.
Name of certified watercourse alteration installer (required after October 2016) ____
Phone # ____________________________________ Certification # ____

5B - All of the following information must be provided for **work to improve fish habitat** in a watercourse or the notification will not be accepted.

Description of work to improve fish habitat: Please provide a short project description including the scope of the project, the type of installation (e.g., digger logs, rock sills, etc.) and how the work will be done (e.g., what kind of tools will be used).
Length of watercourse alteration ____m (cannot exceed 15 m*) * if this is exceeded then you must submit an application for approval.

Information for the certified installer will be required as of October 2016.
Name of certified watercourse alteration installer (required after October 2016) ____
Phone # ____________________________________ Certification # ____

5C - All of the following information must be provided for **maintenance of structures** in a watercourse or the notification will not be accepted.

Description of maintenance:____Please provide a short project description including the scope of the project and the type of structure undergoing maintenance. Please note that any change to the size of the structure is considered a modification and means the activity does not qualify under the "maintenance" notification category.

Information for the certified installer will be required as of October 2016.
Name of certified watercourse alteration installer (required after October 2016) ____ Phone # _____________________________________ Certification # ____

5D - All of the following information must be provided for a **culvert or other closed bottomed structure**, or the notification will not be accepted.

The Watercourse Alteration Sizer course teaches how to determine the information requested below. Please refer to the certification training manual for guidance. All of the following information must be provided for this section.

Information about the watercourse:
Up-stream Drainage Area____________(km^2) (cannot exceed 20 km^2*)
Watercourse Slope__________% (cannot exceed 8%*)
Watercourse Velocity __________(m/s)
Watercourse Channel Width _________(m)
Watercourse Channel Depth ___________(m)

Information about the construction *(check one):*
New construction ❑; Removal ❑; Replacement ❑; Expansion ❑; or Reduction ❑

Length of culvert _________(m) (cannot exceed 25 m*)
Diametre of culvert _______(mm)
Length of dissipation pool _________(m)
Width of dissipation pool __________(m)

* if this is exceeded then you must submit an application for approval.

Watercourse slope *(check one):*
- ❑ Culvert on a watercourse with 0.5% slope or less; or
- ❑ Culvert on a watercourse with slope between 0.5% and 8.0% (Requires a Professional Engineer to design)

You must provide the name and phone number of the certified sizer or Professional Engineer. Also provide the certification/ qualification number of the certified sizer or professional engineer.
Name of certified watercourse alteration sizer or professional engineer ____________________________- ______________________ Phone # _____________________________________ Certification # ____

Information for the certified installer will be required as of October 2016.
Name of certified watercourse alteration installer (required after October 2016) ____ Phone # _____________________________________ Certification #

5E - All of the following information must be provided for a **bridge or other open bottomed structure** or the notification will not be accepted.

The Watercourse Alteration Sizer course teaches how to determine the information requested below. Please refer to the certification training manual for guidance. All of the following information must be provided for this section.

Information about the watercourse:
Up-stream Drainage Area___________(km^2)(cannot exceed 20 km^2*)
Watercourse Velocity _________(m/s)
Watercourse Channel Width ________(m)
Watercourse Channel Depth __________(m)

Information about the construction *(check one)*:
New construction ❑; Removal ❑; Replacement ❑; Expansion ❑; or Reduction ❑

Check one and complete the information under the section checked:

❑ Bridge/concrete span;
Provide width of span _____(m) (cannot exceed 15 m*)

Or

❑ Pipe arch/open bottom structure
Provide width of structure _______(mm) (cannot exceed 3600 mm*)
Provide length of structure _______(m) (cannot exceed 25 m*)

* if this is exceeded then you must submit an application for approval.
You must provide the name and phone number of the certified sizer or Professional Engineer. Also provide the certification/ qualification number of the certified sizer or professional engineer.
Name of certified watercourse alteration sizer or professional engineer __________________________-____________________
Phone # ___________________________________ Certification # ____

Information for the certified installer will be required as of October 2016.
Name of certified watercourse alteration installer (required after October 2016) ____
Phone # ___________________________________ Certification # ____

SECTION 6 – DECLARATION

This section is mandatory.

Please ***check one*** option that applies to your situation in the following statement:

You must check one of the following boxes.

❑ I own the site,

❑ I have a lease or other written agreement or option with the landowner or occupier that enables me to carry out
the activity on the site, or

❑ I have the legal right or ability to carry out the activity without the consent of the landowner or occupier.

I **agree** that the information I have provided in this Notification, including personal information, may be disclosed to the Department of Fisheries and Oceans.

I **understand** that I must provide all information about the activity, such as sketches, plans, and calculations, if requested by Nova Scotia Environment for a compliance audit

I **have read and understand** the regulations and standard that applies to the activity to which the notification relates, including the Nova Scotia Activities Designation Regulations, and the Nova Scotia Approval and Notification Procedures Regulations.

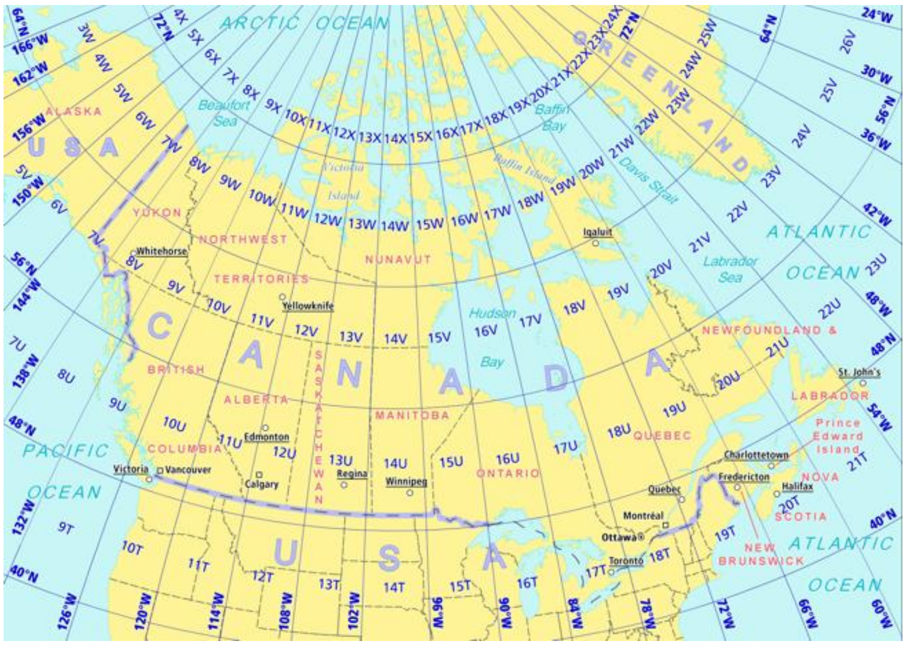
I **verify** that I will carry out the activity in compliance with the *Environment Act* and the applicable regulations and standard.

I agree with all of the declaration statements. You must sign and date the form. Scanned signatures will be accepted.

Notifier's signature   Date (yyyy/mm/dd)

UTM (Universal Transverse Mercator) Collection

UTM: Acronym for *universal transverse Mercator*. A projected coordinate system that divides the world into 60 north and south zones, 6 degrees wide. http://support.esri.com/en/knowledgebase/GISDictionary/term/UTM Nova Scotia is broken up into 3 UTM Zones, Zone 19, Zone 20 and Zone 21. The majority of the province will fall into Zone 20. Zone 19 is a small area close to Yarmouth, Zone 21 is a small area close to Glace Bay on Cape Breton Island. (See Zones below) The X and Y values for UTM coordinates are called Northing and Easting. **Nothing is a 6 digit number; Easting is a 7 digit number.**



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

There are three easy ways to collect UTM coordinates, you can use a GPS unit, Google Earth or take them directly from a 1:50,000 topographical sheet. (NTS)

GPS Collection:

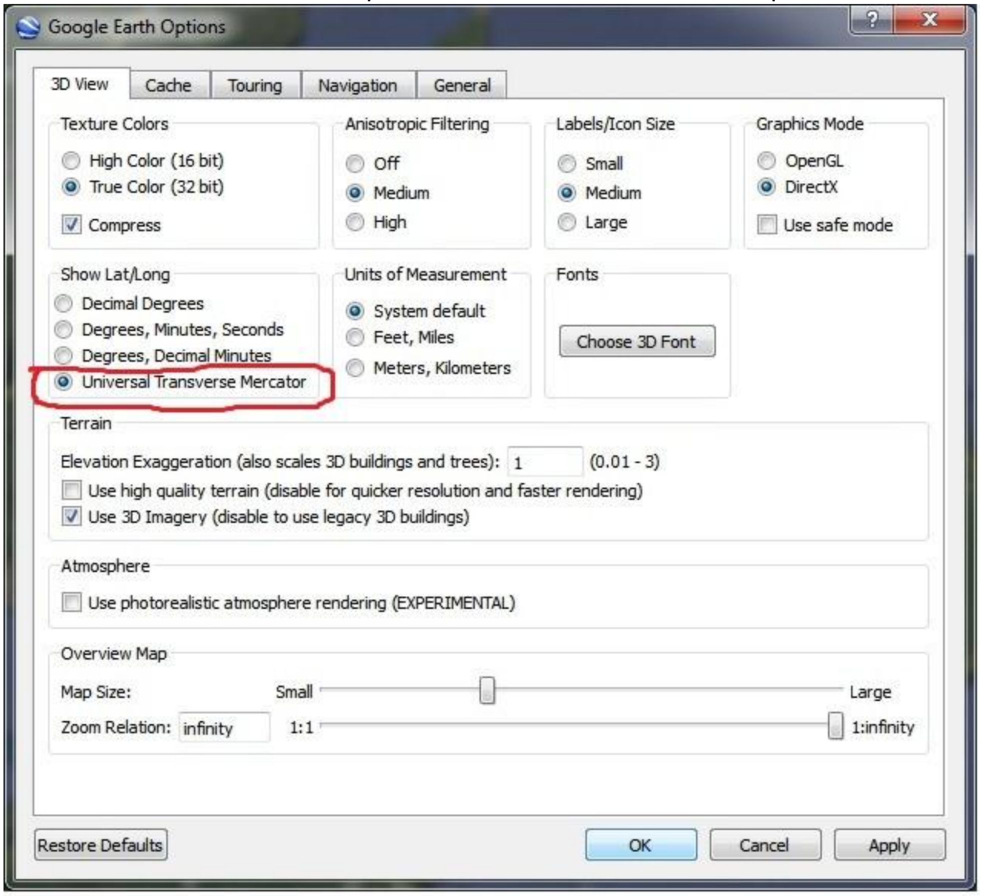
The first thing to do is enter your GPS unit's set-up screen to set up the GPS to collect in UTM. **Use your supplied user's manual to accomplish this.** Most Garmin GPS units will follow the following procedure: (There may be slight variations of these directions depending on which GPS you have)

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****** **Now any point you collect will be in a UTM format.**

Google Earth:

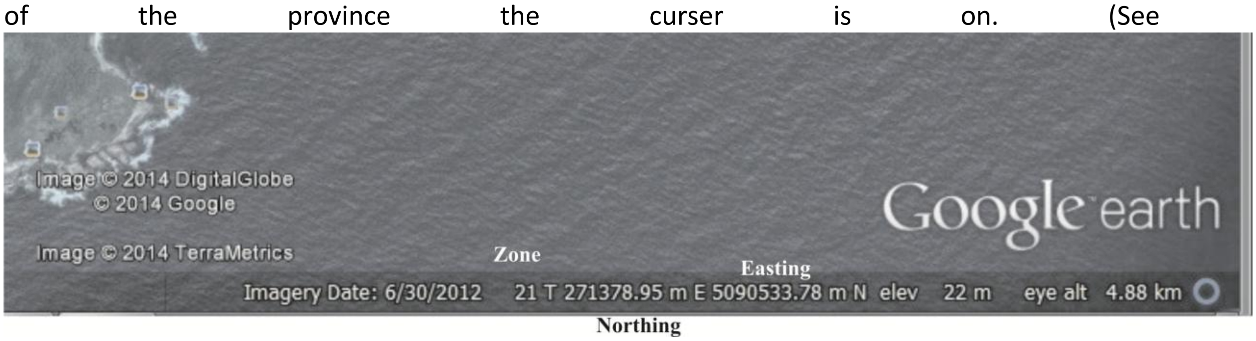
Install Google Earth on your machine if you do not have it.

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 coordinates will be displayed in the lower right hand corner of the google maps screen. Google earth also provides you with the zone automatically depending on what part of the province the curser is on. (See below)

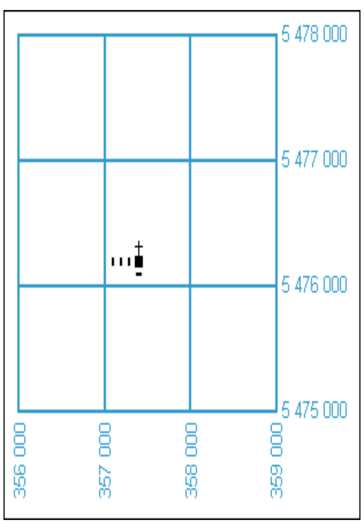


NTS Sheet (1:50,000 Topo)

Civilian UTM Grid Reference System

Horizontal lines are designated by their distance from the equator in metres. Because Canada's southernmost point is about 4 620 000 metres from the equator, all horizontal lines in Canada have a "northing" value above that figure. Vertical lines are measured from a separate point for each zone, namely, an imaginary line lying 500 000 metres west of the zone's central meridian. Actually, zones never attain the full width of 1 000 000 metres which such a measurement suggests; in fact, in northern Canada, zone widths shrink to as little as 80 000 metres (40 000 metres on either side of the central meridian). In practice, this means that vertical lines are counted from the central meridian or 500 000 metre line, those to the left of it having an "easting" value of less than 500 000 metres, and those on the right having a value above that.

The number of metres north of the equator represented by the bottom horizontal grid line on a map is always shown in the lower left-hand corner of the map. Similarly, the number of metres east of the zero vertical line represented by the left vertical grid line is also shown in the lower left-hand corner.



If a given point on a map is positioned exactly at the intersection of a vertical and horizontal line, its location may be read off simply from the map margins. Its full designation or its "coordinates" would include the zone number, followed by the easting and northing values. On a 1 000-metre grid, these coordinates might read: **Zone 14, 357 000, 5 476 000**. The values of the first vertical and horizontal lines appearing in the southwest corner of the map are given in full. The other grid lines are numbered in an abbreviated fashion.

Few points, however, are conveniently located at grid intersections. Usually the point to be described (such as the church in Figure 4, right) is somewhere between lines. In this case, it is necessary to measure or estimate the distance to the nearest vertical line to the west and to the nearest horizontal line to the south and to add these metric values to the grid values given at the margin.

Figure 4 - Civilian System

As in the above example, if a point is located 400 metres east of the vertical line of 357 000, and 200 metres north of the horizontal line of 5 476 000, its coordinates would be: **Zone 14, 357 400, 5 476 200**. With these three numbers, any point on the northern hemisphere can be unmistakably identified. There is a similar reference in the southern hemisphere, but confusion never results from this.

The civilian system of designating UTM Grid coordinates is straightforward and, since it uses only numbers, it can be handled by digital mapping software and Geographic Information Systems (GIS), an important consideration with any kind of technical data. It does, however, require the use of large and somewhat cumbersome figures. To get around this, military map-makers have developed a somewhat different system consisting of a combination of letter and numbers, the Military Grid Reference System.

This material updated from ***The Universal Transverse Mercator Grid***, Department of Energy, Mines and Resources Canada, Surveys and Mapping Branch, Ottawa, © 1969, The Queen's Printer.

APPENDIX B

EXAMPLES OF BRIDGE ABUTMENTS

Constructing Bridge Abutments

Abutments are the foundation of the bridge, supporting the structure and protecting the banks of the watercourse from the pressure of the traffic using the bridge. Abutments are normally constructed from concrete, wood, steel or aluminum.

Some acceptable types of abutments for forestry operations include:

- Bin Wall Abutment
  Squared Timber Crib
- Cast in Place Concrete
- Pre-cast lock block
- Sill log abutment

The following provides guidelines on the installation / construction of Squared Timber Crib and Bin Wall abutments. These types of abutments tend to be most frequently used for bridges built for forestry operations.

Squared Timber Crib Abutment

A timber crib abutment is made from squared timber, often 20 x 20 cm (8 x 8 in) in size. It can be built having either an open or closed face.

- A closed face abutment provides a relatively tight, uniform surface with no gaps between the timbers. In areas where ice flows may damage the abutment, this type should be used.
- An open face abutment requires the use of backfill material larger than the open spaces between the timbers to prevent backfill from falling through into the watercourse.
- Use the following guidelines when constructing a timber crib abutment.
- Prior to any construction or placement on site, treated timber must be dried and cured.
- Excavate and prepare the foundation.
- In the first layer, place the face timber parallel to the watercourse. In addition, place the back timber parallel to the face timber at the back. The back timber extends an equal distance beyond the length of the face timber on each end. Level this first layer before adding any further layers (see Figure 1).
- The second layer consists of wing timbers which join the face and back timber at a 45° angle using drift-pins.
- Within the frame, tie-backs join the face and back timbers at a 90° angle.
- Continue to repeat the layer sequence until the desired height of the abutment is reached.
- Bevel the ends at the corners where the face timbers and the wing timbers join.
- Begin backfilling the crib when a height of 1 m (3 ft) has been reached. This will allow the backfill to be properly compacted.
- Line the bottom of the crib with filter fabric and begin placing backfill material in and directly behind the crib in layers of 15 to 20 cm (6 to 8 in).
- Compact the backfill by hand in the corners of the crib.
  - Grade the area around the crib in an effort to carry water away from the crib and to prevent ponding.

Figure 1. Construction of the base of a timber crib abutment

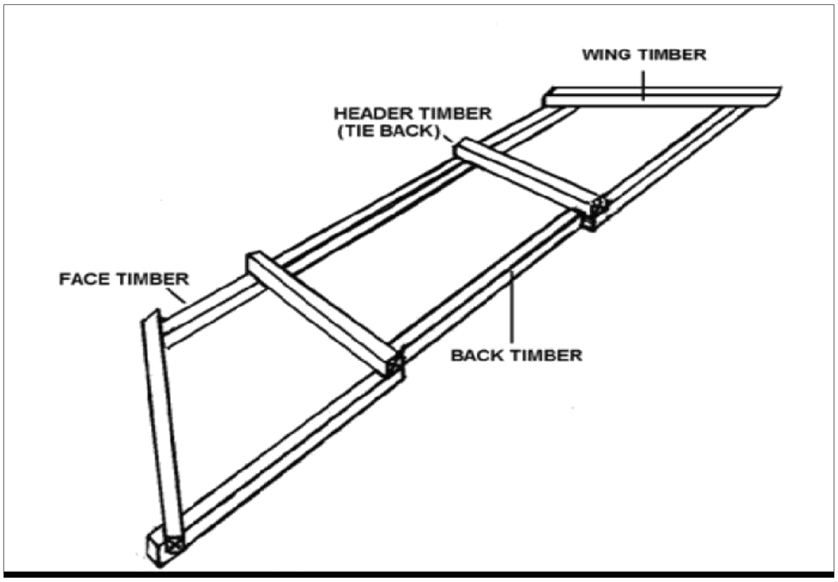
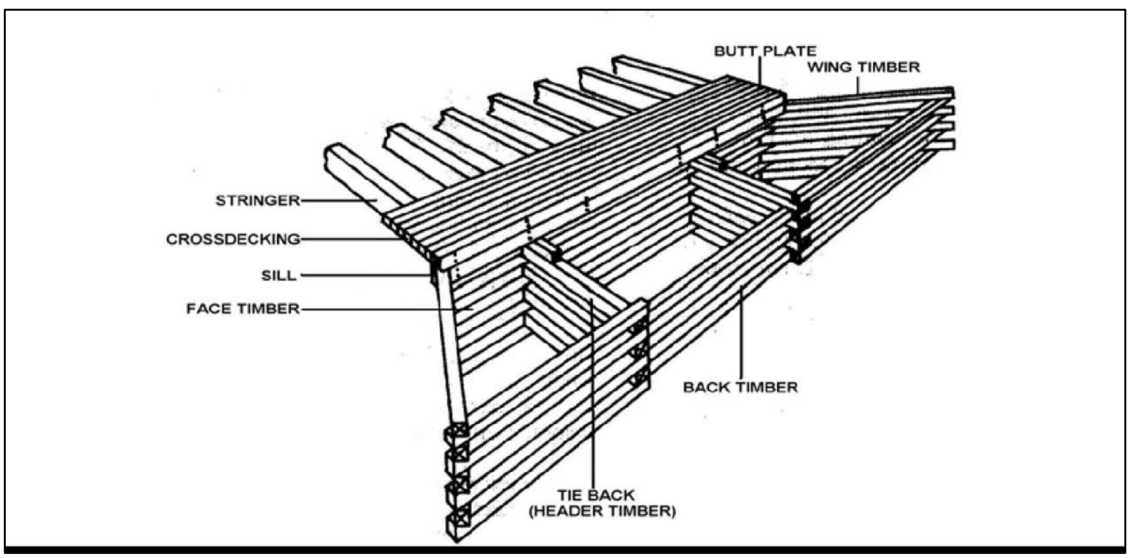


Figure 2 Angle view of a timber crib abutment with features identified.



Bin Wall Abutment

A bin wall abutment is a lightweight corrugated steel or aluminum retaining wall. This abutment is sized before ordering and can be assembled by hand on or off site. (See Figure 3 and 4 for views.)

The following guidelines pertain to the installation of a Bolt- a-Bin abutment, one type of bin wall abutment.

- Excavate and prepare the foundation.
- On top of the foundation material, provide a 20 cm (8 in) layer of soil to act as a compressible cushion under the grade plates of the bin. This soil should be free from rocks, debris and organic material. A layer of filter fabric may be placed between the foundation and the soil.
- After setting the bin on the foundation, line the bottom and edges with filter fabric and begin placing backfill material in and directly behind the bin in layers of 15 to 20 cm (6 to 8 in).
- Compact the backfill by hand in the corrugations and along the steel and aluminum bin joints.
- Wrap a perforated pipe in filter fabric, place it at the bottom of the wall near the rear face and extend it away from the bin to provide an outlet for water within the bin. The pipe should be at least 15 cm (6 in) in diameter.
- Grade the area around the bin in an effort to carry water away from the bin and to prevent ponding.

Figure 3 Side view of Bolt-a-Bin Abutment

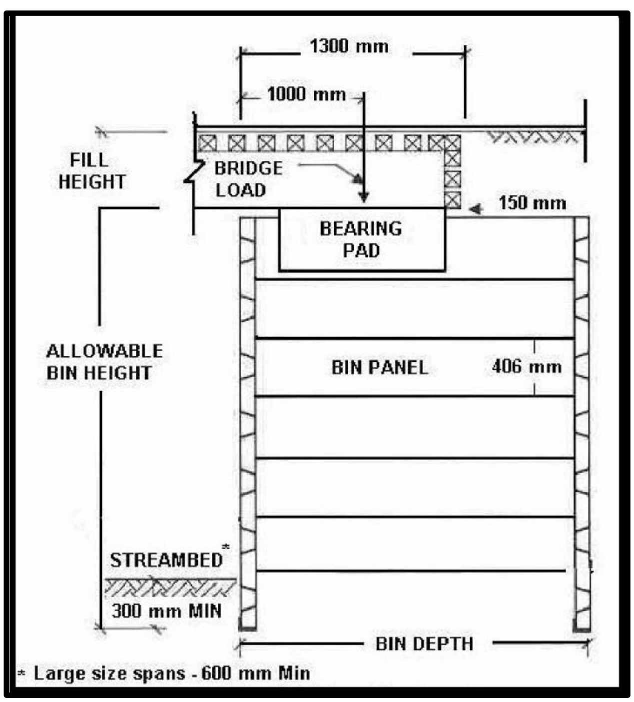
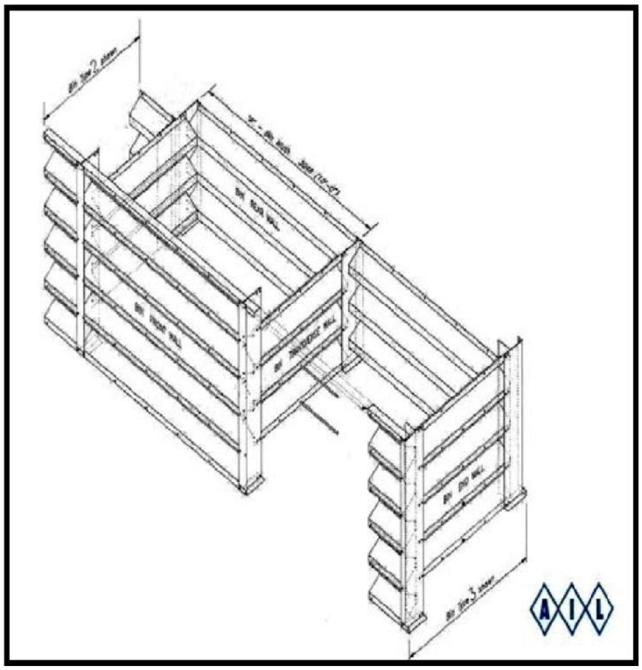


Figure 4 Front view of Bolt-a-Bin Abutment



Constructing a bridge

- Construct a cofferdam on the side of the watercourse where construction of the first bridge abutment is to take place. Remember to leave two-thirds of the watercourse unobstructed for fish passage.
- In conjunction with the installation of cofferdams, install silt fencing to isolate the work site.
- Once the cofferdam is closed and de-watered, construct an abutment in the designated location at or above the high water mark.
- Place a sill (bearing plate) parallel and behind the top face timber (panel) of the completed abutment.
- The sill is a squared timber or a concrete pad that provides support to the stringers.
- Place butt plates on blocks behind the sills to prevent the stringers from sliding over and beyond the sills.
- Align stringers parallel to the direction of the road from abutment to abutment.
- Extend stringers beyond the edge of each abutment to the center of the sill or a minimum of 45 cm (18 in), whichever the greater.
- Stringers are generally not less than 15 cm (6 in) square.
- Place stringers equal distances apart across the width of the bridge. Spacing should not exceed 50 cm (20 in) apart.
- Stringers support the weight of the decking and, as such, should have no material defects.
- Place cross-decking perpendicular to the stringers equal distances apart.
- Cross-decking should overhang the outside stringers equally on each side of the bridge.
- Place travel planking or wheel runs perpendicular to the cross-decking to protect the deck from wear. Travel planking should be 5 to 7 cm (2 to 3 in) thick.
- Travel planking should be wide enough and spaced far enough apart to accommodate any vehicle.
- Place curbing and railings along each side of the bridge as a guide to traffic.
- Upon completion of the project, remove the cofferdam starting from the downstream end.

APPENDIX C

Freshwater Intake Fish Screen Guidelines

Fisheries and Oceans Canada. 1994. Technical Advice for Fish Screens.

Freshwater Intake Fish Screen Guidelines

Introduction & Guideline Objectives

This guideline has been prepared to assist proponents in the design and installation of fish screens for the protection of anadromous and resident fish where freshwater is extracted from fish-bearing waters. This guideline will also assist regulatory agencies in the review of fish screen proposals. The objective of the guideline is to provide a standard-of-practice and guidance for end-of-pipe fish screens at freshwater intakes to prevent potential losses of fish due to entrainment or impingement. Entrainment occurs when a fish is drawn into a water intake and cannot escape. Impingement occurs when an entrapped fish is held in contact with the intake screen and is unable to free itself. The severity of the impact on the fisheries resource and habitat depends on the abundance, distribution, size, swimming ability, and behaviour of the organisms in the vicinity of the intake, as well as, water velocity, flow and depth, intake design, screen mesh size, installation and construction procedures and other physical factors.

The guideline deals exclusively with the sizing and design of fixed screens that are often placed at the end of a pipe used to extract water up to 0.125 m3/s, or 125 litres per second (L/s) (i.e., 2000 US gallons per minute (US gpm)). The guideline is intended for use in addressing fish screens for small permanent and temporary withdrawals for irrigation, construction, small municipal and private water supplies, etc. It is not intended for application to hydroelectric or canal screen designs; however, such proposals can be considered by regulatory agencies on a site-specific basis. The guideline focuses on the technical aspects of intake screens and the protection of fish.

This guideline has been developed to provide protection of freshwater fish with a minimum fork length of 25 mm (approximately 1 inch) since most eggs and fish larvae remain in bottom substrates until they reach the fry stage (i.e., 25 mm fork length). Other designs, in addition to intake screens, may be appropiate to address fish and fish habitat protection associated with water withdrawals. Such proposed designs should be addressed with the appropriate regulatory agencies on a site-specific basis.

Information Requirements

Information that should be provided to facilitate evaluation of an end-of-pipe intake screen design intended for fish protection during a freshwater withdrawal is highlighted below.

- fish presence, species, and possible fish size or fish habitat conditions at the project site
- rate or ranges of rates of withdrawal from the watercourse
- screen open and effective areas
- physical screen open parameters with respect to the intake and the watercourse
- screen material, method of installation and supporting structures
- screen maintenance, cleaning, or other special requirements

Design, Installation & Maintenance

The appropriate design of a fish screen is largely dependent upon the species and the size of fish requiring protection. Appropriate installation and maintenance/cleaning of the screen are also important in keeping approach velocities low and ensuring satisfactory operation of the screen. For the purposes of this guideline, emphasis is placed on the protection of freshwater fish with a minimum fork length of 25 mm from entrainment and impingement due to water extraction activities. Depending upon site-specific circumstances, a case may be made whereby the minimum fork length size of fish to be protected is greater than 25 mm. In this instance, the fish screen criteria for open screen area (Table 2 and Figure 1) and screen mesh size (2.54 mm) presented here do not apply. Fish screen criteria and guidance for the protection of fish larger than 25 mm is provided by Katopodis (1992).

The following sections address the appropriate design of fixed freshwater intake end-of-pipe fish screens for the protection of fish with a minimum fork length of 25 mm.

Fish Screen Criteria

To protect fish from impingement or entrainment, the approach velocity (i.e., the water velocity into, or perpendicular to, the face of an intake screen) should not exceed certain values based on the swimming mode (i.e., subcarangiform or anguilliform) of the fish present in the watercourse. The subcarangiform group includes fish that swim like a trout or salmon, and move through the water by undulating the posterior third to half of their bodies. The anguilliform group includes fish that swim like an eel, and move through the water by undulating most or all of their body. Table 1 presents the swimming modes of most common fish species in Canada.

Envelope curves for approach velocities were developed for each swimming mode corresponding to a minimum fork length of 25 mm and a maximum endurance time of 10 minutes (the time the fish is in front of the face of the screen before it can elude it). To satisfy approach velocities of approximately 0.11 m/s and 0.038 m/s for the subcarangiform and anguilliform groups respectively, curves indicating the required open screen areas, based on fish swimming performance data, including fish species and size (Katopodis, 1990) and related to flows/extractions, were developed. Table 2 presents the required open screen area, in both metric and non-metric units, for end-of-pipe intake screens with a capacity up to 125 L/s (2000 US gpm). The open screen area is the area of all open spaces on the screen available for the free flow of water. The same information is presented graphically in Figure 1.

Table 1 - Summary of Common Fish Species and Swimming Modes

SUBCARANGIFORM SWIMMING MODE

Common Name	Scientific Name
Alewife (Gaspereau)	*Alosa pseudoharengus*
Arctic Char	*Salvelinus alpinus*
Arctic Grayling	*Thymallus arcticus*
Atlantic Salmon	*Salmo salar*
Broad Whitefish	*Coregonus nasus*
Brook Trout	*Salvelinus fontinalis*
Brown Trout	*Salmo trutta*
Carp	*Cyprinus carpio*
Channel Catfish	*Ictalurus punctatus*
Chinook Salmon	*Oncorhynchus tshawytscha*
Chum Salmon	*Oncorhynchus keta*
Cisco	*Coregonus artedii*
Coho Salmon	*Oncorhynchus kisutch*
Cutthroat Trout	*Oncorhynchus clarki clarki*
Dolly Varden	*Salvelinus malma*
Goldeye	*Hiodon alosoides*
Green Sturgeon	*Acipenser medirostris*
Inconnu	*Stenodus leucichthys*
Kokanee	*Oncorhynchus nerka*
Lake Sturgeon	*Acipenser fulvescens*
Lake Trout	*Salvelinus namaycush*
Lake Whitefish	*Coregonus clupeaformis*
Largemouth Bass	*Micropterus salmoides*
Longnose Sucker	*Catostomus catostomus*
Mooneye	*Hiodon tergisus*
Mountain Whitefish	*Prosopium williamsoni*
Ouananiche	*Salmo salar ouananiche*
Pink Salmon	*Oncorhynchus gorbuscha*
Rainbow Smelt	*Osmerus mordax*
Rainbow Trout	*Oncorhynchus mykiss*
Sauger	*Stizostedion canadense*
Smallmouth Bass	*Micropterus dolomieui*
Sockeye Salmon	*Oncorhynchus nerka*
Walleye	*Stizostedio vitreum*
White Bass	*Morone chrysops*
White Perch	*Morone americana*
White Sturgeon	*Acipenser transmontanus*
White Sucker	*Catostomus commersoni*
Yellow Perch	*Perca flavescens*

ANGUILLIFORM SWIMMING MODE

Note: The few data points available for Northern Pike *(Esox lucius)* are close to the anguilliform group.

Common Name	Scientific Name
American Eel	*Anguilla rostrata*
Burbot	*Lota lota*
Sea Lamprey	*Petromyzon marinus*

Design of Fixed End-of-Pipe Fish Screens

Once the required open area has been found from Table 2 or Figure 1, the effective screen area must be calculated. It is the area occupied by the open spaces (i.e., open screen area) and the screen material available for the free flow of water. The effective screen area should be provided at the intake location and is determined as follows:

$$\text{Effective Screen Area } (m^2 \text{ or } ft^2) = \frac{\text{Open Screen Area (Table 2)}}{\left(\frac{\text{\% Open Area (Table 3)}}{100}\right)}$$

It should be noted that if the percent (%) open screen area is maximized, then the effective screen area required for a given flow is minimized. The narrowest dimension of any opening on the screen is referred to as the design opening, regardless of opening shape. The maximum design opening for a fish of 25 mm fork length is estimated at 2.54 mm (0.10 inches). Guidance on screen openings and materials is presented below.

- The screen openings may be round, square, rectangular, or any combination thereof, but should not have any protrusions that could injure fish.
- Screen materials may include brass, bronze, aluminum, monel metal, galvanized or stainless steel, and plastics. The screen material should be resistant to corrosion and UV light.
- Note: clogging due to corrosion is minimized with the use of stainless steel.
- Welded wedge wire screens offer reduced debris clogging and increased open area and screen stiffness, in comparison to round wire mesh and punch plate.

Table 3 presents several common types of screening material that meet the requirements of wire diameter, clear opening width and percent open area,

The dimensions of the fish screen can be calculated after the correct shape, configuration, location, and method of installation have been determined. This will usually be determined after a site investigation and a review of these guidelines. Included in Figure 2 are common screen shapes and the associated dimensions and area formulae. These are just examples of the many shapes and sizes in which fish screens can be fabricated. Screens are instream structures and, as such, should have sufficient strength and durability, and be capable of withstanding any potential large forces and impacts. Figure 3, 4, and 5 illustrate some of the various configurations, applications, and screen material types of end-of-pipe fish screens.

Installation

- Screens should be located in areas and depths of water with low concentrations of fish throughout the year.

- Screens should be located away from natural or man-made structures that may attract fish that are migrating, spawning, or in rearing habitat.

- The screen face should be oriented in the same direction as the flow.

- Ensure openings in the guides and seals are less than the opening criteria to make “fish tight”.

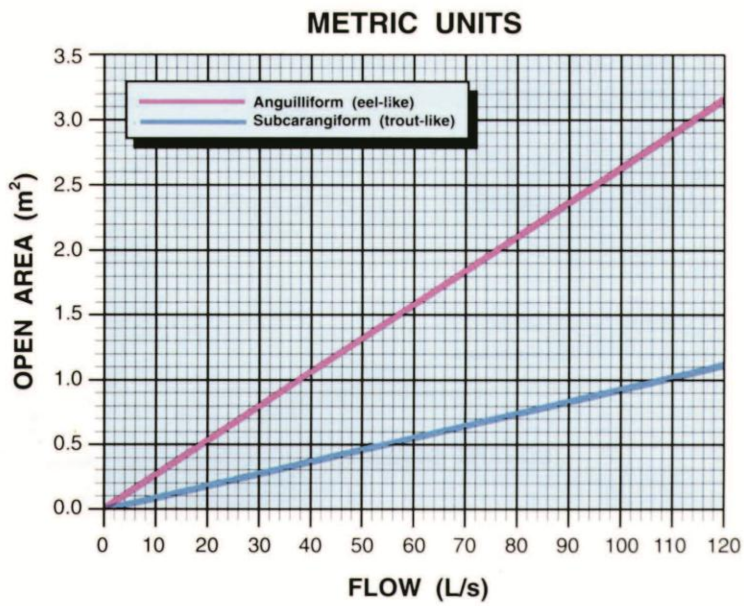
- Screens should be located a minimum of 300 mm (12 in.) above the bottom of the watercourse to prevent entrainment of sediment and aquatic organisms associated with the bottom area.

- Structural support should be provided to the screen panels to prevent sagging and collapse of the screen.

- Large cylindrical and box-type screens should have a manifold installed in them to ensure even water velocity distribution across the screen surface. The ends of the structure should be made out of solid materials and the end of the manifold capped.

- Heavier cages or trash racks can be fabricated out of bar or grating to protect the finer fish screen, especially where there is debris loading (woody material, leaves, algae mats, etc.). A 150 mm (6 in.) spacing between bars is typical.

Figure 1 - Open Screen Area for End-of-Pipe Water Intake Flow



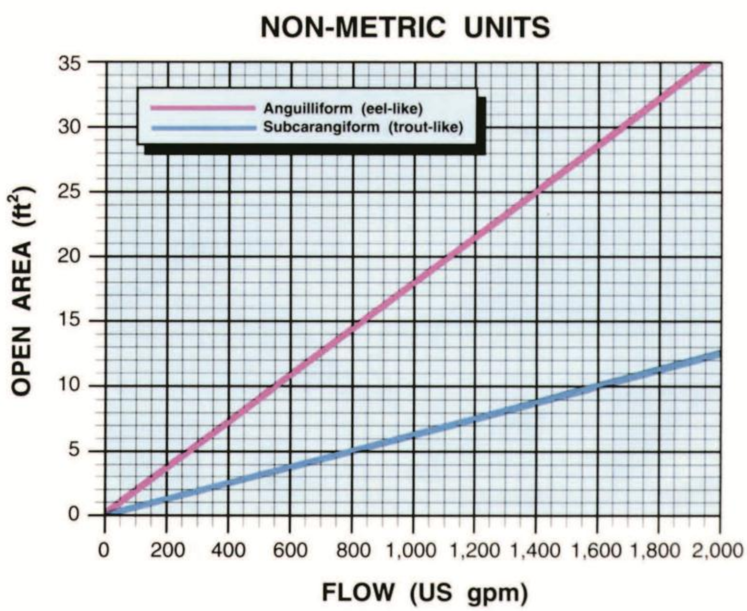


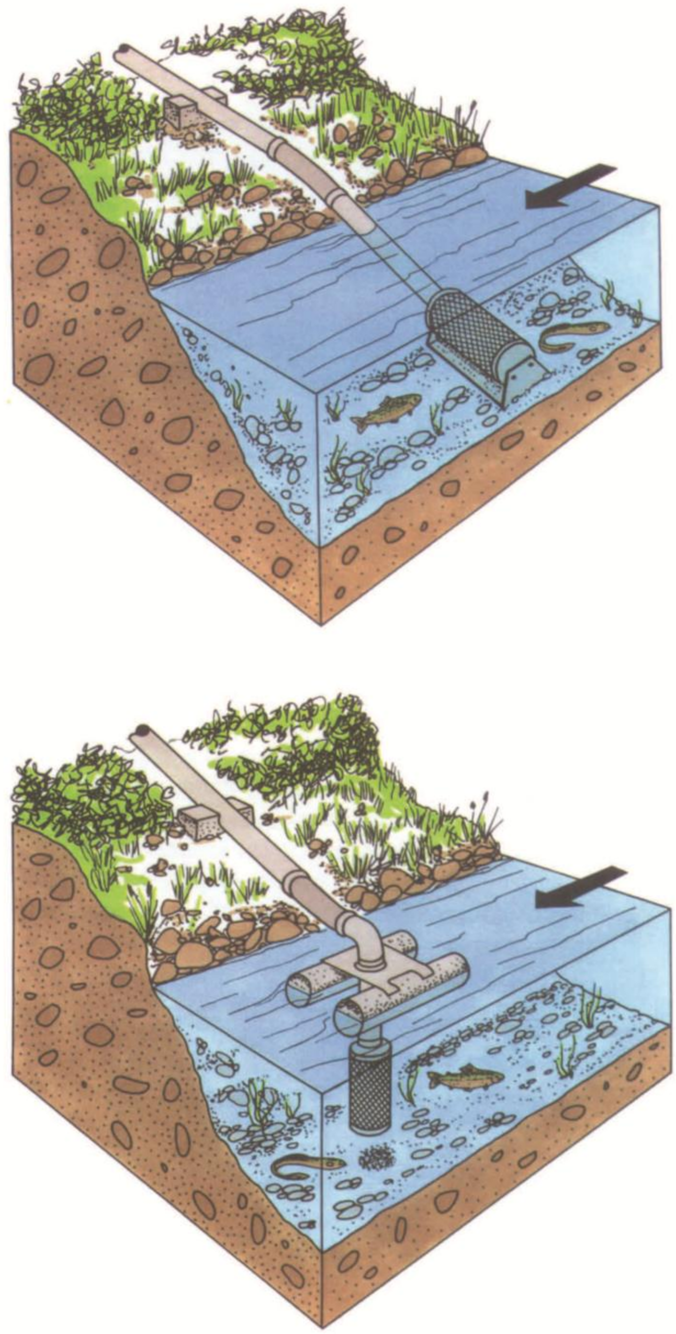
Table 2 - Open Screen Area Required for End-of-Pipe Water Intakes

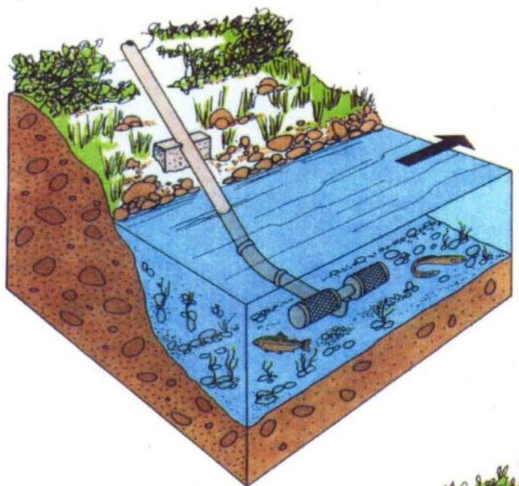
Metric Units			Non-Metric Units		
Flow (L/s)	Subcarangiform (m²)	Anguilliform (m²)	Flow (US gpm)	Subcarangiform (ft²)	Anguilliform (ft²)
1	0.01	0.03	10	0.1	0.2
5	0.05	0.13	50	0.3	0.9
6	0.06	0.16	100	0.6	1.8
8	0.07	0.21	150	0.9	2.7
10	0.09	0.26	200	1.3	3.6
12	0.11	0.31	250	1.6	4.5
14	0.13	0.37	300	1.9	5.4
15	0.14	0.39	350	2.2	6.2
16	0.15	0.42	400	2.5	7.1
18	0.17	0.47	450	2.8	8.0
20	0.18	0.52	500	3.2	8.9
22	0.20	0.58	550	3.5	9.8
24	0.22	0.63	600	3.8	10.7
25	0.23	0.65	650	4.1	11.6
26	0.24	0.68	700	4.4	12.5
28	0.26	0.73	750	4.7	13.4
30	0.28	0.79	800	5.0	14.3
32	0.30	0.84	850	5.4	15.2
34	0.31	0.89	900	5.7	16.0
35	0.32	0.92	950	6.0	16.9
36	0.33	0.94	1000	6.3	17.8
38	0.35	0.99	1050	6.6	18.7
40	0.37	1.05	1100	6.9	19.6
45	0.42	1.18	1150	7.2	20.5
50	0.46	1.31	1200	7.6	21.4
55	0.51	1.44	1250	7.9	22.3
60	0.55	1.57	1300	8.2	23.2
65	0.60	1.70	1350	8.5	24.1
70	0.65	1.83	1400	8.8	25.0
75	0.69	1.96	1450	9.1	25.8
80	0.74	2.09	1500	9.4	26.7
85	0.78	2.23	1550	9.8	27.6
90	0.83	2.36	1600	10.1	28.5
95	0.88	2.49	1650	10.4	29.4
100	0.92	2.62	1700	10.7	30.3
110	1.02	2.88	1750	11.0	31.2
120	1.11	3.14	1800	11.3	32.1
125	1.16	3.30	1850	11.6	33.0
			1900	12.0	33.9
			1950	12.3	34.8
			2000	12.6	35.7

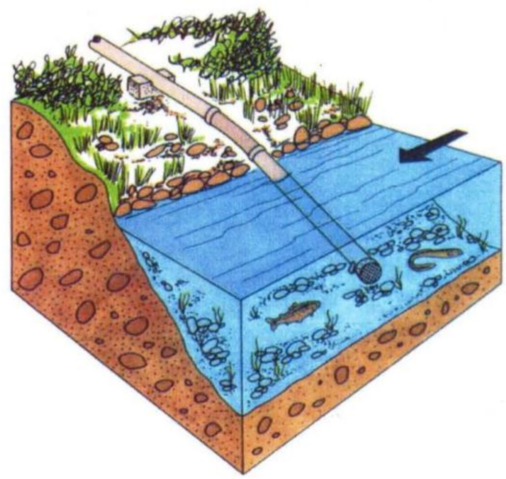
Table 3 - Examples of Screen Material

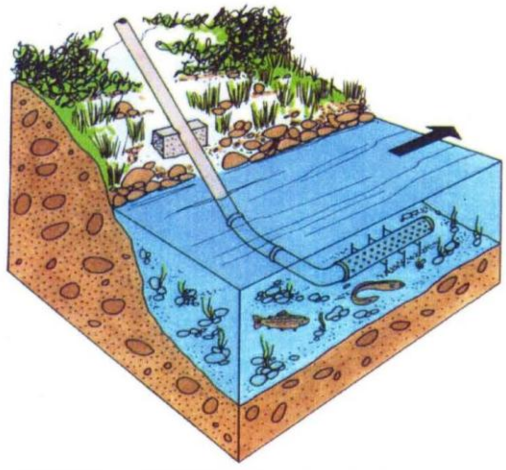
Material	Wire Thickness	Opening Width	% Open Area
8x 8 Stainless Steel Alloy Mesh	0.711 mm (0.028")	2.44 mm (0.096")	60
#7 Mesh Wire Cloth	1.025mm (0.041")	2.54 mm (0.100")	51
#8 Mesh Wire Cloth	0.875 mm (0.035")	2.25 mm (0.089")	52
#8 Mesh Wire Cloth	0.700mm (0.028")	2.54 mm (0.100")	62
#60 Wedge Wire Screen	1.50mm (0.059")	2.54 mm (0.100")	63
#45Wedge Wire Screen	1.10mm (0.080")	2.54 mm (0.100")	69

Figure 5 - Examples of Typical Installations of End-of-Pipe Screen









Cleaning and Maintenance

• Provision should be made for the removal, inspection, and cleaning of screens.

• Ensure regular maintenance and repair of cleaning apparatus, seals, and screens is carried out to prevent debris-fouling and impingement of fish.

• Pumps should be shut down when fish screens are removed for inspection and cleaning.

• Screens may be cleaned by methods such as air or water, backwashing, removal and pressure washing or scrubbing.

• Under certain site-specific winter conditions, it may be appropriate to remove screens to prevent screen damage.

• Flexible suction pipe may be used instead of solid, fixed piping for ease of screen removal and cleaning.

• Pump suction pressure can be measured to assess the need for screen cleaning.

To facilitate intake screen cleaning/maintenance, design and installation features such as orientation of the screen (e.g., in a cove) or variation in mesh shape (i.e., square wire/bars versus round wire/bars), etc. may be considered for regularly cleaned screens. For screens that will not be cleaned regularly, provision of considerably more open screen area (e.g., four times more) than determined from Table 2/Figure 1 may be considered. Such design/installation features should be addressed with the appropriate regulatory agencies on a site-specific basis.

For more information on the appropriate design of freshwater intake end-of-pipe fish screens, see Section 20 of the manual.

References

Katopodis, C. 1990. Advancing the art of engineering fishways for upstream migrants. Proceedings of International Symposium on Fishways '90, Oct. 8-10, 1990, Gifu, Japan, p. 19-28.

Katopodis, C. 1992. Fish screening guide for water intakes. Working Document, Freshwater Institute, Winnipeg, Manitoba.

Katopodis, C, 1994. Analysis of ichthyomechanical data for fish passage or exclusion system design. Proc. International Fish Physiology Symposium, July 16-21, 1994, Vancouver, B.C. American Fisheries Society and Fish Physiology Association.

Katopodis, C. and R. Gervais, 1991. Icthyomechanics, Working Document, Department of Fisheries and Oceans, Freshwater Institute, Winnipeg, Manitoba.

Glossary

Anadromous: Fish species that migrate from the sea to freshwater systems in order to spawn.

Anguilliform: The type of swimming mode for fish that swim like an eel, and move through the water by undulating most or all of their body.

Effective Screen Area: The area occupied by the open spaces (i.e., open screen area) and screen material available for the free flow of water.

Entrainment: Occurs when a fish is drawn into a water intake and cannot escape.

Fork Length: The straight line distance measured from the tip of the nose to the fork of the tail of a fish.

Impingement: Occurs when an entrapped fish is held in contact with the intake screen and is unable to free itself.

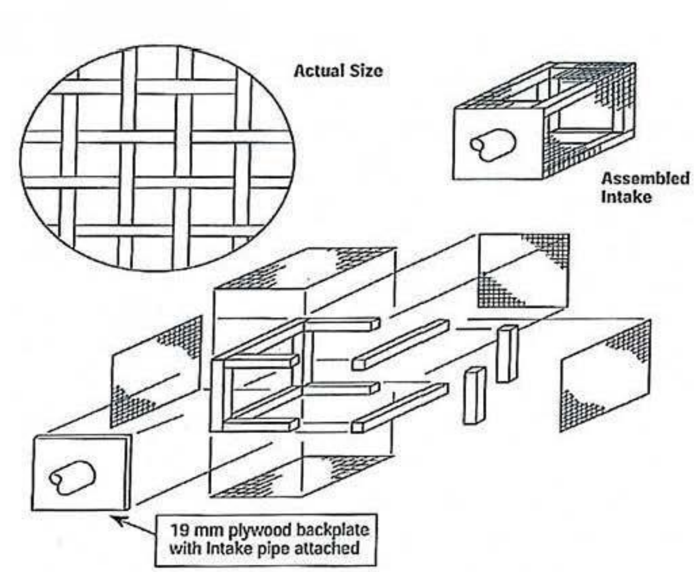
Open Screen Area: The area of all open spaces on the screen available for the free flow of water.

Subcarangiform: The type of swimming mode for fish that swim like trout or salmon, and move through the water by undulating the posterior third to half of their body.

Units of Conversion

To Convert	Into	Multiply By
cubic feet per second	cubic metres per second	0.0283
cubic feet per second	litres per second	28.3
cubic feet per second	US gallons per minute	448.9
cubic metres per second	cubic feet per second	35.3
cubic metres per second	US gallons per minute	15850
litres per second	cubic feet per second	0.0353
litres per second	cubic feet per minute	2.12
litres per second	cubic metres per second	0.001
litres per second	US gallons per minute	15.85
square metre	square foot	10.76
square metre	square inch	1550
square foot	square metre	0.0929
US gallons per minute	litres per second	0.0631
US gallons per minute	cubic feet per second	0.00223
US gallons per minute	Imperial gallons per minute	0.833
Imperial gallons per minute	litres per second	0.0758

Temporary Intake Screens



1 Dimensions of the assembled structure will vary according to the rate of intake.

2 1 square metre of open area of screen is required for each 0.15 cubic metres per second of water extracted.

3 Velocity through the screen must not exceed 15 centimetres per second.

4 Wire mesh with a horizontal distance between the openings of no greater than 7.5 millimetres is attached to the wooden frame using steel staples.

5 Treated wood must be completely dry before being immersed in water.

6 Attatch intake pipe to backplate.

7 Intake must be elevated to allow flow through screen bottom or other dimensions must be increased to ensure that sufficient screen is available.

Sample Calculation

A proponent wishes to withdraw water at a rate of 0.075 m^3/s from a nearby pond. The pond supports populations of brown trout, brook trout, and American eel. The intake is proposed to be cylindrical with the ends solid and #60 wedge wire screen around the cylinder.

What size must the intake screen be to satisfy the guideline requirements?

There are 4 steps to finding the answer:

1. Determine the fish swimming mode.
2. Determine the open screen area.
3. Determine the effective screen area.
4. Determine the dimensions necessary to produce the effective screen area.

1. Fish Swimming Mode

The fish swimming mode is found from Table 1. Brook trout and brown trout are listed as subcarangiform swimmers, while the American eel is an anguilliform swimmer.

2. Open Screen Area

Table 2 lists the required open screen area for both subcarangiform and anguilliform swimmers under flows up to 125 L/s (2000 US gpm). To use the table, if is necessary first to convert the flow from cubic metres per second to litres per second.

$$0.075\ \frac{m^3}{s} \times \frac{1000\ L}{1\ m^3} = 75\ \frac{L}{s}$$

For a flow of 75 L/s, Table 2 indicates that the open screen area must be:

- 0.69 m^2 for subcarangiform swimmers, and
- 1.96 m^2 for anguilliform swimmers.

The higher number (1.96 m^2) is the more stringent requirement, therefore, it is used in the calculation of effective screen area.

3. Effective Screen Area

The screen material in this case is # 60 Wedge Wire. A review of Table 3 indicates that the % Open Area for this material is 63%, With this value and the previously determined area from Step 2, the following formula is used to determine the Effective Screen Area.

$$\text{Effective Screen Area} = \frac{\text{Open Screen Area}}{\left(\frac{\text{\% Open Area}}{100}\right)}$$

$$= \frac{1.96\ m^2}{\left(\frac{63}{100}\right)}$$

$$= 3.111\ m^2$$

4. Dimensions of Intake Screen

Figure 2 lists several common screen shapes and their respective area formulae. For a cylindrical screen where the ends are solid and screening is around the cylinder, the following formula applies:

$$\text{Area} = \pi DL$$

The unknown dimensions are diameter (D) and length (L). These dimensions are determined by choosing a value for one and solving the equation for the other.

If the diameter is 0.600 m, then the length follows as:

$$\text{Area} = \pi DL$$

$$3.111\ m^2 = (0.600\ m)L$$

$$3.111\ m^2 = (1.885\ m)L$$

$$L = \frac{3.111\ m^2}{1.885\ m}$$

$$L = 1.65\ m$$

A 0.600 m diameter, 1.65 m long cylindrical screen would meet the design requirements. It should be noted that the dimensions given are representative of the screening area only; they do not include any screen that may be blocked by framing, etc. By comparison, if the pond only supported trout (subcarangiform), a 0.600 m diameter, 0.58 m long cylindrical screen would meet the design requirements.

APPENDIX D
CALCULATING RIP-RAP SIZE FOR BANK STABILIZATION

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

Determining Water Velocity

Rip-rap sizing to stabilize the bank of a watercourse to prevent further erosion or scour must be in accordance with Table I. In order to determine the size and quantity of material required to do bank stabilization with rip-rap or the strength of materials required to build a retaining wall, the velocity of the water must be determined. A certified watercourse alteration sizer could also determine the water velocity and the size and quantity of rip-rap material for bank stabilization.

Table 1 Rip-rap stone size chart

Class 1 1:100 year flow velocity up to and including 3 m per second	Class 1 At least 70% of the rip-rap must be between 0.3 m and 0.45 m
Class 2 1:100 year flow velocity greater than 3 m per second and up to 4 m per second	Class 2 At least 70% of the rip-rap must be between 0.3 m and 0.75m
Class 3 1:100 year flow velocity above and including 4 m per second	Class 3 At least 70% of the rip-rap must be between 0.5m and 1.2m

Watershed Drainage Area

The watershed drainage area must be delineated above the point where the stabilization is to take place.

Drainage area is determined as follows:
The first step is to delineate the watercourse, including all tributaries, upstream of the proposed alteration site.

- Using a topographic map, mark the location of the proposed erosion protection site on the map with a circle (see figure 1

Figure 1: Topographic Map of Watercourse Erosion Protection Site Identified

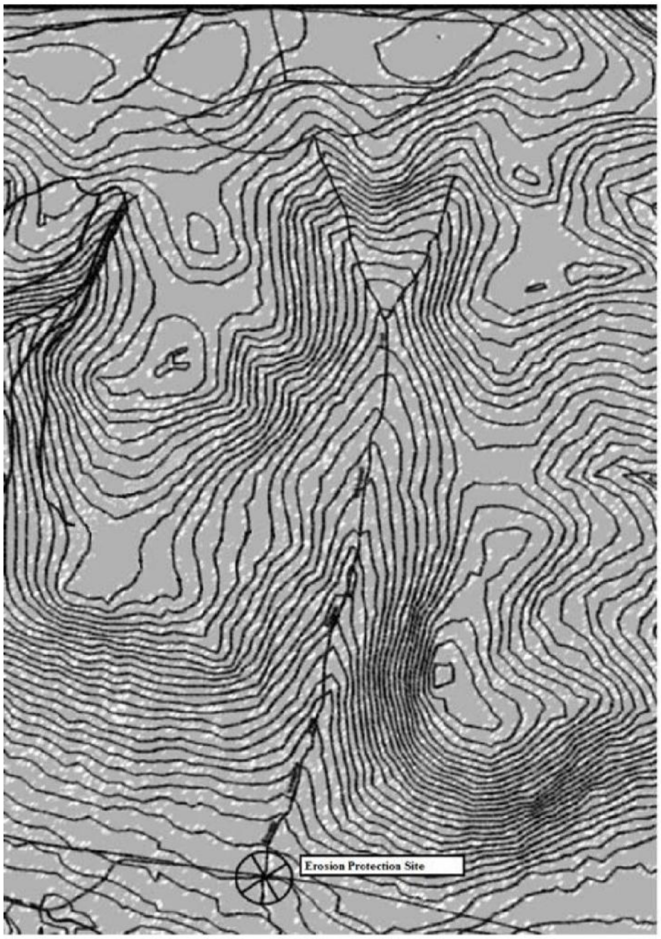
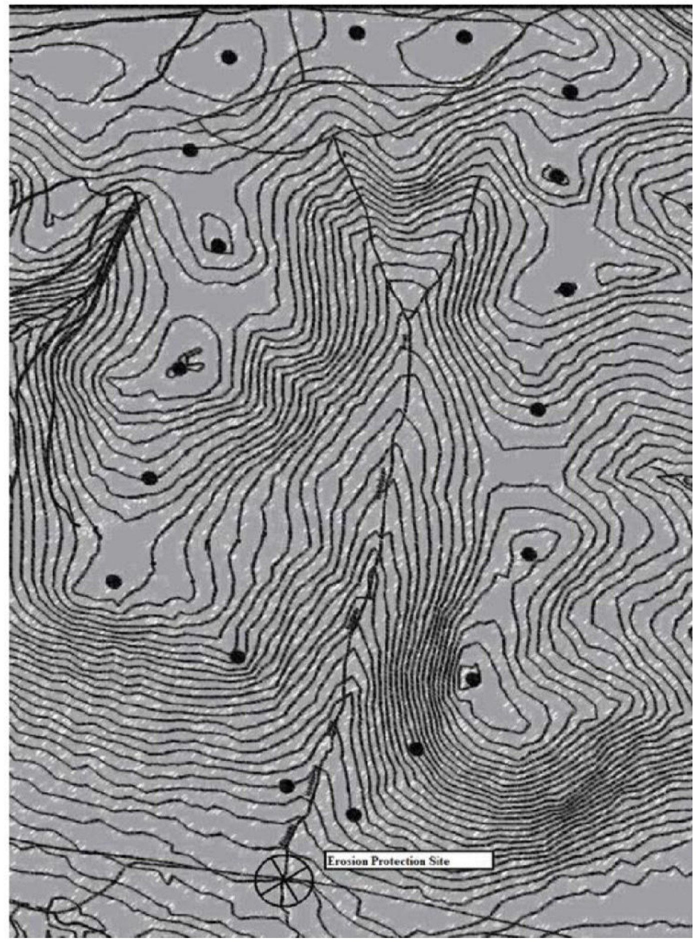


Figure 2: Topographic Map Identifying High Points of Elevation Surrounding Watercourse



- Highlight the watercourse including all tributaries upstream of the location. The contour lines will form a “v” where they cross the watercourse. The “v” will point upstream.

- Mark small dots on the high points along both sides of the watercourse (see figure 2). The high points are inside every closed circular shaped contour line.

- Beginning at the proposed crossing site, connect the dots around the watercourse moving in a clockwise fashion. The line will not be straight; the line should cross contours at right angles as much as possible.

- **Cross-sectional area of a watercourse**
  Delineation is complete when the area is enclosed (see figure 3)

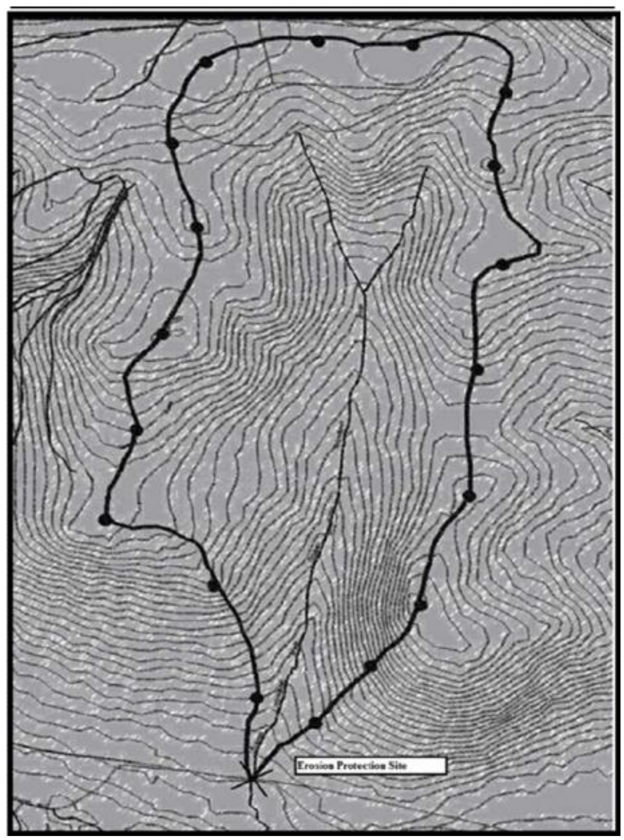
Double check

To make sure you have delineated the watershed properly, especially small watersheds, delineate the drainage areas of the watercourses next to the watercourse you are working with. The boundaries of the watersheds should align with each other.

- Using a Planimeter or Dot Grid, measure the outlined area on the map to determine the drainage area upstream of the crossing. The planimeter or dot grid must be calibrated for the map scale (eg., 1:50,000 or 1:10,000) that you are using.

NOTE: Mapping software such as Arc GIS, Map Info or other software can also be utilized to delineate drainage area.

Figure 3 Topographic Map Identifying Delineation of the Drainage Area



Design Flow is calculated using the drainage area as follows:

"A" = Drainage area
"Q" = Design Flow or discharge (see Example 1)

Example 1
Calculating Design Flow in Hants County

What is the design flow (Q) for a drainage area (A) equaling 912 ha?

Convert to km^2= $\frac{912 \text{ ha}}{100}$ = 9.12 km^2

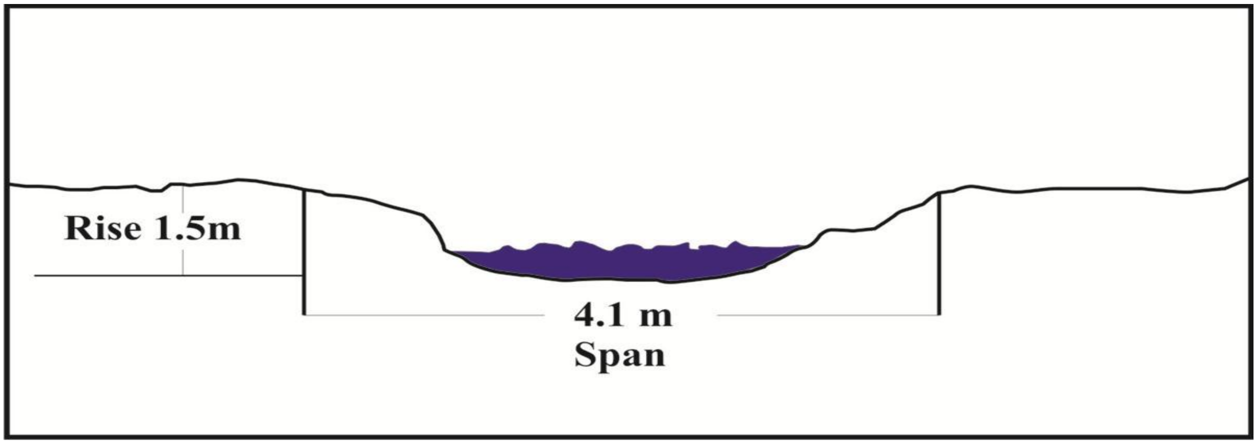
Design flow (Q m^3/s= 1.25 x9.12 km^2
11.4 m^3/s

The design flow is 11.4 m^3/s

1.25 is the rainfall coefficient for Hants County. See Rainfall Coefficient Map for 1:100 Year Storm below.

Cross-sectional area (a) is calculated from the measurement of the width of the channel (span) and the depth of the channel (rise). See figure 4.

Figure 4 Cross-sectional Area of Watercourse



EXAMPLE 2

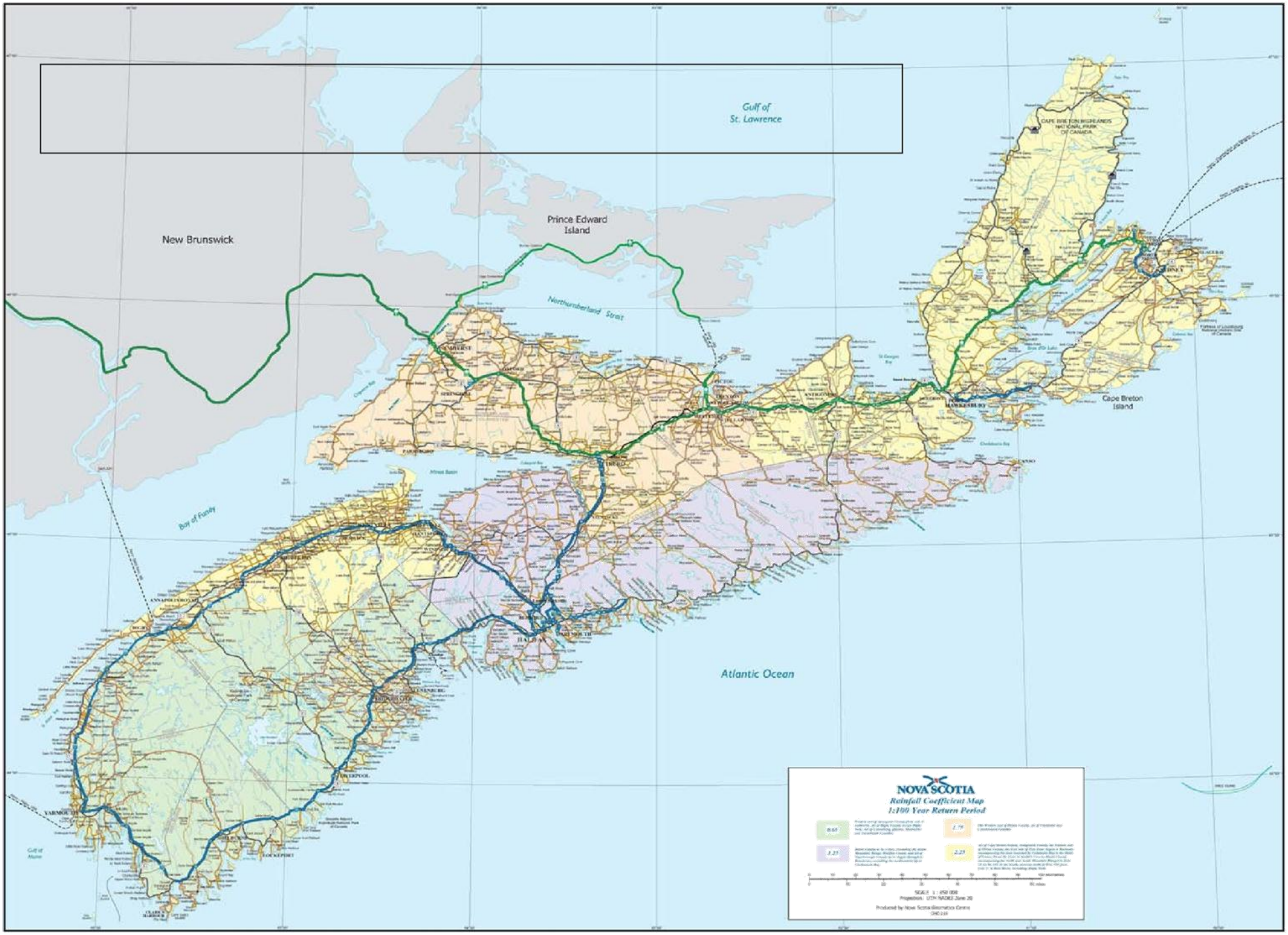
CALCULATING WATER VELOCITY

What is the water velocity for a site with a calculated design flow of 11.4 m^3/s? The span measures 4.1 m and the rise is 1.5 m.

Waterway Opening (m^2)=		rise x span
End Area (a)	=	1.5 m x 4 m
	=	6.15 m^2
Water velocity (v, m/s)	=	$\frac{Q}{a}$
	=	$\frac{11.4\ m^3/s}{6.15\ m^2}$
	=	1.85 m/s

A water velocity of 1.85 m/s requires 70 % of the rip-rap to be between 200 and 450 mm in size for rip-rap erosion protection.

Design Flow Formula Map for Nova Scotia for 1:100 Year Storm Event



NOVA SCOTIA

Rainfall Coefficient Map
1:100 Year Return Period

Coefficient	Area
0.65	Western end of Annapolis County from exit 21 southwest, All of Digby County except Digby Neck, All of Lunenburg, Queens, Shelburne and Yarmouuth Counties.
1.75	The Western end of Pictou County, all of Colchester and Cumberland Counties
1.25	Hants County to St. Croix, excluding the South Mountain Range, Halifax County and all of Guysborough County up to Argyle through to Roachvale, excluding the northeastern tip at Chedabucto Bay.
2.25	All of Cape Breton Island, Antigonish County, the Eastern end of Pictou County, the East side of Hwy from Argyle to Rachvale encompassing the area bounded by Cedabucto Bay to the Strait of Canso, From St. Croix to Smith's Cove in Hants County encompassing the North and South Mountain Ranges to Exit 21 on the 101 in the South, allareas north of Hwy 101 from Exit 21 to Bear River, including Digby Neck.

0 10 20 30 40 50 60 70 80 90 100 kilometres

0 10 20 30 40 50 60 miles

SCALE 1 : 650 000

Projection: UTM NAD83 Zone 20

Produced by Nova Scotia Geomatics Centre

CMC-218