Certification Manual

For Watercourse Alteration Sizers

January 2015

NOVA SCOTIA

Contents

ACKNOWLEDGEMENTS

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- Fisheries and Oceans Canada, Fisheries Protection Program, Maritimes Region for their collaboration, knowledge, and assistance in editing this manual.

- New Brunswick Environment and Local Government for allowing the use of New Brunswick's Watercourse and Wetland Alteration Technical Guideline in the development of educational materials for Nova Scotia.

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 Certification Manual for Watercourse Alteration Sizers is to provide practical information that focuses on environmental protection. These stages include, but are not limited to, planning, sizing, replacement and decommissioning of 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 existing watercourse alteration regulation 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 process.

1.2 LIMITATIONS OF THE CERTIFICATION MANUAL FOR WATERCOURSE ALTERATION SIZERS

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 selecting and sizing some watercourse crossings. It provides 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 and issuing of all watercourse alteration approvals and notifications 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 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.

PROVINCIAL	
NS Environment Act (1995)	Nova Scotia Environment
Activities Designation Regulations	Nova Scotia Environment
Approvals and Notification Procedures Regulations	Nova Scotia Environment
Nova Scotia Watercourse Alterations Standard	Nova Scotia Environment
Environmental Emergency Regulations	Nova Scotia Environment
Environmental Assessment Regulations	Nova Scotia Environment
Petroleum Management Regulations	Nova Scotia Environment
Sulphide Bearing Material Disposal Regulations	Nova Scotia Environment
Nova Scotia Endangered Species Act	NS Department of Natural Resources
Nova Scotia’s Wildlife Habitat and Watercourse Protection Regulations	NS Department of Natural Resources
FEDERAL	
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 & Protection of Critical Habitat (Sec. 32, 33, 58)
Canadian Environmental Assessment Act	Purpose (Sec.6); 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.)

A watercourse alteration application must be completed and filed with the NS Department of Environment. No watercourse alteration can begin until the application has been adequately reviewed and an approval issued.

The watercourse alteration program includes the following types of submissions:

1. Approvals
2. Notifications

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.

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 original notification form. 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.

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

The notifier would complete and sign the notification form for the alteration. If you are providing the sizing for a watercourse crossing but your client is signing the form, you will 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 D for guidance on how to complete the notification form.

The calculations and other information used to determine the type and size of crossing structure must be kept. The information is not submitted with the notification form but you may be required to provide this and other information for an audit being conducted by NS Environment. See section 10.0 Auditing.

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 NOVA SCOTIA WATERCOURSE ALTERATIONS STANDARD

The NS Watercourse Alteration 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 at: 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.

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) and meet the other notification conditions above. The Guideline for fish passage can be found at: http://www.dfo-mpo.gc.ca/Library/353873.pdf

- 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 always required certified sizers may sometimes be involved in applications for approval since sizers have some knowledge of watercourse hydraulics and importance of aquatic ecosystems. A sizer may assist in the development of some of the accompanying documentation for an application for approval.

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.

1.7 COMPLETION OF TRAINING PROGRAM

Certified Watercourse Alteration Sizers have successfully completed a course of instruction relevant to the sizing of watercourse crossings that has been approved by the Minister of Environment.

Individuals successfully completing this Certification program will be recognized by Nova Scotia Environment as having been suitably trained for sizing bridges and culverts eligible for Notification as per the Watercourse Alteration Standard (i.e. a **Sizer**). Certified individuals are recognized to size bridges and culverts up to the specifications published in the Regulations to be installed between June 1st and September 30th of the same year.

Notifications do 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.

1.7.1 Eligible submissions for a Sizer

As a certified sizer you are able to:

- Size culverts and closed-bottom structures that are eligible for notification.
- Size bridges and open - bottom structures that are eligible for notification.
- Apply for approvals for projects that exceed the notification conditions, provided you have the necessary expertise.

1.7.2 Responsibilities of Certified Sizers

It is a Certified Sizer'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 Sizers to promote their authorization to plan and size some watercourse crossings under a streamlined notification process and also to promote their ability to plan crossing that follow best environmental practices.

The responsibilities of certified sizers 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.
- Plan watercourse crossing sites in accordance with training provided for qualifying Watercourse Alteration Sizers. Efforts should include planning of entire road system or project and not just individual crossing sites.
- Select types and sizes of watercourse crossing structures in accordance with instruction provided during the training for Watercourse Alteration Sizers and any updates provided by Nova Scotia Environment from time to time.
- Provide your name, phone number and certification number as a Sizer 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 notifer 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.

Sizers are also expected to communicate with the Certified Installer on the following, where applicable:

- 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 length.
  - Type of material to be used.

- 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 (showing 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.

- Diagram showing dimensions and location of an open bottom structure.

- 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.

1.7.3 Failure to Comply

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

2 POSSIBLE IMPACTS OF WATERCOURSE ALTERATIONS

Nova Scotia has over 6,700 lakes, 1000s of named rivers and many more that are unnamed, 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 and scour, 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.
- 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 as well, such as 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

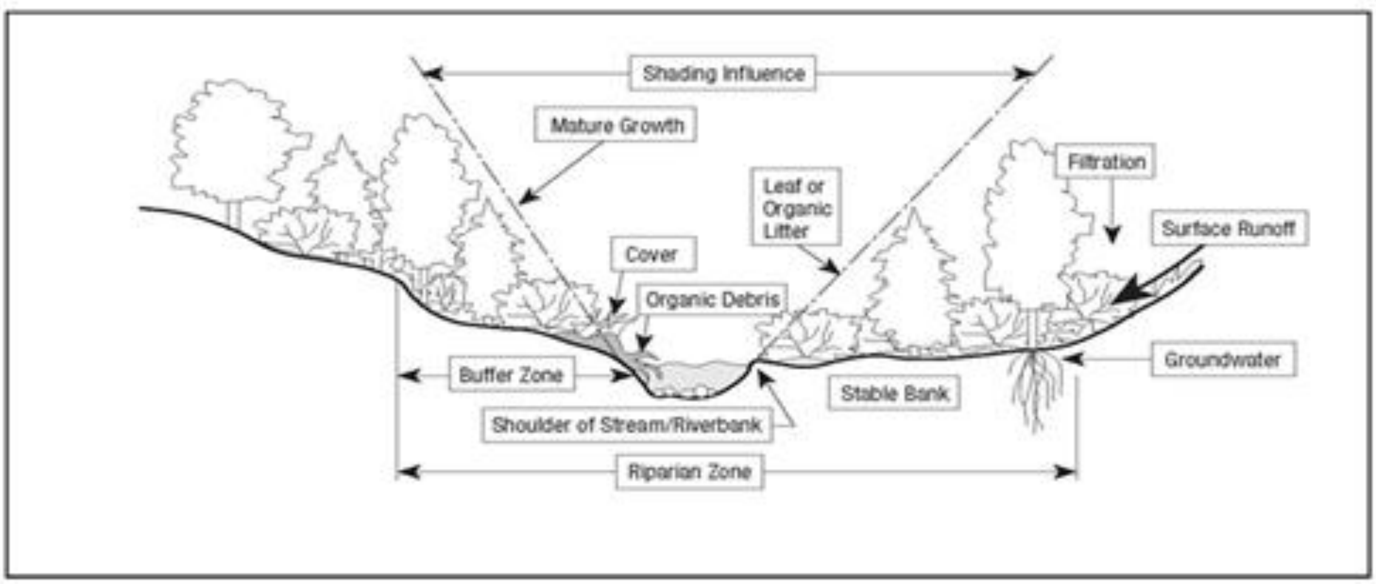
In addition to siltation of the watercourse, water quality can be affected by construction materials on site. For example the lime in concrete can create very alkaline conditions in a watercourse that is toxic to aquatic life. Petroleum products for vehicles and equipment and preservatives in wood products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

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

Detrimental effects can occur as a result of short-term or continuous long-term exposure to varying levels of erosion or sedimentation and other harmful substances. 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.

3 PLANNING WATERCOURSE ALTERATIONS

Comprehensive planning is essential during the preconstruction phase of proposed roads and watercourse crossings and for the maintenance and modification of existing watercourse crossings. 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 the road system.

> 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 CROSSING LOCATION

Use of topographic mapping, geology mapping, orthophoto mapping and / or aerial photos for planning watercourse crossings is essential. These maps and photos often identify natural and manmade features such as wetland areas and existing roads that will assist in the road layout process.

3.1.1 Areas to Avoid

Prior to deciding on a crossing location, 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.
- 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.

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/

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 areas. 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:
http://www.novascotia.ca/nse/water/docs/Protected.Water.Areas.Map.pdf

- Habitat for species at risk. 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 habitats. 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 https://novascotia.ca/natr/wildlife/biodiversity/species-list.asp.

- Any critical habitat identified for a wildlife species that is classified as endangered, threatened or of special concern as part of a Recovery Strategy, Action Plan or Management Plan under the federal *Species at Risk Act (*SARA). 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.

3.2 FIELD INSPECTION

A field inspection of the proposed crossing 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 crossings.

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.

Locate watercourse crossings within a straight section of the watercourse.

Road approaches should be stable with the minimum slope possible for a distance of 30 m (100 feet) on either side of the watercourse crossing.

Whenever possible avoid crossing watercourses at locations where valuable fish habitat (pools, spawning riffles) or 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.

Stream bottom should be stable with a rocky or hard, non-erodible bottom.

Stream banks should have stable slopes with stable soil/rock conditions and abundant vegetation.

Stream flow must not be altered 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 crossing sites should be recorded and maintained (this is applicable to new crossing sites or for existing sites where a crossing needs to be modified):

- Location of crossing (UTM coordinates: northing and easting).

- Photos of the crossing site and photos of the watercourse upstream and downstream of the crossing site.

- An account of why the site was selected for new crossings or why a modification to an existing crossing is needed.

- Features of watercourse at crossing site, including bed material, bank material, and width and depth of channel. Diagrams of the watercourse in plan and profile view should be completed for new crossings.

- If you anticipate installing a closed bottom culvert, survey data of elevations in watercourse as per instruction in section 3.3. This information will be used to develop a watercourse profile and to determine the slope of the 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 for this crossing. Further information on selecting a structure is included in section 3 and 4 of the manual.

- 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.

TIPS ON HOW TO IDENTIFY/MEASURE:

WIDTH – the width of the channel at the bank full height. 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 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”.

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

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

3.3 WATERCOURSE SLOPE (only needed if you want to install a pipe culvert or other closed bottom structure)

Watercourse slope or stream gradient is the ratio of drop in a stream per unit distance. A high gradient indicates a steep slope and rapid flow of water (i.e. more ability to erode); whereas a low gradient indicates a more level stream bed and sluggishly moving water, which may be able to carry only small amounts of very fine sediments. High gradient streams tend to have steep, narrow V-shaped valleys, and are referred to as young streams. Low gradient streams have wider and less rugged valleys, with a tendency for the stream to meander.

Watercourse slope or gradient is an important factor in the creation of fish habitat. For example, mountainous areas with long steep streams often consist of rough shallow riffle-type waters, giving salmon and trout fewer opportunities to rest and gather energy in calm pools.

The velocity and discharge of water in a stream are also dependent on its gradient. The steeper the terrain, generally the faster water will flow. A high water velocity, combined with a steep stream, may prove to be very challenging or even impassable to a migrating fish.

Watercourse slope is defined as:

The vertical drop from the upstream control to the downstream control divided by the length between these two points and is usually expressed in percentages or degrees. (See Figure 3-1)

Slope =((A –B) / L) * 100

Where,

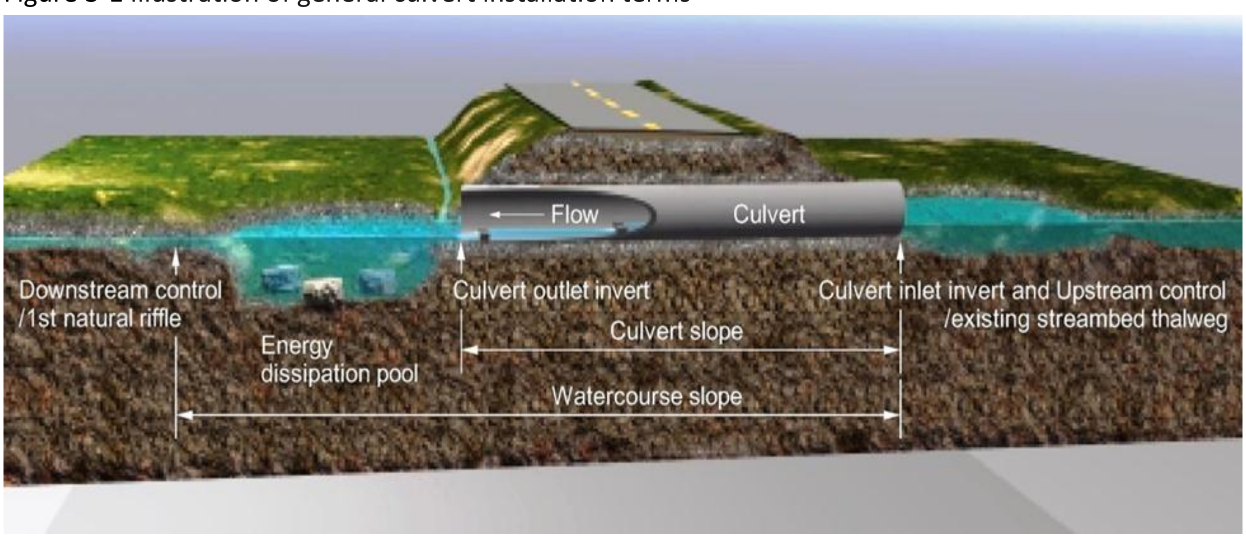
A = is the upstream control, located at the thalweg elevation of the existing watercourse at the proposed culvert inlet.

B = is the downstream control, located at the thalweg elevation at the first natural undisturbed riffle located at a distance of 3 times the culvert diameter (width) plus a minimum of 3.5 m downstream of the proposed culvert outlet. (The downstream control is not to be altered.)

L = is the distance between A and B.

Note: If the culvert has an apron, the culvert outlet would be the downstream end of the apron.

Figure 3-1 Illustration of general culvert installation terms

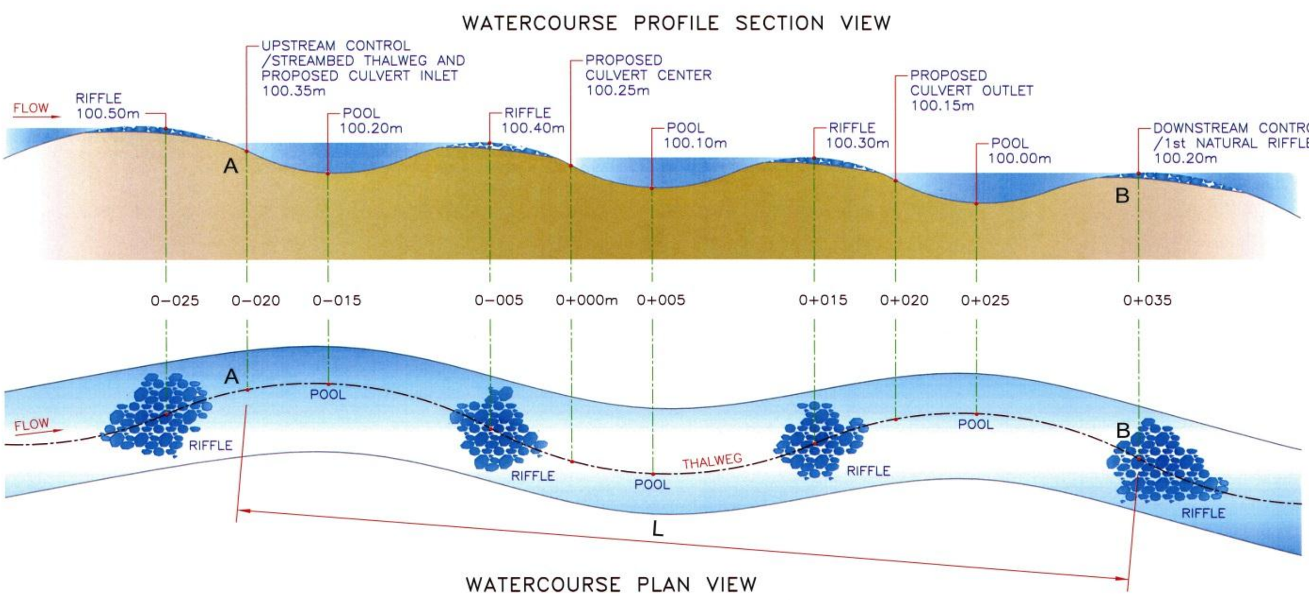


If there are no identifiable riffles downstream of the proposed culvert location or if the diameter and the length of the culvert has not been calculated, then survey the thalweg elevation at 5 metre intervals for a distance downstream of the proposed culvert outlet. This data can be used to develop a stream profile, which can be used to determine the slope of the watercourse once the diameter and length of the culvert is calculated. The watercourse should be surveyed far enough downstream to capture the elevation of the natural riffle, which will be the control elevation downstream of the proposed energy dissipation pool. As a rule of thumb, you should capture the elevations of at least two riffles downstream of the proposed crossing site.

3.3.1 Create a watercourse profile diagram

Using the survey data, create a watercourse profile diagram. Figure 3-2 is a watercourse profile diagram created with the site survey data in Table 3-1.

Figure 3-2 Example of watercourse profile diagram.



3.3.2 Calculating Watercourse Slope

The watercourse slope is the vertical drop measurement of a watercourse from the upstream control to the downstream control then divided by the length between these two points. Slope is typically displayed as a percentage.

Table 3-1 Example of site survey data collected in the field to design a proper culvert watercourse crossing

Station	Streambed Elevation (m)	Remarks
0-025	100.50	Top of riffle
0-020	100.35	Proposed culvert inlet
0-015	100.20	Bottom of pool
0-005	100.40	Top of riffle
0+000	100.25	Proposed culvert center
0+005	100.10	Bottom of pool
0+015	100.30	Top of riffle
0+020	100.15	Proposed culvert outlet
0+025	100.00	Bottom of pool
0+035	100.20	Top of riffle

Example 3-1 is a calculation of slope for a proposed culvert installation.

Before determining the slope of the watercourse, the watershed size, diameter and length of the structure should be calculated (see section 5). The diameter of the culvert will be used to determine the size of the energy dissipation pool. The downstream control will be the elevation of the thalweg of the first natural undisturbed riffle located downstream of the energy dissipation pool. This downstream control should not be altered.

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

EXAMPLE 3-1 Calculating Watercourse Slope

The watercourse slope is calculated as follows:

$((\mathbf{A} - \mathbf{B}) / \mathbf{L}) * 100$

Where:

A = 100.35m - the elevation of the thalweg at the proposed culvert inlet location

B = 100.2m – the elevation of the thalweg of the natural undisturbed riffle downstream of the culvert and the energy dissipation pool

L = 55m

Therefore: $= ((100.35m - 100.2m)/55m)*100$
$= \mathbf{0.27\ \%}$

In this example the watercourse slope is calculated to equal a **0.27%** gradient.

Slope is an important watercourse feature. Slope is one of the primary controls on water velocity in a watercourse. Slope needs to be measured properly to ensure that the appropriate crossing structure is used.

If the slope, as determined above, is 0.5% or less then:

- a closed bottom culvert (without fish passage baffles) or an open bottom structure may be installed; and
- the sizing may be completed by a certified sizer or a professional engineer.

If the slope is greater than 0.5% then:

- a closed bottom culvert with fish passage considerations may be installed; the design must be completed by a professional engineer; or
- an open bottom structure may be installed and the sizing may be completed by a certified sizer.

3.4 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).

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 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 to stabilize 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.

- Generally, the construction period is best planned to take place during the normal low flow period which is between June 1st and September 30th, every year. The reasons for this are listed below:

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 and when construction is completed using techniques prescribed by Nova Scotia Environment then there is no submission required to install or remove a temporary crossing. The bed and banks of a watercourse must not be disturbed and the crossing must be constructed in a manner that will prevent disturbing the watercourse and the flow of the water during installation or use of the crossing. The Certification Manual for Watercourse Alteration Installer provides further details.

3.5 SELECTING THE TYPE OF STRUCTURE

All crossings impact the environment to some degree; careful planning and design can minimize this impact. 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 have the least impact.

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.

See further information in section 4.0.

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 so as to not impede water flow in the watercourse and must be able to pass fish.

3.7 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/downstream 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/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.

3.8 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.

3.8.1 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 and done under notification if the following conditions are met:

- the length of the culvert or structure is 25 m or less;
- the watercourse slope is less than 0.5%;
- the watershed of the watercourse crossing is 20 km2 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.

3.8.2 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;
- a low flow thalweg (channel) is created to provide fish passage;
- 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; and
- 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.

3.8.3 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).

3.9 THE NEXT STEP

During the planning process, watercourse alteration sites are identified. For access across a watercourse, structures such as culverts, bridges or temporary crossings (portable bridges) may be used. In the watercourse alteration program, the Nova Scotia Watercourse Alterations Standard, the Nova Scotia Certification Manuals for Watercourse Alteration Sizers and Installers, and the watercourse alteration guide have been developed to promote environmentally acceptable methods of structure design, construction/installation, stabilization and maintenance.

4 TYPES OF WATERCOURSE CROSSING STRUCTURES AND SELECTING STRUCTURES

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 effects 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, 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.
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.

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.

4.1 ENVIRONMENTAL CONSIDERATIONS FOR SELECTION OF WATERCOURSE CROSSING TYPE

4.1.1 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 natural flow regime.
- Bridge crossings rarely provide a barrier to fish passage.
- Bridge construction requires less instream activity; therefore, reduces the potential for environmental impacts.
- Bridges and other open bottom structures are less susceptible to beaver damming.

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 watercourse slope 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.

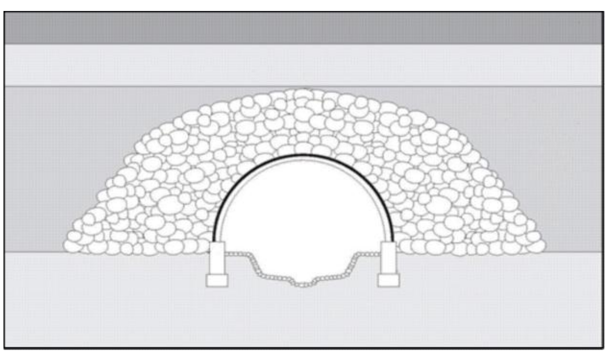
- The streambed is soft and unable to support a culvert.

- 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 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).

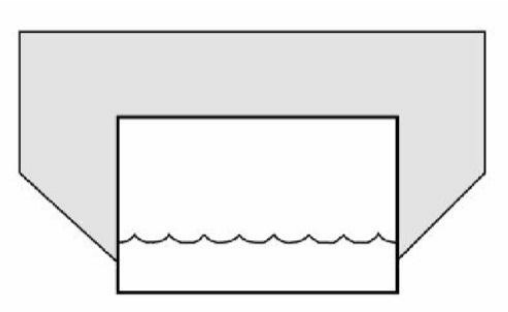
Material: Made from steel or concrete

- 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.

4.1.2 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

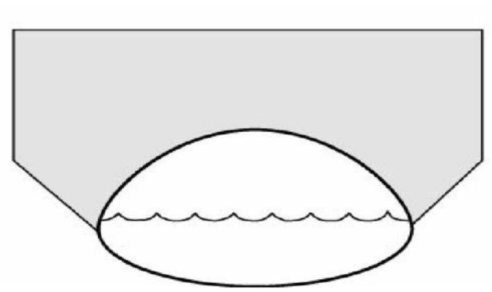


Box culverts in some respects are similar to bridges. For example, their dimensions allow them to be used in areas where fill is limited as they require little backfill or excavation.

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

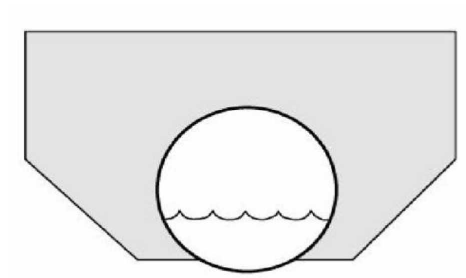


Pipe arch culverts are closed bottom structures embedded into the substrate.

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.
  - More susceptible to beaver damming, especially if it is a baffled culvert.
  - 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.
  - Maintenance costs are high (debris removal, etc.)

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.

5 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 following sections provide a method to determine the size of a crossing structure.

5.1 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. The coefficients used in Appendix C to determine design flow in this manual should be considered conservative in that they may not completely represent the flows currently being experienced under our changed climate.

5.2 CULVERT SELECTION AND SIZING – CLOSED BOTTOM

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.

5.2.1 Requirements for culvert design and selection

It is important to understand a number of terms related to the characteristics of a watercourse and related to the components of a crossing structure. These terms may be defined in the Activities Designation Regulations, the Nova Scotia Watercourse Alterations Standard, and in the glossary of this manual.

- Certified Sizers are not eligible to complete sizing for closed bottom culverts installed in watercourses with slope exceeding 0.5 %.

- The process for closed bottom culverts installed in watercourses with gradients exceeding 0.5 % (up to 8.0% gradients) requires that a Professional Engineer design the structure and 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).

- 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.

- All culverts must be designed to carry intended loads.

- The minimum circular / pipe culvert size permitted for installation in a watercourse is 450 mm (18 in).

- The maximum permissible diameter for an open bottom culvert is 3660 mm (12 ft).

- The drainage area (watershed) above the watercourse crossing must not exceed 20 km2 for culverts under notification process.

- The maximum length of any closed bottom culvert to be installed is 25 m (82 ft) under the notification process.

- The culvert inlet invert elevation must be set at the thalweg elevation of the existing watercourse.

- The culvert outlet invert elevation must be set at a depth equal to 20% of the culvert diameter/height, to a maximum of 0.4 m, below the downstream control thalweg elevation (the first natural undisturbed riffle downstream). This downstream control is not to be altered.

- Culverts installed under Notification must be installed between June 1st and September 30th.

- The headwater depth to culvert diameter / rise ratio should be 1.0:1.0 for pipe arches and circular/pipe culverts to avoid flooding and wash out of culverts. A 1.5:1 ratio could be used to determine the culvert size but there is greater chance of flooding and wash out of the culvert (see section 5.4.2 for further information on headwater depth).

- 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. See section 8.0 for size of rip rap.

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

NOTE: Closed bottom 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 steeper slope.

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

5.3 STEPS TO LAYING OUT A CULVERT ON A WATERCOURSE

1. Site Assessment – general site conditions, is it a watercourse (as defined by NSE) and are fish present.

2. Once the watercourse and watershed has been identified then the structure can be sized for the 1:100 year estimated storm flow. Once the diameter is calculated then the length of the proposed culvert can also be determined based on the proposed right of way specific to that project, road cover required and the proposed area of the crossing.

3. Create the profile of the existing watercourse slope by surveying the watercourse far enough upstream and downstream of the proposed structure to capture at least two riffles upstream and two riffles downstream.

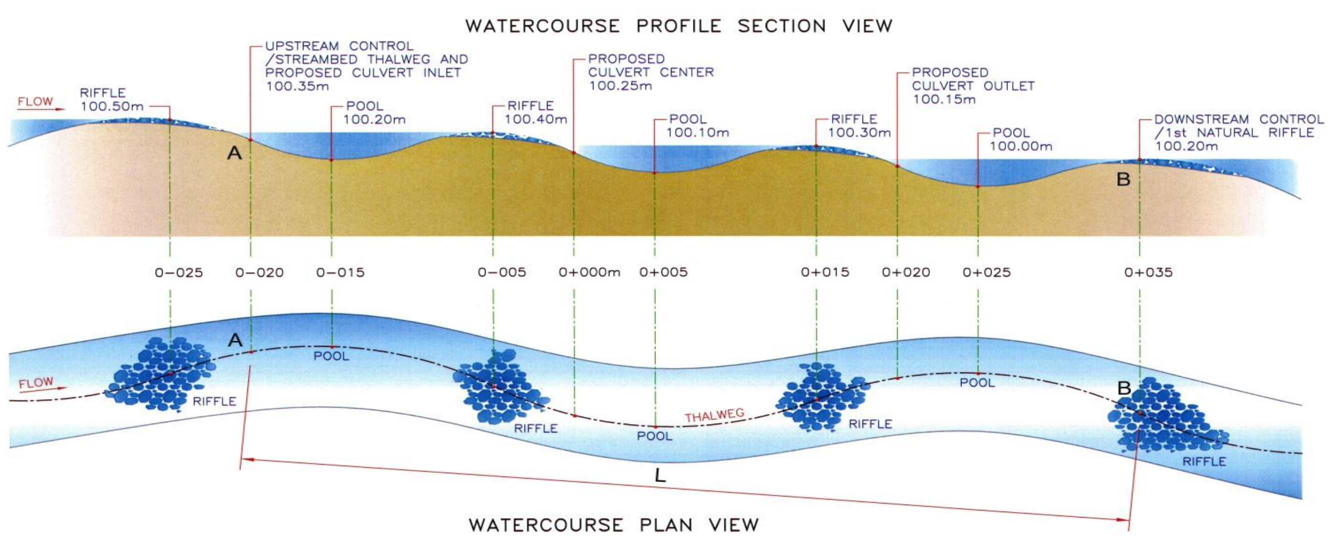
4. Determine the existing watercourse slope ((A-B))/L) *100:
   Where A is the upstream control, located at the thalweg elevation of the existing watercourse at the proposed culvert inlet.

   Where B is the downstream control thalweg elevation at the first natural undisturbed riffle located downstream of the proposed energy dissipation pool. It is located at a distance of 3 times the culvert diameter/width plus a minimum of 3.5 m downstream of the culvert outlet. The 3.5 m may be needed to stabilize the downstream end of the pool.

   Where L is the distance between A and B. (See Figure 5-1.)

5. Once the watercourse slope is calculated from the existing stream profile in step 3 then that will determine whether it meets the notification criteria. If the watercourse slope is less than or equal to 0.5% and the watershed area is 20 km^2 or less, then the structure can be installed under the notification process.

Figure 5-1 Example of watercourse profile diagram



If the existing watercourse slope exceeds 0.5% and the plan is still to install a closed bottom culvert then it requires a design by a professional engineer.

If it is decided that an open bottom structure is to be installed under a notification, the size calculation can be completed by a Sizer. Go to section 6 of the Manual.

6. Starting at the upstream end the new culvert inlet invert is to be located at the streambed thalweg elevation, which becomes the upstream control. This will also determine where the culvert outlet will be located, as the length of the structure would have been determined in step 2 calculation. The outlet of the culvert is to be set at a depth equal to 20 percent of the diameter (height) to a maximum of 0.4 m below the downstream control elevation (first natural undisturbed riffle downstream).

7. If the sizing of the culvert needs to be adjusted (diameter or length) then step 4 and 6 will need to be repeated to meet the criteria under the notification process. If the right of way extends beyond what was surveyed, then step 3 will also need to be repeated

5.4 CULVERT SIZING

Proper culvert sizing promotes fish passage and minimizes changes to the aquatic habitat and water flow. An undersized culvert may result in complete washout of the culvert or increased water velocity within the pipe creating a barrier to fish passage and causing scouring at the outlet. An oversized culvert may result in a decreased water depth which may also act as a barrier to fish passage.

When sizing culverts, it is necessary to first calculate both the required diameter and length.

5.4.1 Calculating Diameter: Parameters

The two parameters required to calculate culvert diameter are:

- **Drainage area** (watershed) is defined as the area of land draining to the point along the watercourse where the proposed crossing is to take place.

- **Design flow** is defined as the discharge which a structure is designed to accommodate without exceeding the adopted design constraints.

Drainage area (watershed) 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 crossing site on the map with a circle (see figure 5-2).

- 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.

> **Note:** Mapping software such as Arc GIS, Map Info or other software can also be utilized to delineate drainage area.

> **The Atlas of Canada: Toporama**
> Find interactive topographic map at http://atlas.gc.ca/site/english/toporama/index.html. The dynamic map viewer makes it easy to find your site and its watershed area.
>
> **Other resources**
> Wet Area Mapping
> http://novascotia.ca/natr/forestry/gis/wamdownload.asp
> Nova Scotia Topographic Database WMS
> https://www.novascotia.ca/geonova/services/nstdb_wms.asp

- Mark small dots on the high points along both sides of the watercourse (see figure 5-3). 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.

- Delineation is complete when the area is enclosed (see figure 5-4).

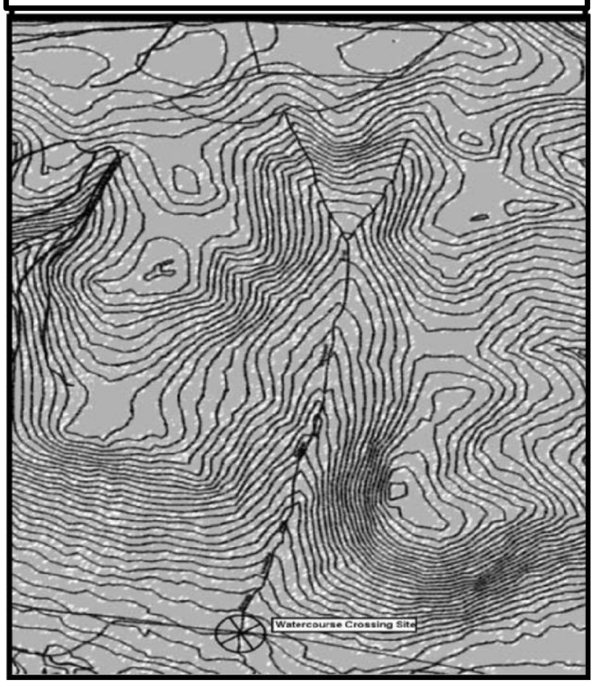
> **Double check**
> To make sure you have delineated the watershed properly, especially small watersheds, delineate the drainage areas of the watercourses next to the watercourse you are working with. The boundaries of the watersheds should align with each other.

- 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) that you are using.

Design Flow is calculated using the drainage area as follows:
"**A**" = Drainage Area,
"**Q**" = Design Flow or discharge (see Example 5-1)

For the Province of Nova Scotia, the coefficient used to determine design flow (Q) is based on the location of the crossing within the Province due to the variance in topography and precipitation intensity across the Province. The coefficient to be used in the determination of the design flow can be found in Appendix C.

Figure 5-2: Topographic Map of Watercourse Crossing Site Identified



The design flow coefficient for Halifax, Hants and Guysborough Counties will be used in the examples in this manual. Ensure the proper coefficient is used for each structure.

Figure 5-3 Topographic Map Identifying High Points of Elevation Surrounding Watercourse

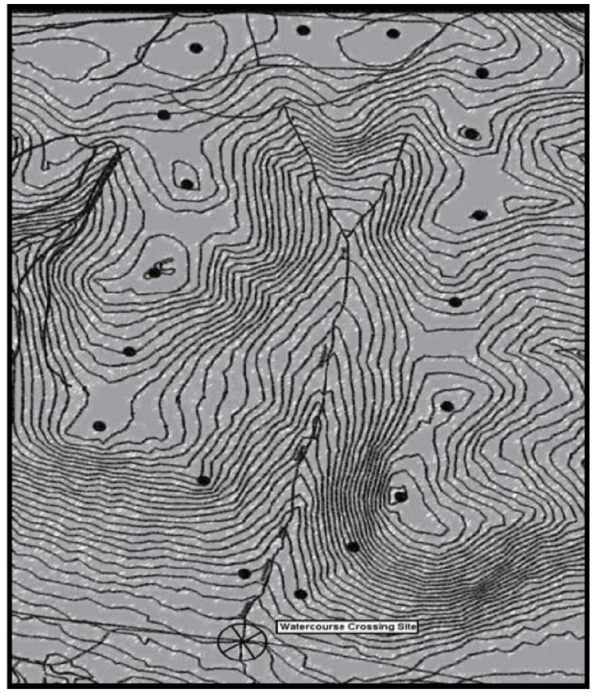
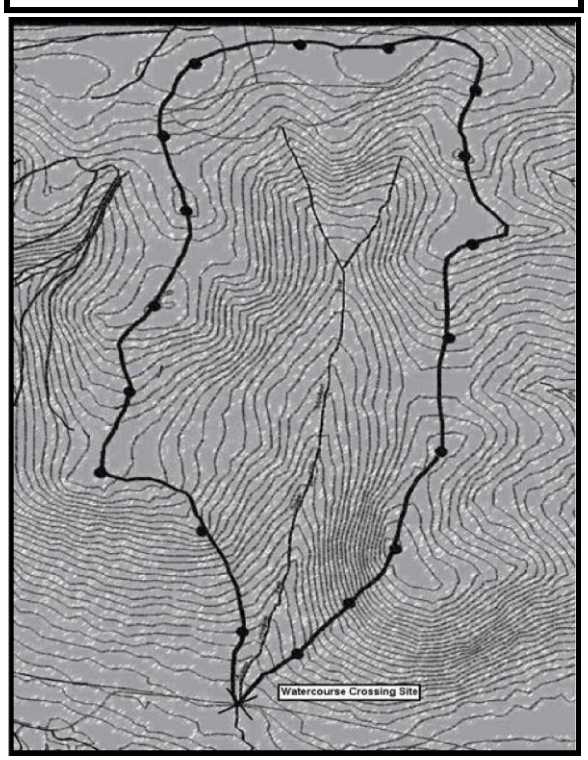


Figure 5-4 Topographic Map Identifying Delineation of the Drainage Area (Ex. 312 ha) Above Crossing Site



Watercourse specific coefficients may be substituted for those in Appendix C provided the data used is for the 1 in 100 year rainfall event not instantaneous gauged streamflow data. This data as well as the source of the data must be provided with the application.

EXAMPLE 5-1
Calculating Design Flow

What is the design flow (Q) for a drainage area (A) equaling 312 ha (as determined in figure 5.4)?

Convert to km^2 = $\frac{312}{100}$ ha = 3.12 km^2

Design Flow ($Q\ m^3/s$) = 1.25 x 3.12 km^2
= 3.9 m^3/s

The design flow is 3.9 m^3/s

5.4.2 Calculating Diameter: Closed Bottom Culvert

The following procedure is used to determine the capacity of a culvert for a known drainage area using a nomograph (see nomographs provided in figures 5-5 and 5-6).

See Appendix A for the following nomographs:

For Corrugated Steel Circular / Pipe
- showing the determination of a culvert size using 1:1 ratio for HW/D

For Concrete / Plastic Circular Pipe
- showing the determination of a culvert size using 1:1 ratio for HW/D

For Corrugated Steel Pipe Arch
- showing the determination of a culvert size using 1:1 ratio for HW/D

Figure 5-5 Nomograph for Corrugated Steel Circular / Pipe Culverts (data provided by the Bureau of Public Roads) showing the determination of a culvert size using 1:1 ratio for HW/D.

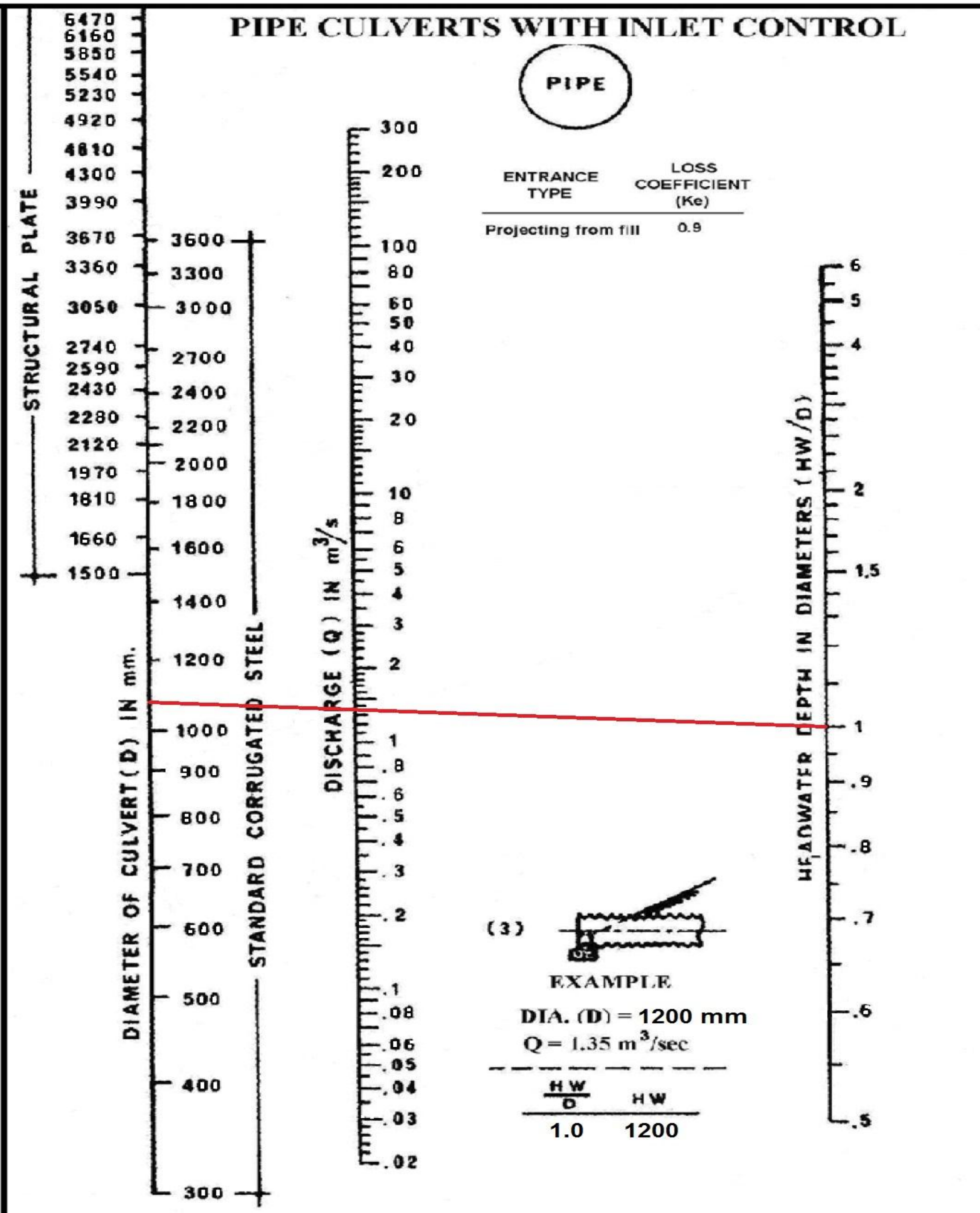
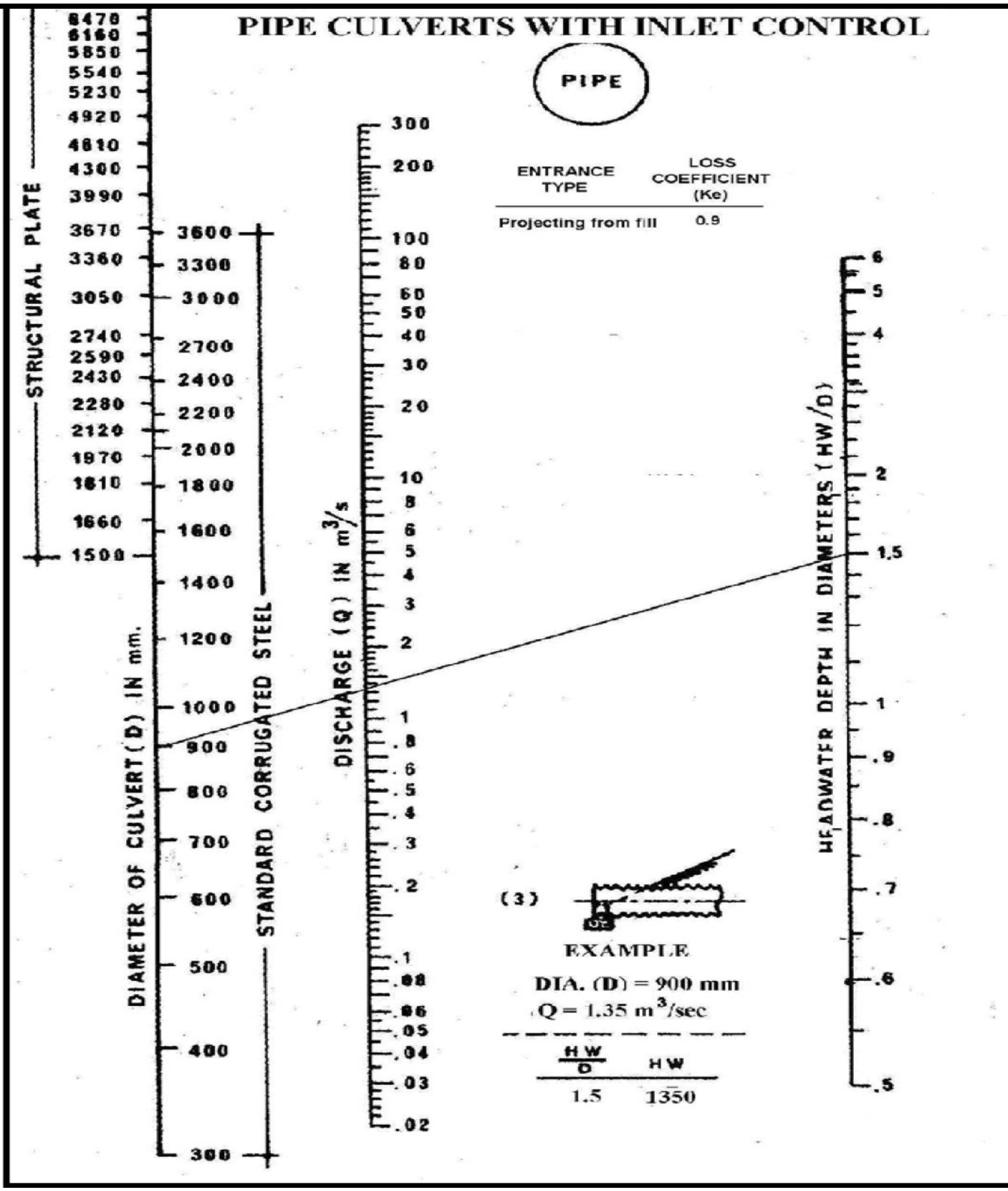


Figure 5-6 Nomograph for Corrugated Steel Circular / Pipe Culverts (data provided by the Bureau of Public Roads) showing the determination of a culvert size using 1.5:1 ratio for HW/D.



1. Calculate the design flow / discharge (Q)

2. On the headwater depth to diameter column (HW/D), locate and mark appropriate HW/D. It is recommended to use 1:1 HW/D ratio (or 1 on the nomograph column). A 1.5:1 ratio could be used to determine the culvert size but there is greater chance of flooding and wash out of the culvert. See text box.

3. On the discharge column (Q), locate and mark the design flow.

4. Connect the two marked points and extend to the diameter of culvert column (D).

5. Where the culvert diameter falls between two sizes, always use the larger one.

If a 1.5:1 ratio is used to determine culvert size it is recommended that a site specific design flow for 1:100 year storm event be determined (as opposed to using the coefficients for permanent structures found in Appendix C). Also a ratio of 1.5:1 should only be used when specific site conditions are appropriate. Site specific conditions include type and depth of road fill material, depth of fill over culvert, velocity of water flow during storm event and impact of flooding, etc.

The maximum allowable drainage area for standard culvert sizes can also be calculated using a nomograph.

Headwater Depth

It is recommended the headwater depth to culvert diameter ratio should be 1:1 for pipe arches and circular/pipe culverts to lower the risk of flooding and the wash out of culverts. This is recommended for several reasons:

- Impacts of climate change include increased frequency and severity of extreme weather events resulting in increased peak flows. Using a 1:1 ratio decreases the risk of wash out and flooding under peak flows.
- Washouts and scour result in the deposition of sediment in the watercourse, impacting the aquatic ecosystem as well as possibly diminishing the hydraulic capacity of the watercourse channel. Diminished hydraulic capacity of the channel can result in scour and flooding.
- Flooding upstream of the crossings will be less during peak flows because the culvert is sized to accommodate greater flows at a lesser depth. Depending on the location, flooding can cause damage to property and infrastructure.
- By avoiding flooding and washouts, the cost of maintenance, repairs and structure replacement are greatly reduced.

NOTE: The maximum allowable drainage area for culverts installed under Notification is 20 km^2.

- Draw a straight line from the diameter of culvert column (D) to the 1.0 standard increment on the headwater depth to diameter (HW/D) column.

- Use the discharge (Q) value where the line intersects the discharge column (Q) and convert to drainage area.

For pipe arch nomographs, refer to the headwater depth in terms of rise (HW/R).

For pipe arch nomographs, diameter of culvert is measured as "Span x Rise".

5.4.3 Calculating Culvert Length

Culvert length must be determined prior to installation. Culverts which are too short in length can become destabilized as a result of scouring. Culverts that are too long can create fish passage problems and scouring.

In Nova Scotia the maximum culvert length under the Standard is 25 m (82 ft). Anything greater than 25 m (82 ft) will require the submission of an application for approval to Nova Scotia Environment for review.

The parameters required to calculate length are as follows (See figures 5-7 or 5-8):

"**L**" - the length of culvert required.
"**W**" - the road width
"**H**" - the total depth from streambed to road surface, including height of cover

The length of the culvert must also extend 0.3 m at both ends in addition to the calculated length. (This measurement is "0.6 m" and is *required* that a length of 0.3 m (1 ft) of culvert extend beyond the toe of the fill at both the upstream and downstream ends).

Important note: When sloped end sections or flared end sections are used, the apron must also be included in the overall length of the culvert (L).

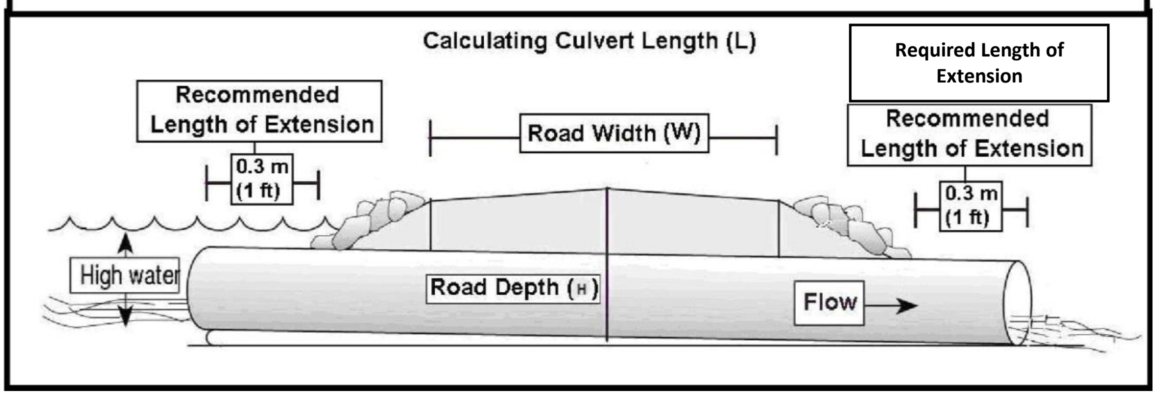
Where the road meets the stream at a right angle, proper culvert length can be calculated using the following formula:

L(m) = W + 4 H + 0.6 m

or

L(ft) = W + 4 H + 2 f t

Figure 5-7 Culvert Length Parameters



In the event that the roadway meets the watercourse crossing at an angle, it is necessary to add 10 % to the culvert length for each 10° skew from the perpendicular.

Example 5-2
Calculating Culvert Length

What is the recommended length of a 1200 mm (48 in) culvert if the roadway is 6.0 m (18.0 ft)? The depth of fill over the culvert is one-half the culvert diameter.

Total Depth (H)	**= 1.2 m + 0.6 m (m)**
	= 1.8 m (5.4 ft)
Length (Lm)	**= 6.0 m + 4(1.8) + 0.6**
	= 13.8 m (41.4 ft)

Where the road meets the culvert at a right angle, the recommended length is **13.8 m (41.4 ft)**

5.4.3.1 Culvert length when using headwalls.

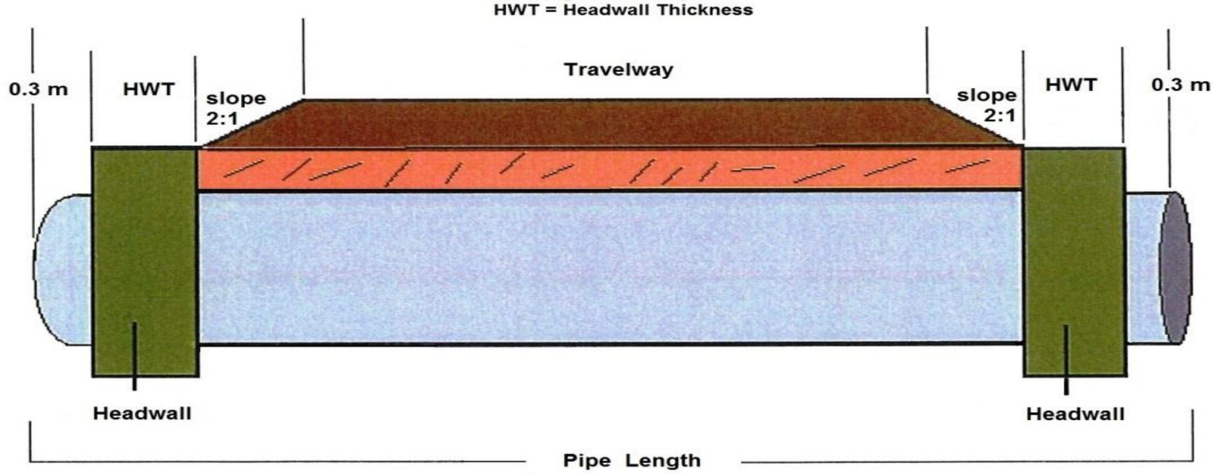
See figure 5-8 for the formula to use to calculate the culvert length when headwalls are to be used.

Figure 5-8

FORMULA FOR PIPE LENGTH WITH HEADWALLS

Pipe Length = W + 4H + (2 x HWT) + 0.6 m

where, W = Width of the Travelway
H = Height of the Pipe
HWT = Headwall Thickness



5.5 FISH PASSAGE

To promote fish passage, the following conditions should be met.

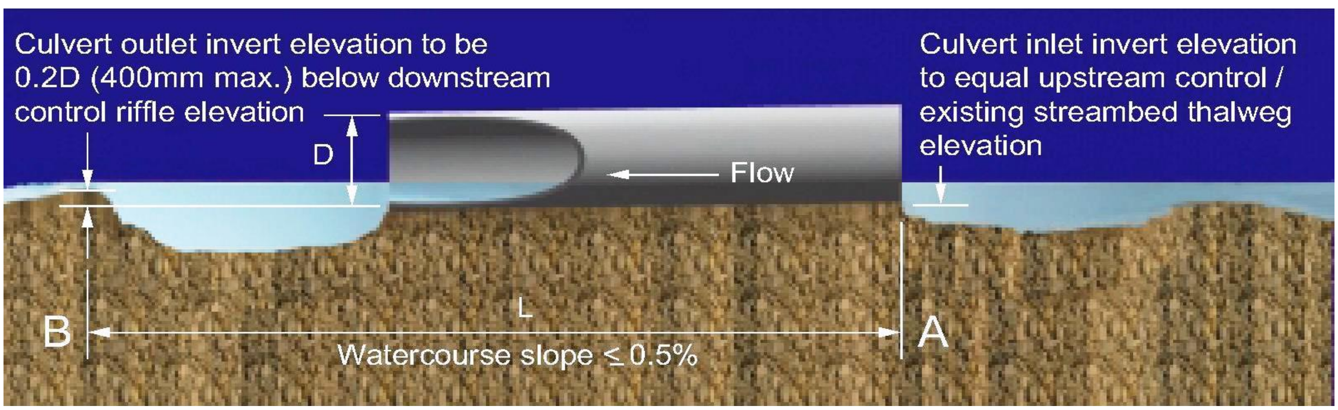
5.5.1 Culvert Installation in watercourses with a slope equal to or less than 0.5 %

The invert of a closed bottom culvert must be properly embedded into the streambed to promote the deposition of a layer of natural substrate and re-establish the natural habitat.

Proper embedding of culverts requires that the culvert inlet invert elevation be set at the thalweg elevation of the existing watercourse. The culvert outlet invert elevation must be set at a depth equal to 20% of the culvert diameter/height, up to a maximum of 0.4m, below the downstream control thalweg elevation (the first natural undisturbed riffle downstream). The downstream control is not to be altered.

A culvert must also have an energy dissipation pool at its outlet.

Figure 5-9 Culvert installation in watercourse with a slope equal to or less than 0.5%



5.5.2 Culvert Installation in watercourses with a slope greater than 0.5 %

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). The guideline can be found at http://www.dfo-mpo.gc.ca/Library/353873.pdf. These structures can be installed under a Notification, but require an engineer to design them.

The engineering requirement for fish passage in closed bottom culverts installed at slopes exceeding 0.5 % can be avoided by choosing to install an open bottom structure (such as pipe arches) or a bridge. In areas where the stream gradient 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.

In the case of an open bottom structure no energy dissipation pool is required.

5.6 ENERGY DISSIPATION POOL

Energy dissipation pools must be constructed at the outlet of all closed bottom culverts, regardless of diameter. The use of an energy dissipation pool at the outlet of a culvert serves two purposes:

- to dissipate the extra energy of the water resulting from the culvert placement and to prevent brook destabilization resulting in a perched culvert outlet; and
- to provide a resting area for migrating fish.

The energy dissipation pool should be sized to ensure stability of the pool during peak flood flows.

5.6.1 Design

- The energy dissipation pool should be stabilized to prevent scour and erosion. The size of rip-rap stone in the dissipation pool must be sufficiently large to withstand velocities produced 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 5-11) 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 to be used in the construction of the pool.
- The average depth of the pool must be a minimum of 1m.
- The width at the bottom of the dissipation pool is to be 2 times the culvert diameter (D) or 2 times 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 5-10 and 5-11.

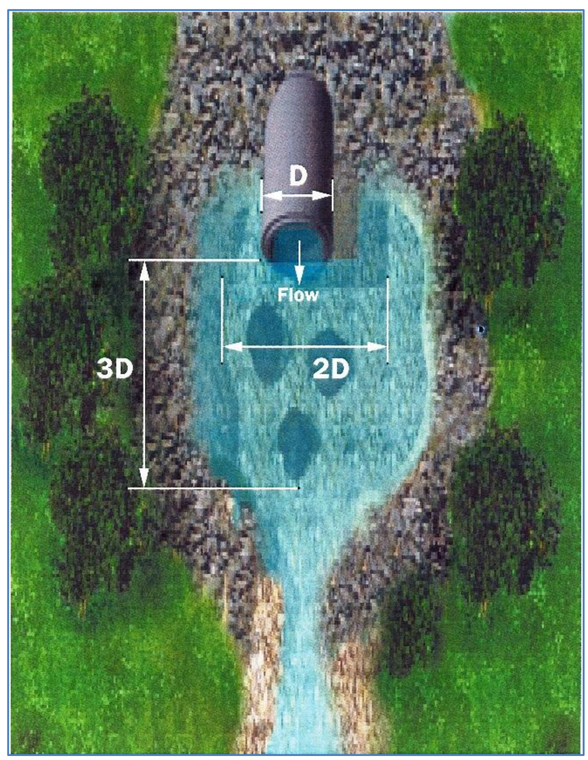
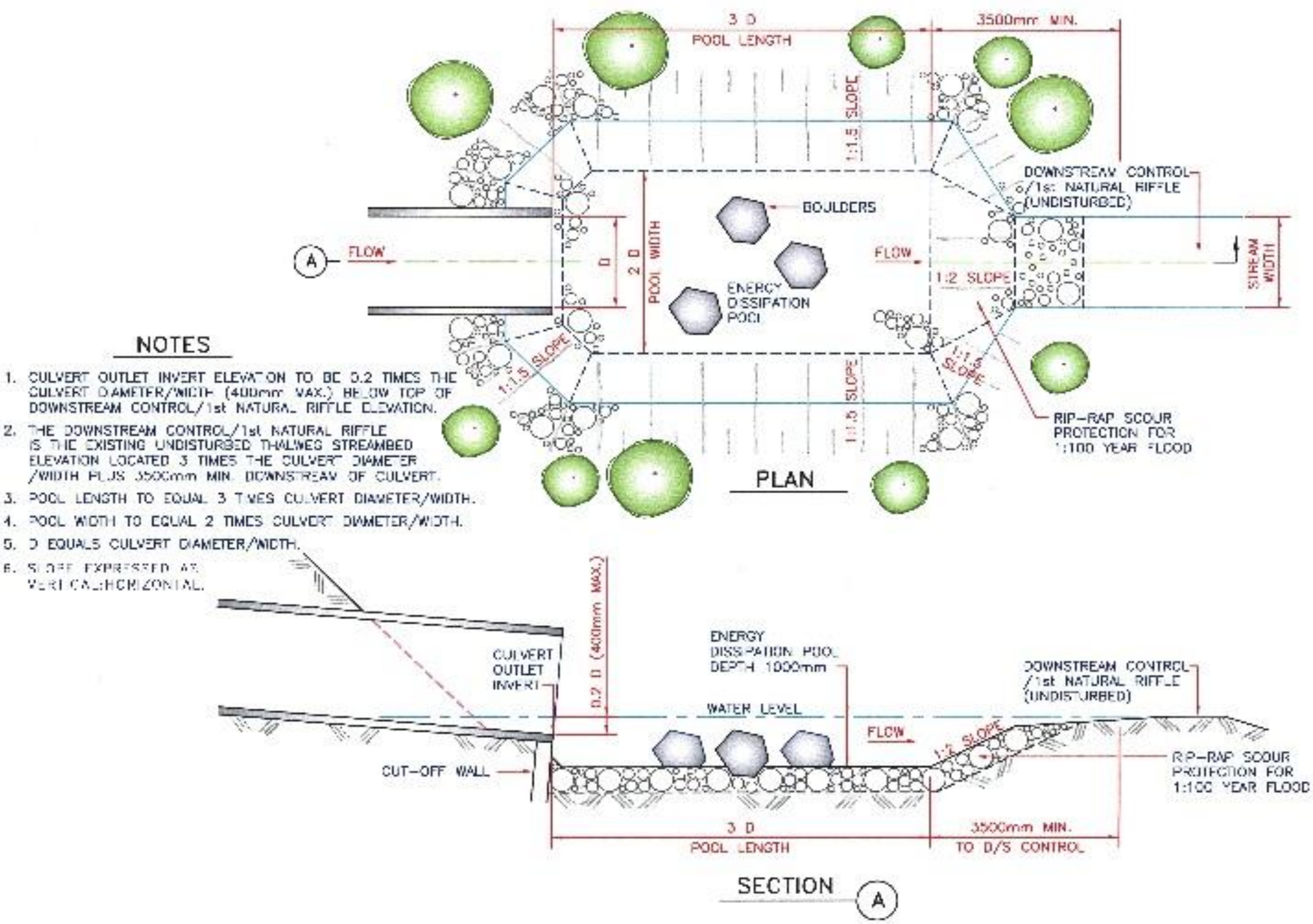


Figure 5-10 Energy Dissipation Pool Dimensions

Figure 5-11 Energy dissipation pool for non-baffled culvert



- 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.

5.7 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 NS Environment and there is no option for a Notification.

If you are hired to size 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.

5.8 NEXT STEPS

After the type of structure has been selected and the size of structure, the following actions may be completed:

- Return to the field to layout and mark the site for installation (at a minimum, mark the location of the structure inlet and the outlet and mark the outlet of the energy dissipation pool).
- Provide drawings and information to installer with instruction on how to follow the marked layout.

5.9 TIMING OF INSTALLATION

All instream activity, including culvert installations, shall be carried out between **June 1st and September 30th** of the same year preferably during low water conditions. The actual time of construction should be kept to a minimum in an effort to prevent any unnecessary environmental problems.

6 ARCH CULVERT AND BRIDGE CONSTRUCTION

Open bottom culverts and bridges are the preferred structures for fish passage and aquatic life simply because the natural bottom of the stream is able to be maintained.

6.1 REQUIREMENTS FOR OPEN BOTTOM CULVERT DESIGN AND SELECTION

Bridges and other open-bottom structures must be designed with a hydraulic capacity large enough to ensure a maximum velocity of 1.8 m/s during a 1:100 year return period storm event.

- A pipe arch or other open bottomed structure may be installed under a notification if the banks are altered and the bed is not disturbed. The Sizer must account for this when selecting a width of the structure so the Installer is able to complete the required excavation to place the footings, erosion protection and other materials without disturbing the bed of the watercourse.

- A watercourse must not be permanently diverted to accommodate the construction or modification of a bridge or open-bottom structure.

- The length of any structural plate arch installed must be 25 m or less.

- Bolted corrugated steel sheet or structural plate arches used in the construction of bridges or other open-bottom structures must meet the requirements of CSA G401-14 Corrugated Steel Pipe Products.

- 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.

- Open-bottom arches must be assembled and backfilled in accordance with the manufacturer's specifications, unless site specific installation specifications are provided by a professional engineer licensed to practice under the Engineering Profession Act.

- The footings should be embedded below the thalweg. Geotechnical engineering assistance may be required to determine the bearing capacity of the soil.

- No part of a bridge or open-bottom structure may permanently disturb the flow of 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.

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

- *Environment Act*
- Activities Designation Regulations

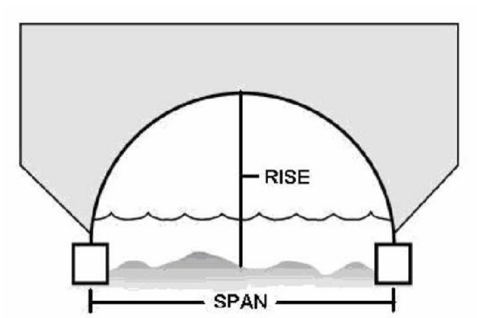
6.2 OPEN BOTTOM CULVERTS: SIZING

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

- To determine water velocity the diameter of the structure is needed.
- To calculate the diameter of an open bottom culvert, it is necessary to determine the:

  Rise (R) which is measured from the streambed to the underside of the vertical dimension of the arch culvert.

  Span (S) which is measured as the horizontal distance between the footings.



Waterway Opening (a) is the cross-sectional area under an open-bottom culvert or bridge available for passage of water. It is also known as the *end area*.

To determine water velocity, calculate:

- Waterway Opening **(a)** = **R** x **S**

- Flow velocity **(v)** = $\frac{\text{Design Flow (Q)}}{\text{Waterway Opening (a)}}$

The maximum acceptable flow velocity for open bottom culverts is 1.8 m/sec (6 ft/sec). If the flow velocity exceeds the acceptable limit, the end area of the open bottom culvert must be increased.

EXAMPLE 6-1 Calculating Arch Sizing
What is the waterway opening required if the design flow is 6.98 m^3/s and the maximum velocity is 1.8 m/s?
Waterway opening (a) = $\frac{6.98 \text{ m}^3\text{/s}}{1.8 \text{ m/s}}$ = 3.88 m^2

The manufacturer's available sizes will dictate the dimensions of the smallest arch that can be used based on the calculated waterway opening. *If an arch matching the calculated end area cannot be supplied, the next larger size available must be used*. The specifications provide a listing of available culvert sizes and corresponding waterway openings.

Standard open bottom culvert sizes available may be different for each manufacturing company. Match culvert sizes with the corresponding end area.

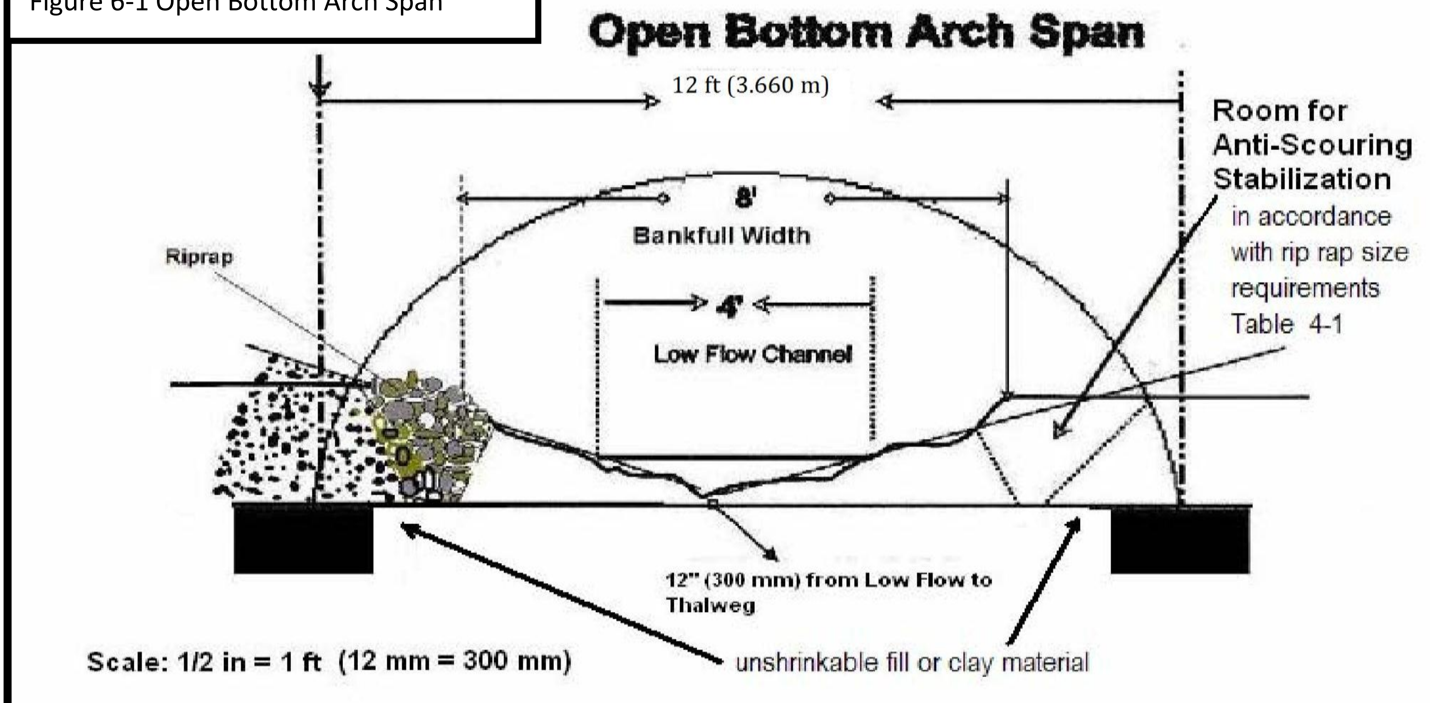
To calculate drainage area, reverse the formula procedure. The maximum acceptable water velocity for open bottom culverts of 1.8 m/s must be used to ensure the culvert is large enough.

Design Flow (Q) = **(a) x Water Velocity (v)**
Drainage Area (km^2) = **Q / 2.25 (use the coefficient for geographic area)**
Drainage Area (ha) = **Drainage Area km^2 x 100**

- Locate the abutments at a minimum elevation equal to or below the thalweg of the stream as **figure 6-1**.

- The centre of the abutment should be located 1 m (3 ft) back from the bank.

Figure 6-1 Open Bottom Arch Span



EXAMPLE 6-2 Calculating Drainage Area

What is the maximum drainage area that could be accommodated using the maximum accepted velocity and a structure with waterway opening of 4.18m^2?

Design Flow (Q m3/s) = 4.18 m^2 x 1.8 m/s

=7.52 m^3/s

Drainage Area (km^2) = $\frac{7.52\ m^3/s}{2.25}$

Drainage Area (ha) = 3.34 km^2 x100

= 334 ha

The drainage area is 334 ha.

The culvert must be long enough to allow a stable foreslope no steeper than 2 horizontal to 1 vertical to be developed. 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 material must be placed on a watercourse bank at a maximum 2 horizontal to 1 vertical slope, unless headwalls/wingwalls are used.

Rip-rap must be sized to withstand 1:100 year flows in the watercourse (see table in Section 8).

6.3 PERMANENT BRIDGE STRUCTURES- REQUIREMENTS FOR SELECTION AND DESIGN

A permanent bridge is defined as a structure erected to span a watercourse which supports a roadway or footpath for vehicle traffic or pedestrians.

Under Notification process, any proposed bridge construction extends only to single span bridges. Certification and/or Notifications do not include the construction of multiple span bridges or bridges requiring instream supports.

Applications for these types of structures shall be submitted individually and subject to review by the appropriate government agencies.

- The following requirements apply to the design and construction of single span. Bridges and other open-bottom structures must be designed with a hydraulic capacity large enough to ensure a maximum velocity of 1.8 m/s during a 1:100 year return period storm event.
- Footings and abutments must be designed and installed such that the bed of the watercourse is not disturbed or altered.
- Bridge decking must be enclosed such that it prevents debris, soil or other contaminants from entering a watercourse.
- The bank of the watercourse is allowed to be altered to accommodate abutment and rip-rap installation.
- The length of the span must be 15 m or less for a bridge, or 3600 mm or less for a structural plate arch or other open-bottom structure.
- Abutments and footings for bridges or other open-bottom structures must be stone, rock, concrete, steel or wood that is rot-resistant.
- The faces and ends of abutments must be protected from erosion and scour.
- Construction or modification of a bridge that includes the application or removal of protective coatings must be carried out in accordance with the *Guidelines for the Application and Removal of Structural Steel Protective Coatings*, as published by the Department and updated from time to time.
- Bridge decking must be enclosed such that it prevents debris, soil or other contaminants from entering a watercourse.
- A watercourse must not be permanently diverted to accommodate the construction or modification of a bridge or open-bottom structure.
- No part of a bridge or open-bottom structure may permanently disturb the flow of the watercourse.
- Bridge abutments must be placed outside the bankfull width of the channel to avoid constriction of the natural flow of water and reduction of the channel cross-section.
- A bridge or other open-bottom structure must be supported by abutments or footings that extend below the thalweg depth.
- Abutments and footings for bridges or other open-bottom structures must be stone, rock, concrete, steel or wood that is rot-resistant.
- The area excavated for placement of an abutment shall be backfilled up to the elevation of the bottom of the watercourse bed with unshrinkable fill, which must be installed in compacted lifts of not more than 0.3m at a time.
- The faces and ends of abutments must be protected from erosion and scour.

- Erosion protection materials must not encroach upon a watercourse bed beyond the thickness of the largest material required for erosion protection. Infilling of a watercourse must not occur except for the placement of erosion protection materials as noted above.

- Erosion protection material must be placed on a watercourse bank at a maximum 2 horizontal to 1 vertical slope, unless headwalls/wingwalls are used.

- Rip-rap must be sized to withstand 1:100 year flows in the watercourse (see Table in Section 8).

- Erosion protection materials must be installed below the thalweg of a watercourse, sized based on the calculated velocity of the stream (see table in Section 8.0) and installed to minimum thickness of 1.5 times the maximum stone size.

- All instream work shall be carried out in isolation of the streamflow (in-the-dry) by dam and pump procedure or by temporary diversion.

- The rise (height) of a bridge must provide sufficient clearance for ice flows, debris, and navigation in identified navigable waters (in compliance with the *Navigation Protection Act*).

- See Section 11 for materials used in structure in or near watercourse.

6.4 BRIDGE SIZING

A properly sized bridge should not impede fish passage, affect the water velocities or alter the aquatic habitat. In situations where bridges are built too small and the water flow becomes constricted, water velocities may be increased resulting in streambed scour. In addition, increased velocities may result in the undermining of the abutments potentially causing the bridge to fail.

Use the following steps to determine the minimal accepted bridge size:

Calculate the design flow (Q, m^3/s)

Calculate the waterway opening (a, m^2)

$$\text{Velocity} = \frac{\text{Design Flow (Q)}}{\text{Waterway Opening (a)}}$$

Verify minimum bridge size using the **maximum design velocity** of 1.8 m/s

6.4.1 Calculating the Design Flow

Bridges must be designed with a hydraulic capacity large enough to pass a peak flow with a 100 year return period. To meet this standard, calculate the following parameters:

- **Drainage area** is defined as the area of land draining to the point along the watercourse where the proposed crossing is to take place.

- **Design flow** is defined as the discharge which a structure is designed to accommodate without exceeding the adopted design constraints.

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 crossing site on the map with a circle (See figure 6-2).

Highlight the watercourse including all tributaries upstream of the location. Mark small dots on the high points along both sides of the watercourse (See figure 6-3).

Connect the dots around the watercourse moving in a clockwise fashion. The line should cross contours at right angles as much as possible. Delineation is complete when the area is enclosed (See figure 6-4).

Using a Planimeter or Dot Grid, measure the outlined area on the map to determine the drainage area upstream of the crossing.

NOTE: Mapping software such as Arc GIS, Map Info or other software can also be utilized to delineate drainage area.

Figure 6-2 Topographic Map of Watercourse Crossing Site Identified

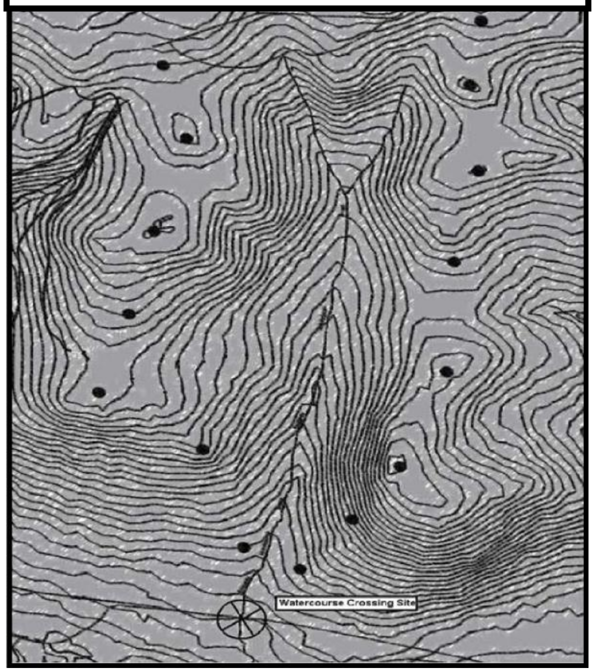
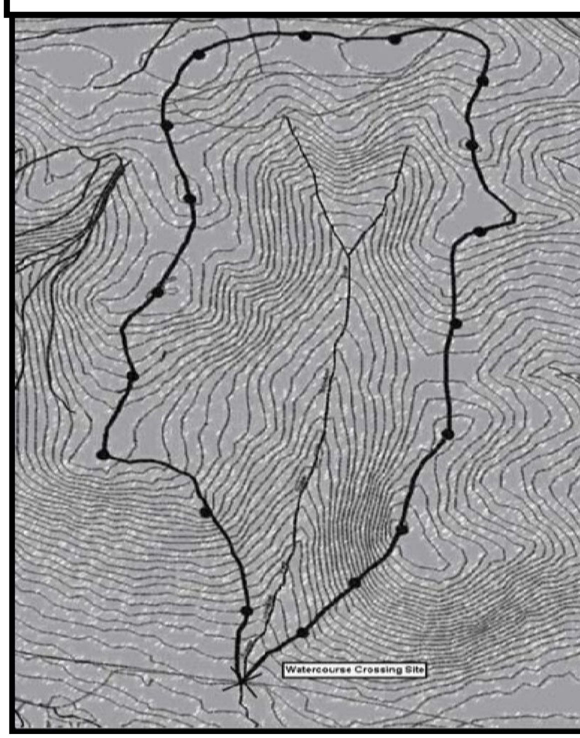


Figure 6-3 Topographic Map – identifying high points of elevation surrounding the watercourse

Figure 6-4 Delineation of the drainage area above crossing site



6.4.2 Calculating the Waterway Opening

The waterway opening represents the minimum end area of the bridge required for a crossing location. It is calculated by measuring the rise and span from the crossing location.

EXAMPLE 6-3
CALCULATING DESIGN FLOW

What is the design flow (Q) for a drainage area (A) equaling 1500 ha?

Convert to km^2	=	1500 ha/100
	=	15.0 km^2
Design Flow (Q)	=	1.25 x 15.0 km^2
(m^3 / sec)	=	18.75 m^3/sec

The design flow for a 1500 ha area is 18.75 m^3/ sec.

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

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

The formula for calculating water velocity is:

$$\textbf{Water velocity} = \frac{\textbf{Design Flow (Q)}}{\textbf{Waterway Opening (a)}}$$

In Example 6-4, the calculations indicate that the proposed bridge size is large enough to meet the hydraulic capacity required to pass a peak flow with a 100 year return period. This may not, however, be the minimum bridge size that should be used.

Rise (R) is measured from the bed of the watercourse to the underside of the stringers of a bridge.

Span (S) is measured as the horizontal distance between the abutments.

Waterway Opening (a) is defined as the cross-sectional area under an open bottom culvert or bridge available for the passage of water.

The formula for calculating waterway opening is:

Waterway Opening (a) = R x S

6.4.3 Verifying Bridge Size - Does it meet the requirements?

The maximum acceptable design velocity passing under a bridge is 1.8 m / sec (6 ft / sec). If the maximum velocity exceeds the acceptable limit, the end area of the bridge must be increased.

EXAMPLE 6-4 CALCULATING WATER VELOCITY

What is the water velocity for a site with a calculated design flow of 14.25 m^3/s? The span measures 4.1 m and the rise is 4 m.

Waterway Opening (m^2)	=	**rise x span**
Area (a)	=	4.1 m x 4 m
	=	16.4 m^2
Water velocity (v, m/s)	=	$\frac{Q}{A}$
	=	$\frac{14.25\ m^3/s}{16.4\ m^2}$
	=	0.86 m/s

A water velocity of 0.86 m/s is less than the maximum acceptable limit of 1.8 m/s.

Before finalizing the bridge size in the prescribed submission, the bridge design must take into account the existing conditions at the crossing site by considering the following factors:

- The design must provide sufficient span (width) to prevent ice blockage.
- The rise (height) must provide sufficient clearance to keep the roadbed free from flood waters which may overtop the structure during period of high flow.
- The rise (height) must provide for sufficient clearance for navigation, if required. An increase in the rise of 120 cm (48 in) above the high water mark is suggested.

If the bridge design does not meet the required hydraulic capacity or any of these preceding factors exist at the proposed crossing location, the bridge size must be increased by adjusting either the rise or the span. In cases where the waterway opening under the bridge must be dramatically increased, the economics of the construction may result in choosing another crossing location.

6.4.4 Bridge Length

Under Notification, the following applies to determining the length of the bridge:

- The length must be equal to or exceed the width of the watercourse at the crossing site.
- The span must not exceed 15 m in length.
- As a minimum the abutments must be placed at the shoulder of the watercourse.
- The bridge must not require piers or other instream intermediate structural supports.

6.5 FISH PASSAGE

At all times during the construction period at least one-third of the channel cross section must remain open to maintain fish passage.

6.6 NEXT STEPS

After the type of structure has been selected and the size of structure, the following actions could be completed:

- Return to the field to layout and mark the site for installation (at a minimum, mark the location of the structure inlet and the outlet and the centre line of the abutment or footing).
- Provide information to installer with instruction on how to follow the marked layout.

6.7 TIMING OF INSTALLATION

All instream activity, including permanent bridge construction, will be carried out from June 1st to September 30th of each year preferably under low flow conditions.

The construction area should be kept to a minimum in an effort to prevent any unnecessary environmental problems.

Note: Bridge abutment work and associated work below the ordinary high water mark (OHWM) must be completed by September 30, however work at the site may extend beyond September 30 so long as the watercourse is able to flow freely and any work below the OHWM has been completed.

7 TEMPORARY BRIDGES

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.

7.1 PLANNING CONSIDERATIONS

Temporary bridges should not be left in place long-term because the waterway opening is typically designed for a limited period of time, during normal flow conditions outside the spring freshet, 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.

Temporary bridges should be used instead of temporary culverts because their installation results in minimal impact to aquatic habitat and disturbance to the bed and banks of the watercourse. They also have the least potential of creating a barrier to fish migration.

Temporary crossings are 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. In Nova Scotia temporary crossing can be installed without an Approval or Notification if they are installed in a manner that does not impact the watercourse or water flow. The following sections outline the expected conditions to be met in order to reduce the impact to the watercourse from a temporary crossing.

7.2 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
- No disturbance of the bed or banks of the watercourse is to occur.
- The bridge must completely span the watercourse with the sills or abutments placed back from the top of bank a minimum of 1 metre.
- Sill logs used to support temporary bridges shall be placed on firm, stable ground outside of the watercourse bed.
- Place sill log(s) parallel to the watercourse, at least 1 m back from the edge of the bank(s) of the watercourse, to found the stringers on. Sill logs should be at least 4 m long and have a minimum diameter of 250 mm.
- 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.

- The structure shall not touch the water surface during operation and must be capable of carrying the intended loads.

- 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.

- The structure must be lifted in place, rather than dragged, and must be removed in the same manner.

- 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 should extend back at least 30 metres on either side of the crossing.

- 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.

- The width of the structure shall not exceed one lane.

- Machine work is to be conducted from the watercourse banks and machinery is not permitted to enter the watercourse unless otherwise approved in writing by the Minister or Administrator.

- 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.

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

7.3 <u>TEMPORARY BRIDGE REMOVAL</u>

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 the 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, hydro-seeding or hay mulch.

- Use sediment and erosion control measures on the approaches.

8 EROSION PROTECTION – CALCULATING RIP-RAP SIZE

Erosion protection materials must be installed below the thalweg of a watercourse, sized based on the calculated velocity of the stream (see Table 8-1) and installed to minimum thickness of 1.5 times the maximum stone size.

Table 8-1 Riprap Sizing

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

8.1 Determining Water Velocity

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.

The watershed drainage area must be delineated above the point where the stabilization is to take place.

Design Flow is calculated using the drainage area as follows:
"A" = Drainage area
"Q" = Design Flow or discharge (see Example 8-1)

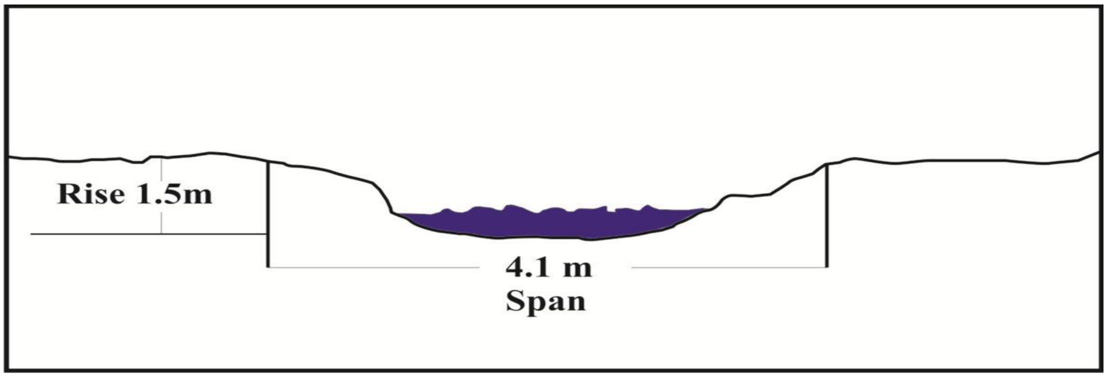
Cross-sectional area of a watercourse
Cross-sectional area (a) is calculated from the measurement of the width of the channel (span) and the depth of the channel (rise). See figure 8-1.

EXAMPLE 8-1
Calculating Design Flow
What is the design flow (Q) for a drainage area (A) equaling 312 ha (as determined in figure 5-4)?

Convert to km^2 = 312 ha/100 = 3.12 km^2
Design Flow (Q m^3/s) = 1.25 x 3.12 km^2
= 3.9 m^3/s
The Design Flow is 3.9 m^3/s

Water velocity
Water velocity is calculated using the design flow and the waterway opening. See Example 8-2.

Figure 8-1 Cross-sectional area of watercourse



EXAMPLE 8-2
CALCULATING WATER VELOCITY
What is the water velocity for a site with a calculated design flow of 3.9 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) = 1.5m x 4m
= 6.15 m^2

Water velocity (v, m/s) = Q/ a

$$= \frac{3.9\ m^3/s}{6.15\ m^2}$$

= 0.63 m/s

A water velocity of 0.63 m/s requires 70% of the rip-rap to be between 200 and 450 mm in size for rip-rap erosion protection.

9 WATER CONTROL MEASURES WHEN WORKING IN A WATERCOURSE

A Nova Scotia Watercourse Alteration Sizer may be involved in the planning and selection of the most appropriate water control measures for the site conditions and type of crossing structure. 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.

9.1 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.

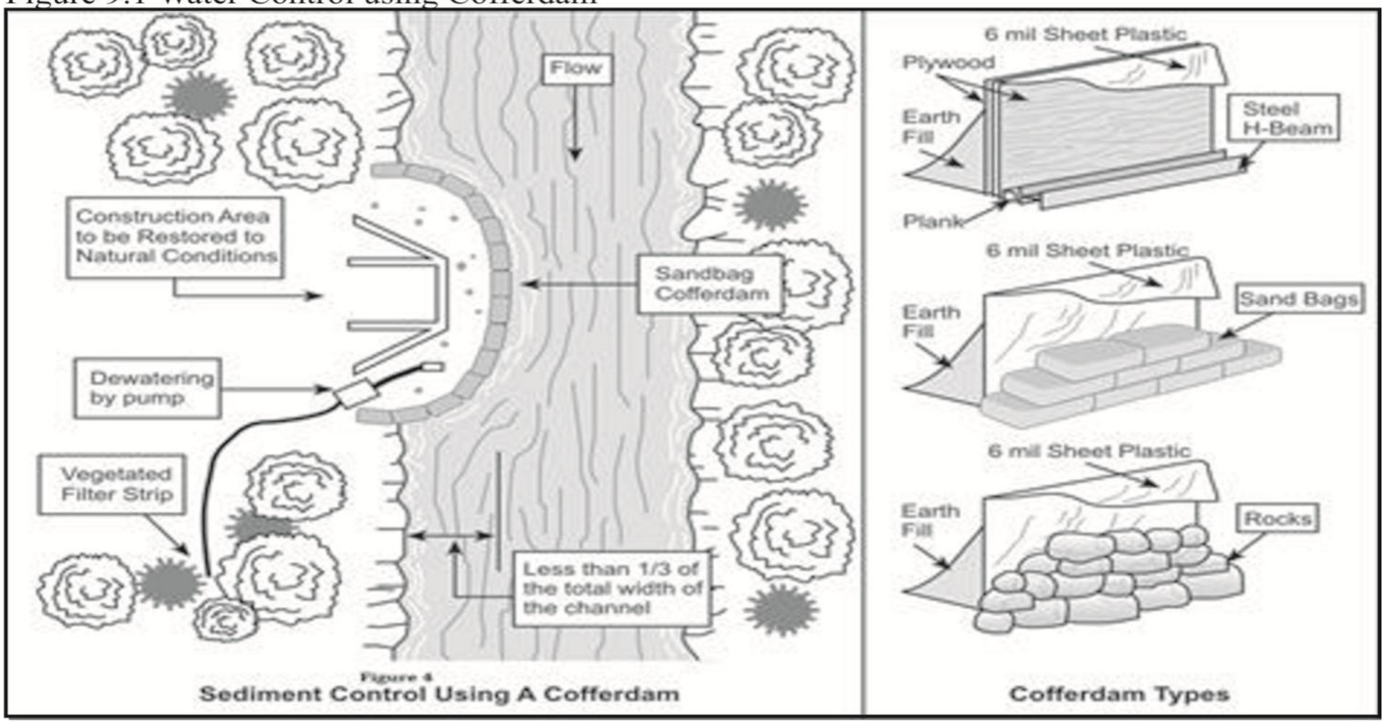
9.2 COFFERDAMS

When cofferdams are used to isolate the work area from flowing water (see figure 9.1):

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.
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.

Figure 9.1 Water Control using Cofferdam

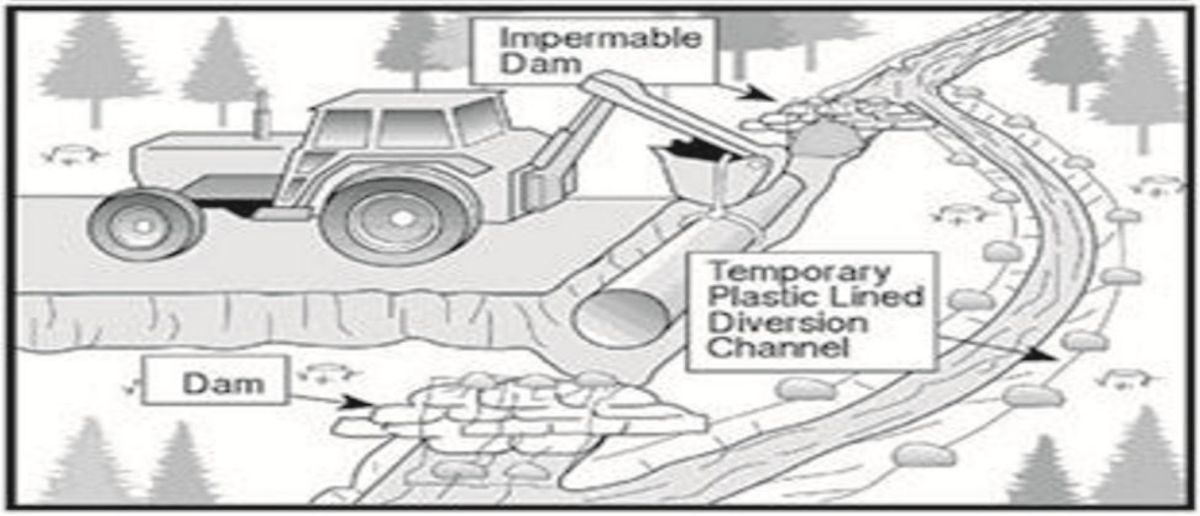


9.3 TEMPORARY DIVERSIONS

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 9.2.
3. Excavate a temporary channel parallel to, and as close as possible to 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 9.2 Water Control Using Temporary Diversion



9.4 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 9.3):

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 9.4 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.

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.

Figure 9.3 Water Control Using Dam and Pump

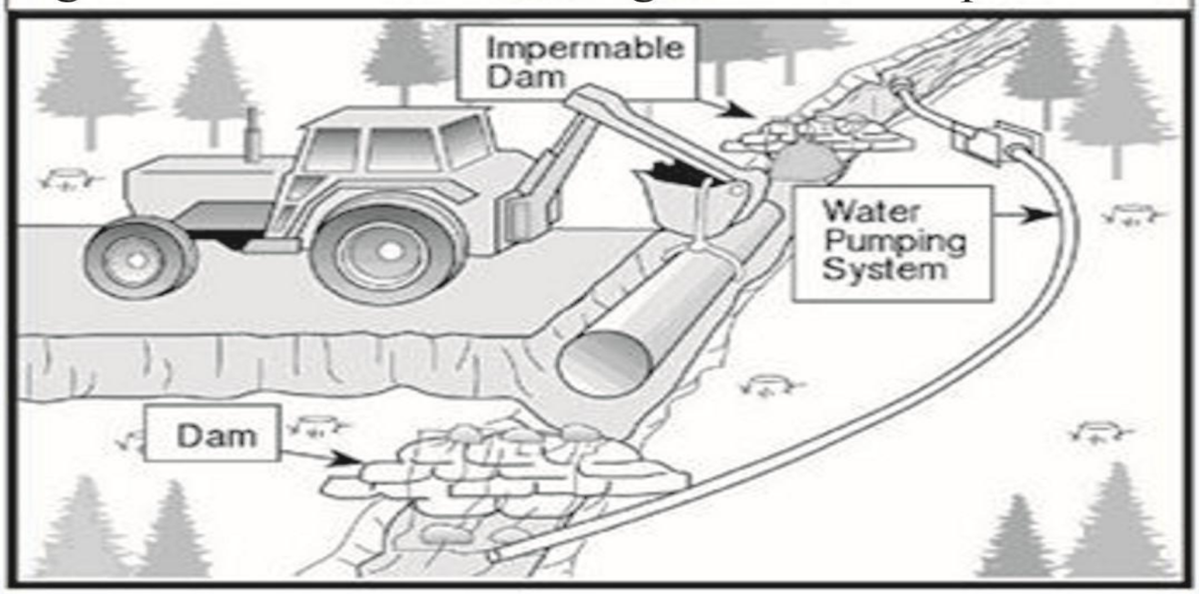
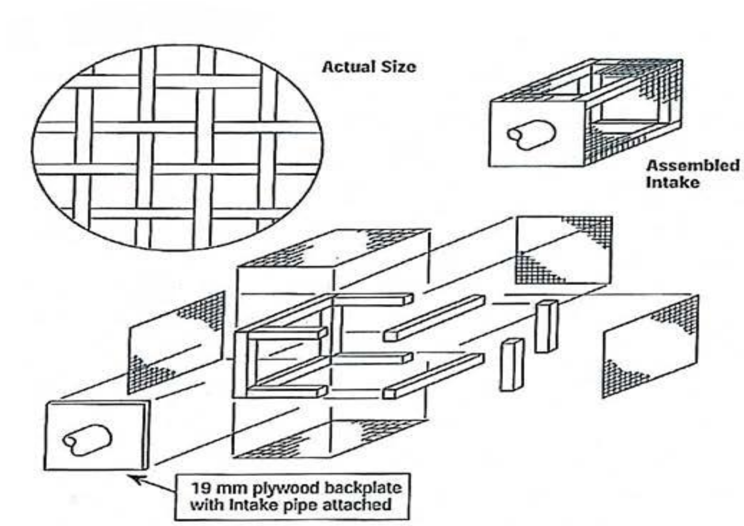


Figure 9-4 Temporary Intake Screen

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

10 EROSION AND SEDIMENTATION CONTROL

A Nova Scotia Watercourse Alteration Sizer may be involved in the planning and selection of the most appropriate erosion and sedimentation control measures for the entire worksite not only as part of the watercourse alteration.

Soil is subject to natural weathering and erosion. Natural, or geologic, erosion by water, wind, and ice has been occurring at a relatively slow rate since the Earth was formed. Some shore and stream channel erosion is natural. Natural erosion occurs slowly, shaping the landscape century by century, maintaining an environmental balance.

Any soil disturbance big or small and especially near water can cause major issues. Therefore design principles should be used. Construction activities and large earth-moving projects accelerate erosion dramatically, mainly by exposing large areas of soil to rain and running water. If this runoff is not properly treated, the result is often serious siltation of nearby watercourses. The consequences are degradation or destruction of fish and wildlife habitat, and water being less useful for fresh water supplies, navigation and recreation. 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.

IT'S A FACT

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

10.1 DESIGN PRINCIPLES

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.

2) Limit the time the disturbed area is exposed.

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

4) Retain existing vegetation wherever feasible. Erosion is minimal on a surface covered with natural vegetation.

5) Encourage permanent re-vegetation of exposed areas and replant riparian areas above the bank full width of the watercourse to restore fish habitat whenever possible.

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; covering erodible soils with mulch, vegetation or rip-rap; and constructing check dams or similar devices in constructed swales and ditches.

8) All exposed soils must be covered with grass seed and mulch and all stockpiled soil should be covered with polyethylene or contain stockpiles with a sediment control fence or mulch the stockpile as a temporary solution.

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

10) 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.

Erosion and sediment control plans need to be developed especially for large projects. 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.

For information on erosion and sediment control measures refer to the *Erosion and Sediment Control Handbook for Construction Sites* at: http://www.novascotia.ca/nse/surface.water/docs/erosionsedimentcontrolhandbook.construction.pdf.

11 MATERIALS USED IN WATERCOURSE

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

11.1 FRESH CONCRETE CAN BE TOXIC TO AQUATIC LIFE

Fresh/wet/uncured concrete must not come into contact with waterflow 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.

11.2 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.
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.

11.3 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.

In subsection 36 (3) of the federal *Fisheries Act*, it is an offence to deposit, or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter any such water.

WHY RISK IT

Follow the requirements for the drying and curing time of pressure treated wood and concrete to reduce the potential for serious water quality problems.

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

12 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
- Nova Scotia Watercourse Alterations Standard

13 GLOSSARY OF TERMS

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

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

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

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

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

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

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.

Head: The height of water above any point or place of reference.

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 isolation of water flow: Separated from the wetted portion of the channel.

Interstitial: Small narrow spaces between substrate.

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

Navigation Protection Act: an Act, administered by the Federal Ministry of Transport, developed to protect the public right of navigation in a navigable watercourse.

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.

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.

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.

Temporary Bridge: A portable structure used for vehicular watercourse crossings that shall remain in place for a period of time (ie., not permanent) usually not exceeding one summer season.

Thalweg: The line joining the lowest points lengthwise of the bed or a watercourse defining its deepest channel.

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

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

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

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

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16 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
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

17 APPENDICES

APPENDIX A

NOMOGRAPHS

Corrugated Steel Circular / Pipe

- showing the determination of a culvert size using 1:1 ratio for HW/D

Concrete / Plastic Circular Pipe

- showing the determination of a culvert size using 1:1 ratio for HW/D

Corrugated Steel Pipe Arch

- showing the determination of a culvert size using 1:1 ratio for HW/D

APPENDIX B

CONVERSION TABLES

Standard CSP Pipes (Page 11-5)
Chart (Page 11-5)

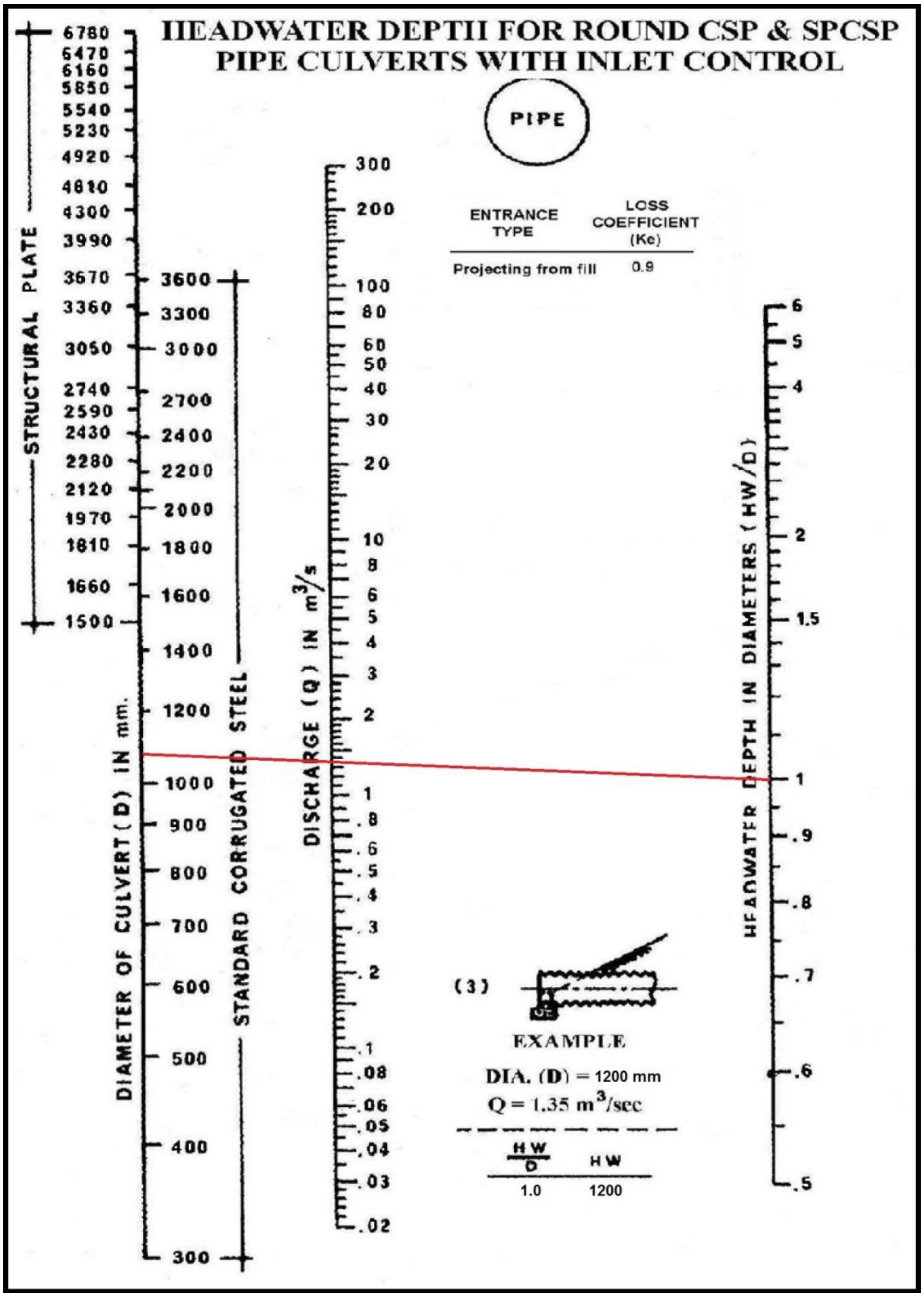
APPENDIX C

Design Flow Formula Map for Nova Scotia for 1:100 Year Storm Event (Permanent Structures) (Page 11-7)
Design Flow Formula Map for Nova Scotia for 1:2 Year Storm Event (Temporary Structures) (Page 11-6)

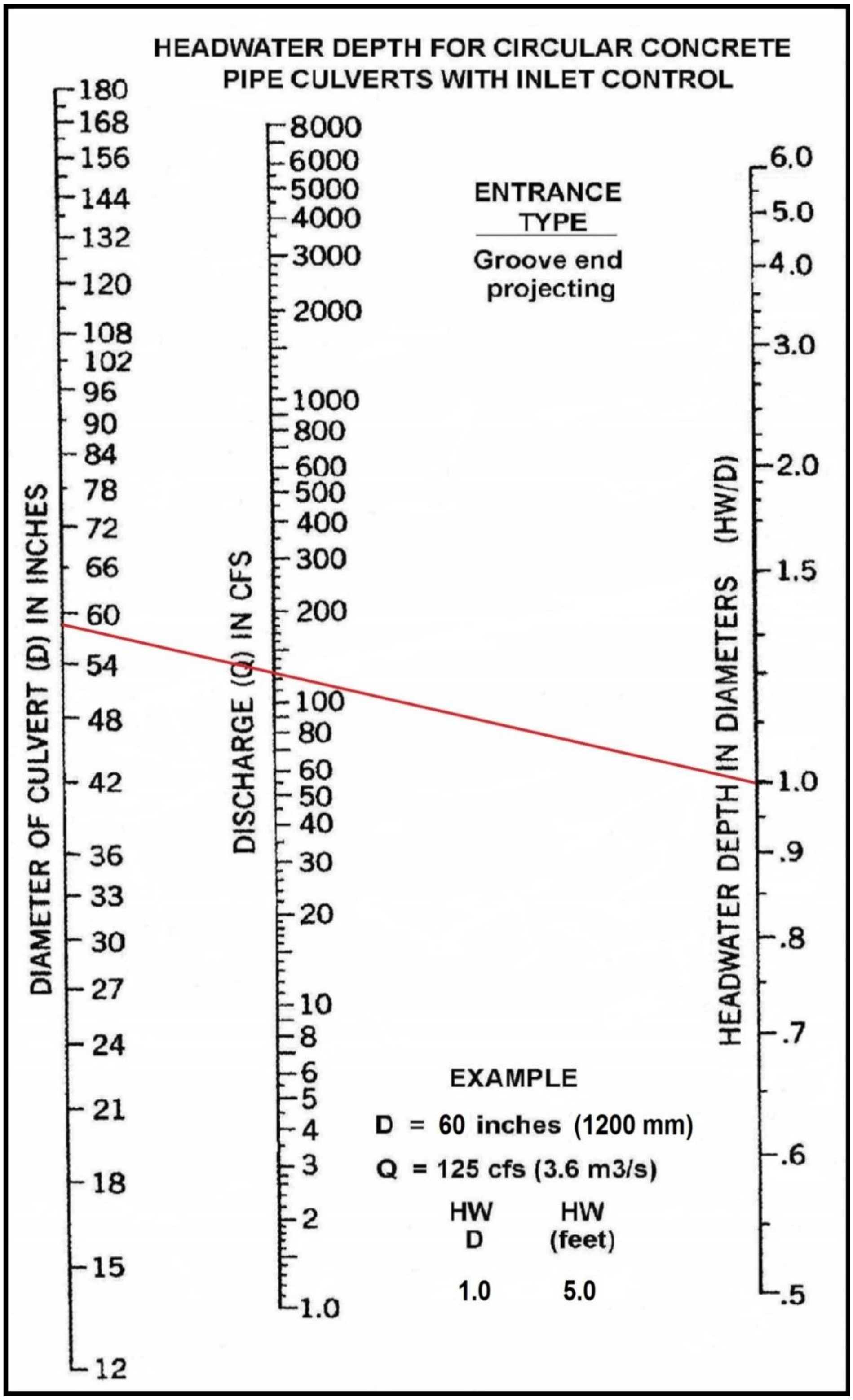
APPENDIX D

Notification Form Guidance

APPENDIX A NOMOGRAPHS



Data are derived from nomographs provided by the Bureau of Public Roads



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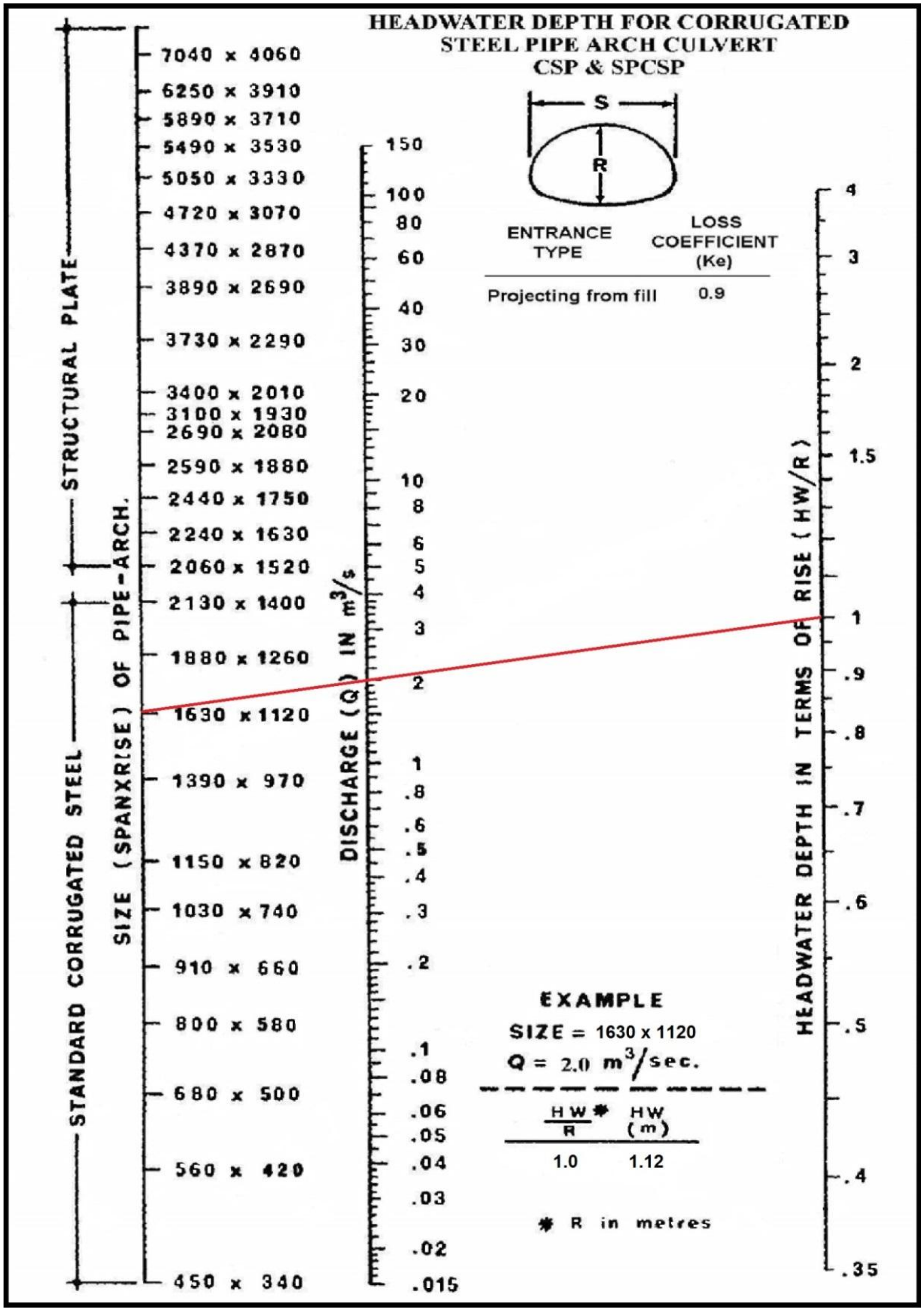


Data are derived from nomographs provided by the Bureau of Public Roads

APPENDIX B

CONVERSION TABLES

Standard CSP Sizes

Inches = Milimeters

- 12″ = 300
- 16″ = 400
- 18″ = 450
- 20″ = 500
- 24″ = 600
- 28″ = 700
- 30″ = 750
- 32″ = 800
- 36″ = 900
- 40″ = 1000
- 48″ = 1200

Inches = Milimeters

- 54″ = 1400
- 60″ = 1500
- 64″ = 1600
- 72″ = 1800
- 80″ = 2000
- 86″ = 2200
- 96″ = 2400
- 108″ = 2700
- 120″ = 3000
- 132″ = 3300
- 144″ = 3600

CHART

Inches vs Millimeters

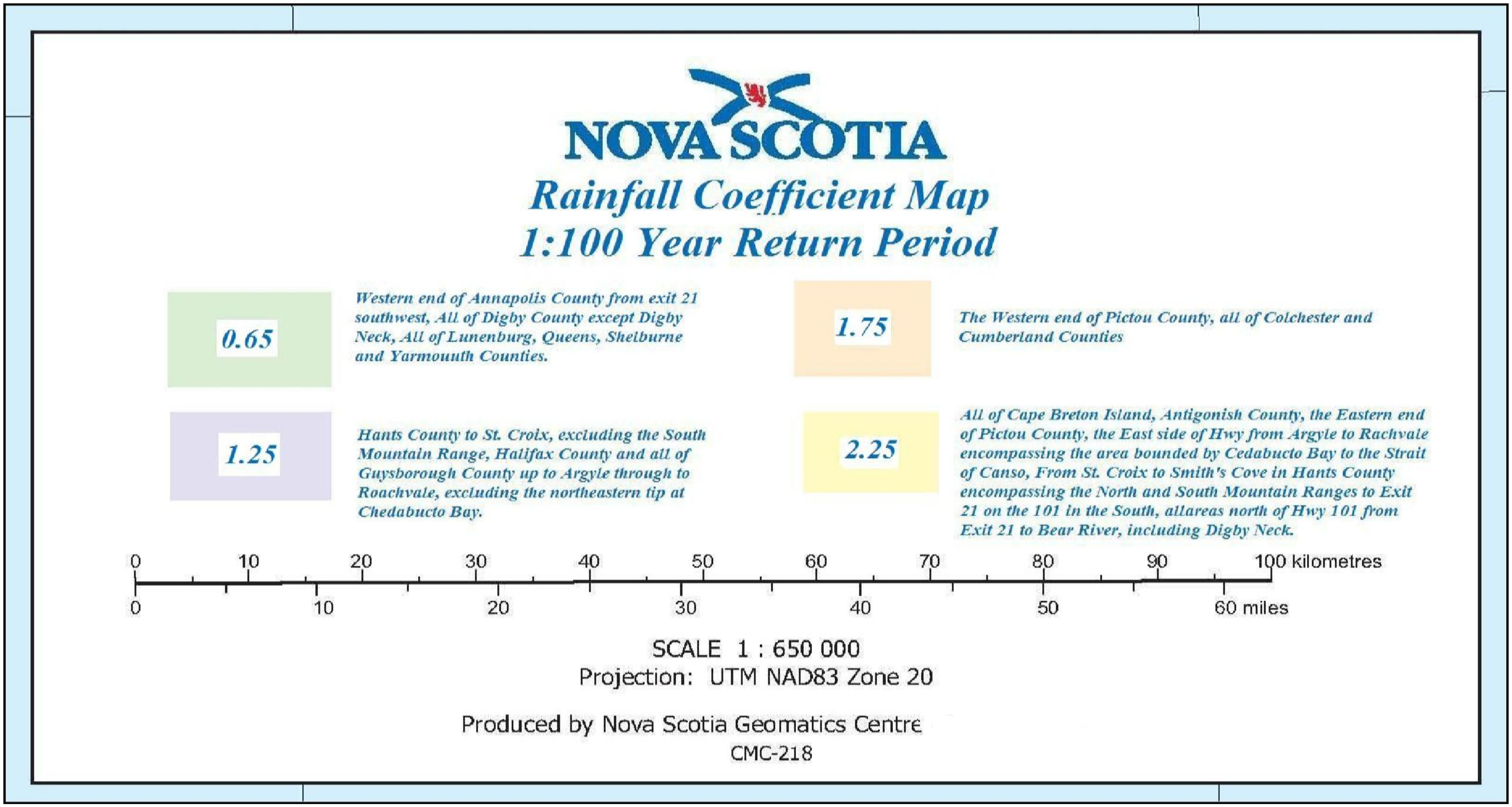
- 12 " = 300 mm
- 15 " = 375 mm
- 18 " = 450 mm
- 24 " = 600 mm
- 30 " = 750 mm

Feet vs Millimeters

- 3' = 900 mm
- 4' = 1200 mm
- 5' = 1500 mm
- 6' = 1800 mm
- 8' = 2400 mm

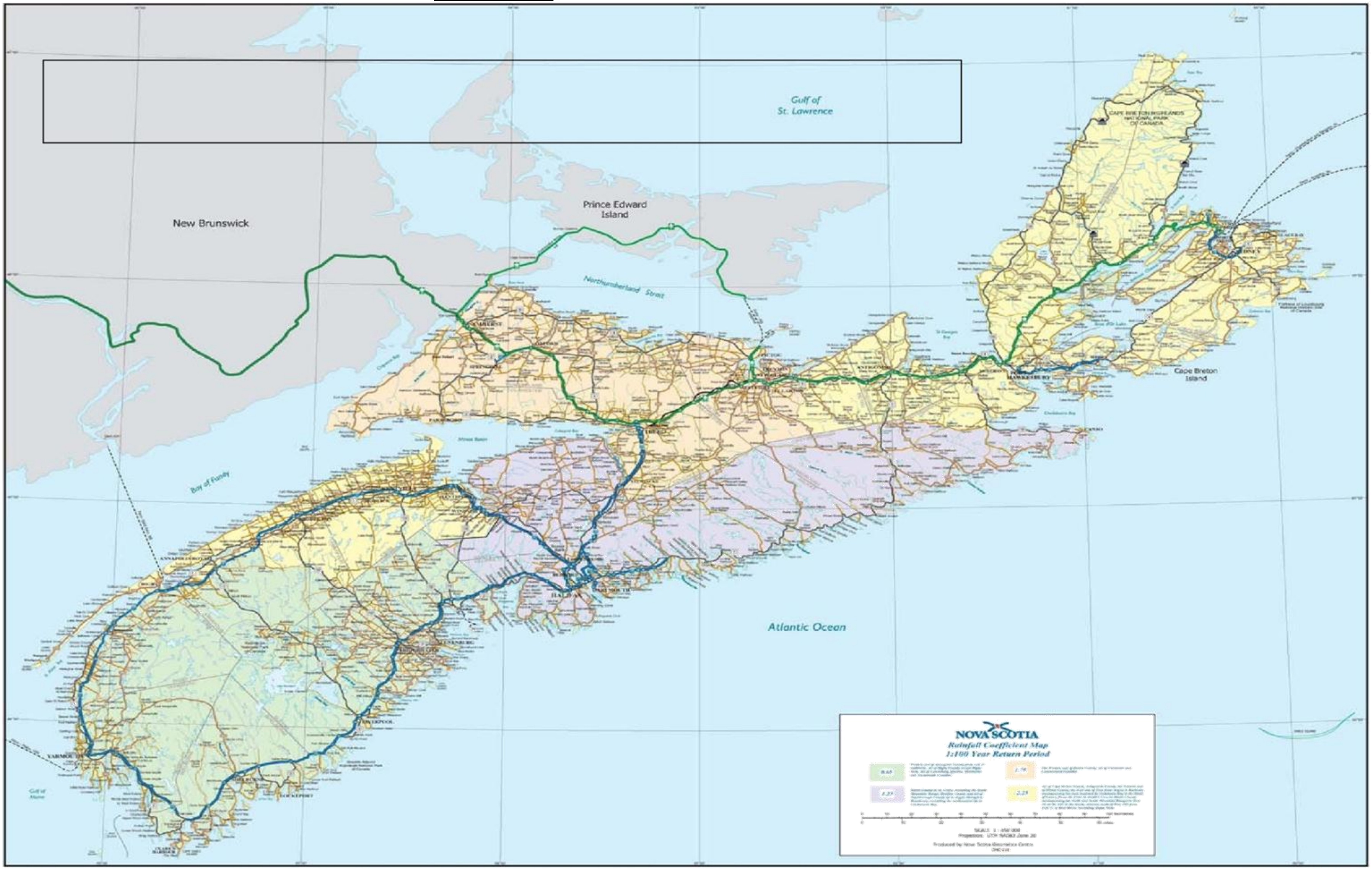
APPENDIX C

Design Flow Formula Map for Nova Scotia for 1:100 Year Storm Event (Permanent Structures)



APPENDIX C

Design Flow Formula Map for Nova Scotia for 1:100 Year Storm Event (Permanent Structures)



APPENDIX C

Design Flow Formula Map for Nova Scotia for 1:2 Year Storm Event (Temporary Structures)

NOVA SCOTIA

Rainfall Coefficient Map

1: 2 Year Return Period

Coefficient	Area
0.40	*Western end of Annapolis County from exit 21 southwest, All of Digby County except Digby Neck, All of Lunenburg, Queens, Shelburne and Yarmouuth Counties.*
0.95	*The Western end of Pictou County, all of Colchester and Cumberland Counties*
0.60	*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.*
1.50	*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

APPENDIX C

Design Flow Formula Map for Nova Scotia for 1:2 Year Storm Event (Temporary Structures)

NOVA SCOTIA
Environment

NOTIFICATION FORM

APPENDIX D -

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 notification:	New ❑	Renewed ❑	Amended ❑	If this is a renewed or amended notification, provide previous notification #______________________

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 Please provide an email if an email has been provided for the Notifier.		
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		
County	Community	
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.**
- ❑ Bridge or other open bottom structure (watercourse bed is not disturbed; bridge with maximum span 15 metres; other open bottom structure with maximum length of 25 m and maximum span of 3600 mm). **Complete section 5E.**

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)

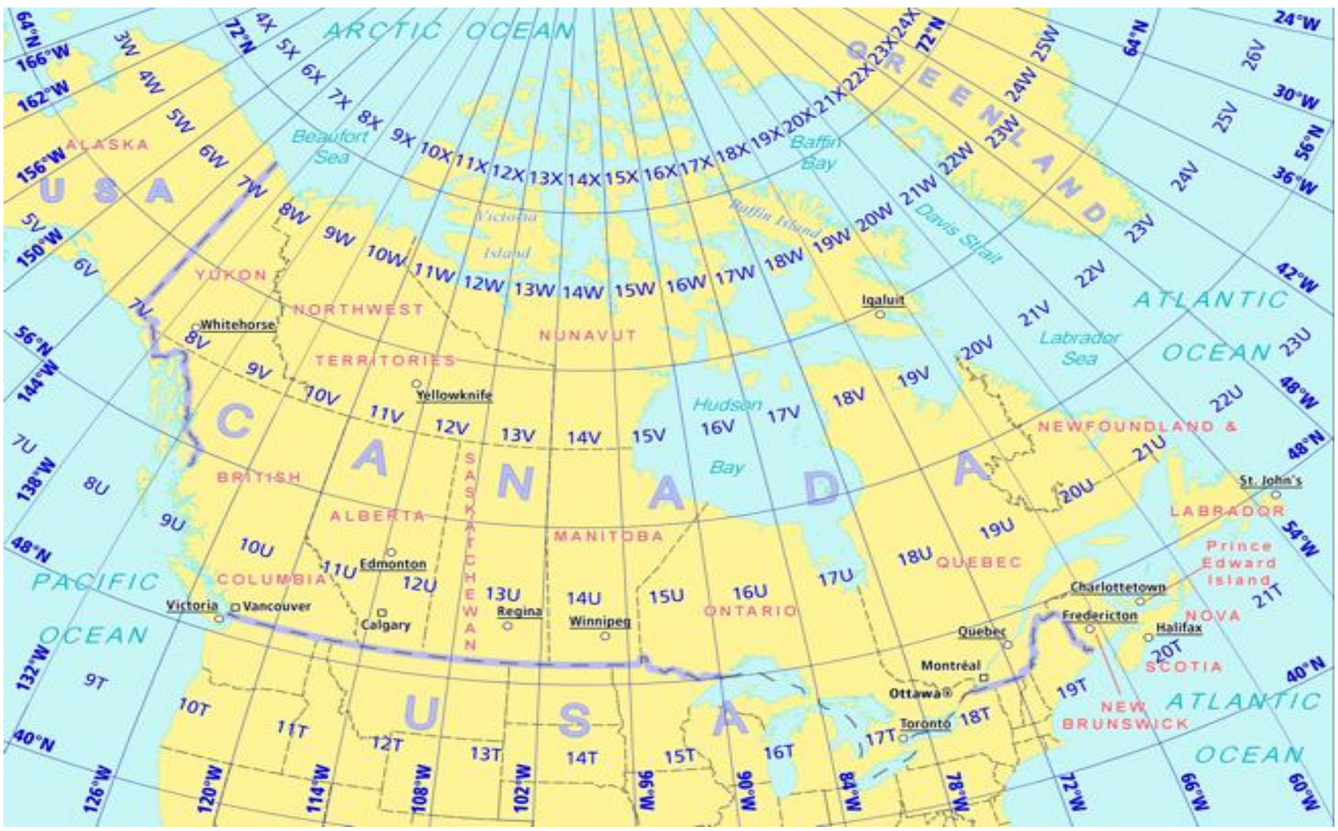
UTM (Universal Transverse Mercator) Collection

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:

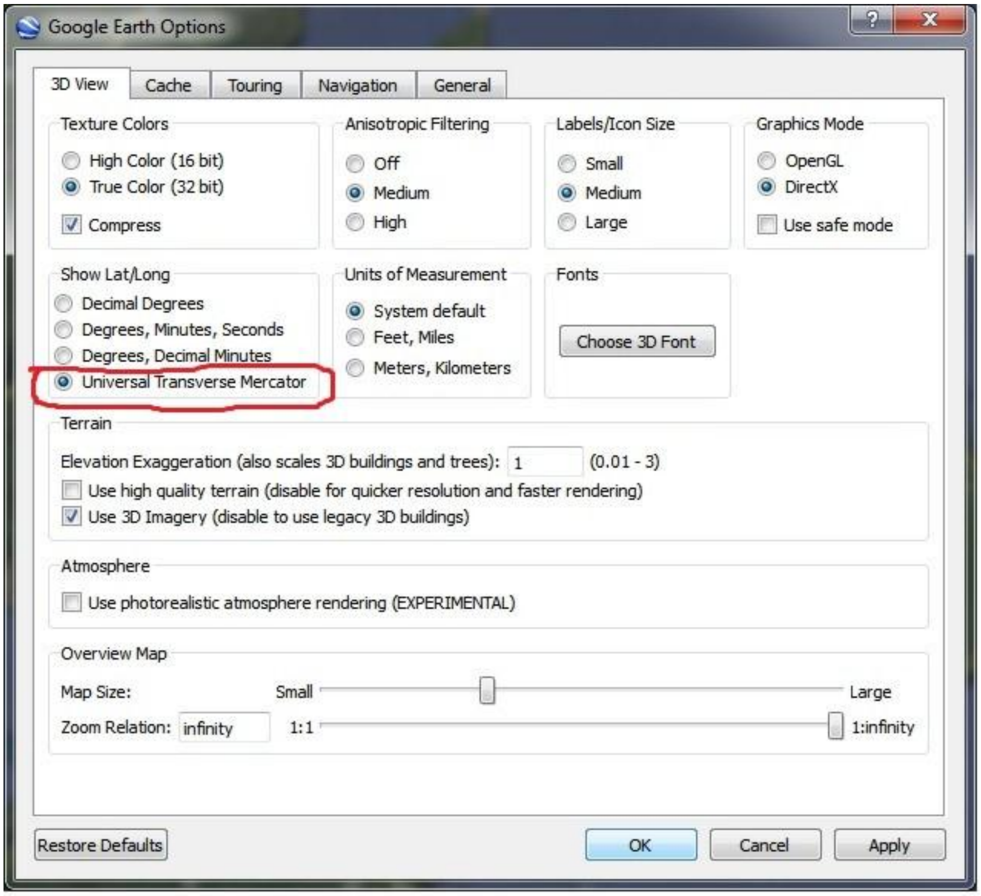
The first thing to do is enter your GPS unit's set-up screen to set up the GPS to collect in UTM. **Use your supplied user's manual to accomplish this.** Most Garmin GPS units will follow the following procedure: (There may be slight variations of these directions depending on which GPS you have)

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:

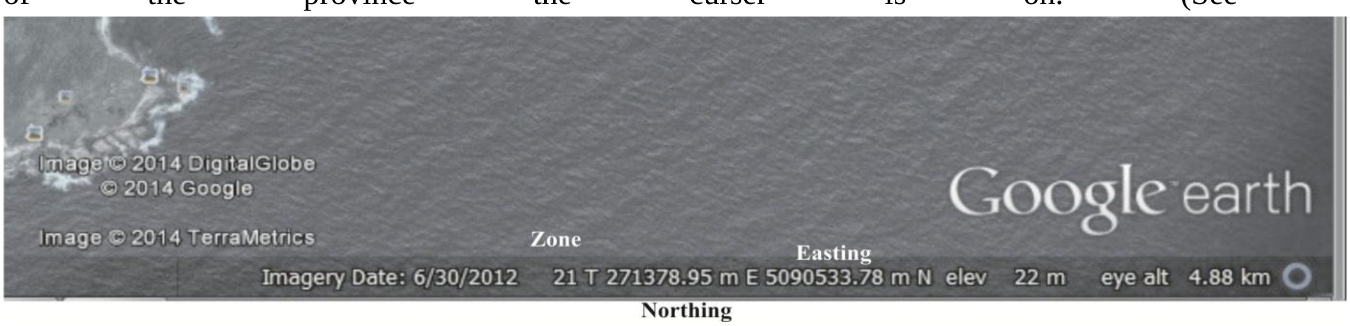
Install Google Earth on your machine if you do not have it.

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

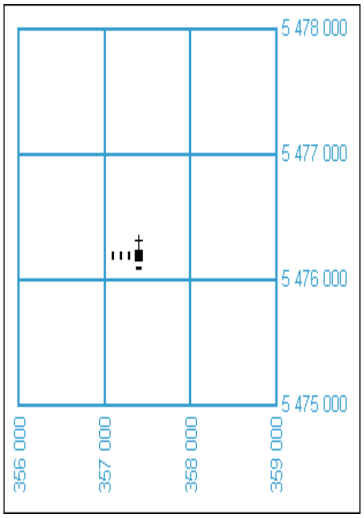
Horizontal lines are designated by their distance from the equator in metres. Because Canada's southernmost point is about 4 620 000 metres from the equator, all horizontal lines in Canada have a "northing" value above that figure. Vertical lines are measured from a separate point for each zone, namely, 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" 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

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

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.