# Technical Guidelines for Watercourse Crossings – Version 1.0

Prepared by: Credit Valley Conservation

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# Comments and Suggestions:

This document is prepared in accordance with CVC's regulatory role empowered under the Conservation Authorities Act. Under Section 28 of the Act, Credit Valley Conservation (CVC) administers Ontario Regulation 160/06 (Development, Interference with Wetlands & Alterations to Shorelines & Watercourses) to ensure public safety and protect property with respect to the natural hazards within CVC's jurisdiction.

This document and the recommendations provided herein were developed based on the most recent scientific research available to CVC as well as professional opinion and experience. CVC will review any new information or technologies that support crossing designs provided by an applicant in support of a specific project.

If you have any questions regarding these guidelines please contact CVC's Planning and Development Services Department.

*Credit River at Derry Road*

# Executive Summary

CVC's Technical Guidelines for Watercourse Crossings provide guidance to applicants on the design and submission requirements of watercourse crossings within the Credit River Watershed. The types of crossings and proposed works include:

- Repair of an existing structure
- Lengthening of an existing structure
- Replacement of an existing structure
- Construction of a new crossing
- Construction of a pedestrian crossing
- Construction of a low traffic pedestrian crossing
- Farm crossings

Each category of crossing may prompt specific technical studies associated with the design of that crossing. Technical studies assess the impact of the proposed work on the watercourse and its associated hazards.

Consider the following in the selection of location, design and construction of crossings:

- Potential watercourse and bank erosion in the vicinity of crossing abutments
- Potential impacts to upstream flooding (i.e. proposed crossing hydraulic capacity)
- Impacts to downstream flooding and potential increases in watercourse/bank erosion
- Potential slope instability pre, during, and post-construction
- Siltation during and after construction (i.e. erosion and sediment controls, and post construction landscape restoration)
- Flood free edge of travelled lane based on the road type

Applicants are responsible for familiarizing themselves with all relevant information and ensuring compliance with the legislation and policies of all applicable agencies. Please note that the information provided within these guidelines is not authoritative but provides recommendations in order to minimize the application review time for related projects. This will also ensure the conservation and protection of natural features and appropriately address natural hazards and potential impacts of crossing.

CVC operates under the authority of the *Conservation Authorities Act* and under Section 28 of the Act administers Ontario Regulation 160/06 (Development, Interference with Wetlands & Alteration to Shorelines and Watercourses). The main objectives of the regulation are to ensure public health and safety and the protection of life and property with respect to natural hazards. In addition, CVC safeguards watershed areas including natural features, wetlands, shorelines, valley lands and watercourses.

Natural heritage features and functions associated with aquatic and terrestrial components of the reach must be considered while locating, designing and constructing crossings. Please refer to the CVC's Fish and Wildlife Crossing Guidelines for more information. Additionally, these guidelines do not include stormwater management criteria or practices for paved roads or surfaces. Please refer *to* CVC's Stormwater Management Criteria for further guidance.

*Belfountain Conservation Area*

# Document Contents:

# 1 Introduction

This document provides guidance to the design and submission requirements of watercourse crossings. New development due to population growth will bring forth the need for additional roads, recreational trails, pedestrian crossings, pathways and other infrastructure throughout the watershed. This will increase the requirement for new crossings as well as the potential for replacement or alteration to existing crossings in order to accommodate the increase in traffic. Any alteration to existing crossings and/or the construction of new crossings within a regulated area associated with a watercourse or valley slope will require the review and approval from Credit Valley Conservation (CVC). This review will ensure that the crossing is designed appropriately and that the design will address the identified natural hazards in an acceptable way.

Watercourse crossings vary in use, structure type and design. The need for the placement of a structure is dependent on the different modes of transportation requiring a route. This can be determined through the municipal planning process, environmental assessment or other processes. Each type of watercourse crossing may require specific technical studies associated with the design of that crossing.

*Meadowvale Pedestrian Bridge*

# 2 Pre-Consultation

Consultation with CVC, municipalities and other regulatory agencies throughout all phases of the project is important for the efficient and timely review of the submissions and ultimately for the preservation of the natural features and watercourses associated with the proposed work. CVC provides input throughout these processes based on the governing principles and policies outlined in our Watershed Planning and Regulation Policies and our regulatory role.

Through the pre-consultation process, CVC provides valuable information and advice on our interests including hazard land management, water management and the protection of natural heritage systems and functions within our jurisdiction. This step is important to narrow down and establish the requirements related to the specific project site and watercourse. Typical technical requirements for a submission are summarized Appendix A by project type. This will be refined during pre-consultation based on the proposed extent of work, associated watercourse and site-specific conditions.

# 3 Project Planning

These guidelines were developed to assist an applicant in the design and submission of watercourse crossings for planning and/or permitting applications. They list technical analyses and identify minimum submission requirements. It is important to note that this document does not provide guidance on ecological and fisheries related requirements. Please refer to CVC's Fish and Wildlife Crossing Guidelines for more information.

These guidelines do not include stormwater management criteria or practices for paved roads or surfaces associated with the design of a crossing. Please refer to CVC's Stormwater Management Criteria for more guidance.

# 4 Background

Damage can occur throughout the watershed due to insufficient crossing design. Based on our watershed-wide experiences, some issues to consider in the location, design and construction of crossings include:

- Potential watercourse and bank erosion in the vicinity of crossing abutments
- Potential impacts to upstream flooding (i.e. proposed crossing hydraulic capacity)
- Impacts to downstream flooding and potential increases in watercourse/bank erosion
- Potential slope instability pre, during and post construction
- Siltation during and after construction (i.e. erosion and sediment controls, and post construction landscape restoration)
- User safety
- Flood free edge of travelled lane based on the road type

In conjunction with these guidelines, the following technical guidance documents prepared by CVC should be reviewed and applied as necessary:

- Fluvial Geomorphic Guidelines
- Slope Stability Definition and Determination Guideline
- Technical Guidelines for Floodproofing
- Fish and Wildlife Grossing Guideline

## 4.1 Extreme Storm Events in Southwestern Ontario

The Greater Toronto and Hamilton Areas have experienced an increase in frequency and intensity of extreme weather events which exacerbate localized natural hazards and urban flooding issues. This has brought awareness to the issues of providing safe conveyance of flows as well as the need to consider the geomorphic processes in a crossing design.

*Failed Slope of Driveway Crossing of Credit River Tributary*

*Spill from Applewood Creek along Dixie Road during August 2005 Storm Event*

On August 19, 2005 an estimated 150 mm of rain fell in a three-hour time frame in the Greater Toronto Area (GTA). This rainfall event measured to be the equivalent of a one in 100-year storm, with an intensity greater than the 1954 Hurricane Hazel (which in today's practice, is the design storm used as the regional storm event).

On July 8, 2013 a high intensity storm coming from east to west occurred over Mississauga and caused significant flood damage in the Cooksville Creek watershed. The Meteorological Service of Canada (MSC) rainfall gauge located at Pearson International Airport recorded approximately 126 mm of rainfall in only two hours. The average July rainfall recorded by the Pearson gauge is approximately 74.4 mm based on climate norms from 1971-2001. Millions of dollars were spent on repairs of the damage due to flooding across Ontario. This storm caused extensive damage to private and public infrastructure and resulted in localized flooding in homes, collapsed sanitary sewers, caused watermain breaks and washed away roads. The Credit River Watershed experienced the catastrophic damages caused by inadequately designed infrastructure during a high intensity storm event. This event raised awareness for the need to build infrastructure that will withstand such storm events.

The proper design and construction of crossing structures becomes increasingly more significant with the unpredictability of the behaviours of the water cycle within our fresh water system. If not properly designed or constructed, crossing structures can have various impacts that can increase upstream flooding and provide additional susceptibility to erosion.

# 5 Design Objective

The preservation of Ontario's natural water systems is instrumental to our future health and well-being. Flooding events can cause damage to the structures themselves as well as property upstream and downstream of the structure if not designed properly.

*Huttonville Creek at Bovaird Drive*

CVC's vision is a *thriving environment that protects, connects and sustains us* and our mission is that *together, it's our nature to conserve and our future to shape through the power of science, education, policy and leadership*. In accordance with Goals 2 and 3 established within CVC's Strategic Plan: "Plan for an environmentally sustainable future; Safeguard people, property and communities from hazards" and "Manage a healthy, resilient environment through protection, restoration and enhancement. In achieving the goal of safeguarding people, property and communities from hazards, there will be fewer people and properties at risk from flooding, erosion and unstable slopes. There will also be sufficient water quantity and quality for communities now and in the future."

# 6 Design Principles

Generally, good crossing designs and construction works should consider the following:

- The proposed works associated with the crossing should not create additional offsite flooding upstream and/or downstream of the crossing.
- Proposed work should not increase flow velocities in the watercourse and should minimize channel erosion.
- Selected crossing should not require alteration to natural channel's form which will compromise the function of the watercourse.
- A crossing should allow natural processes associated to the natural channel including: sediment transport, down-cutting, lateral and longitudinal migration over the planning horizon.
- A crossing in the confined valley system should avoid filling in the valley or disturbing the valley walls.
- A good design should not require hardening of the bed and bank of the watercourse.

The guidelines recognize various designs and construction works based on the scope of the project and accordingly may require different design principles and technical requirements. Repair of an existing structure, lengthening of an existing structure, replacement of an existing structure and construction of a new crossing will be subject to Section 6 of these guidelines. Pedestrian crossings and farm crossings will be subject to the general design principles of Section 6 and to specific design principles in Section 7 and 8.

In order to assist in categorizing the review, works associated to the crossing and crossing type are generally grouped in the below six categories. These categories do not cover all types of work and a site-specific requirement will be developed through pre-consultation and/or through a planning process such as a Municipal Class EA.

- **Repair of an existing structure**: Any crossing that will be restored to the pre-approved conditions as well as the repair work to existing structures including plaster, embankment repair, patchwork, etc.
- **Lengthening of an existing structure**: This may be required as a result of a road widening project or inadequate condition based on the age of the structure.
- **Replacement of an existing structure**: This may be required as a result of failure due to the hydraulic capacity, inadequate condition based on the age of the structure or the obstruction of the geomorphic processes.
- **Construction of a new crossing**: A new crossing may be required in instances where a new road is being constructed.
- **Construction of a pedestrian crossing**: This is a pedestrian crossing with the purpose of connecting communities and intended for all year use. Note that a pedestrian crossing will be treated as a regular crossing unless otherwise agreed that it is a low traffic pedestrian crossing. See Section 7 for further details.
- **Construction of a low traffic pedestrian crossing**: This is a crossing that will have infrequent traffic in locations such as a private back yard, or a park where inexpensive wooden bridges are removed during winter months, etc. See Section 7.1 for further details.
- **Farm crossings**: A farm crossing is typically used for private machinery access across a small watercourse, where no alternative access is possible. See Section 8 for further details.

The following sections provide guidance on the design of a crossing through principles based on the technical input. Guidance will be refined during pre-consultation as specified previously in Section 2.

## 6.1 Hydrology

In most cases, CVC will provide peak flow rates for all design storms (2-year through 100-year and Regional events) to be applied to the hydraulic assessment as necessary. Where flows are not available for the use of the proposed work, CVC staff will identify the method of estimating flows in accordance with CVC's most current hydrology standards. Please refer to the Technical Guidelines for Flood Hazard Mapping for the modelling parameters that are accepted when completing hydrologic assessments.

## 6.2 Hydraulics and Flooding

CVC regulates lands containing flood hazards based on the Regulatory storm event which is the greater of the Regional storm event as identified by the Province (Hurricane Hazel) and the 100-year storm event.

When a hydraulic assessment is required, CVC will provide the existing hydraulic model as the basis for the assessment, if one is available. It's important to confirm the validity of the existing hydraulic model prior to the start of design. This information may need to be updated based on a more recent geodetic survey in order to simulate the existing scenario as accurately as possible. An update to a hydraulic model must be accompanied by a technical memo that outlines the work being proposed and how it was reflected in the model update. Note a technical memo can be required at all stages in the design and is triggered by the need for a model update.

Where the existing hydraulic model is not available or outdated, CVC staff will require the applicant to develop one. All hydraulic analyses must be conducted using the 1D version of HEC-RAS unless otherwise directed by CVC. The application of the 2D or linked HEC-RAS model shall only proceed following written approval by CVC staff.

It is expected the applicant will complete a geodetic survey of watercourse cross-sections upstream and downstream of the structure in accordance with the [Technical Guidelines for Flood Hazard Mapping](). For structure replacement, the applicant must also complete a geodetic survey of the profile and existing structure in accordance with the aforementioned guideline document. Submit the hydraulic model with appropriate geo-references based on the surveyed information. For more assistance, contact CVC for up-to-date information.

*Levi Creek at Old Derry Rd*

The following guidance helps determine the optimal crossing from a hydraulics perspective:

a. New bridges or crossings will not be acceptable where they create adverse backwater effects onto the upstream neighbouring property. Likewise, bridges will not be acceptable where they increase velocities and flood levels on downstream neighbouring properties. These effects must be considered for the full range of design flows (2-year to 100-year and Regional flows) and a hydraulic backwater analysis (using HEC-RAS, etc.) must be performed for any bridge designed by a licensed professional engineer.

*Credit River at King Street*

b. There must be no increase in flood risk at the site location and at upstream properties during all design storms from 2-year to 100-year and Regional events. There must be no offsite[1] increase in water surface elevations as well as the Energy Grade Line during the Regulatory storm event.

[1] Offsite refers to any property that is not owned by the Municipality or alternatively, the applicant, located either upstream or downstream from the subject site location.

c. The hydraulic assessment must show the proposed work will not bring fill into the floodplain. When required and properly justified, the fill amount must be minimized in order to achieve the proposed design conditions.
d. It's important that a crossing be located, designed and constructed appropriately to minimize on-going repair, watercourse and riparian area remedial works, or the early and unanticipated need for replacement and/or relocation of structures caused by hydraulic characteristics of migrating or eroding watercourses. The culvert skewness must also be considered in the hydraulic analyses.
e. For crossings that include siderails as a part of the design, it is required that the hydraulic analysis be based on a blockage of 50 per cent of the total area of those siderails.
f. All obstructions, inclusive of parapet walls, jersey barriers, sound barriers, etc must be considered when completing the hydraulic model and spill analysis.
g. Where a crossing is overtopping or flooding, a structural engineer should confirm that the crossing is able to withstand flood forces and velocities associated with the storm events that are overtopping the structure. This decreases the possibility of the structure being dislodged during a storm event and creating further issues downstream. Refer to the related document CVC's Technical Guidelines for Floodproofing for design considerations regarding saturated soils, hydrostatic pressures, and bearing/settlement conditions.

### 6.2.1 Design Considerations

The functional road classification determines the minimum design flow for the sizing of a new road crossing. Table 6.1 indicates the return period of the design flow for new crossings.

Additionally, the specification of freeboard accounts for variable factors including the conveyance of ice and debris through the structure. As specified in the Ontario Ministry of Transportation's Drainage Design Standards (January 2008), the desirable freeboard is measured vertically from the Energy Grade Line elevation for the Design Flow to the edge of the travelled lane and the minimum freeboard is measured vertically from the High Water Level for the design flow to the edge of the travelled lane, at the lowest point in the sag. See Figure 6.1 for an illustration of what is considered the freeboard along a cross section.

***Figure 6.1:*** *Standard Road Classification Geometry (source: MTO Water Crossings Drainage Design Standards January 2008)*

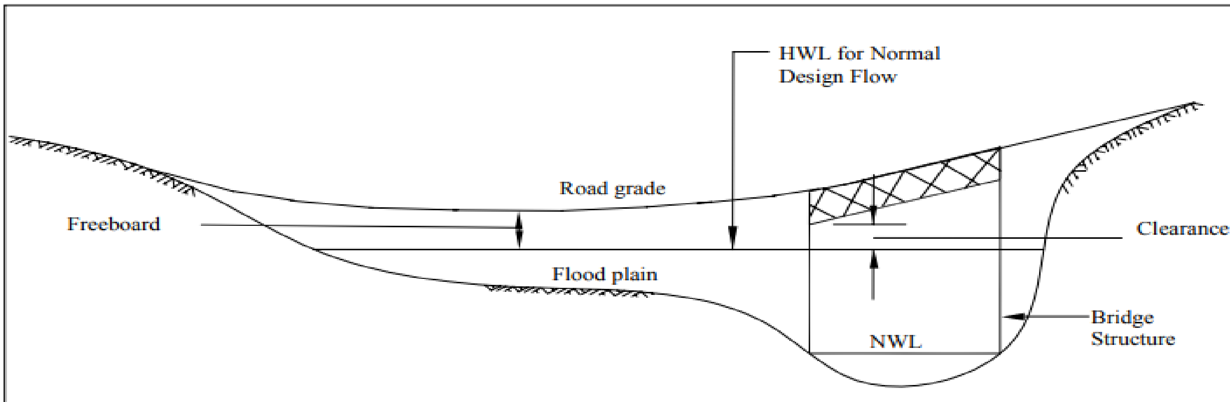



Figure WC2.1-Freeboard and Clearance for Normal Design Storm

Refer to the below **Table 6.1** for the requirements for freeboard based on the functional road classification. It is understood that all applicable crossings will be designed in accordance with the Canadian Highway Bridge Design Code.

**Table 6.1:** Design Considerations for Crossings

| Type of Crossing | Return Period of Design Flows | Minimum Freeboard (m) |
|---|---|---|
| Arterial Roads<br>Collector Roads | Regulatory* | 0 |
| | 100-year | 1.0 |
| Local Roads | 100-year | 0.3 |

***The depth of overtopping on the road should be determined through a Site-specific Risk Assessment (Section 6.2.2).

An alteration to an existing crossing should also meet the design guidelines as set out in **Table 6.1**. However, if this can not be achieved, a Site-Specific Risk Assessment (Section 6.2.2) must be completed. CVC expects that the existing conditions will be improved during the proposed scenario with the goal of making the road flood free.

Additionally, all crossing replacement designs should be flood free to the best extent feasible and for all other crossings. Safe conveyance must be provided based on the CVC's and municipal regulation and criteria.

### 6.2.2 Site-specific Risk Assessment

If the applicant is unable to achieve the above listed guidance, a Site-specific Risk Assessment is to be completed to consider site constraints and impact the proposed work may have on the regulated watercourse. Please consult with CVC prior to the completion of this assessment to appropriately scope the process. Consider the following:

- Frequency and depth of flooding for the proposed structure.
- Magnitude of the flow rate and flow velocity.
- Volume of traffic using the road.
- Consequence of the road overtopping in terms of safe ingress and egress from residences and institutions that may be affected by flooding, including consideration of emergency vehicle access.
- Existing flood risk to any buildings or structures adjacent to and upstream of the proposed structure.
- Identification of land use and the extent of flooding upstream of the proposed structure.
- Feasibility (including cost) of conveying the Regulatory flow without increasing upstream flood elevations.

This risk assessment will be documented to include all analyses and decisions. It is recommended that where one is prepared, it will be submitted as early in the process as possible to provide adequate timing for consideration. CVC in consultation with the municipality will consider modifying the design standards subject to broad considerations associated with technical / economic feasibility.

*Crossing of Shaw's Creek Road in Caledon*

Furthermore, open dialogue between the applicant and CVC is encouraged throughout the completion of this Site-Specific Risk Assessment.

## 6.3 Fluvial Geomorphology

Watercourses are dynamic systems that migrate longitudinally and laterally, depending on the form of a watercourse. Often existing crossings are not designed to accommodate watercourse processes and require frequent structural maintenance and an engineered channel bed and banks both upstream and downstream of a crossing. The CVC's Fluvial Geomorphic Guidelines (specifically Fact Sheets I and III) will assist in determining the hazard delineation and address fluvial geomorphological concerns.

If a fluvial geomorphic assessment is completed, it must be accompanied by a technical memo written and signed by a qualified professional that is a Professional Geoscientist (professional fluvial geomorphologist) or Professional Engineer registered in Ontario.

Additional guidance is as follows:

*Shaw's Creek Crossing in Alton*

a. The crossing design should respect the fluvial geomorphic process in the watercourse in order to minimize the negative impacts on the aquatic and terrestrial environment.
b. The span of crossings should be selected based on detailed fluvial geomorphic analyses. Abutments, piers and other bridge components should be located outside of the 100-year local erosion hazard. Determination of the local erosion hazard is separate from the procedure of determining meander belt and scour potential at a specific site. The 100-year local erosion hazard will determine the extent at which the crossing infrastructure should be placed in order to avoid future channel realignment or unnecessary hardening of the channel or banks. This assessment must be completed by a professional fluvial geomorphologist or equivalent. Any existing reports for the watercourse can also be considered for this purpose.
c. Generally, a geomorphic study is required to determine the crossing opening. However, for the watercourses that are less than 4 m wide, the crossing opening of three times the bankfull channel can be adopted without undertaking a geomorphic study.

d. Where the existing bridge abutments interfere with the erosion hazard, a fluvial geomorphic assessment must be completed in order to identify if the abutment needs removal or relocation.
e. It is recognized that larger crossings, may require piers in the watercourse. This must be specified early in the process. In some cases, as early as during the environmental assessment.
f. For new crossings, the footing depths are based on the scour depth (see Section 6.3.1) as identified by a fluvial geomorphologist. Provide the method used, results of the analyses and the input parameters used to determine the type and depth of footings.
g. The replacement or new construction of a crossing must be an open footing culvert or bridge, unless there is a compelling reason why a closed bottom culvert would provide greater social, economic and environmental benefits. Closed bottom culverts must be embedded (sunk into the stream) by at least 10 per cent of the height of the culvert, if there is no substrate (engineered material) incorporated into the design. Otherwise, if a design substrate is proposed, consider embedment of the culvert equivalent to two times the depth of the substrate above the base of the closed bottom culvert. The general principle is that if the crossing cannot be embedded, then closed bottom culverts should not be used. Over time the closed bottom culvert can result in a perched crossing, which requires expensive repairs or watercourse modifications. Properly designed crossings not only reduce long term maintenance cost but also enhance the natural environment in the vicinity of the crossing.


*Bridge at Terra Cotta Conservation Area*

h. For guidance and information regarding the sizing and design of substrate through a proposed crossing, refer to CVC's Fluvial Geomorphic Guidelines.

In the case of crossing replacements, it is recognized that some crossings may not meet fluvial geomorphic guidelines due to several challenges as determined through a Municipal Class EA. In these cases, an appropriate justification for selecting the span will be required. This can be completed through an appropriate planning process.

It is recognized that there may be watercourses with small upstream drainage areas. Depending on these channel characteristics, a fluvial geomorphic assessment may not be required. Contact CVC to receive further clarification and confirmation of these characteristics.

### 6.3.1 Scour Protection

Scour assessment is defined as the technical and professional evaluation of the long-term risks due to potential vertical erosion and/or degradation of watercourse channels, including three types of scours: natural, localized and general.

Scour processes and risks can be assessed at a range of scales in space and time. Defining types of scour is relevant to selecting the most appropriate methods relevant to the varying contexts and risks for channel scour. (Philips, 2019)

CVC has developed scour assessment guidelines by defining terminology, identifying key scientific resources, and standardizing expectations for delineation of the scour hazard limit (SHL). These scour assessment guidelines contribute to CVC's Fluvial Geomorphology Guidelines as an accepted reference for planning reviews related to engineering and infrastructure projects crossing under watercourses.

Please contact CVC for the Scour Assessment Guidelines or refer to CVC's website.

## 6.4 Geotechnical

The erosion hazard in a confined valley system is determined by adding the toe erosion allowance to the slope stability allowance as determined by a Geotechnical Engineer, which is explained in detail within CVC's Slope Stability Definition and Determination Guideline. A confined system is defined in CVC's Fluvial Geomorphic Guidelines. The following should be considered from a geotechnical perspective when designing a crossing within a confined system:

*Crossing of Naturalized Channel at Sandalwood Parkway*

a. The crossing structures should span the valley so that the bridge abutments are outside of the 100-year erosion hazard. The objective is that the crossing structure and associated infrastructure does not have a negative impact to the valley slope and/or on the natural geomorphic processes. It is recognized that spanning the valley is not always practical given the site conditions. This would need to be documented and properly justified through an appropriate planning process.
b. In any case, the geotechnical engineer must identify the erosion hazard and determine the impacts of the proposed works on the stability of the valley slopes. This information must be used in selecting the location and size of the proposed crossing.
c. The geotechnical engineer must confirm that the proposed design has no off-site impacts on the stability of the slope. Structural alteration of the valley slope to accommodate any crossing infrastructure is not a recommended approach.
d. For existing crossings, alternatives should be examined through an appropriate planning process. Effort must be made to remove the road and crossing outside the erosion hazard.
e. The toe erosion allowance, which is a component of the erosion hazard, is required. Where the watercourse is less than 15 m from the toe of slope, the above mentioned guideline provides typical toe erosion rates. Site-specific 100-year erosion rates can be determined by a qualified geomorphologist. Refer to the CVC's Slope Stability Definition and Determination Guideline for further direction.

These practices should be kept in mind when designing the crossing as well as during construction. Proper restoration of disturbed valley slopes and applying the proper treatments as necessary is very important to the longevity of the new or altered crossing.

## 6.5 Hydrogeology

A hydrogeologist may need to evaluate the site under high groundwater conditions. Further hydrogeologic assessment may be required where a crossing structure may impact the natural movement of groundwater, inclusive of groundwater recharge or discharge. The assessment must provide mitigation strategies with considerations for the discharge during dewatering activities. A detailed dewatering plan would be required in instances where dewatering will occur during construction.

## 6.6 Erosion and Sediment Control (ESC)

Construction activity in or near a watercourse or valley slope associated with a watercourse, can accelerate the erosion process with the potential to contaminate the downstream waterbodies with sediment laden runoff. The Erosion and Sediment Control Guideline for Urban Construction, produced by the Greater Golden Horseshoe Area Conservation Authorities, provides guidance on the use of ESC measures during construction activities.

*ESC Measures along Naturalized Channel*

Note that an understanding of the construction timing is essential in determining the need for specific ESC and mitigation measures.

The applicant and practitioner are responsible for the submission and ultimate implementation of a comprehensive ESC plan. If the construction duration is relatively long and/or the watercourse is sensitive to erosion, multi-stage construction ESC plans will be required to ensure adequate control for the entire period of work.

The application of adequate controls at construction sites is essential to safeguarding downstream receiving waterbodies and ensures aquatic and terrestrial habitats are effectively protected from construction.

# 7 Pedestrian Crossings

Pedestrian crossings are structures that have been designed and installed across watercourses for active or passive pedestrian traffic (e.g. pathways for access to schools across the channel, pedestrian trail linkages, etc.). Presently, most pedestrian crossings are installed with the purpose of connecting communities. Such pedestrian crossings are also travelled by maintenance vehicles and are often open during winter months. They are located in urban areas and accommodate year-round traffic. This requires that the crossings are built to ensure safe public access during major storms while respecting natural hazards. A pedestrian crossing design should consider the design principles and criteria provided in Section 6, as it falls under the same classification as a new bridge crossing on collector or local roads. A summary of design considerations are listed in **Table 7.1** below. As specified previously, if the applicant is unable to achieve the design criteria, a Site-Specific Risk Assessment is to be completed per Section 6.2.2. Please refer to Section 7.1 for alternative guidance based on the conclusion of the Site-specific Risk Assessment.

*Huttonville Creek Pedestrian Bridge*

**Table 7.1:** Design Considerations for Pedestrian Crossings

| Type of Crossing | Return Period of Design Flows | Freeboard (metres) |
|---|---|---|
| New Pedestrian Crossing | 100-year | 0.3 |

## 7.1 Low Traffic Pedestrian Crossing

It is recognized that some inexpensive crossings will have infrequent traffic such as crossings in private back yards, or parks where there are wooden bridges (or similar). Such "low traffic pedestrian crossings" can be designed with lower technical considerations. These pedestrian crossings facilitate infrequent pedestrian only traffic on private property or in rural areas and have a limited footprint.

*Hungry Hallow (Low Traffic) Pedestrian Bridge, Georgetown*

### 7.1.1 Design Considerations

The width measurement is simply the horizontal level distance from bank to bank and the depth is the vertical distance in the centre of the channel, at the bankfull stage. Measurements are made in the riffle or in a straight reach between oppositely swinging meanders. The riffle should appear more shallow and faster than the meanders upstream and downstream. If there is a deeper section across the riffle, closer to one bank than the other, this is where the depth measurement should be made. If these conditions are not immediately obvious, then a best approximation should be made. Refer to **Table 7.2** below for design considerations for the crossing span of a Low Traffic Pedestrian Crossing.

**Table 7.2:** Low Traffic Pedestrian Crossing span

| Watercourse Location | Minimum Height = X (times) bankfull depth | Minimum Span = X (times) bankfull width |
|---|---|---|
| Credit River above the "Forks" and all other watercourses | 1 ½ + 30 cm when depth is greater than 60 cm | 1 ½ (or 1 for existing man-made channelization) |
| Credit River below the "Forks" | 2 | 1 ½ |

*The minimum design height is measured from the deepest point of the bed of the channel and the minimum design span is centred over the bankfull width of the channel. Note that the minimum design span defines a limit that must be respected for bridges built either perpendicular or on an angle over the watercourse.*

Apply the following guidance when considering the design of a low traffic pedestrian crossings:

a. Generally, low traffic pedestrian crossings should not be located across the curving section of a meander because of the susceptibility of the outside bank to erosion.
b. The use of standard pipe or box culverts is not appropriate conveyance techniques under a pedestrian crossing. These structures disrupt habitat and the natural stability of a channel.
c. The construction of hard erosion protection on one or both banks is not supported.
d. Any disruption, grading, or realignment of the existing natural channel is also not supported unless it is designed to restore or enhance aquatic habitat.
e. Adding fill in the floodplain when grading the trail over the crossing must be avoided. Any grading including bridge approaches can not create an offsite flooding impact. Addition of fill within the floodplain may trigger further requirements from CVC.

*Rattray Marsh (Low Traffic) Pedestrian Bridge*

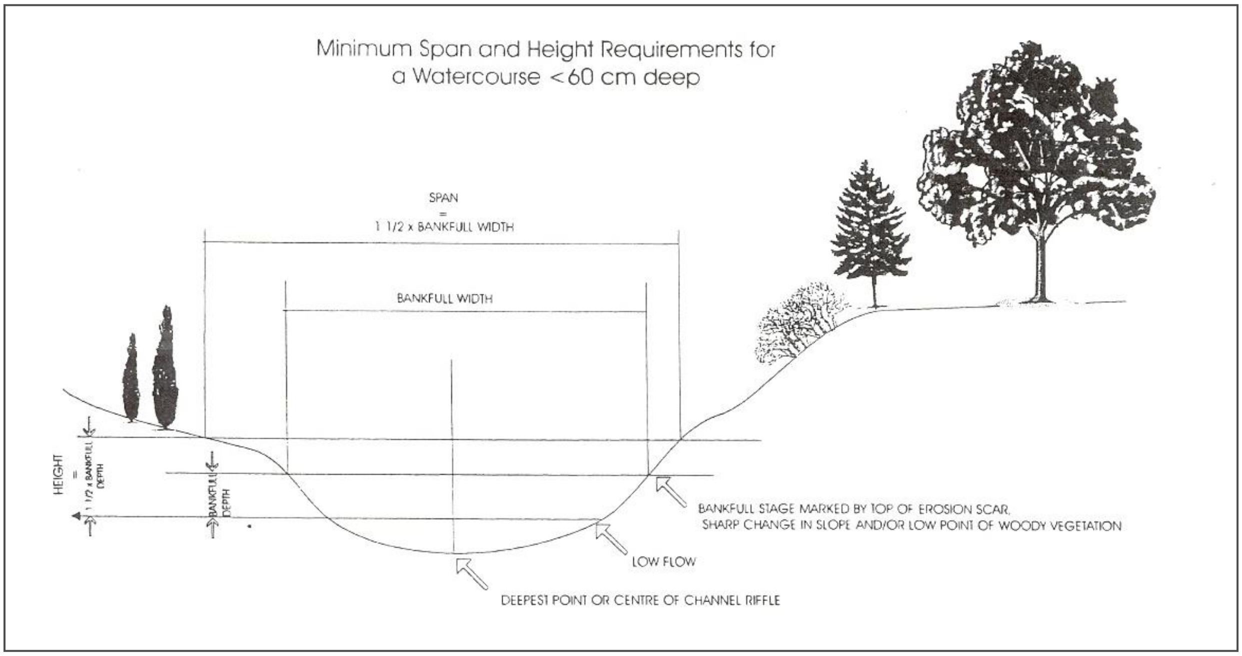
f. Due to the arching configuration of prefabricated bridges, it is acceptable if only the centre 1/2 - 2/3 of the span is above the height requirements.
g. A qualified Professional Engineer must demonstrate that the crossing is providing the appropriate ingress and egress for the intended level of usage. This includes the review of flow depths and velocities during all design storm at the bridge deck and associated access/trail. A crossing which can not provide flood free access during 25-year storm

are considered high risk depending upon the frequency of public use and should follow the site-specific risk assessment as described in Section 6.2.2.

h. Where crossing structures are exposed to frequent flooding, structures should be designed for structural integrity by a qualified Professional Engineer. Bridges should be securely anchored such that they will not become an obstruction at downstream culverts, crossings, channel bends, etc.

See Figure 7.1 for an application example of the low traffic pedestrian crossing criteria.

***Figure 7.1:*** *Low Traffic Pedestrian Crossing Criteria*




# 8 Farm Crossings

A farm crossing is typically used for private machinery access across small watercourses to access agricultural fields or buildings, where there is no reasonably safe or convenient alternative access that doesn't require crossing a watercourse. These crossings should provide safe access during the 10-year storm event or as determined by CVC. Refer to **Table 8.1** for the Design Considerations for a farm crossing. Where a crossing is proposed to access a habitable structure, CVC's criteria for safe ingress/egress will apply.

A ford (bed level) crossing can be considered where site conditions permit. A ford is a dip in the road with good footing that is constructed to facilitate a crossing while providing a safe and maintenance free access. The objective of such a crossing is to maintain the natural fluvial geomorphic processes, safe flood conveyance, fish passage and wildlife movement.

**Table 8.1:** Design Considerations for Farm Crossings

| Type of Crossing | Return Period of Design Flows | Freeboard (metres) |
|---|---|---|
| Farm Crossing | 10 | 0.3 |

Similar to other crossing types as discussed in this document, farm crossings may result in an increase in upstream flooding. Upstream impacts due to flooding may not be a significant concern where the increase to flooding is localized to the existing field and there is no impact to upstream properties and/or structures on the property. However, if the crossing is located within close proximity to a neighbouring property, farm structures and/or habitable buildings, additional analysis may be required to demonstrate that the crossing does not adversely impact upstream structures and property. Note that CVC may require a hydraulic assessment for such crossings, which will be determined during the pre-consultation stage.

*Farm Crossing in Caledon*

Experience shows that farm crossings can also obstruct the natural fluvial processes in a watercourse and often result in barriers to fish passage. In accordance with CVC's Fluvial Geomorphic Guidelines, a typical farm crossing over a small watercourse should generally be sized to span equivalent to three times the bankfull width of the watercourse. In these cases, it is also expected that the crossing be open bottom to allow for the natural geomorphic processes to occur.

However, for a closed bottom replacement culvert, the culvert should be embedded by at least 10 per cent of the height of the culvert. Discussions of this option can take place following CVC's assessment of the current conditions at the site location. The replacement of an existing crossing will be reviewed based on a reasonable approach to improve the current conditions of the system.

Please note that the aforementioned technical requirements will depend on the sensitivity of the system as determined by CVC staff. These factors include the following:

- Aquatic habitat
- Geomorphic conditions (erosion potential)
- Watercourse designation (intermittent or permanent)
- Off-site flooding potential

Before designing a new crossing, pre-consultation with CVC staff is strongly recommended. Staff can provide recommendations on suitable locations to reduce impacts to the environment but to also reduce costs to the landowner and to clearly identify the technical requirements needed for an application.

# 9 Submission Requirements

Submission and approval requirements vary based on the type of work proposed in addition to the local conditions and constraints for the crossing. See Appendix A for a comprehensive list of the submission requirements for work as identified within this document. The submission requirements will be refined through the process of pre-consultation.

It's important to note the scope of work must be clearly outlined in a technical memo and/or as illustrated on a General Arrangement Plan.

# 10 References

CVC consulted the following references in the development of this document:


Roger Philips, May 2019, CVC Fluvial Geomorphology Guidelines Review – Scour Assessment Discussion Paper

Credit Valley Conservation Authority, April 2010, Watershed Planning and Regulation Policies

Credit Valley Conservation Authority, Dec 2014, Strategic Plan

Credit Valley Conservation Authority, 2017, Fish and Wildlife Grossing Guideline

Credit Valley Conservation Authority, Technical Guidelines for Floodproofing

Credit Valley Conservation Authority, April 2015, Fluvial Geomorphic Guidelines

Credit Valley Conservation Authority, Feb 2014, Slope Stability Definition and Determination Guidelines

David Suzuki Foundation, Water Impacts (http://www.davidsuzuki.org/issues/climate-change/science/impacts/water-impacts/)

Greater Golden Horseshoe Area Conservation Authorities, December 2006, Erosion and Sediment Control Guideline for Urban Construction

Levine, Jessica, August 2013, An Economic Analysis of Improved Road-Stream Crossings

Ontario Ministry of Environment and Climate Change, Nov 2016, Facts on Climate Change

Ontario Ministry of Transportation, January 2008, Drainage Design Standards for Water Crossings

# Appendix A:

# Submission Requirements

**A1: Repair of an Existing Structure**

This type of work applies to any crossings that will be restored to the pre-approved conditions as well as the repair work to existing structures including plaster, embankment repair, patchwork, etc.

A technical assessment is not required unless there is evidence of historically recurring failures.

| Minimum Technical Requirements | Include the following content in the submission: |
|---|---|
| Technical Memo | project description, rational for proposed works, discussion of alternate considerations |
| Key Plan | site location, watercourse and structure location |
| General Arrangement drawing | plan and profile views |
| Erosion and Sediment Control Plan | locations and details of the ESC measures, construction access, dewatering requirements and flow diversion as necessary, applicable notes |
| Construction Staging Plan | site layout of temporary construction measures inclusive of staging and sequencing as necessary |
| Restoration and Stabilization | slope protection measures, restoration |

### A2: Alteration of an Existing Structure

This type of work may be required as a result of a road-widening project or inadequate condition based on the age of the structure.

| Minimum Technical Requirements | Include the following content in the submission: |
|---|---|
| Technical memo or report | scope of work (including in-stream or near water works) |
| Hydraulic Analysis | letter/report and digital copy of model(s) that confirms there will be no off-site flooding or erosion impact due to the proposed works |
| Fluvial Geomorphic Assessment | a report in accordance with CVC's Fluvial Geomorphic Guidelines and/or as established for the local site conditions |
| Geotechnical Assessment | slope stability assessment in accordance with CVC's Slope Stability Guidelines |
| Public Safety | where the travel path floods frequently, the applicant has to confirm that the public safety has been considered |
| Hydrogeology Report/analysis | groundwater investigation where groundwater interferes with the proposed work |
| Key Plan | site location, watercourse and structure location |
| General Arrangement drawing | plan and profile views (inclusive of existing and proposed conditions, grades, etc) |
| Erosion and Sediment Control Plan | locations and details of the ESC measures, construction access, dewatering requirements and flow diversion as necessary, applicable notes |
| Construction Staging Plan | site layout of temporary construction measures inclusive of staging and sequencing as necessary |
| Restoration and Stabilization | slope protection measures, restoration |

Note* All technical reports and drawings must be signed by a qualified Professional

**A3: Replacement of an Existing Structure**

This type of work may be required as a result of failure due to the hydraulic capacity, inadequate condition based on the age of the structure or geomorphic processes.

| Minimum Technical Requirements | Include the following content in the submission: |
|---|---|
| Technical memo or report | scope of work (including in-stream or near water works) |
| Hydraulic Analysis | letter/report and digital copy of model(s) that confirms there will be no off-site flooding or erosion impact due to the proposed works (See Table 6.1 within the report) |
| Fluvial Geomorphic Assessment | a report in accordance with CVC's Fluvial Geomorphic Guidelines and/or as established for the local site conditions |
| Geotechnical Assessment | slope stability assessment in accordance with CVC's Slope Stability Guidelines |
| Public Safety | where the travel path floods frequently, the applicant has to confirm that the public safety has been considered |
| Hydrogeology Report/analysis | groundwater investigation where groundwater interferes with the proposed work |
| Key Plan | site location, watercourse and structure location |
| General Arrangement drawing | plan and profile views (inclusive of existing and proposed conditions, grades, etc) |
| Erosion and Sediment Control Plan | locations and details of the ESC measures, construction access, dewatering requirements and flow diversion as necessary, applicable notes |
| Construction Staging Plan | site layout of temporary construction measures inclusive of staging and sequencing as necessary |
| Restoration and Stabilization | slope protection measures, restoration |

Note* All technical reports and drawings must be signed by a qualified Professional

### A4: Construction of a New Crossing

The following requirements apply to bridges designed for mixed traffic use, including pedestrian, multi-modal and vehicular modes of transportation.

| **Minimum Technical Requirements** | **Include the following content in the submission:** |
|---|---|
| Technical memo or report | scope of work (including in-stream or near water works) |
| Design Criteria | document recommendations and the design criteria established in the Environmental Assessment report |
| Hydraulic Analysis | report and digital copy of model(s) that confirms there will be no off-site flooding or erosion impact due to the proposed works (See Table 6.1 within the report) |
| Fluvial Geomorphic Assessment | report in accordance with CVC's Fluvial Geomorphic Guidelines and/or as established for the local site conditions |
| Geotechnical Assessment | slope stability assessment in accordance with CVC's Slope Stability Guidelines |
| Structural Confirmation | structural integrity confirmation where crossing overtops during major flows |
| Public Safety<br>Site-specific Risk Assessment | where the travel path floods frequently, the applicant has to confirm that the public safety has been considered |
| Hydrogeology Report/analysis | groundwater investigation where groundwater interferes with the proposed work |
| Key Plan | site location, watercourse and structure location |
| General Arrangement drawing | plan and profile views (inclusive of existing and proposed conditions, grades, etc) |
| Erosion and Sediment Control Plan | locations and details of the ESC measures, construction access, dewatering requirements and flow diversion as necessary, applicable notes |
| Construction Staging Plan | site layout of temporary construction measures inclusive of staging and sequencing as necessary |
| Restoration and Stabilization | slope protection measures, restoration |

Note* All technical reports and drawings must be signed by a Professional Engineer

**A5: Construction of a Low-Traffic Pedestrian Crossing**

These guidelines apply for the design and installation of a low traffic pedestrian crossing, as outlined in the guidelines. Generally, these structures facilitate infrequent pedestrian only traffic on private property or in rural or park areas and have a limited footprint.

| Minimum Technical Requirements | Include the following content in the submission: |
|---|---|
| Technical memo or report | scope of work (including in-stream or near water works) and confirm that the crossing width and height is achieved |
| Fluvial Geomorphic Assessment | a report in accordance with CVC's Fluvial Geomorphic Guidelines and/or as established for the local site conditions |
| Geotechnical Assessment | slope stability assessment in accordance with CVC's Slope Stability Guidelines |
| Structural Confirmation | structural integrity confirmation where crossing overtops during major flows |
| Public Safety<br>Site-specific Risk Assessment | where the travel path floods frequently, the applicant has to confirm that the public safety has been considered |
| Hydrogeology Report/analysis | groundwater investigation where groundwater interferes with the proposed work |
| Key Plan | site location, watercourse and structure location |
| General Arrangement drawing | plan and profile views (inclusive of existing and proposed conditions, grades, etc) |
| Erosion and Sediment Control Plan | locations and details of the ESC measures, construction access, dewatering requirements and flow diversion as necessary, applicable notes |
| Construction Staging Plan | site layout of temporary construction measures inclusive of staging and sequencing as necessary |
| Restoration and Stabilization | slope protection measures, restoration |

Note* All technical reports and drawings must be signed by a qualified Professional

**A6: Construction of a Farm Crossing**

The following submission requirements apply to the aforementioned farm crossings.

| Technical Requirements | Include the following content in the submission: |
|---|---|
| Minimum Technical Memo | project description, rational for proposed works, any discussion and subsequent guidance by CVC staff as a result of the site visit |
| Key Plan | site location, watercourse and structure location |
| General Arrangement drawing | plan sketch and profile views |
| Erosion and Sediment Control Plan | locations and details of the ESC measures, construction access, dewatering requirements and flow diversion as necessary, applicable notes |
| Construction Staging Plan | site layout of temporary construction measures inclusive of staging and sequencing as necessary |
| Restoration and Stabilization | slope protection measures, restoration |