1 GENERAL

1.1 SCOPE

1.1.1 Scope of Code

The Canadian Highway Bridge Design Code, CAN/CSA-S6-00 (CHBDC) applies subject to each of the CHBDC sections specified herein by section number and title, being amended, substituted or modified, as the case may be, in accordance with the amendments, substitutions and modifications described herein as corresponding to each such CHBDC section.

The Canadian Highway Bridge Design Code, CAN/CSA-S6-00 (CHBDC) shall apply for the design and construction of Ministry bridges and other Ministry structure types that are referenced in the scope of CHBDC.

The "BC Ministry of Transportation Supplement to the Canadian Highway Bridge Design Code, CAN/CSA-S6-00" (Supplement to CHBDC S6-00) shall also apply for the design and construction of Ministry bridges and other Ministry structures types that are referenced in the scope of CHBDC.

In the event of inconsistency between the Supplement to CHBDC S6-00 and the CHBDC, the Supplement to CHBDC S6-00 shall take precedence over the CHBDC.

In the event of inconsistency, between Project specific Contracts and Terms of Reference prepared by or on behalf of the Ministry, on the one hand, and the Supplement to CHBDC S6-00 or the CHBDC, on the other hand, the Project specific Contracts and Terms of Reference shall take precedence over the Supplement to CHBDC S6-00 or the CHBDC, as the case may be.

1.2 DEFINITIONS

1.2.1 Administrative Definitions

BC Supplement to TAC Geometric Design Guide: means the compilation of Ministry recommended design practices and instructions comprising supplemental design guidelines which are published by the Ministry and which are to be used concurrently with the Transportation Association of Canada's Geometric Design Guide for Canadian Roads.

CHBDC: means the Canadian Highway Bridge Design Code CAN/CSA-S6-00.

Design-Build Standard Specifications (DBSS): means the BC Ministry of Transportation Design-Build Standard Specifications for Highway Construction relating to material specification, construction methodology, quality testing requirements and payment which are published by the Ministry and which are applicable to Ministry Design-Build bridge and highway construction projects unless otherwise specified.

Engineering Association: means the Association of Professional Engineers and Geoscientists of B.C.

Flyover: means a structure carrying one-way traffic over a highway from one highway to another highway.

Footbridge: means a structure providing access to pedestrians over water and land but not over a road.

Highway: has the same definition as given in S6-00 and includes a Provincial public undertaking, within the meaning of the Transportation Act, S.B.C. 2004, c. 44.

Low Volume Road Structure: means a bridge or structure, as designated by the Ministry, on a side road with an average daily traffic ADT (for a period of high use) total in both directions, not exceeding 500 vehicles per day.

Ministry: means the BC Ministry of Transportation.

Numbered Route: means a highway, within the meaning of the Transportation Act, S.B.C. 2004, c. 44, designated by number by the Ministry.

Overhead: means a structure carrying a highway over a railway or railway and other facility.

Overpass: means a structure carrying a highway over a road or lesser highway.

Pedestrian Overpass: means a structure carrying pedestrians over a road, highway or other facility.

Railway Overhead: means a structure carrying a railway or a railway and other facility over a highway,

Regulatory Authority: means the persons who may from time to time hold, or be acting in the position of, the Office of Chief Engineer of the BC Ministry of Transportation

Special Provisions (SP): means the project specific construction specifications relating to material specification, construction methodology, quality testing requirements and payment which are prepared by or on behalf of the Ministry and are applicable to Ministry construction projects.

SPZ: means Seismic Performance Zone

Standard Specifications (SS): means the BC Ministry of Transportation Standard Specifications for Highway Construction relating to material specification, construction methodology, quality testing requirements and

payment which are published by the Ministry and which are applicable to Ministry bridge and highway construction projects unless otherwise specified.

S6-00: means the Canadian Highway Bridge Design Code CAN/CSA-S6-00

TAC Geometric Design Guide for Canadian Roads: means the roadway design guidelines published by the Transportation Association of Canada which is to be used concurrently with the BC Supplement to TAC Geometric Design Guide.

Underpass: means a structure carrying a road or lesser highway over a highway.

1.5 GENERAL PROVISIONS

1.5.1 Application

Exemptions from the Supplement to CHBDC S6-00, including for the purpose of application of codes other than S6-00, may be obtained with prior written Approval.

The following products, materials or systems shall not be incorporated into Ministry bridge projects unless specifically consented to by the Ministry:

a) Steel grid decking;

b) Induced current cathodic protection system;

c) Modular deck joints;

d) Bridge deck heating systems;

e) Timber components;

f) Proprietary composite steel/concrete girders;

g) Full depth precast deck panels;

h) MSE walls with dry cast concrete block facings;

i) Walls with wire facings for median walls and upslope retaining walls visible to road traffic; and

j) MSE walls with polymeric reinforcement used as abutment walls or wing walls.

k) FRP products

l) Polymer composite based structural products

m) Welded shear keys for box beams

1.5.2.3 Design Life

For any calculations which are time dependent (including fatigue, corrosion and creep), the length of time shall be specified as 100 years.

1.5.2.6 Economics

Delete the first sentence and replace with the following:

After safety, total life cycle costs shall be a key consideration in selecting the type of structure but may not be the determining consideration on all projects.

1.5.2.8 Aesthetics

General guidelines for bridge aesthetics are set out in the Ministry's Manual of Aesthetic Design Practice.

1.5.4 Construction

The Ministry SS and SP for bridge construction take precedence over this section of S6-00.

1.5.4.3 Construction Methods

Commentary: *Reference Volume 2 Procedures and Directions, for guidelines associated with transportation of bridge girders in BC.*

1.6 GEOMETRY

1.6.2 Structure Geometry

1.6.2.1 General

Delete the first paragraph and replace with:

Roadway and sidewalk widths, curb widths and heights, together with other geometrical requirements not specified in S6-00 or this Supplement, shall comply with the BC Supplement to TAC Geometric Design Guide, or in their absence, with the TAC Geometric Design Guide for Canadian Roads.

Change the first sentence of the second paragraph to read:

Sidewalks and cycle paths shall be separated from traffic by a barrier or guide rail. For design speeds ≤ 60 km/h, a raised curb may be used with the curb having a face height of 200 mm and a face slope not flatter than one horizontal to three vertical.

Accommodation of cyclists shall be in accordance with the Ministry Cycling Policy.

Design widths for shoulder bikeways shall be in accordance with the BC Supplement to TAC Geometric Design Guide.

Commentary: *In most cases, the bridge deck width will incorporate the lane and shoulder width dictated for the highway. Generally this information shall be provided by the Regional Highway Designer or designate. In the case of bridge structures that are greater than 300 m in length, consideration may be given to reducing the stipulated shoulder width on the structure.*

The following table of sidewalk widths shall be used to determine the sidewalk width for various site conditions. The widths specified shall be the clear distance from the back of parapet or face of curb to the railing. Sidewalks are to be located on the side of the highway which is predominantly used by either pedestrians or cyclists. In dense urban areas, consideration shall be given to providing a sidewalk on both sides of the bridge. Where shoulder widths are provided that are 2.0 m or greater, consideration shall be given to accommodating cyclists on the roadway.

Type of Traffic	Direction	Minimum Width (metres)
Pedestrian Only	Bi-directional	1.5[1]
Pedestrian Only	Bi-directional	1.8[2]
Pedestrian and Cycle	Uni-directional	2.5[3]
Pedestrian and Cycle	Bi-directional	3.5[3]

Notes:

1. Sidewalk width applies where the approach roadways has no sidewalk
2. Minimum sidewalk width or match sidewalk width approaching structure
3. These widths are intended for high volume urban areas. Reductions will be considered on a project specific basis with Approval.

1.6.2.2 Clearances

Minimum vertical clearance to bridge structures shall be 5.0 m over all paved highway surfaces, including any on- or off-ramp(s) that pass underneath. The minimum vertical clearance to pedestrian underpasses, sign bridges, and other lightweight structures spanning the highway shall be 5.5 m.

Long-term settlement of supports, superstructure deflection and pavement overlay shall be accounted for in the vertical clearances.

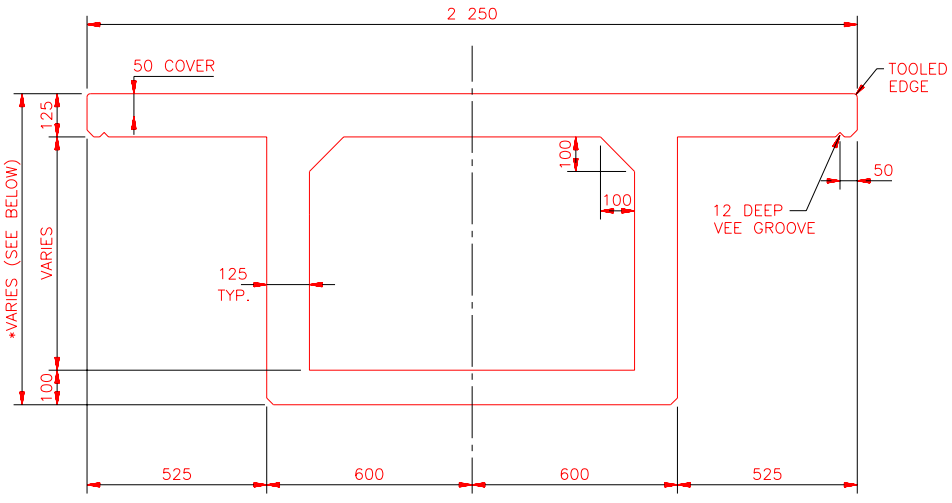
Consideration shall be given to providing horizontal separation between adjacent structures for maintenance access and to avoid pounding during seismic events. For gaps greater than 0.6 m and up to 3 m between adjacent structures, fall arrest provisions shall be provided to prevent people from falling through the gap.

1.6.2.3 Pedestrian/Cycle Bridges

A maximum gradient of 1:12 shall be used for wheelchair traffic on ramps. The clear distance between the inside faces of railings shall comply with Clause 1.6.2.1 but shall not be less than 2.0 m.

At locations where there is a change in gradient at the piers, the provision of a smooth curve over the piers shall be considered for improving the aesthetics.

Commentary: *The following details a concrete single cell box beam that has been modified as a pedestrian bridge structure which has been utilized throughout BC.*



TYPICAL SECTION

* 900mm – (20m–25m SPAN)
1 100mm – (25m–30m SPAN)
1 200mm – (30m–35m SPAN)
1 300mm – (35m–40m SPAN)

1.7 BARRIERS

1.7.2 Roadside Substructure Barriers

The standard sidewalk railing, when incorporated into the structure, shall extend a minimum of 3 m beyond the bridge abutments.

When barrier is placed with less than 125 mm clearance to a structural component, the structural component shall be designed for full impacts loads.

1.8 AUXILIARY COMPONENTS

1.8.2 Approach Slabs

The inclusion of approach slabs on paved roads shall be based on site-specific conditions as directed by the Ministry. Approach slabs shall be 6 m in length, located at least 100 mm below finished grade, anchored to the abutments and shall be as wide as the full bridge deck. A clear cover of 70 mm shall be used for the top reinforcing bars.

Approach slabs shall have a 100 mm minimum asphalt overlay but do not require a waterproofing membrane unless specified otherwise by the Ministry.

Approach slabs shall be provided for bridges on Numbered Routes where total settlement greater than 50 mm is anticipated between the abutment and the roadway fill. Approach slabs shall be provided for structures in Seismic Performance Zones 3 and 4. Approach slabs are not required for low-volume road structures.

1.8.3 Utilities on Bridges

The Ministry “Utility Policy Manual” shall apply regarding installation of utilities on or near bridges.

1.9 DURABILITY AND MAINTENANCE

1.9.2 Bridge Deck Drainage

1.9.2.1 General

Commentary: *In general the following objectives relate to bridge deck drainage:*

- *Water shall not pond on decks;*
- *Deck drainage inlets should be avoided when possible.*

Deck drainage inlets may be avoided in bridges with the following characteristics, subject to analysis regarding rainfall intensity and volume:

- *Two lanes or less;*
- *Minimum 2% crossfall;*
- *Minimum 1% longitudinal grade;*
- *Less than 120 m in length.*

Runoff water from the surface of bridges and/or approach roads shall be conveyed to discharge at locations that are acceptable to environmental agencies and the Ministry.

When deck inlets are required they shall use air drop discharge unless otherwise directed by environmental agencies. Water may not be discharged onto railway property, pavements, sidewalks or unprotected slopes. Discharge into rivers and creeks require approval by the appropriate environmental regulatory agency.

1.9.2.2 Deck Surface

1.9.2.2.1 Crossfall and Grades

Delete the first paragraph and replace with the following:

Bridge deck drainage of the roadway shall be achieved by providing a minimum 2% transverse crossfall and by providing a desirable longitudinal grade of 2%, except where, for limited lengths, vertical curves or superelevation transitions preclude this. In cases where there is extreme topographical hardship, the absolute minimum longitudinal grade shall be 0.5%.

The last paragraph is deleted and replaced with the following:

All sidewalks, safety curbs, tops of barriers, raised medians, or other deck surfaces that are raised above the roadway, and are wider than 300 mm, shall have a minimum transverse crossfall of 2% to direct surface runoff away from median longitudinal expansion joints. Deck runoff from sidewalks can be directed to the outside of the bridge, subject to approvals from the regulatory environmental agencies.

Commentary: *For long term durability, it is preferable to control all drainage and direct it to deck drains. Directing drainage over the facia can lead to freeze-thaw durability problems in colder climates.*

1.9.2.2.2 Deck Finish

Concrete bridge decks shall be textured by tining in accordance with SS 412.31.04. The tining shall create transverse grooves 3 mm wide by 1.5 mm

to 3 mm deep at 20 mm centre to centre spacing. Concrete bridge decks which receive a waterproof membrane and asphalt topping shall have a smooth float finish. Sidewalks shall receive a transverse broom finish.

1.9.2.3 Drainage System

1.9.2.3.1 General

This clause is amended such that the maximum encroachment on to the traffic lanes shall be limited to 1.2 m. Future settlement shall be considered when locating drains.

1.9.2.3.3 Downspouts and Downpipes

The last sentence in the fourth paragraph is amended as follows:

"Downspouts shall project a minimum of 500 mm below adjacent members…"

Commentary: *Scuppers for lateral drainage may be more effective and practical on flat grades than having drainpipes. Scuppers are easily installed on a slope with the outlets fully embedded in the deck or deck overlay prior to the construction of the concrete parapets.*

The position and length of discharge pipes shall be such that water falling at an angle of 45°to the vertical does not touch any part of the structure.

Catch basins are normally required just beyond the limits of the structure. A continuous length of barrier or curb and gutter shall be provided to connect the bridge curb or barrier to the catch basin to prevent washouts at the ends of the wingwalls.

Drain pipes shall be galvanized and straight to facilitate cleaning.

Commentary: *Support brackets may be required for girders and steel trusses deeper than 2.3 m.*

Typical downspout details are shown in the following figures:

Figure 1.9.2.3.3a

Deck Drain Setting Detail

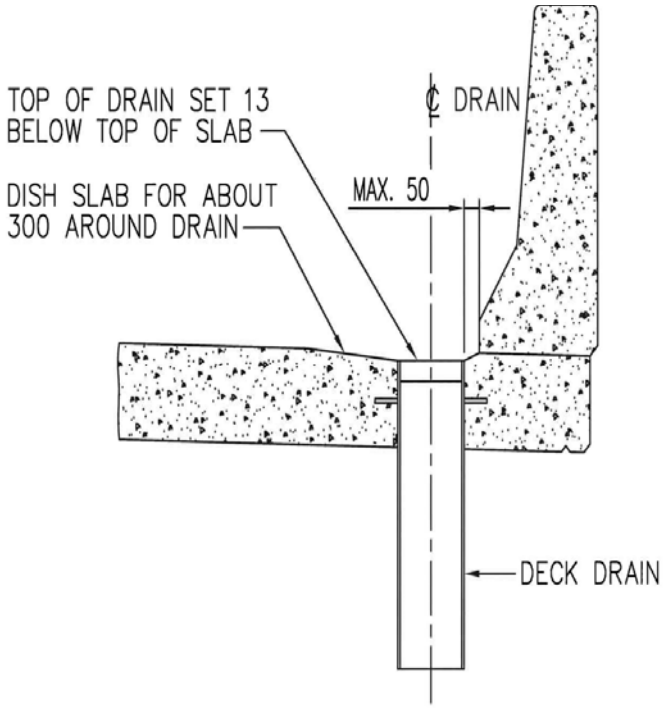
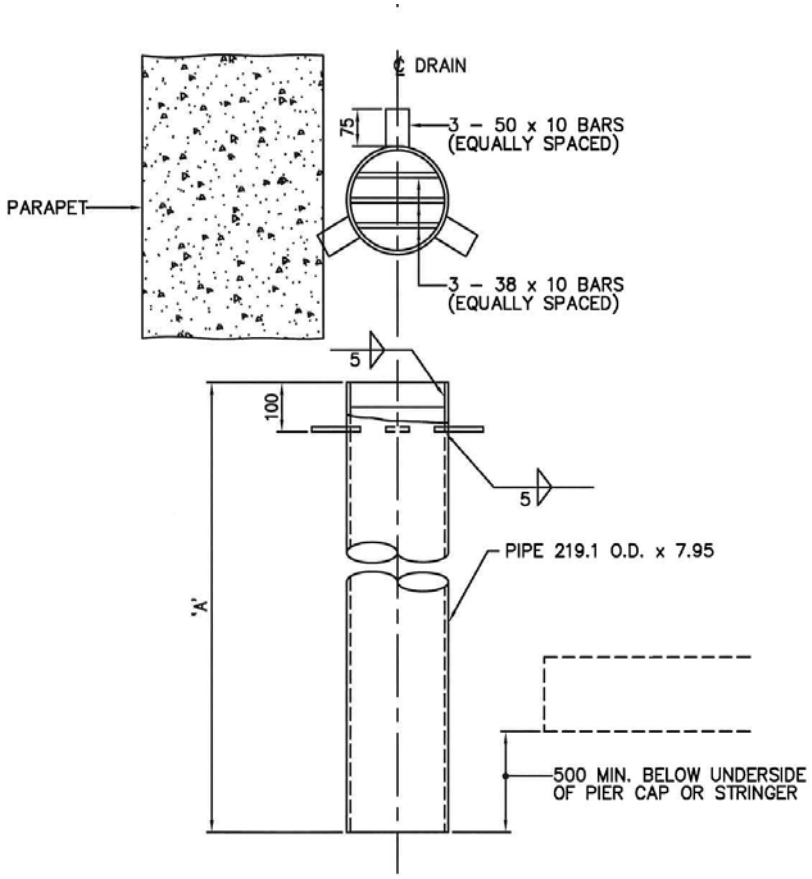


Figure 1.9.2.3.3b

Deck Drain Fabrication Detail



1.9.3 Maintenance Requirements

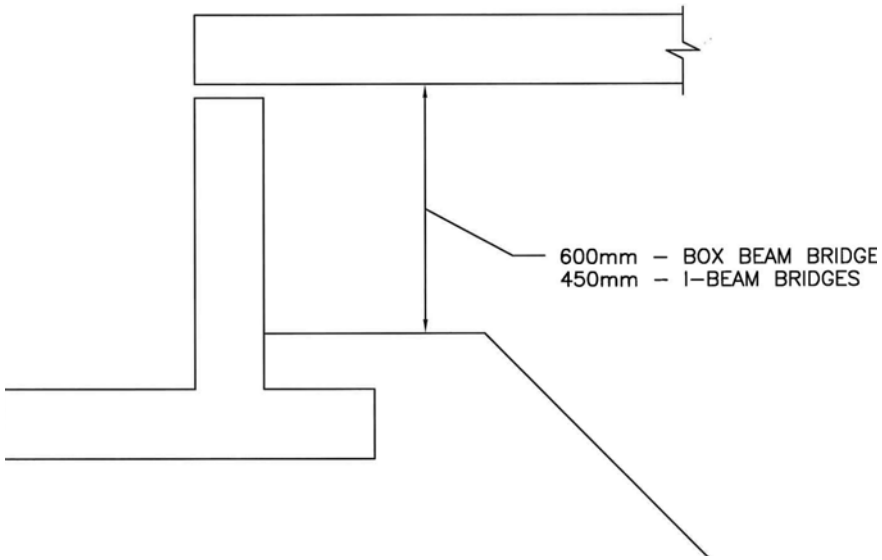
The following minimum clearances shall be maintained between the top of berm in front of the abutment and the underside of the superstructure to facilitate the inspection of bridges:

I-Beam Bridges (Steel or Prestressed Concrete)	450 mm
Box Beam Bridges	600 mm

Reference Clause 8.20.8 for end diaphragm details to facilitate inspection and maintenance.

Figure 1.9.3

Abutment Berm Detail



1.9.3.1.2 Removal of Formwork

All formwork shall be removed.

1.9.3.1.5 Access to Primary Component Voids

Drains shall be screened so that the larger mesh opening dimension does not exceed 15 mm.

1.9.3.3 Bearing Maintenance and Jacking

Sufficient vertical and horizontal space shall be provided between the superstructure and the substructure to accommodate the jacks required for bearing replacement. A minimum vertical clearance of 150 mm is suggested. For steel girders the web stiffeners of the end diaphragm must be located accordingly.

Connections between bearings and sole plates shall be bolted and not welded.

1.10 HYDRAULIC DESIGN

1.10.1 Design Criteria

1.10.1.1 General

Delete and replace the first paragraph with the following:

The hydraulic design of bridges, buried structures, culverts and associated works shall comply with the requirements of the TAC Guide to Bridge Hydraulics, (latest edition).

1.10.1.2 Normal Design Flood

Delete and replace the first paragraph with the following:

The return period for the design flood is as follows:

Bridges	200-year
Buried Structures and Culverts (≥3m Span)	200-year
Low-Volume Road - Bridges/Buried Structures	100-year

Commentary: *Floodplain maps are available for a number of locations throughout the Province and show the areas affected by the 200-year flood. The maps are generally drawn to a scale of 1:5,000 with 1 metre contour intervals and show the natural and man-made features of the area.*

For information on maps and air photos, refer to:

http://wlapwww.gov.bc.ca/wat and click on "Floodplain Mapping", or contact Land Data BC at http://srmwww.gov.bc.ca/bmgs/airphoto/index.html.

Low-volume roads shall be considered as side roads with an average daily traffic ADT (for a period of high use) total in both directions, not exceeding 500 vehicles per day. The service function of low-volume roads is usually oriented towards local rural roads, recreational roads, and resource development roads. Numbered Routes shall not be considered as low-volume roads for hydraulics design purposes.

For additional information, refer to: Guidelines for Design and Construction of Bridges on Low-Volume Roads – by Engineering Branch, Ministry of Transportation.

1.10.1.3 Check Flood

Delete paragraphs since these are not applicable to the Ministry.

1.10.1.5 Design Flood Discharge

Delete and replace the paragraph with the following:

The design floods shall be estimated by the following methods, unless otherwise Approved.

For large drainage areas (>25 km2), the recommended design flow calculation methods are:

- Station Frequency Analysis
- Regional Frequency Analysis

Commentary: *The most commonly used distributions to describe extreme flows are:*

- *Extreme Value Type 1 (Gumbel)*
- *Three Parameter Lognormal*
- *Log Pearson Type 3*

The Ministry generally uses the Log Pearson Type 3 distribution. Annual peak daily and peak instantaneous flows are available from Water Survey of Canada (WSC) gauging stations.

For information on Frequency Analysis, refer to: TAC Guide to Bridge Hydraulics, Section 3.2 (June 2001)

Flow data can be obtained from the Water Survey of Canada website http://www.wsc.ec.gc.ca/index_e.cfm?cname=main_e.cfm . Follow the "Data Products and Services" link.

b) For drainage areas less than 25 km2, design flows can be estimated using the SCS Unit Hydrograph Method.

If the drainage areas approach the upper limits, efforts shall be made to check the results using other methods (e.g. measured flow data, regional frequency analysis, etc.) and confirmed with an on-site inspection of stream channel capacity.

Commentary: *For information on the SCS Method, refer to TAC Guide to Bridge Hydraulics, Section 3.4.3 (June 2001).*

Hydrologic soil groups and soil/land use curve numbers (CN) can be obtained from soil maps available from the Ministry of Environment or from textural classifications provided by geotechnical investigations.

c) For urban and small drainage areas (<10 km^2), the recommended design flow calculation is the Rational Method:

$$Qp = \frac{CiA}{360}$$

Where: Q_p = peak flow, m^3/s

C = runoff coefficient

i = rainfall intensity = P/Tc, mm/hr

P = total precipitation, mm

T_c = time of concentration, hr

A = drainage area in hectares

Commentary: *For information on the Rational Formula Method, refer to the TAC Guide to Bridge Hydraulics, Section 3.4.1 (June 2001).*

In selecting the runoff coefficient (C), the land is considered as developed to the limit of its zoning. For smaller drainage areas, detailed land use information may be available, resulting in a more precise estimate of the runoff coefficients. With larger drainage basins, only general information is usually available, resulting in the need to use conservative assumptions for the runoff coefficients.

The table below from the Manual of Operational Hydrology in BC, Hydrology Section, Ministry of Environment (1991) presents conservative C values for

coastal type drainage basins where the maximum runoff occurs as a result of fall and winter rains.

Table C1.10.1.5
Maximum Runoff Coefficients for Coastal Type Basin

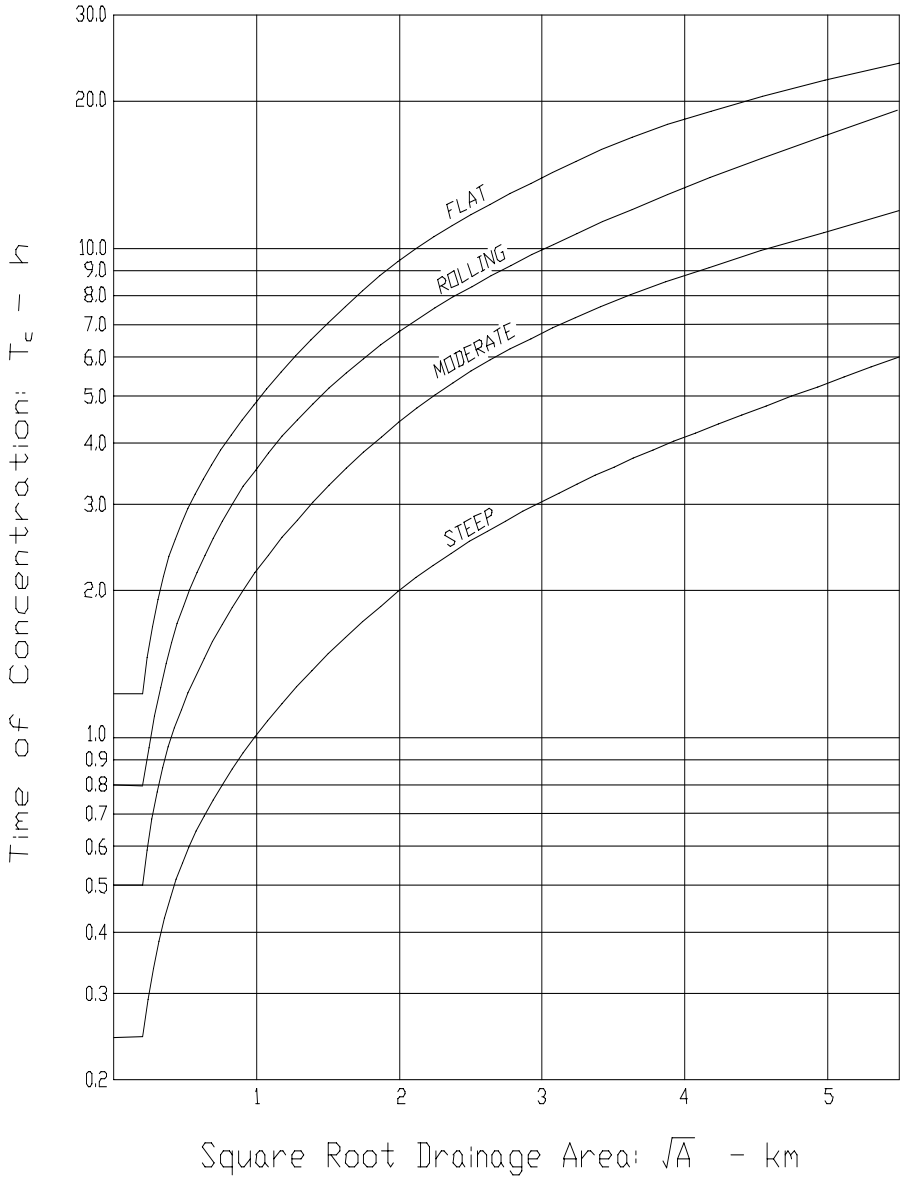
Surface Cover/ Physiography	***Impermeable***	***Forested***	***Agricultural***	***Rural***	***Urban***
Mountain (>30%)	*1.00*	*0.90*			
Steep Slope (20% - 30%)	*0.95*	*0.80*			
Moderate Slope (10% - 20%)	*0.90*	*0.65*	*0.50*	*0.75*	*0.85*
Rolling Terrain (5% - 10%)	*0.85*	*0.50*	*0.40*	*0.65*	*0.80*
Flat (<5%)	*0.80*	*0.40*	*0.30*	*0.55*	*0.75*

The Water Management Method developed by the Ministry of Environment, Hydrology Section, as shown above, is limited to drainage areas of up to 25 km^2. The time of concentration is dependent on the basin characteristics and the following parameters shall be considered:

Flat	*approximately 0% slope*
Rolling	*approximately 1% slope*
Moderate	*approximately 2.5% slope*
Steep	*greater than 10% slope*

For agricultural and rural basins, the curves labeled flat and rolling should be used. For forested watersheds, the curves labeled rolling, moderate and steep should be used.

Figure C1.10.1.5
Time of Concentration



1.10.4.1 Scour Computations

Hec-Ras numerical analysis is approved for the computation of general and local scour based on the D50 and D90 streambed particle sizes.

Commentary: *The sieve analysis is used for determining the streambed particle sizes, where:*

D50 = Bed material particle size in a mixture of which 50% are smaller.

D90 = Bed material particle size in a mixture of which 90% are smaller.

1.10.4.2 Soils Data

If the Hec-Ras numerical analysis is used, the D50 and D90 streambed particle sizes shall be determined.

Commentary: *The sieve analysis is used for determining the streambed particle sizes, where:*

D50 = Bed material particle size in a mixture of which 50% are smaller.

D90 = Bed material particle size in a mixture of which 90% are smaller.

1.10.5.2 Spread Footings

Abutments and piers subject to potential scour shall have piled foundations, unless otherwise Approved.

Commentary: *Use of spread footings for abutments and piers may be considered acceptable on low-volume roads or in other special circumstances, provided a risk review acceptable to the Ministry is carried out to satisfy the use.*

1.10.5.2.2 Protection of Spread Footings

Riprap and MSE walls shall not be considered as an “Approved means” for protecting the bottom of spread footings against scour.

Commentary: *The use of riprap may be considered as an “Approved means” on low- volume road bridges, if Approved.*

1.10.5.5 Protective Aprons

Delete and replace the second paragraph with:

Riprap shall conform to the clauses in Section 205, of the Ministry Standard Specifications for Highway Construction. The gradation of the class of riprap shall be in accordance to Table 205-A of those specifications.

The class of riprap used shall be based on the design chart available in the Ministry BC Supplement to TAC Geometric Design Guide, (2001), Section 1030, Figure 1030A.

Commentary: *Refer to:*

http://www.gov.bc.ca/ and click sequentially on "Ministry and Organizations", "Transportation", "Report and Publications", "Engineering Publications", "Construction Maintenance Publications", and "Standard Specifications for Highway Construction".

http://www.gov.bc.ca/ and click sequentially on "Ministry and Organizations", "Transportation", "Report and Publications", "Engineering Publications", "Traffic, Electrical, Highway Safety and Geometric Standards Section", and "BC Supplement to TAC Geometric Design Guide, 2001 Edition".

1.10.6.1 Backwater - General

Hec-Ras numerical analysis is approved for determining the backwater profile.

1.10.7.1 Soffit Elevation - Clearance

Delete and replace the first paragraph with the following:

Unless otherwise Approved, the clearance between the soffit and the Q200 design flood elevation shall not be less than 1.5 m for bridges; and not less than 0.5 m on low-volume road bridges for the Q100 flood elevation.

Commentary: *Clearances shall be increased for crossings subject to ice flows, debris flows and debris torrents. For waters Transport Canada declares to be navigable, a vertical clearance capable of allowing passage of the largest air draft vessel at the 100-year flood level or the HHWLT (Higher High Water, Large Tide) shall be provided. This allowance also includes a calculation of maximum wave height. For small watercourses capable of carrying only canoes, kayaks and other small craft a clearance of 1.7 m above the 100-year flood level is usually considered to be adequate. For small watercourses less clearance may be considered by Transport Canada if cost and road design factors are affected significantly. Transport Canada, having authority of works over or in Navigable Waters, can require other clearance requirements. Vessel Surveys and studies may also be required to determine clearance requirements and navigable areas and channel(s) within the waterway. Applications and communications with the Transport Canada and Port Authorities shall be coordinated by the Ministry's Rail, Navigable Waters Coordinator.*

For additional information, refer to Volume 2 Procedures and Directions.

1.10.9.3 Channel Erosion Control – Slope Revetment

Riprap shall be used for protecting the bank slopes and bridge end fills of abutments, and shall conform to SS 205. The revetment shall be keyed into the streambed to the estimated total scour depth. The revetment shall be wrapped around the bridge end fills and both ends shall be keyed into the bank slopes.

The riprap design chart is available in the BC Supplement to TAC Geometric Design Guide, Section 1030, Figure 1030A.

Commentary: *Refer to http://www.gov.bc.ca and click sequentially on "Ministry and Organizations", "Transportation", "Report and Publications", "Engineering Publications", "Traffic, Electrical, Highway Safety and Geometric Standards Section", and "BC Supplement to TAC Geometric Design Guide, 2001 Edition".*

1.10.11.2 Culvert End Treatment

Cut-off walls shall be used at both ends of the culvert, unless otherwise Approved.

Commentary: *This will alleviate failure of culverts from uplift and piping during extreme flood events which has occurred at some Ministry sites.*

1.10.11.6.6a Soil-Steel Structures

Cut-off walls are required at both ends for closed-bottom type soil-metal structures. Collar walls are required at both ends for open-bottom type soil-metal structures.