BRITISH COLUMBIA
The Best Place on Earth

Ministry of Transportation   Engineering Branch   **M E M O R A N D U M**

Date 2007-06-29

File:
Cliff:

To: All Manual Holders

Re: *BC Supplement to TAC Geometric Design Guide*, 2007 edition

This manual (in a red three ring binder) replaces the 2001 edition of the *BC Supplement to TAC Geometric Design Guide* (blue binder). Refer to the list on page 2 which outlines the most significant updated material.

Designers are advised to read the Preface of the manual which explains the policy of the BC Ministry of Transportation in using the 2007 edition of the *BC Supplement to TAC Geometric Design Guide* to produce designs for roads under the Ministry's jurisdiction.

The holder of the manual should visit the Internet site of the BC Ministry of Transportation on a regular basis, and particularly at the start of a design assignment, to verify that his/her manual is up-to-date.

For any questions or comments on the content of the *BC Supplement to TAC Geometric Design Guide*, contact the following persons:

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Their have been revisions throughout the 2007 edition; however, some of the most noteworthy updated material includes:

Chapter 300 Alignment:
- new section on increasing the minimum horizontal radius on steep downgrades
- incorporation of Technical Bulletins

Chapter 400 Cross Section:
- new cut and fill slopes in accordance with Clear Zone
- 1.8 m wide sidewalks

Chapter 500 Low-volume Roads:
- re-issue of material dated August 1995

Chapter 600 Safety Elements:
- updated the roadside barrier index figure to show e and f values for max. 6% S.E.
- new section on Roadside Safety
- updated material and drawings on flares for roadside barriers
- incorporation of Technical Bulletins on rumble strips
- new section on fencing for pedestrians and cyclists

Chapter 700 Intersections & Accesses:
- protected left turn intersection added
- new drawing for a collector intersection with a raised median
- new section on the design of accesses to private property
- new section on roundabouts

Chapter 900 Auxiliary Facilities:

Incorporation of Technical Bulletins on
- Slow Moving Vehicle Pullout
- Truck Climbing Lane Warrants and Design
- Passing Lane Warrants and Design

Chapter 1000 Hydraulics:
- revised culvert diameter that defines a structure
- revised language on detention storage
- revised cover requirements
- new durability discussion

Chapter 1100 Railway Crossings and Utilities:
- revised level railway crossing construction application requirements
- revised pedestrian crossing requirements
- revised sightline (clear view triangle) requirements

Chapter 1200 Contracts and Drawings:
- new section on Issuing of Drawings for Tender
- revised section on Property Acquisition Plans (Right-of-Way drawings)

Chapter 1500 Alpine Ski Village Roads:
- new section

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Ministry of Transportation

BC Supplement to TAC Geometric Design Guide 2007 Edition

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PREFACE

The **BRITISH COLUMBIA SUPPLEMENT TO TAC GEOMETRIC DESIGN GUIDE** serves many purposes:

- It provides the designer with specific information and instructions related to the production of Contract Documents and Drawings for the tendering of Construction Projects;
- It provides, in one location, certain operational and procedural instructions pertaining to established BC Ministry of Transportation's (BC MoT) process for highway design projects.
- It summarizes geometric design elements as well as other non-geometric standards that are relevant to the designer, complementary to the TAC Guide, and specific to BC MoT projects. Most of the non-geometric standards are matters of policy while most geometric design elements are governed by basic rules of physics.

The **BRITISH COLUMBIA SUPPLEMENT TO TAC GEOMETRIC DESIGN GUIDE** explains the preferred recommended practice for use on BC MoT projects. The latest edition of the **Transportation Association of Canada's "Geometric Design Guide for Canadian Roads" (or TAC Guide)** is the principal source for basic design principles. The AASHTO publication "A Policy on Geometric Design of Highways and Streets" is also recommended as a secondary reference.

The Guidelines contained in the BC Supplement are not meant to be universally applicable. The dimensions shown are either "typical values" (i.e. those which are most commonly used) or "limiting values", specifically stated as recommended minimum or maximum. The "limiting values" are the limits within which a design will lead to the construction of a safe and economical highway. The designer should also note that the BC Supplement recommends certain values or practices to ensure consistency of design on the Provincial Highway system and to achieve life cycle economies.

The application of geometric elements should be carefully considered within the context of the goals of the project. In the absence of other specific Ministry policy, the geometric elements provided in this Manual are applicable to all Highway Designs, tempered by engineering judgement. The Ministry Executive has recently endorsed "**Corridor Ambient Geometric Design Elements Guidelines Policy**" (See TAB 13). Highway Projects that fall under this Policy are not constrained to the geometric elements within this Manual or the TAC Guide; however, the designer should still consider these two manuals as references for geometric design. *For all projects, including those governed by the Ambient Corridor Policy, Ministry operational instructions, process and Contract Drawing preparation is still governed by the applicable sections of this Manual*.

Highway Designers are urged to use the **BC Supplement and the TAC Guide** in a manner that will not stifle their technical judgement and creativity, particularly with regard to staying away from the "limiting values". The designer should evaluate the safety risks of using several limiting values for a combination of design elements at any one location. Higher values are more appropriate where the incremental life cycle benefits in terms of safety, aesthetics, operational efficiency and flexibility in future upgrading, would offset any present increase in construction costs. It is often preferable to use higher values for those design parameters that govern alignment, as modification at a later stage is more costly. Lower values may be appropriate, where safety and operational efficiencies are not adversely affected; yet construction costs can be decreased. This is particularly relevant on rehabilitation or local improvement projects, when the decreased geometric elements are consistent with present geometric elements and the driving experience.

Manual Format:

The BC Supplement is a compilation of BC MoT recommended design practices and instructions to be used for Ministry projects. These are issued in the form of Technical Documents each one deals with a specific subject and is cross-referenced to the TAC Guide for background information.

The BC Supplement is not meant as a complete design guide but as a complement to the TAC Guide.

The **BRITISH COLUMBIA SUPPLEMENT TO TAC GEOMETRIC DESIGN GUIDE (or BC Supplement)** should be used concurrently with the **TAC GEOMETRIC DESIGN GUIDE FOR CANADIAN ROADS (or TAC Guide)** as the main references on all BC MoT design work.

Updates to the BC Supplement are effective immediately for all MoT projects that have not yet reached pre-tender meeting stage. Any case for exception must be justified in writing using primarily the design principles contained in the TAC Guide (or alternatively the AASHTO Guide) and approved by the Ministry Design representative on the project.

Ministry Publication Policy:

The following Contact is provided for ordering copies of the most current BC Supplement. **It is the responsibility of the Manual Holder to acquire updates and to maintain the currentness of the BC Supplement:**

Queen's Printer Online Publications
ID Stock Number is **7610003312**

Web Page address is: www.publications.gov.bc.ca

An electronic version of the BC Supplement is available from the Ministry of Transportation Web Page. There is no charge for the electronic version. Updates will also be available from this site.

Web Page address is: http://www.th.gov.bc.ca/publications/eng_publications/geomet/TAC/TAC.htm

The TAC Geometric Design Guide for Canadian Roads must be purchased directly from the Transportation Association of Canada in Ottawa.

Web Page address is: http://www.tac-atc.ca/

Technical Advice:

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500 LOW-VOLUME ROADS CHAPTER

600 SAFETY ELEMENTS CHAPTER

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1100 RAILWAY CROSSINGS & UTILITIES CHAPTER

1200 CONTRACTS and DRAWINGS CHAPTER

1300 GEOMETRIC IMPROVEMENTS CHAPTER

1400 SUBDIVISION ROADS CHAPTER

1500 ALPINE SKI VILLAGE ROADS CHAPTER

GLOSSARY

110.01 ENVIRONMENTAL AGENCIES

Environmental agency contact shall be as stated on the Agency Listing. A copy of the current list is available from:

Highway Engineering
Environmental Management Section
Ministry of Transportation and Highways
4-B 940 Blanshard Street
PO Box 9850 Stn Prov Govt
Victoria BC V8W 9T5

Telephone: (250) 387-7557

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300 ALIGNMENT CHAPTER

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330
HORIZONTAL AND VERTICAL ALIGNMENT

330.01 Circular Curves

BC adopts and concurs with the engineering principles and discussion throughout Section 2.1.2.1 of TAC. However, we wish to supplement the Tables provided with MoT specific procedures and recommended guidelines.

Maximum Superelevation

Rural Areas: Design Domain

As stated in TAC, 0.06 m/m is the preferred maximum superelevation. The following guidelines indicate the MoT recommendations in the selection of Design e_{max} values.

- Rural Ambient Designs — Match existing e_{max}
- All other Rural Roads — 0.06 m/m

.

Where a Rural Ambient Project is reconstructing a significant length of highway, the designer should consider using 0.06 m/m as maximum superelevation.

Minimum Radius

Urban Areas: Design Domain

As per TAC discussion, p 2.1.2.4

Minimum Radius

Rural Areas: Design Domain

The following table is provided for Minimum Radii for Rural Design. This is a supplement to TAC Table 2.1.2.4

Table 330.A Minimum Radii for Rural Designs

Design Speed (km/h)	Minimum Radius (m)				
	Crown Section			Superelevated Section	
	Normal[2] (-0.02 m/m)	Reverse[3] (0.02 m/m)		Maximum Rate[1]	
		emax +0.06	emax + 0.08	+0.06 m/m	+0.08 m/m
40	700	475	525	55	50
50	1100	745	820	90	80
60	1600	1080	1190	130	120
70	2150	1470	1615	190	170
80	2800	1950	2120	250	230
90	3550	2470	2700	340	300
100	4380	3070	3350	440	390
110	5300	3780	4100	600	530
120	6300	4535	4920	750	670

Notes	1.	On downgrades in excess of 3%, the minimum horizontal radius should be increased. The method to calculate the increase is described on the following page.
	2.	To determine the minimum radius for normal crown, the (e+f) value is set at 0.018 in TAC Eqn 2.1.1: $e+f = V^2/127R$.
	3.	The minimum radius reverse crown is solved by re-arranging the basic equation for superelevation (TAC Eqn. 2.1.1) and solving for R when e = +0.02. Superelevation distribution is non-linear, resulting in different minimum radius values at Reverse Crown for e_{max} 0.06 and e_{max} 0.08. The method of distributing “e” and “f” is described in more detail on the following page.
	4.	All values are based on Max. Lateral Friction values from TAC Table 2.1.2.1

Minimum Radius on Downgrades

The minimum horizontal radius should be increased on steep downgrades to enhance road safety.

The minimum curve radius should be increased by 10% for each 1% increase in grade over 3%.

$R_{g\ (min)} = R_{(min)}$ (1+ (G-3)/10)

Where:

$R_{(min)}$ = minimum radii from Table 330.A
G = grade (%)
$R_{g\ (min)}$ = minimum radius on grade (m)

Example: Design Speed = 100 km/h; e=0.06; G=6%
$R_{(min)}$ = 440 m from Table 330.A.

$R_{g\ (min)}$ = 440(1+(6-3)/10) = 572 m or
570 m (rounded)

[Note: Rounding should be to the nearest 10 m increment.]

The applied superelevation rate shall be selected from the appropriate table of superelevations (**Table 330.D or 330.E)** for the adjusted value of $R_{g\ (min)}$.

Rural and High Speed Urban Design – Superelevation Distribution:

The general formula for the relationship of speed, radius, superelevation and friction is given by **TAC Equation 2.1.1** as: e+f = V^2/127R

For rural and high speed urban roadways the method used for distributing e and f is referred to as "Method 5" in the AASHTO publication. The formula for calculating *e* is as follows:

For any radius R :

$$e = \frac{V^2}{127R + V^2\left[\frac{1}{e_{max}} - \frac{1}{(e+f)_{max}}\right]} \qquad \textbf{330.01.01}$$

Where e_{max} is 0.06 or 0.08 and $(e+f)_{max}$ is e_{max} plus f_{max} which is taken from TAC Table 2.1.2.1
For clarity, let's call the bracketed part of the denominator 'z'

$$e = \frac{V^2}{127R + V^2 z} \qquad \textbf{330.01.02}$$

The 'z' value is a function of design speed and maximum superelevation. It is a constant for each design speed and maximum superelevation as shown in the following table.

The designer can now calculate the superelevation for any radius that may be desired.

Table 330.B Superelevation Calculation Factors

Speed (km/h)	"z" for Max Super of: 0.06 m/m	0.08 m/m
40	12.319	8.500
50	12.121	8.333
60	11.905	8.152
70	11.905	8.152
80	11.667	7.955
90	11.404	7.738
100	11.111	7.500
110	10.417	6.944
120	10.000	6.618
130	9.524	6.250

The resultant friction *f* is solved as V^2/127R minus the solved *e* from **Equation 330.01.02**. The friction can be used as the entry point into the Barrier Warrant Index Nomograph, **Figure 610.A.**

The TAC Tables 2.1.2.6 and 2.1.2.7 have an insufficient number of design radii that are often necessary to deal with the challenges of horizontal alignment in British Columbia.

In order to facilitate design, MoT has developed superelevation tables that cover a greater number of design radii. On the following pages are two tables:
Table 330.D for e_{max} = 0.06 m/m and
Table 330.E for e_{max} = 0.08 m/m.

These tables also indicate design values for Spiral Lengths (see Section 330.02) and Tangent Runout.

Table 330.D Superelevation and Spiral Lengths, e_{max} = 0.06 m/m

	40 km/h				50 km/h				60 km/h			
Rad.	e	L2	L4	L6	e	L2	L4	L6	e	L2	L4	L6
8000	NC				NC				NC			
5000	NC				NC				NC			
3000	NC				NC				NC			
2000	NC				NC				NC			
1500	NC				NC				RC	40	40	40
1300	NC				NC				RC	40	40	40
1250	NC				NC				RC	40	40	40
1200	NC				NC				RC	40	40	40
1150	NC				NC				RC	40	40	40
1100	NC				NC				RC	40	40	40
1050	NC				RC	30	30	30	0.020	40	40	40
1000	NC				RC	30	30	30	0.021	40	40	40
950	NC				RC	30	30	30	0.022	40	40	40
900	NC				RC	30	30	30	0.023	40	40	40
850	NC				RC	30	30	30	0.024	40	40	40
800	NC				RC	30	30	30	0.025	40	40	40
750	NC				RC	30	30	30	0.026	40	40	40
700	NC				0.021	30	30	30	0.027	40	40	40
650	RC	30	30	30	0.022	30	30	30	0.029	40	40	40
600	RC	30	30	30	0.023	30	30	30	0.030	40	40	40
550	RC	30	30	30	0.025	30	30	30	0.032	40	40	40
500	RC	30	30	30	0.027	30	30	30	0.034	40	40	40
475	0.020	30	30	30	0.028	30	30	30	0.035	40	40	40
450	0.021	30	30	30	0.029	30	30	30	0.036	40	40	50
425	0.022	30	30	30	0.030	30	30	30	0.037	40	40	50
400	0.023	30	30	30	0.031	30	30	40	0.038	40	40	50
380	0.024	30	30	30	0.032	30	30	40	0.039	40	40	50
360	0.025	30	30	30	0.033	30	30	40	0.041	40	40	50
340	0.026	30	30	30	0.034	30	30	40	0.042	40	40	50
320	0.027	30	30	30	0.035	30	30	40	0.043	40	40	50
300	0.028	30	30	30	0.037	30	30	40	0.044	40	40	60
290	0.028	30	30	30	0.037	30	30	40	0.045	40	40	60
280	0.029	30	30	30	0.038	30	30	50	0.046	40	40	60
270	0.030	30	30	30	0.039	30	40	50	0.047	40	40	60
260	0.030	30	30	30	0.040	30	40	50	0.047	40	50	60
250	0.031	30	30	40	0.040	30	40	50	0.048	40	50	60
240	0.032	30	30	40	0.041	30	40	50	0.049	40	50	60
230	0.033	30	30	40	0.042	30	40	50	0.050	40	50	60
220	0.034	30	30	40	0.043	30	40	50	0.051	40	50	60
210	0.035	30	30	40	0.044	30	40	50	0.052	40	50	60
200	0.036	30	30	40	0.045	30	40	50	0.053	40	50	70
190	0.037	30	30	40	0.046	30	40	50	0.054	40	50	70
180	0.038	30	30	40	0.047	30	40	60	0.055	50	50	70
170	0.039	30	30	40	0.048	30	40	60	0.056	50	50	70
160	0.040	30	30	40	0.049	30	40	60	0.057	50	50	70
150	0.041	30	30	50	0.051	30	50	60	0.058	50	60	70
145	0.042	30	40	50	0.051	30	50	60	0.059	60	60	70
140	0.043	30	40	50	0.052	30	50	60	0.059	60	60	70
135	0.044	30	40	50	0.053	40	50	60	0.060	60	60	70
130	0.044	30	40	50	0.054	40	50	60	0.060	60	60	70
125	0.045	30	40	50	0.054	40	50	60	min R = 130			
120	0.046	30	40	50	0.055	40	50	60				
115	0.047	30	40	50	0.056	40	50	60				
110	0.048	30	40	50	0.057	40	50	70				
105	0.049	30	40	50	0.057	50	50	70				
100	0.050	30	40	50	0.058	50	50	70				
95	0.051	30	40	60	0.059	50	50	70				
90	0.052	30	40	60	0.060	50	50	70				
85	0.053	30	40	60	min R = 90							
80	0.054	30	40	60								
75	0.055	30	50	60								
70	0.056	40	50	60								
65	0.058	40	50	60								
60	0.059	40	50	60								
55	0.060	40	50	70								
	min R = 55											

	70 km/h				80 km/h				90 km/h			
Rad.	e	L2	L4	L6	e	L2	L4	L6	e	L2	L4	L6
8000	NC				NC				NC			
5000	NC				NC				NC			
3000	NC				NC				RC	50	50	50
2000	RC	40	40	40	RC	50	50	50	0.023	50	50	50
1500	RC	40	40	40	0.024	50	50	50	0.029	50	50	50
1300	0.022	40	40	40	0.027	50	50	50	0.031	50	50	50
1250	0.023	40	40	40	0.027	50	50	50	0.032	50	50	50
1200	0.023	40	40	40	0.028	50	50	50	0.033	50	50	50
1150	0.024	40	40	40	0.029	50	50	50	0.034	50	50	50
1100	0.025	40	40	40	0.030	50	50	50	0.035	50	50	60
1050	0.026	40	40	40	0.031	50	50	50	0.036	50	50	60
1000	0.027	40	40	40	0.032	50	50	50	0.037	50	50	60
950	0.027	40	40	40	0.033	50	50	50	0.038	50	50	60
900	0.028	40	40	40	0.034	50	50	50	0.039	50	50	60
850	0.030	40	40	40	0.035	50	50	50	0.040	50	50	60
800	0.031	40	40	40	0.036	50	50	60	0.042	50	50	70
750	0.032	40	40	40	0.038	50	50	60	0.043	50	50	70
700	0.033	40	40	50	0.039	50	50	60	0.045	50	50	70
650	0.035	40	40	50	0.041	50	50	60	0.046	50	60	70
600	0.037	40	40	50	0.042	50	50	60	0.048	50	60	80
550	0.038	40	40	50	0.044	50	50	70	0.050	50	60	80
500	0.040	40	40	60	0.046	50	50	70	0.052	60	60	80
475	0.041	40	40	60	0.047	50	50	70	0.053	60	60	80
450	0.043	40	40	60	0.049	50	60	70	0.054	60	60	80
425	0.044	40	50	60	0.050	50	60	70	0.055	60	70	90
400	0.045	40	50	60	0.051	50	60	80	0.057	70	70	90
380	0.046	40	50	60	0.052	50	60	80	0.058	70	70	90
360	0.047	40	50	60	0.053	50	60	80	0.059	80	80	90
340	0.048	40	50	70	0.054	60	60	80	0.060	80	80	90
320	0.050	40	50	70	0.056	60	60	80	min R = 340			
300	0.051	40	50	70	0.057	60	60	80				
290	0.052	50	50	70	0.057	70	70	90				
280	0.052	50	50	70	0.058	70	70	90				
270	0.053	50	60	70	0.059	70	70	90				
260	0.054	50	60	70	0.059	70	70	90				
250	0.055	50	60	70	0.060	80	80	90				
240	0.055	50	60	80	min R = 250							
230	0.056	60	60	80								
220	0.057	60	60	80								
210	0.058	60	60	80								
200	0.059	60	60	80								
190	0.060	70	70	80								
180	min R = 190											

	100 km/h				110 km/h				120 km/h				
Rad.	e	L2	L4	L6	e	L2	L4	L6	e	L2	L4	L6	Rad.
8000	NC				NC				NC				8000
5000	NC				RC	60	60	60	RC	70	70	70	5000
3000	0.020	60	60	60	0.024	60	60	60	0.027	70	70	70	3000
2000	0.027	60	60	60	0.032	60	60	60	0.036	70	70	70	2000
1500	0.033	60	60	60	0.038	60	60	70	0.043	70	70	80	1500
1300	0.036	60	60	60	0.042	60	60	70	0.047	70	70	90	1300
1250	0.037	60	60	60	0.042	60	60	80	0.048	70	70	90	1250
1200	0.038	60	60	60	0.043	60	60	80	0.049	70	70	90	1200
1150	0.039	60	60	70	0.044	60	60	80	0.050	70	70	90	1150
1100	0.040	60	60	70	0.046	60	60	80	0.051	70	70	90	1100
1050	0.041	60	60	70	0.047	60	60	80	0.052	70	70	100	1050
1000	0.042	60	60	70	0.048	60	60	80	0.053	70	70	100	1000
950	0.043	60	60	70	0.049	60	70	90	0.054	70	80	100	950
900	0.044	60	60	70	0.050	60	70	90	0.056	70	80	100	900
850	0.046	60	60	80	0.052	60	70	90	0.057	80	80	110	850
800	0.047	60	60	80	0.053	60	70	90	0.059	80	80	110	800
750	0.048	60	60	80	0.055	70	70	100	0.060	80	80	110	
700	0.050	60	60	80	0.056	70	80	100	min R = 760				
650	0.052	60	60	90	0.058	80	80	100					
600	0.053	60	70	90	0.060	80	80	110					
550	0.055	70	70	90	min R = 600								
500	0.057	70	70	90									
475	0.058	80	80	100									
450	0.059	80	80	100									
425	0.060	80	80	100									
400	min R = 440												

e Max 0.06 m/m

e Superelevation

NC Normal Crown Section

RC Remove adverse crown and superelevate at 0.02 m/m

L2 MINIMUM spiral for two lanes and ramps

L4 MINIMUM spiral for three lanes and for four lanes with up to 3.0 m median

L6 MINIMUM spiral for six lanes with up to 3.0 m median

Tangent Runout:

Normally established as 15 times the number of lanes. I.E. 30 m for two lanes; 60 m for four lanes and 90 metres for six lanes.

Use the following method - superelevation runout - where grade and pavement width may result in an otherwise poor drainage design:

1. Tangent runout for 2-lane, 4-lane and 6-lane is 0.02/e times L2, L4 or L6 respectively; where e is the design superelevation for the radius in question.

2. Using the above method, the tangent runout must still fall within the following ranges:

   L2: Runout between 20 and 30 metres
   L4: Runout between 30 and 60 metres
   L6: Runout between 40 and 90 metres

Note: Refer to section 330.01 - **Minimum Radius on Downgrades.**

Table 330.E Superelevation and Minimum Spiral Lengths, e_{max} = 0.08 m/m

	40 km/h				50 km/h				60 km/h				70 km/h				80 km/h			
Rad.	e	L2	L4	L6	e	L2	L4	L6	e	L2	L4	L6	e	L2	L4	L6	e	L2	L4	L6
8000	NC				NC				NC				NC				NC			
5000	NC				NC				NC				NC				NC			
3000	NC				NC				NC				NC				NC			
2000	NC				NC				NC				RC	40	40	40	0.021	50	50	50
1500	NC				NC				RC	40	40	40	0.021	40	40	40	0.027	50	50	50
1300	NC				NC				RC	40	40	40	0.024	40	40	40	0.030	50	50	50
1250	NC				NC				RC	40	40	40	0.025	40	40	40	0.031	50	50	50
1200	NC				NC				RC	40	40	40	0.026	40	40	40	0.031	50	50	50
1150	NC				NC				0.021	40	40	40	0.026	40	40	40	0.032	50	50	50
1100	NC				NC				0.021	40	40	40	0.027	40	40	40	0.034	50	50	50
1050	NC				RC	30	30	30	0.022	40	40	40	0.028	40	40	40	0.035	50	50	50
1000	NC				RC	30	30	30	0.023	40	40	40	0.029	40	40	40	0.036	50	50	50
950	NC				RC	30	30	30	0.024	40	40	40	0.031	40	40	40	0.037	50	50	60
900	NC				RC	30	30	30	0.025	40	40	40	0.032	40	40	40	0.039	50	50	60
850	NC				RC	30	30	30	0.026	40	40	40	0.033	40	40	50	0.040	50	50	60
800	NC				0.020	30	30	30	0.027	40	40	40	0.035	40	40	50	0.042	50	50	60
750	NC				0.022	30	30	30	0.029	40	40	40	0.036	40	40	50	0.044	50	50	70
700	NC				0.023	30	30	30	0.030	40	40	40	0.038	40	40	50	0.046	50	50	70
650	RC	30	30	30	0.024	30	30	30	0.032	40	40	40	0.040	40	40	60	0.048	50	50	70
600	RC	30	30	30	0.026	30	30	30	0.034	40	40	40	0.042	40	40	60	0.050	50	60	80
550	RC	30	30	30	0.028	30	30	30	0.036	40	40	50	0.045	40	50	60	0.053	50	60	80
500	0.021	30	30	30	0.030	30	30	40	0.039	40	40	50	0.048	40	50	70	0.056	50	60	80
475	0.022	30	30	30	0.031	30	30	40	0.040	40	40	50	0.049	40	50	70	0.058	50	70	90
450	0.023	30	30	30	0.032	30	30	40	0.042	40	40	50	0.051	40	50	70	0.059	50	70	90
425	0.023	30	30	30	0.033	30	30	40	0.042	40	40	50	0.051	40	50	70	0.060	50	70	90
400	0.025	30	30	30	0.035	30	30	40	0.045	40	40	60	0.054	40	60	70	0.063	50	70	90
380	0.026	30	30	30	0.036	30	30	40	0.046	40	40	60	0.056	40	60	80	0.065	50	70	100
360	0.027	30	30	30	0.038	30	30	40	0.048	40	50	60	0.057	40	60	80	0.066	50	70	100
340	0.028	30	30	30	0.039	30	40	50	0.050	40	50	60	0.059	40	60	80	0.068	60	80	100
320	0.030	30	30	30	0.041	30	40	50	0.051	40	50	60	0.061	40	60	80	0.070	60	80	100
300	0.031	30	30	30	0.042	30	40	50	0.053	40	50	70	0.063	40	60	90	0.072	60	80	110
290	0.032	30	30	40	0.043	30	40	50	0.054	40	50	70	0.064	50	70	90	0.073	70	80	110
280	0.033	30	30	40	0.044	30	40	50	0.055	40	50	70	0.065	50	70	90	0.074	70	80	110
270	0.034	30	30	40	0.045	30	40	50	0.056	40	50	70	0.066	50	70	90	0.075	70	80	110
260	0.034	30	30	40	0.046	30	40	50	0.058	40	50	70	0.068	50	70	90	0.076	70	90	110
250	0.035	30	30	40	0.048	30	40	60	0.059	40	60	70	0.069	50	70	90	0.077	80	90	110
240	0.036	30	30	40	0.049	30	40	60	0.060	40	60	80	0.070	50	70	90	0.079	80	90	120
230	0.037	30	30	40	0.050	30	40	60	0.061	40	60	80	0.071	60	70	100	0.080	80	90	120
220	0.039	30	30	40	0.051	30	50	60	0.063	40	60	80	0.073	60	70	100	min R = 230			
210	0.040	30	30	40	0.053	30	50	60	0.064	40	60	80	0.074	60	80	100				
200	0.041	30	30	50	0.054	30	50	60	0.066	40	60	80	0.075	60	80	100				
190	0.043	30	40	50	0.056	30	50	60	0.067	40	60	80	0.077	70	80	100				
180	0.044	30	40	50	0.057	30	50	70	0.069	50	60	90	0.078	70	80	110				
170	0.046	30	40	50	0.059	40	50	70	0.070	50	70	90	0.080	80	80	110				
160	0.047	30	40	50	0.061	40	50	70	0.072	50	70	90	min R = 170							
150	0.049	30	40	50	0.063	40	60	70	0.074	50	70	90								
145	0.050	30	40	50	0.064	40	60	70	0.075	60	70	90								
140	0.051	30	40	60	0.065	40	60	70	0.076	60	70	90								
135	0.052	30	40	60	0.066	40	60	80	0.077	60	70	100								
130	0.053	30	40	60	0.067	40	60	80	0.078	60	70	100								
125	0.055	30	50	60	0.068	40	60	80	0.079	60	70	100								
120	0.056	30	50	60	0.069	40	60	80	0.080	70	80	100								
115	0.057	30	50	60	0.071	40	60	80	min R = 120											
110	0.058	30	50	60	0.072	40	60	80												
105	0.060	30	50	60	0.073	50	60	80												
100	0.061	30	50	70	0.075	50	70	90												
95	0.063	40	50	70	0.076	50	70	90												
90	0.064	40	50	70	0.078	50	70	90												
85	0.066	40	50	70	0.079	60	70	90												
80	0.068	40	60	70	0.080	60	70	90												
75	0.070	40	60	70	min R = 80															
70	0.072	40	60	80																
65	0.074	40	60	80																
60	0.076	40	60	80																
55	0.078	40	60	80																
50	0.080	50	70	90																
	min R = 50																			

	90 km/h				100 km/h				110 km/h				120 km/h				
Rad.	e	L2	L4	L6	e	L2	L4	L6	e	L2	L4	L6	e	L2	L4	L6	Rad.
8000	NC				NC				NC				NC				8000
5000	NC				NC				RC	60	60	60	RC	70	70	70	5000
3000	RC	50	50	50	0.022	60	60	60	0.026	60	60	60	0.030	70	70	70	3000
2000	0.026	50	50	50	0.030	60	60	60	0.036	60	60	60	0.041	70	70	80	2000
1500	0.032	50	50	50	0.038	60	60	60	0.044	60	60	80	0.050	70	70	90	1500
1300	0.036	50	50	60	0.042	60	60	70	0.049	60	70	90	0.055	70	80	100	1300
1250	0.037	50	50	60	0.043	60	60	70	0.050	60	70	90	0.057	70	80	110	1250
1200	0.038	50	50	60	0.044	60	60	70	0.051	60	70	90	0.058	70	80	110	1200
1150	0.039	50	50	60	0.045	60	60	80	0.053	60	70	90	0.060	70	80	110	1150
1100	0.040	50	50	60	0.047	60	60	80	0.054	60	70	100	0.061	70	90	110	1100
1050	0.041	50	50	60	0.048	60	60	80	0.056	60	70	100	0.063	70	90	120	1050
1000	0.043	50	50	70	0.050	60	60	80	0.057	60	80	100	0.065	70	90	120	1000
950	0.044	50	50	70	0.051	60	60	80	0.059	60	80	100	0.067	70	90	120	950
900	0.046	50	50	70	0.053	60	70	90	0.061	60	80	110	0.069	70	100	130	900
850	0.047	50	60	70	0.055	60	70	90	0.063	60	80	110	0.071	80	100	130	850
800	0.049	50	60	80	0.057	60	70	90	0.065	60	90	110	0.073	80	100	130	800
750	0.051	50	60	80	0.059	60	70	100	0.067	70	90	120	0.076	90	110	140	750
700	0.053	50	60	80	0.061	60	80	100	0.070	70	90	120	0.078	90	110	140	700
650	0.056	50	70	90	0.063	60	80	100	0.073	80	100	130	0.080	100	110	150	650
600	0.058	50	70	90	0.066	60	80	110	0.076	80	100	130	min R = 670				
550	0.061	50	70	90	0.069	70	90	110	0.079	90	100	140					
500	0.064	60	80	100	0.072	70	90	120	0.080	100	110	140					
475	0.066	60	80	100	0.074	80	90	120	min R = 530								
450	0.068	60	80	100	0.076	80	90	120									
425	0.068	60	80	110	0.076	80	90	130									
400	0.071	70	80	110	0.079	90	100	130									
380	0.073	70	90	110	0.080	100	100	130									
360	0.075	80	90	120	min R = 390												
340	0.077	80	90	120													
320	0.078	80	90	120													
300	0.080	90	90	120													
290	min R = 300																

e Max 0.08 m/m

e Superelevation

NC Normal Crown Section

RC Remove adverse crown and superelevate at 0.02 m/m

L2 MINIMUM spiral for two lanes and ramps

L4 MINIMUM spiral for three lanes and for four lanes with up to 3.0 m median

L6 MINIMUM spiral for six lanes with up to 3.0 m median

Tangent Runout:

Normally established as 15 times the number of lanes. I.E. 30 m for two lanes; 60 m for four lanes and 90 metres for six lanes.

Use the following method - superelevation runout - where grade and pavement width may result in an otherwise poor drainage design:

1. Tangent runout for 2-lane, 4-lane and 6-lane is 0.02/e times L2, L4 or L6 respectively; where e is the design superelevation for the radius in question.
2. Using the above method, the tangent runout must fall within the following ranges:

   L2: Runout between 20 and 30 metres
   L4: Runout between 30 and 60 metres
   L6: Runout between 40 and 90 metres

Notes:

1. Table 330.E is only used in special cases such as:
   a. On ramps with tight radii where truck overturning is a concern;
   b. For rehabilitation or reconstruction projects on existing highways for which the MoT's approved ambient design element on the Design Criteria Sheet is 8% maximum superelevation.
2. Refer to section 330.01 - **Minimum Radius on Downgrades**.

330.02 Spiral Curves

BC uses ***Spiral Length*** as opposed to Spiral Parameter; as shown on **Table 330.D** and **Table 330.E**. The lengths are based upon the same rationale as used in TAC; the formulae are converted below to express the Spiral as a Spiral Length "Ls" rather than a Spiral Parameter "A".

For **Comfort**: $Ls = \frac{V^3}{28R}$ **330.02.01**

For **Superelevation** $Ls = \frac{100we}{2s}$ **330.02.02**

For **Aesthetics**: $Ls = \frac{V}{1.8}$ **330.02.03**

Segmental Spirals

It is preferable to use a connecting or segmental spiral between two curves of different radii and it is mandatory when the radius of the flatter curve is more than 50% greater than the radius of the sharper curve.

There are two distinct cases where a segmental spiral would be used. First, where the spiral is needed to adjust the superelevation between the two curves. The second case is where the segmental spiral is used for a speed-change facility, as between a highway curve and an interchange loop.

Case 1

80 km/h; e_{max} =0.08; R_1=600 m; R_2=230 m.
What is the La Length? From Table 330.E, Min Ls for R 230 = 80 m

Min Segmental $La = Ls * \frac{R_1 - R_2}{R_1}$ = 49.333 m

Use La = 50 m

Whenever a solved La is rounded, the Ls generated by the La needs to be determined for detailed calculations of the segmental spiral data.

Resultant $Ls = La * \frac{R_1}{R_1 - R_2}$ = 81.081 m

Case 2:

135 m of Segmental spiral is needed to decelerate from a highway curve of R_1 250 m at 70 km/h to an interchange loop of R_2 50 m at 40 km/h. What is the length of the total spiral?

$$Ls = La * \frac{R_1}{R_1 - R_2} = 135 * \frac{250}{250 - 50} = 168.750 \text{ m}$$

330.03 Crest Vertical Curve

The design speed shall be used to determine the minimum design rate of vertical curvature (K). Taillight height shall be used for all roads other than Low Volume Roads. The additional 1.0 second perception reaction time is NOT required for taillight height designs. This represents the minimum and should be exceeded where possible.
The use of rock as object height is only required for low volume roads; the additional perception reaction time is also required. This represents the minimum and should be exceeded where possible.

Table 330.F Minimum K Factors to Provide Stopping Sight Distance on Crest Curves

Design	Minimum SSD (m)		Minimum Crest Curve	
Speed	Rock (150 mm)	Taillight (380 mm)	Rock	Taillight
40	45	45	5	4
50	65	65	11	8
60	85	85	18	13
70	110	110	30	22
80	140	140	50	36
90	190*	170	90*	53
100	220*	200	120*	74
110	245*	220	150*	90

* Represents 1 second of additional perception/reaction time.

There is no maximum K value for open shoulder designs with unimpeded flows into the ditch. For curbed designs, K values greater than 50 may have poor drainage near the flat points (grade less than 0.3%).

330.04 Vertical and Horizontal Alignments Near and On Bridges

Alignment Constraints

While it may be aesthetically pleasing to place a bridge on a reversing curve with spirals, this often will introduce logistical complexities in the design and construction of the structure. The introduction of a superelevation transition such as tangent runout can add substantially to the design calculations and construction efforts resulting in a higher the final cost for bridges.

Bridges over fish-bearing streams often have special drainage requirements. In cases where the grade is insufficient to carry water across a bridge or at the bottom of a sag curve, water will pond unless special and very costly drainage works are constructed on both sides of the bridge deck to meet environmental regulations. Many jurisdictions have established grade requirements for bridges to minimize the risk of water accumulation on the deck.

In selecting the roadway's horizontal and vertical alignments near and at bridge crossings, the highway designer should take into account the above constraints on the design of the structure.

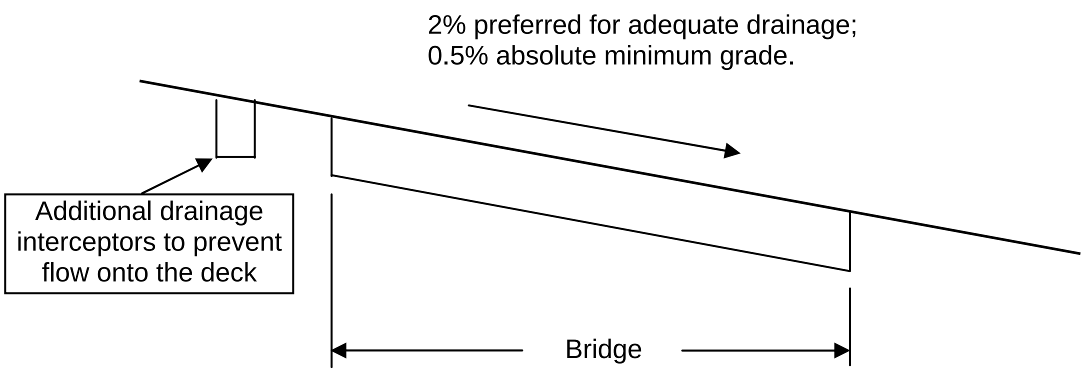
Recommendations

The Bridge Engineering Section and the Geometric Standards and Design Section have developed the following guidelines for use by Highway Design Staff and Consultants.

- Bridge Section and/or the Bridge Design Consultant should be part of the preliminary design process to address the following concerns and to balance needs of both the grading and structural design;
- Desirable Grade on Bridges is 2%. Absolute Minimum Grade is 0.5% based on extreme topographical hardship;
- Avoid bridges in the bottom of Sag Vertical Curves;
- Because of our winter conditions and the ease with which bridge decks can freeze, additional drainage pickups should be standard for the downgrade (upstream) approach to bridges;
- Bridges should be located on tangent and outside of tangent runout of the nearest curve or located completely within the circular curve portion.

Reference

Rural Road Design, A Guide to the Geometric Design of Rural Roads, AUSTROADS, Sydney 2003.



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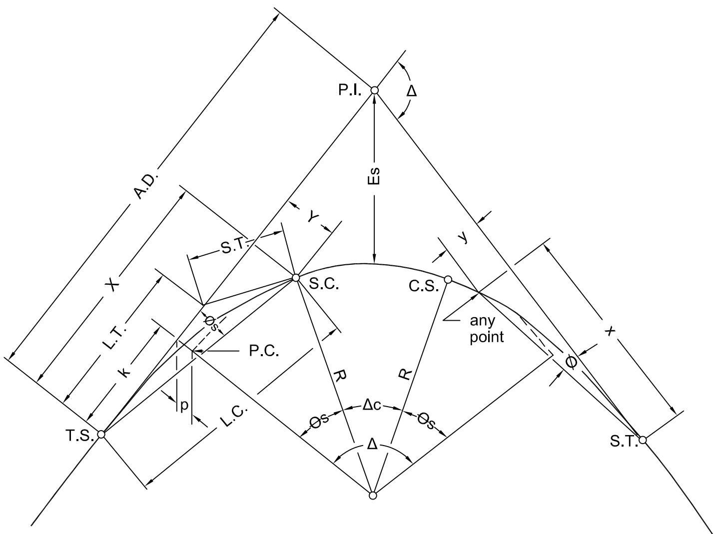
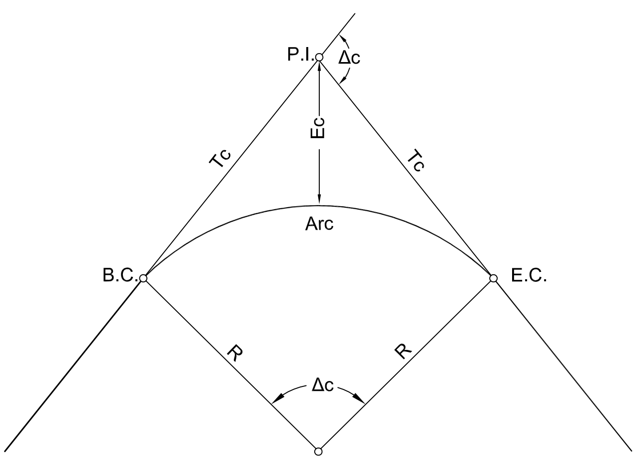
MoT Section	340		TAC Section	Not Applicable

Figure 340.A Spiral and Circular Curve Nomenclature



CURVE WITH TRANSITION BOTH ENDS
Figure (a)



CIRCULAR CURVE
Figure (b)

P.I.	Point of intersection of the main tangents	
T.S.	Tangent to Spiral: common point of tangent and spiral - beginning of spiral	
S.C.	Spiral to Curve: common point of spiral and circular curve - beginning of circular curve	
C.S.	Curve to Spiral: common point of circular curve and spiral - end of circular curve	
S.T.	Spiral to Tangent: common point of spiral and tangent - end of spiral	
S.C.S.	Mid-point of a curve which is transitional throughout	
R	Radius of the circular curve	
r	Radius of a curve at any length on the spiral	
Ls	Length of spiral between T.S. and S.C.	
ℓ	Length between any two points on the spiral	
A.D.	Tangent distance P.I. to T.S. or S.T.; apex distance	
Es	External distance from P.I. to centre of circular curve portion or to S.C.S. of a curve transitional throughout	
Arc	Length of circular curve from S.C. to C.S.	
Δ	IntersectIon angle between the tangents of the entire curve	
Δc	Intersection angle between tangents at the S.C. and at the C.S. or the central angle of a circular curve	
Θs	Spiral Angle: The intersection angle between the tangent of the complete curve and the tangent at the S.C.	
Θ	Intersection angle between tangent of complete curve and tangent at any other point on the spiral	
Øs	Deflection angle from tangent at T.S. to S.C.	
Ø	Deflection angle from tangent at any point on spiral to any other point on spiral	
L.T.	Long tangent distance of spiral only	
S.T.	Short tangent distance of spiral only	
L.C.	Long chord of the spiral curve; distance from T.S. to S.C.	
P	Offset distance from the tangent of P.C. of circular curve produced	
k	Distance from T.S. to point on tangent opposite the P.C. of the circular curve produced	
X,Y	Coordinates of S.C. from T.S.	
x,y	Coordinates of any other point on spiral from the T.S.	
Tc	Tangent distance P.I. to B.C. or E.C.	Circular Curve only
B.C.	Beginning of curve	Circular Curve only
E.C.	End of curve	Circular Curve only
Arc	Length of curve from B.C. to E.C.	Circular Curve only
Δc	Intersection angle between the tangents	Circular Curve only
Ec	External distance from P.I. to centre of curve	Circular Curve only

MoT Section	340		TAC Section	Not Applicable

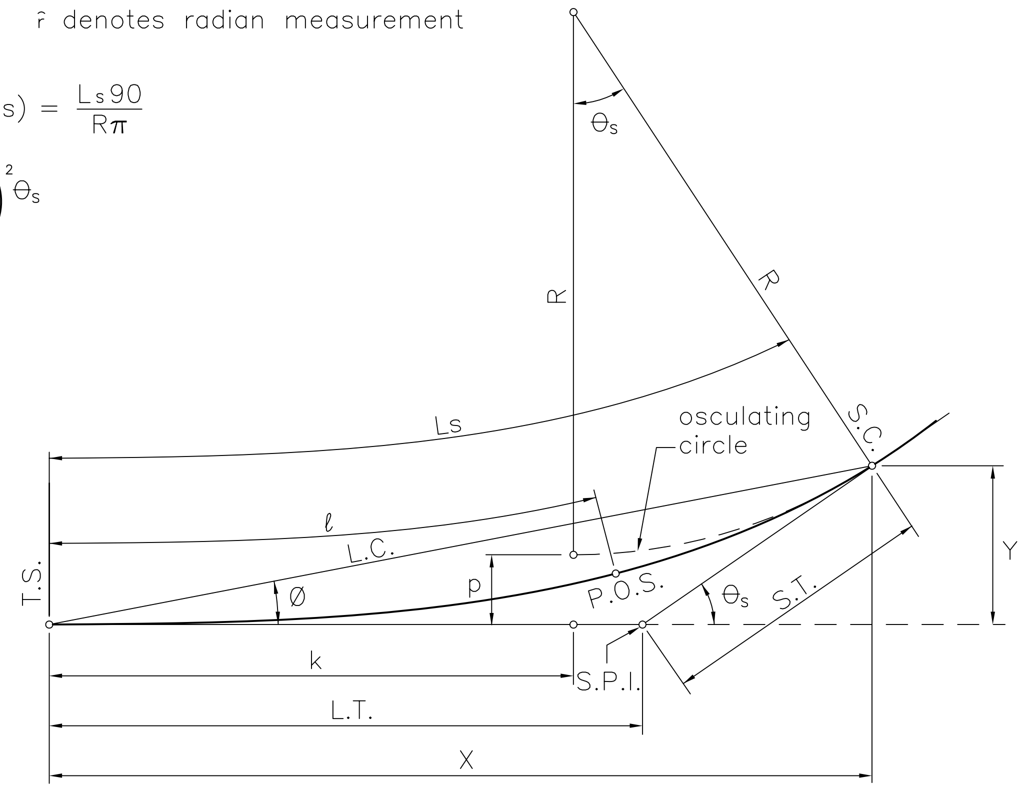
Figure 340.B Spiral Formulae

$$\theta_{s\hat{r}} = \frac{Ls}{2R}$$ $\hat{r}$ denotes radian measurement

$$\theta_s\,(\text{degrees}) = \frac{Ls\,90}{R\pi}$$

$$\theta_\ell = \left(\frac{\ell}{Ls}\right)^2 \theta_s$$

$$r = \frac{Ls\,R}{\ell}$$



$$X = Ls\left(1 - \frac{\theta_{s\hat{r}}^2}{5\times2!} + \frac{\theta_{s\hat{r}}^4}{9\times4!} - \frac{\theta_{s\hat{r}}^6}{13\times6!} + - - -\right)$$

For any point on the spiral substitute:

1. ℓ for Ls
2. $\theta_{\ell\hat{r}}$ for $\theta_{s\hat{r}}$

$$Y = Ls\left(\frac{\theta_{s\hat{r}}}{3\times1!} - \frac{\theta_{s\hat{r}}^3}{7\times3!} + \frac{\theta_{s\hat{r}}^5}{11\times5!} - \frac{\theta_{s\hat{r}}^7}{15\times7!} + - - -\right)$$

$$k = \frac{Ls}{2}\left(1 - \frac{\theta_{s\hat{r}}^2}{5\times3!} + \frac{\theta_{s\hat{r}}^4}{9\times5!} - \frac{\theta_{s\hat{r}}^6}{13\times7!} + - - -\right) = X - R\sin\theta_s$$

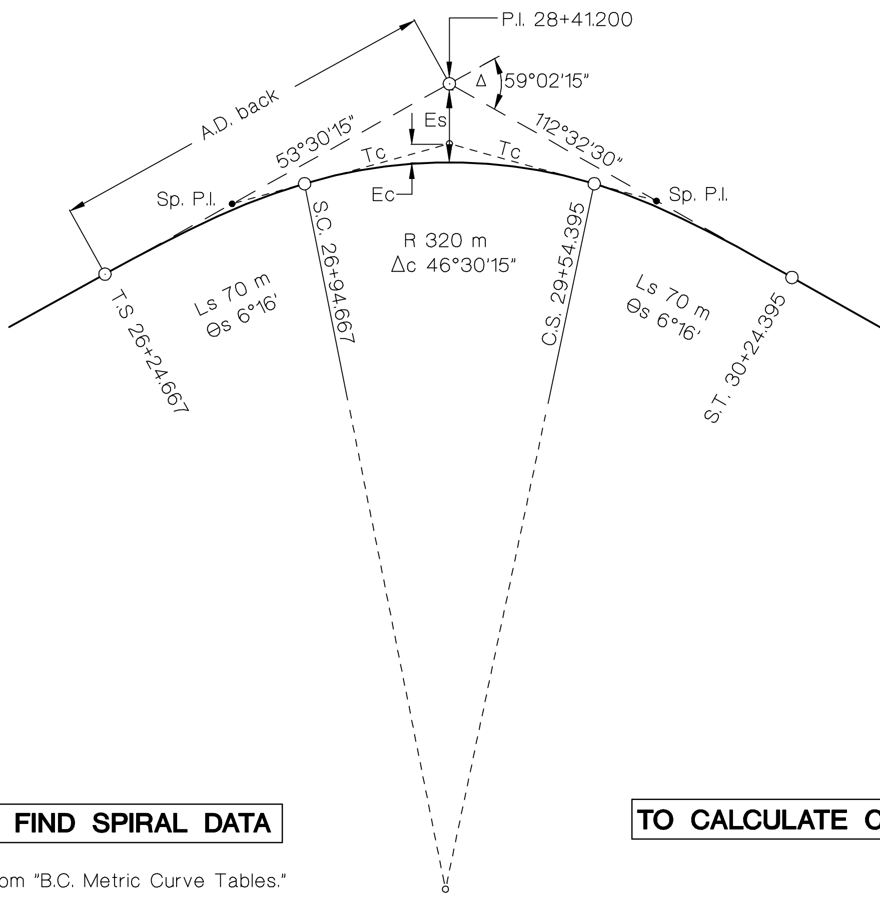
$$L.T. = X - \frac{Y}{\tan\theta_s}$$

$$p = \frac{Ls}{2}\left(\frac{\theta_{s\hat{r}}}{3\times2!} - \frac{\theta_{s\hat{r}}^3}{7\times4!} + \frac{\theta_{s\hat{r}}^5}{11\times6!} - \frac{\theta_{s\hat{r}}^7}{15\times8!} + - - -\right) = Y - R + R\cos\theta_s$$

$$S.T. = \frac{Y}{\sin\theta_s}$$

$$L.C. = \sqrt{X_s^2 + Y_s^2} \qquad \varnothing_s = \arctan\left(\frac{Y_s}{X_s}\right) = \frac{\theta_s}{3} - C_s \quad \text{where } C_s\,(\text{in seconds}) = 0.0031\,\theta_s^3$$

Figure 340.C Circular Curve with Equal Spirals



GIVEN

Design Speed 80 km/h
Radius 320 m
Ls 70 m
Δ 59°02'15"

FIND

Curve Data

N.T.S.

TO FIND SPIRAL DATA

1. From "B.C. Metric Curve Tables."

TABLE B

Ls 70 m R 320 m	X = 69.916 Y = 2.550 k = 34.986 p = 0.638
	L.T. = 46.696
Theta (Θs) = 6°16'	S.T. = 23.360
Phi (Øs) = 2°05'19"	L.C. = 69.963

$$\text{Theta } (\Theta s) = \frac{Ls}{2R}\left(\frac{180}{\pi}\right)$$

OR

$$(\Theta s) = \frac{Ls}{R}\left(\frac{90}{\pi}\right)$$

$$= \frac{70}{320}\ 28.6479 = 6.26673°$$

$$\Theta s = 6°16'$$

TO CALCULATE CURVE DATA

$$\Delta c = \Delta - 2\Theta s$$
$$= 59°02'15" - (2 \times 6°16')$$
$$\Delta c = 46°30'15"$$

$$Arc = R \times \text{radian } 46°30'15" *$$
$$= 320 \times 0.8116508$$
$$Arc = 259.728$$

$$Tc = R \tan \frac{\Delta c}{2}$$
$$= 320 \times 0.429677$$
$$Tc = 137.497$$

$$Ec = \frac{R}{\cos\frac{\Delta c}{2}} - R$$
$$= 320 \div 0.918777 - 320$$
$$Ec = 28.289$$

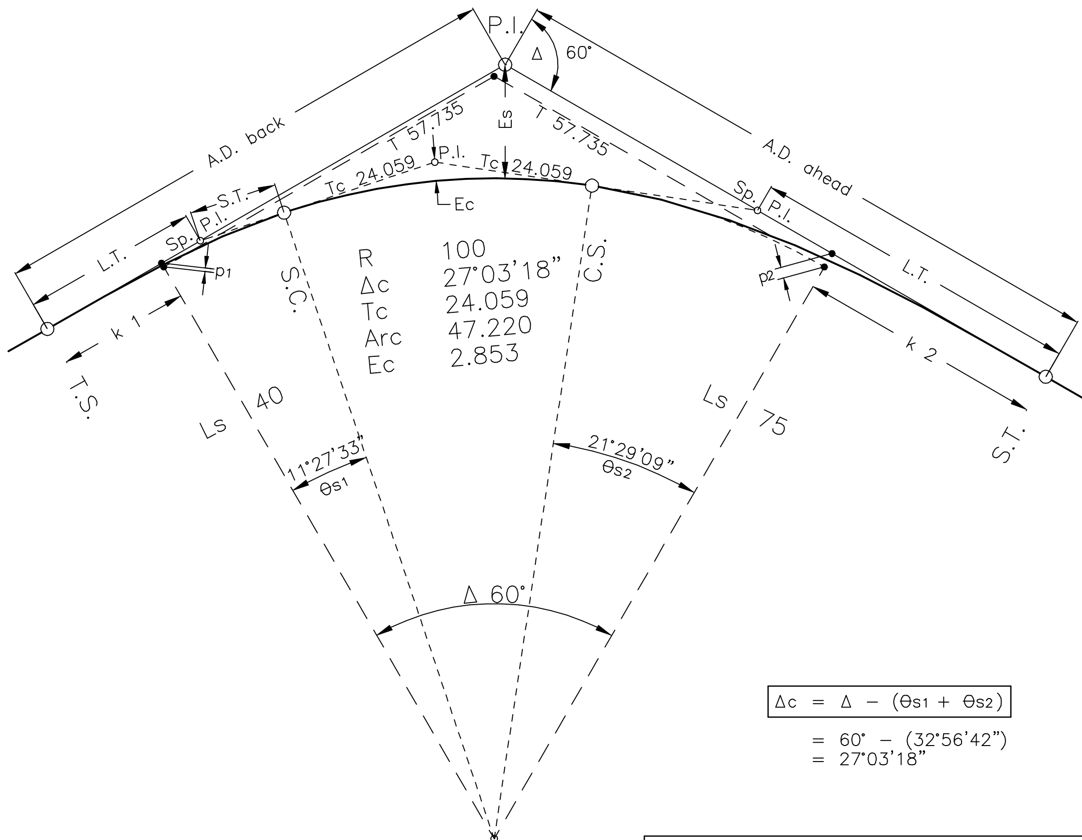
$$A.D. = (R + p) \tan \frac{\Delta}{2} + k$$
$$A.D. = 216.533$$

$$Es = \frac{R + p}{\cos\frac{\Delta}{2}} - R$$
$$= \frac{320.638}{0.870195} - 320$$
$$Es = 48.467$$

* NOTE

$$1 \text{ degree} = \frac{\pi}{180} \text{ radian}$$
$$\therefore 46°30'15" = 46.5041667\left(\frac{\pi}{180}\right)$$
$$= 0.8116508 \text{ radian}$$

Figure 340.D Circular Curve with Unequal Spirals



$$\Delta c = \Delta - (\theta s_1 + \theta s_2)$$

$= 60° - (32°56'42")$

$= 27°03'18"$

$$\text{A.D. back} = k_1 + \frac{(R + p_2) - (R + p_1)\cos\Delta}{\sin\Delta}$$

$$= 19.973 + \frac{102.332 - 100.666\cos 60°}{\sin 60°}$$

A.D. back = 80.016

$$\text{A.D. ahead} = k_2 + \frac{(R + p_1) - (R + p_2)\cos\Delta}{\sin\Delta}$$

$$= 37.325 + \frac{100.666 - 102.332\cos 60°}{\sin 60°}$$

A.D. ahead = 94.483

GIVEN:		From B.C. Metric Curve Tables	
R	100	T.5. →	L.S. 40, R 100
Δ	60°	k_1	19.973
Ls_1	40	p_1	0.666
Ls_2	75	L.T.	26.723
FIND:	A.D. ahd.	S.T.	13.384
	A.D. back	θs_1	11°27'33"
	Curve data		

Ls 75 not given in Tables

$$\theta s = \frac{Ls}{R}\left(\frac{90}{\pi}\right) \quad \therefore \quad \theta s_2 = \frac{75}{100}\ 28.6479$$

$= 21.485917°$

From Table C (Unit Spiral) = 21°29'09"

T.71 → Theta 21.486° (interpolate)
p_2 0.031094 x 75 = 2.332
k_2 0.497666 x 75 = 37.325
L.T. 0.671645 x 75 = 50.373
S.T. 0.337863 x 75 = 25.340

$$Es = \sqrt{(\text{A.D. back} - k_1)^2 + (R + p_1)^2} - R$$

$$= \sqrt{(80.016 - 19.973)^2 + (100 + 0.666)^2} - 100$$

Es = 17.213

(Formula valid only if Es is on a Circular Curve)

Figure 340.E Three Transition Compound Curve - General Layout

EXAMPLE 1

Proceeding from flatter to sharper curve.

GIVEN
ΔI = 42° 03'
R_1 = 600
R_2 = 230
Ls_1 = 50
Ls_2 = 80
La = 50

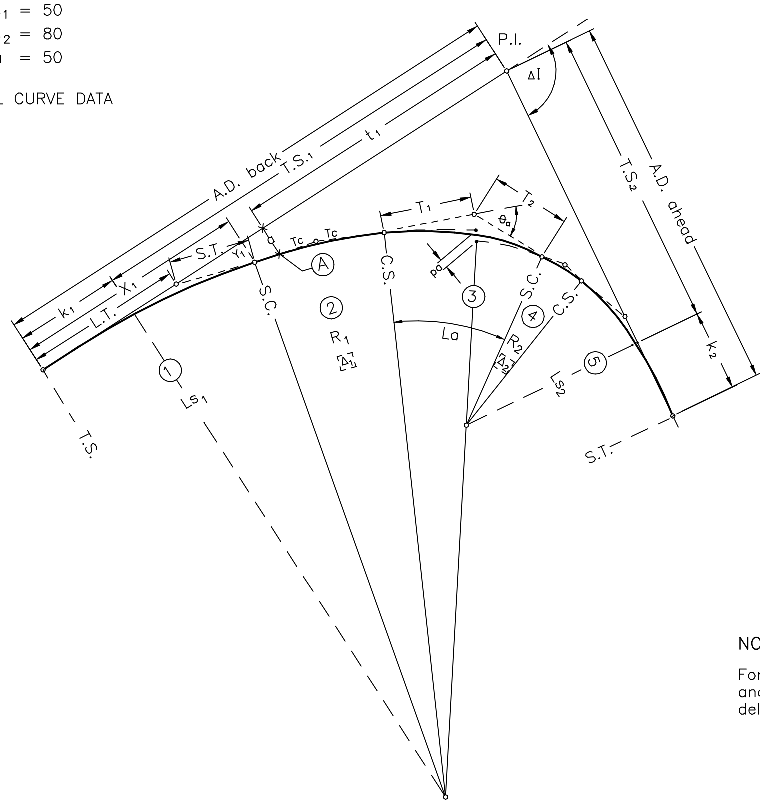
FIND ALL CURVE DATA

CASE 1

Δ_1 and Δ_2 are not given.

From a preliminary plan showing P.I., ΔI and bearings, it was determined that curve (2) (R 600) has to pass through point (A);

∴ T.S.$_1$ is fixed.



NOTE:

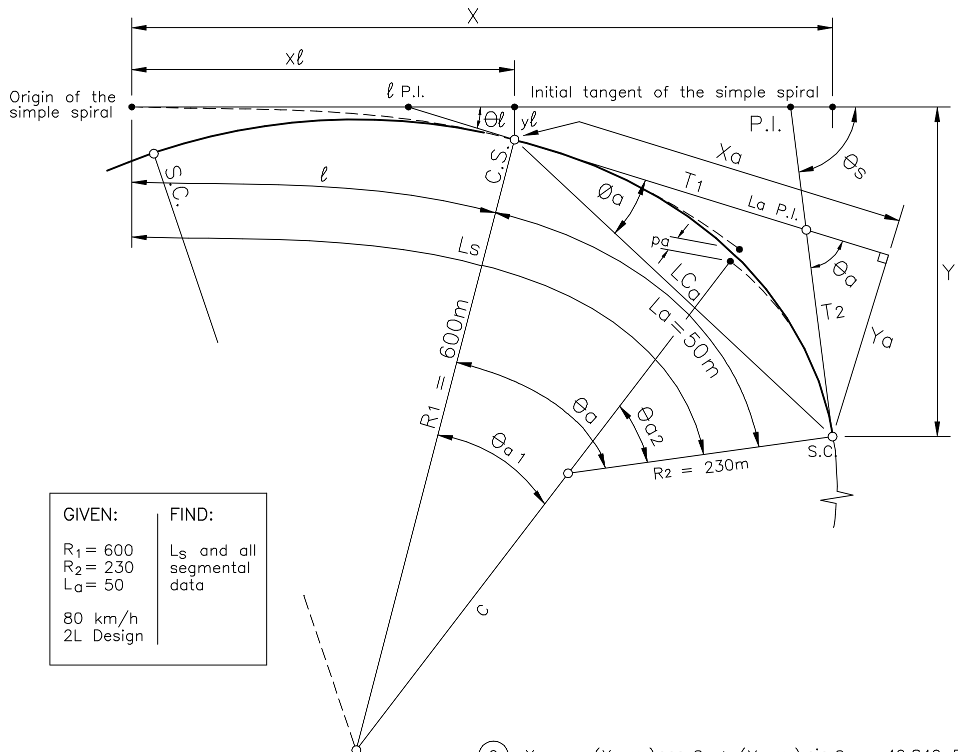
For graphical reasons, scale and proportions are distorted deliberately.

1. USE B.C. METRIC CURVE TABLES TO FIND SPIRAL DATA FOR Ls_1 AND Ls_2.
2. SOLVE SEGMENTAL SPIRAL – La 50, USING PROCEDURE SHOWN ON FIGURE 340.01.06
3. CALCULATE CURVE DATA, USING PROCEDURE SHOWN ON FIGURE 340.01.07

CALCULATED CURVE DATA

1 — Ls_1 50	3 — La 50	4 — R_2 230
X 49.991	θa 8° 36' 54"	Δ 12° 01' 26"
Y 0.694	θa1 2° 23' 12"	Tc 24.222
k 24.999	θa2 6° 13' 42"	Arc 48.267
p 0.174	pa 0.279	Ec 1.272
L.T. 33.336	Xa 49.850	Ch 48.178
S.T. 16.669	Ya 3.195	**5 — Ls_2 80**
L.C. 49.996	T1 28.761	X 79.758
θs 2° 23' 14"	T2 21.329	Y 4.628
Ø 0° 47' 45"	Øa 3° 40' 02"	k 39.960
2 — R_1 600		p 1.158
Δ 9° 03' 34"	P.I. N. 1000.000	L.T. 53.418
Tc 47.534	E. 500.000	S.T. 26.744
Arc 94.870	A N. 924.199	L.C. 79.893
Ec 1.880	E. 507.000	θs2 9° 57' 52"
Ch 94.771		Ø2 3° 19' 14"

Figure 340.F Three Transition Compound Curve - Segmental Spiral



1. $L_a = 50$ (see 330.02)

2. $L_s = L_a\left(\dfrac{R_1}{R_1 - R_2}\right) = 81.081$

3. $\Theta_s = \dfrac{L_s}{R_2} \times \dfrac{90}{\pi} = 10.099^\circ = 10^\circ 05' 57''$

4. $\Theta_a = L_a\left(\dfrac{1}{R_2} + \dfrac{1}{R_1}\right)\dfrac{90}{\pi} = 8.615^\circ = 8^\circ 36' 54''$

5. $\ell = L_s - L_a = 31.081$

6. $\Theta_\ell = \dfrac{\ell}{R_1} \times \dfrac{90}{\pi} = 1.484^\circ = 1^\circ 29' 02''$

7. From Unit Spiral Tables $\Theta_s = 10.099^\circ$ interpolate (or use spiral formulae 340.C)
   $X = 80.829$ $Y = 4.753$

8. From Unit Spiral Tables $\Theta_\ell = 1.484^\circ$ interpolate (or use spiral formulae 340.C)
   $x_\ell = 31.079$ $y_\ell = 0.268$

9. $X_a = (X - x_\ell)\cos\Theta_\ell + (Y - y_\ell)\sin\Theta_\ell = 49.849\ 5^*$

10. $Y_a = (Y - y_\ell)\cos\Theta_\ell - (X - x_\ell)\sin\Theta_\ell = 3.195\ 1^*$

11. $\Theta_{a1} = \arctan\left(\dfrac{X_a - (R_2 \sin\Theta_a)}{R_1 - [Y_a + (R_2 \cos\Theta_a)]}\right) = 2^\circ 23' 12''$

12. $\Theta_{a2} = \Theta_a - \Theta_{a1} = 6^\circ 13' 42''$

13. $C = R_1 - R_2 - pa$
    $= \sqrt{[X_a - (R_2 \sin\Theta_a)]^2 + \{R_1 - [Y_a + (R_2 \cos\Theta_a)]\}^2}$
    $= 369.721$

14. $T_1 = X_a - \dfrac{Y_a}{\tan\Theta_a} = 28.760$

15. $T_2 = \dfrac{Y_a}{\sin\Theta_a} = 21.330$

16. $Ø_a = \arctan\left(\dfrac{Y_a}{X_a}\right) = 3^\circ 40' 02''$

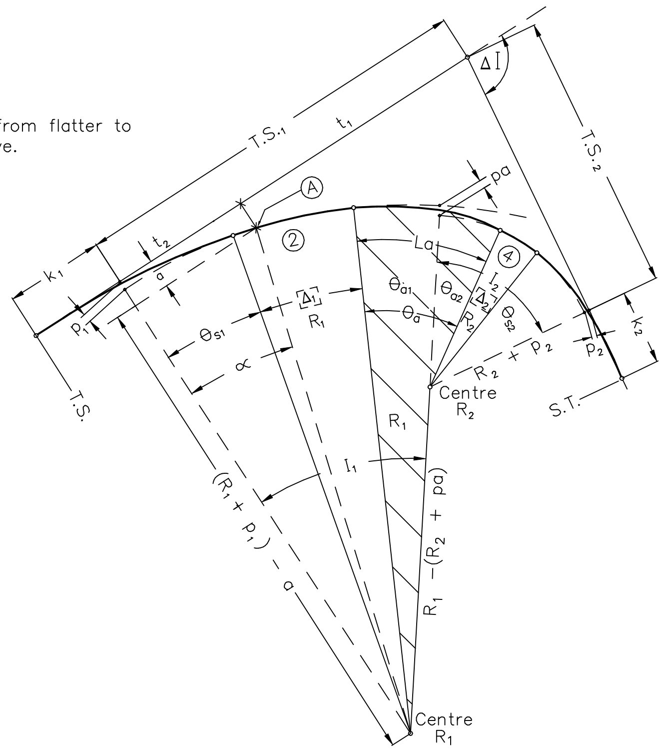
17. $LC_a = \sqrt{X_a^2 + Y_a^2} = 49.952$

* For sufficient accuracy of T_1 and T_2, use at least 4 decimal places

Figure 340.G Three Transition Compound Curve Calculations

EXAMPLE 1

Proceeding from flatter to sharper curve.



GIVEN

$\Delta I = 42^\circ\ 03'$

$R_1 = 600$

$R_2 = 230$

$Ls_1 = 50$

$Ls_2 = 80$

$La = 50$

FIND ALL CURVE DATA

FIGURE 2

CALCULATION PROCEDURE

Solve curve data for La (see Figure 340.01.06)

From coōrdinates of (A) : $a = 7.014 \quad t_1 = 75.801$

Centre of R_1 and T.S.$_1$ become fixed.

$$\text{Cos} \propto = \frac{(R_1 + p_1) - a}{R_1} = \frac{600.174 - 7.014}{600} \quad \therefore \propto = 8^\circ\ 39'\ 35''$$

$$t_2 = R_1 \sin\propto = 600 \sin 8^\circ\ 39'\ 35'' = 90.340$$

$$\text{T.S.}_1 = t_1 \ldots\ldots 75.801 + t_2 \ldots 90.340 = 166.141$$

$$\text{Cos } I_2 = \frac{\text{T.S.}_1 \sin \Delta I - (R_2 + p_2) + (R_1 + p_1) \cos \Delta I}{R_1 - R_2 - pa}$$

$$= \frac{166.141 \sin 42^\circ\ 03' - 231.158 + 600.174 \cos 42^\circ\ 03'}{369.721}$$

$$I_2 = 28^\circ\ 13'\ 00''$$

$$\Delta_2 = I_2 - (\theta_{a2} + \theta_{S2}) = 28^\circ\ 13'\ 00'' - (6^\circ\ 13'\ 42'' + 9^\circ\ 57'\ 52'') = 12^\circ\ 01'\ 26''$$

$$I_1 = \Delta I - I_2 = 42^\circ\ 03'\ 00'' - 28^\circ\ 13'\ 00'' = 13^\circ\ 50'\ 00''$$

$$\Delta_1 = I_1 - (\theta_{a1} + \theta_{S1}) = 13^\circ\ 50'\ 00'' - (2^\circ\ 23'\ 12'' + 2^\circ\ 23'\ 14'') = 9^\circ\ 03'\ 34''$$

$$\text{T.S.}_2 = \frac{(R_1 + p_1) - (R_2 + p_2)\cos \Delta I - (R_1 - R_2 - pa)\cos I_1}{\sin \Delta I}$$

$$= \frac{600.174 - 231.158 \cos 42^\circ\ 03' - 369.721 \cos 13^\circ 50'}{\sin 42^\circ\ 03'}$$

$$= 103.807$$

$$\text{AD back} = \text{T.S.}_1 + k_1 = 166.141 + 24.999 = 191.140$$

$$\text{AD ahead} = \text{T.S.}_2 + k_2 = 103.807 + 39.960 = 143.767$$

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400 CROSS SECTIONS CHAPTER

400 CROSS SECTION CHAPTER TABLES

400 CROSS SECTION CHAPTER FIGURES

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410
CROSS SECTIONS

410.01 INTRODUCTION

The following deals with the production of cross sections, which form part of the information for construction contracts. Because of the variety of designs, universal statements about the content of cross sections are difficult; therefore, this is a general discussion.

Cross sections provide a third dimension to plan and profile that ties the horizontal and vertical alignment to the ground. They are used for such purposes as:

- Identifying areas of conflict due to the interaction of the design template and the existing ground.
- Helping to identify R/W requirements.
- Determining embankment and excavation project quantities.
- Determining various roadway design features such as drainage curbs, roadside barrier, ditching and cross culvert locations, etc.
- Assisting Construction supervisors to better understand the designer's intent for such things as driveways, structures and drainage.
- Assisting contractors in the bidding process for evaluating station to station quantities, cut and fill slopes, and potential construction problems.

410.02 FORMAT

Cross sections shall be reproducible. Normally, they will be done on roll stock. Each end of the roll will have the same information as shown on the title or key page of the contract drawings. Each L-line shall start a new stack.

D size cut sheets are also acceptable. There shall be a title page with the same information as above. Each page shall identify the L-line and/or road name or structure that the sections represent. Each L-line shall start with a new stack.

Submissions for the purpose of design reviews are often provided as half size copies on 11" x 17" sheets. Adobe PDF files are also convenient for review. Contact the appropriate Regional Manager of Design to verify what format will be acceptable for design reviews.

For rural projects, use a natural scale of 1:100 or 1:250 for both horizontal and vertical.

Urban projects usually require the larger horizontal scale of 1:100. The vertical scale is exaggerated and is normally 1:50. A scale of 1:25 is optional where needed.

The major grid shall typically be at 5 m intervals, although 10 m may be used on mountainous projects.

The control line of the cross sections should align with a major grid line.

Rural spacing for <u>plotted</u> cross sections shall be no greater than 20 m on tangents and curves, with 10 m spacing for rock sections and 5 m spacing at retaining walls and other critical areas. Cross sections at horizontal alignment curve and spiral transition stations should also be included. The design cross section spacing requirements specified in Section 1270.8 of the CAiCE Design Project Data Format Terms of Reference must be followed. This may result in significantly more closely spaced cross sections for design purposes; however, the final <u>plotted</u> cross sections do not necessarily have to include all of the design cross sections.

Urban spacing shall be 10 m for both tangents and curves with 5 m spacing at retaining walls. Cross sections at accesses and other critical areas may be needed to provide additional information.

The cross sections are plotted with the chainage increasing from the bottom of the page to the top for each stack.

410.03 CONTENT

Existing Features:

The following list is included as an example of the type of information typically needed to identify the existing features. The uniqueness of each project will determine what information needs to be shown.

- Existing ground line with features identified.
- Original ground elevation at the control line.

- Station of each cross section.
- Existing R/W boundaries.
- Existing utilities and drainage (e.g. access and cross culverts).
- Structures (e.g., retaining walls, endwall, fences, buildings, etc.).
- All accesses – a cross section at each centreline.
- Side roads – a cross section at each centreline. Identify the road.

Proposed Features:

The following list is included as an example of the type of information typically needed to transmit the intent of the design. The uniqueness of each design will determine exactly what information needs to be shown.

- Finished grade line and cross fall with proposed elevation at centreline or control line.
- Complete roadway structure and subgrade cross fall if different from finished grade.
- Elevations of toe of fill slope and lowest ditch point.
- Proposed R/W boundaries.
- Stratum lines and stripping.
- Drainage and utility locations, except utility pole lines.
- Show typical location of utility poles once per stack, if generally parallel.
- Clear zone limit, where applicable.
- Indicate the foreslope, backslope and fill slope values once per stack and each time the slopes change.
- Structures (e.g., retaining walls, endwall, fences, buildings, etc.) within the proposed R/W.
- Provide necessary information on the composition and staging of embankments (e.g., lightweight core, surcharge, etc.).
- Sound berms with slopes and elevation.
- Drainage information (e.g., drainage arrows to indicate flow direction).
- Curb and gutter.
- Roadside and median barrier.

Special Sections:

- Special sections shall be interspersed as required to pick up other features such as ground breaks and changes in ground type (i.e., change from rock to Type D) and accesses, etc.
- Cross sections at creek crossings, existing large culverts with drainage channels, etc.
- Cross sections at critical control points.

Optional Useful Information:

- Areas and volumes (cut and fill) for each type of material, excluding pavement and gravels, should be shown on the cross sections. This data can assist the contractors in preparing their bid.
- Properties Branch may request cross sections at property boundaries.

430
CROSS SECTION ELEMENTS

Table 430.A summarizes the cross section elements for BC Highways according to Design Speed, Classification and Design volumes. (Also refer to Figures 440.A through 440.H). See Section 620 for Clear Zone discussion.

Table 430.A Cross Section Elements

Road Class	Total Design Volume	Lane Width (m)	Paved Shoulder Width [1] (m)	Design Speed [2] (km/h)	Normal X-Fall	Fill Slope (desirable)
LVR [3]	≤ 200 ADT	Refer to Section 510 [3]	0.5 Gravel	30-90	Refer to Section 510 [3]	2 to 1
RLU		3.6	1.0 [4]	50-80	0.02 m/m	4 to 1
RCU	≤ 450 DHV [5]	3.6	1.5	50-80		4 to 1
	> 450 DHV [5]		1.5	60-90		
RCD		3.6	2.5	60-90		4 or 5 to 1
RAU	< 200 DHV [5]	3.6	1.5	70-90		4 or 5 to 1
	≤ 450 DHV [5]	3.6	2.0	70-90		
	> 450 DHV [5]	3.6	2.5	80-100		
RAD		3.7	3.0	80-100		4 or 5 to 1
RED		3.7	3.0	80-110		4 or 5 to 1
RFD		3.7	3.0	80-110		4 or 5 to 1

1 Minimum width is 1.5 m for Shoulder Bikeway when applicable. See Table 430.B below.
2 Justification is required where less than the maximum design speed for each classification is selected.
3 See Section 510 for Low-volume Roads details.
4 Typical minimum shoulder width required to nearest edge of roadside barrier is 1.3 m.
5 On a typical rural highway, the DHV is about 15% of the ADT.

Table 430.B Design Widths for Shoulder Bikeways

Controlling Condition	Minimum Design Width (m)
For Most Cases, except as below	1.5
For Design Speed ≥ 70 km/h **and** SADT > 5,000	2.0
For Design Speed > 80 km/h **and** SADT > 10,000	2.5
All Freeways and Expressways	3.0

- The travel lane(s) next to a shoulder bikeway should be at least 3.6 m wide
- SADT = Summer Average Daily Traffic (July and August).

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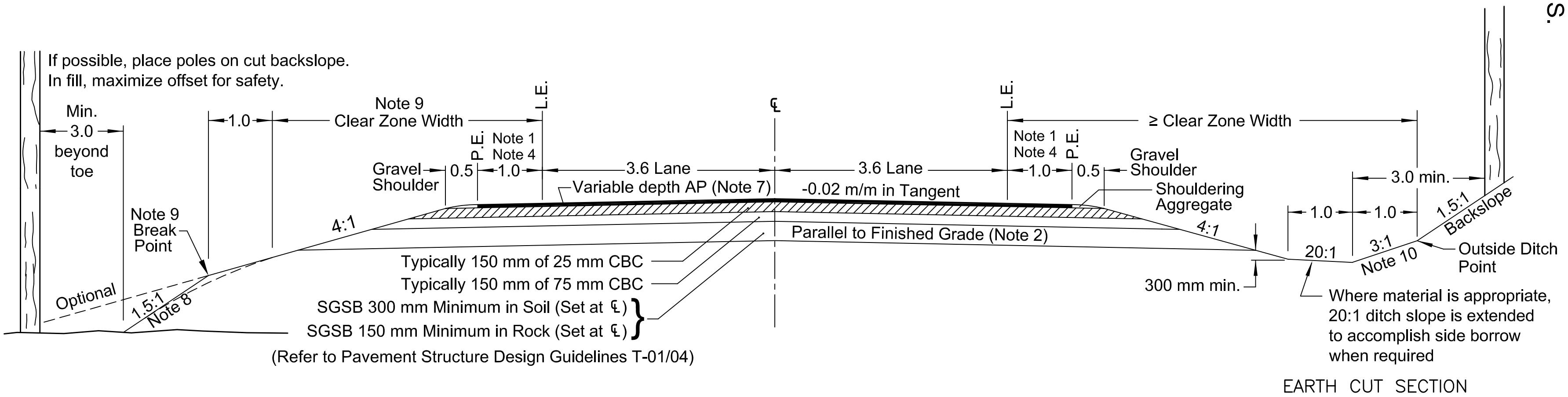
MoT Section	440		TAC Section	Figure 2.2.13.2

Figure 440.A Typical Section - Rural Local Undivided

N.T.S.



Notes:

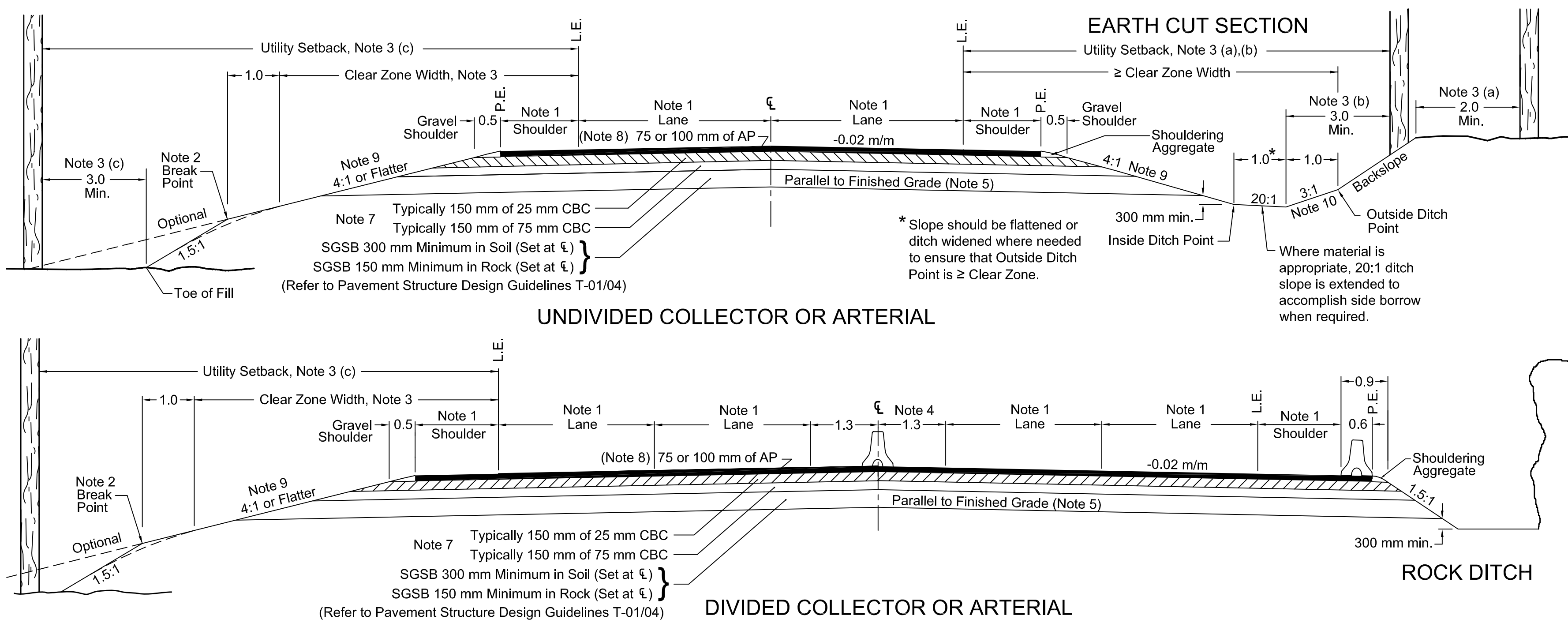
1. See Table 430.A for lane and shoulder widths.
2. Tangent subgrade may be increased to -0.03 or -0.04 m/m in earth to facilitate drainage, but only when directed by Geotechnical Staff.
3. For rock ditch details, see Figure 440.H
4. For roadside barrier, 1.3 m is required to the nearest edge of barrier.
5. These are typical gravel depths to be used in the absence of geotechnical investigation.
6. Design Speeds 50 - 80 km/h.
7. Typically Type 'B' or Type 'C' Pavement Design. (see Technical Circular T-01/04)
8. Fill slopes should be as flat as possible and no steeper than 1.5:1. Desirable is 4:1 or flatter.
9. Clear Zone Width to be in accordance with the requirements in Section 620. Rounding or "smoothing" at Break Point to be done during construction.
10. The 3:1 ditch slope is not mandatory. A single backslope may be used starting at the low point of the ditch.

Terms:

AP	Asphalt Pavement
CBC	Crushed Base Course
SGSB	Select Granular Sub Base
L.E.	Lane Edge
P.E.	Pavement Edge

Figure 440.B Typical Section - Rural Collector and Arterial

N.T.S.



Notes:

1. See Table 430.A for Lane and Shoulder Widths.

2. Rounding or "smoothing" at Break Point to be done during construction.

3. Clear Zone is a function of Speed and Traffic Volume. Clear Zone Width to be in accordance with the requirements in Section 620. Utilities should be located outside of the Clear Zone. The desirable location of utility poles shall be, in order of preference: (a) min. 2 m beyond top of cut, (b) min. 3 m beyond lowest ditch point, (c) min. 3 m beyond toe of fill. See the current edition of the Ministry's utility policy manual for additional placement guidelines.

4. Minimum half-width is 1.3 m from Lane Edge to Centreline. Check for SSD along median barrier on curves. Median barrier may not be required on 4-Lane Collectors or Arterials with low volumes and is not generally used on 2-Lane Collectors or Arterials.

5. Tangent subgrade may be increased to -0.03 or -0.04 m/m in earth to facilitate drainage, but only when directed by Geotechnical Staff.

6. See Figure 440.F through 440.H for Barrier/Drainage Curb, Retaining Wall and Rock Ditch Details.

7. These are "typical" gravel depths to be used in the absence of a specific Geotechnical recommendation.

8. Type "A", > 1,000,000 ESALs, use 100 mm of AP; or Type "B", 100,000 to 1,000,000 ESALs, use 75 mm of AP. Where pavement is 100 mm, full depth extends only 0.6 m into the paved shoulder, depending on shoulder width. See Figure 440.E for this Alternate Shoulder Detail.

9. Ditch slopes and fill slopes steeper than 4:1 must be evaluated for barrier need.

10. The 3:1 ditch slope is not mandatory. A single backslope may be used starting at the low point of the ditch.

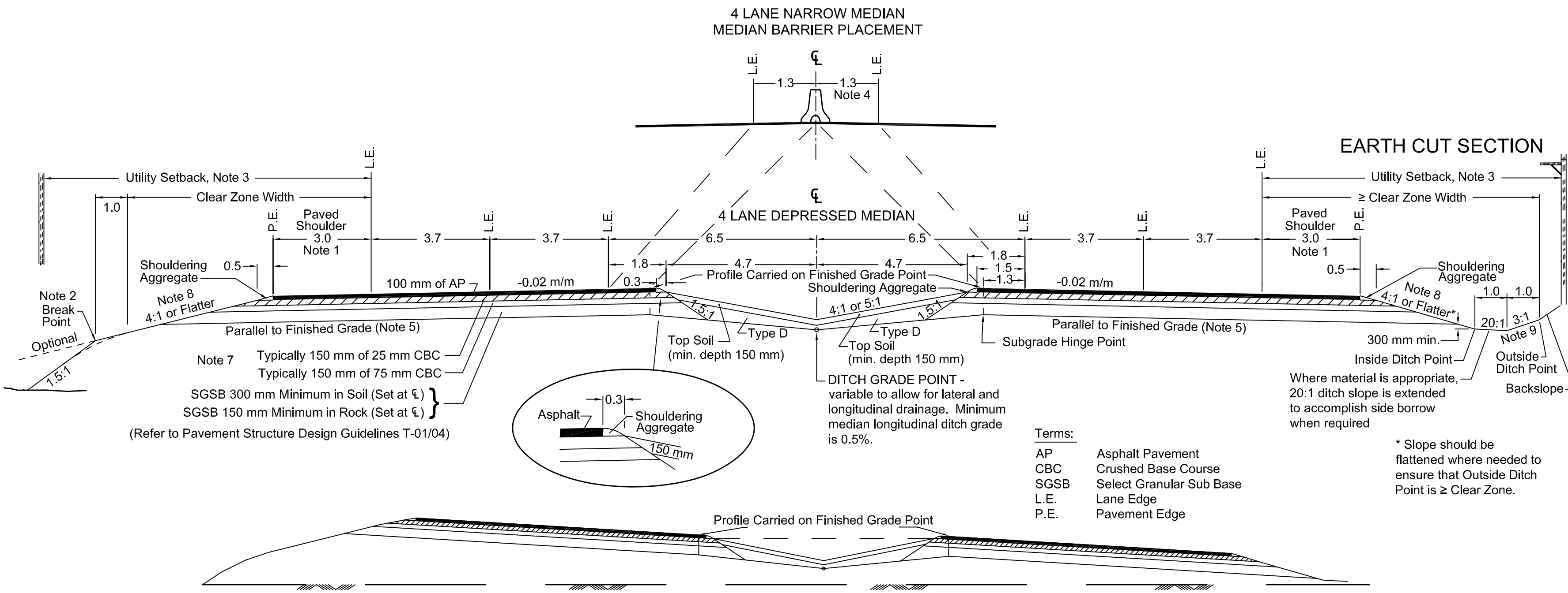
Terms:

AP	Asphalt Pavement
CBC	Crushed Base Course
SGSB	Select Granular Sub Base
L.E.	Lane Edge
P.E.	Pavement Edge
ESAL	Equivalent Single Axle Load

MoT Section	440		TAC Section	Figure 2.2.13.12

Figure 440.C Rural Freeway/Expressway - No Development to 6 Lanes

N.T.S.



Notes:

1. Shoulder Widths are typically 3.0 m. Exceptions permitted with sign-off by Chief Engineer. See Fig. 440.E for Alternate Shoulder Detail using 50 mm of AP.

2. Rounding or "smoothing" at Break Point to be done during construction.

3. Clear Zone is a function of Speed and Traffic Volume. Clear Zone Width to be in accordance with the requirements in Section 620. Utilities should be located outside of the Clear Zone. The desirable location of utility poles shall be, in order of preference: (a) min. 2 m beyond top of cut, (b) min. 3 m beyond lowest ditch point, (c) min. 3 m beyond toe of fill. See the current edition of the Ministry's utility policy manual for additional placement guidelines.

4. Minimum half-width is 1.3 m from Lane edge to Centreline. Check for SSD along median barrier on curves. Median Barrier may not be required on Expressways or Freeways initially; allowance is made for placement at later time. Centreline radius and/or median widths for ultimate placement of barrier are to be checked for SSD.

5. Tangent Subgrade may be increased to -0.03 or -0.04 m/m in earth to facilitate drainage, but only when directed by Geotechnical Staff.

6. See Figure 440.F through 440.H for Barrier/Drainage Curb, Retaining Wall and Rock Ditch Details.

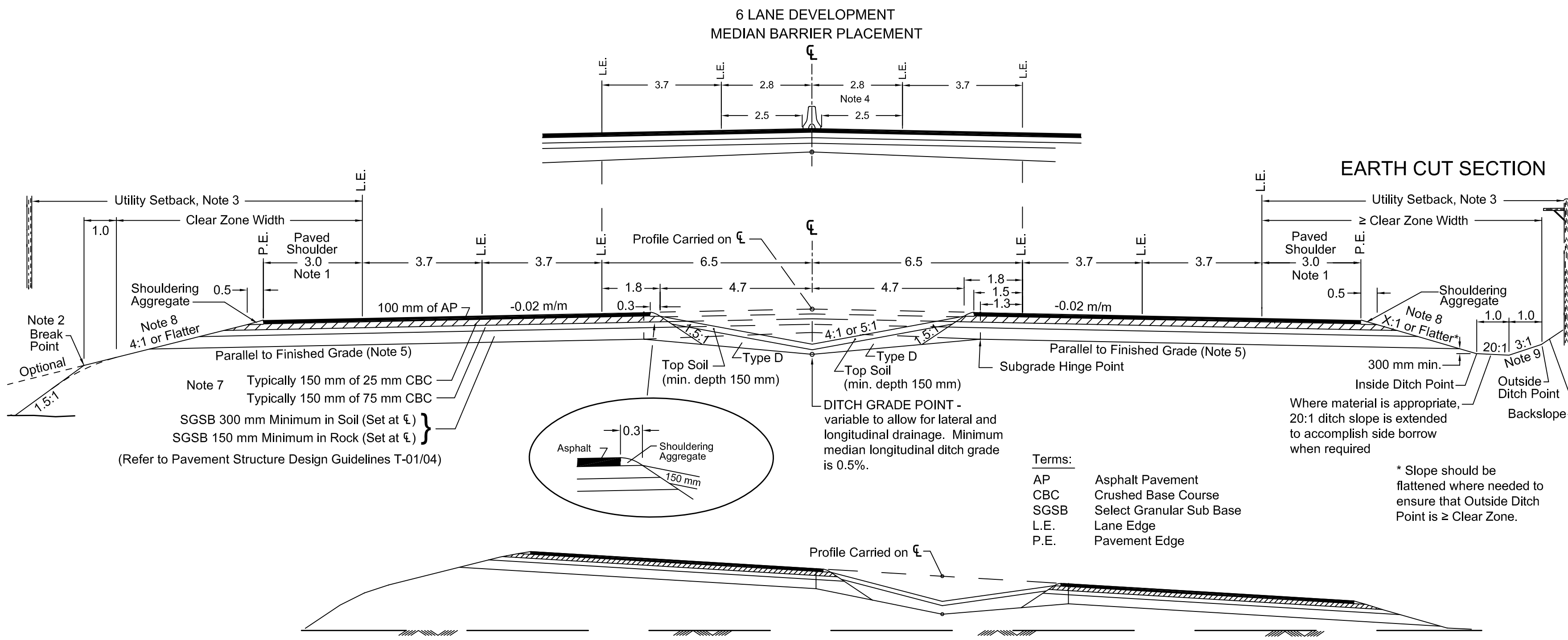
7. These are "typical" gravel depths to be used in the absence of a specific Geotechnical recommendation.

8. Ditch slopes and fill slopes steeper than 4:1 must be evaluated for barrier need.

9. The 3:1 ditch slope is not mandatory. A single backslope may be used starting at the low point of the ditch.

Figure 440.D Rural Freeway/Expressway - With Development to 6 Lanes

N.T.S.



Notes:

1. Shoulder Widths are typically 3.0 m. Exceptions permitted with sign-off by Chief Engineer. See Fig. 440.E for Alternate Shoulder Detail using 50 mm of AP.

2. Rounding or "smoothing" at Break Point to be done during construction.

3. Clear Zone is a function of Speed and Traffic Volume. Clear Zone Width to be in accordance with the requirements in Section 620. Utilities should be located outside of the Clear Zone. The desirable location of utility poles shall be, in order of preference: (a) min. 2 m beyond top of cut, (b) min. 3 m beyond lowest ditch point, (c) min. 3 m beyond toe of fill. See the current edition of the Ministry's utility policy manual for additional placement guidelines.

4. Minimum half-width is 2.8 m from Lane edge to Centreline. Check for SSD along median barrier on curves.

5. Tangent Subgrade may be increased to -0.03 or -0.04 m/m in earth to facilitate drainage, but only when directed by Geotechnical Staff.

6. See Figure 440.F through 440.H for Barrier/Drainage Curb, Retaining Wall and Rock Ditch Details.

7. These are "typical" gravel depths to be used in the absence of a specific Geotechnical recommendation

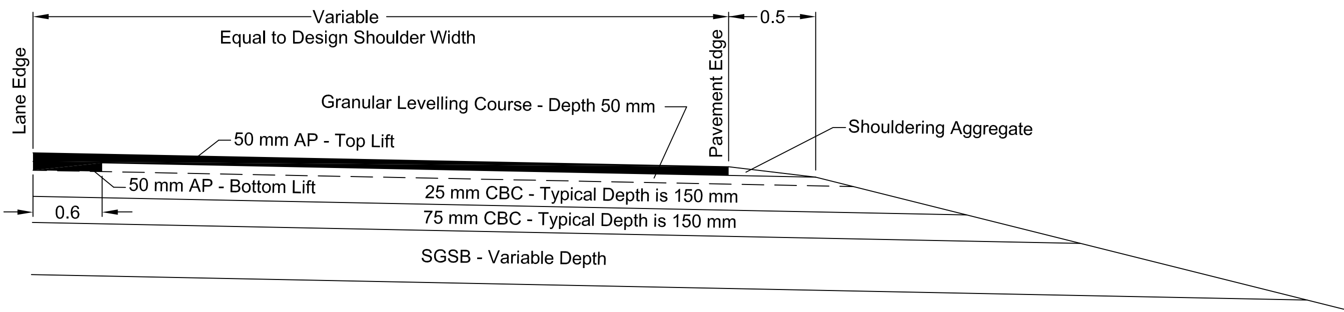
8. Ditch slopes and fill slopes steeper than 4:1 must be evaluated for barrier need.

9. The 3:1 ditch slope is not mandatory. A single backslope may be used starting at the low point of the ditch.

MoT Section	440		TAC Section	Not Applicable

Figure 440.E Alternate Shoulder Detail - Pavement Depth Reduction

N.T.S.



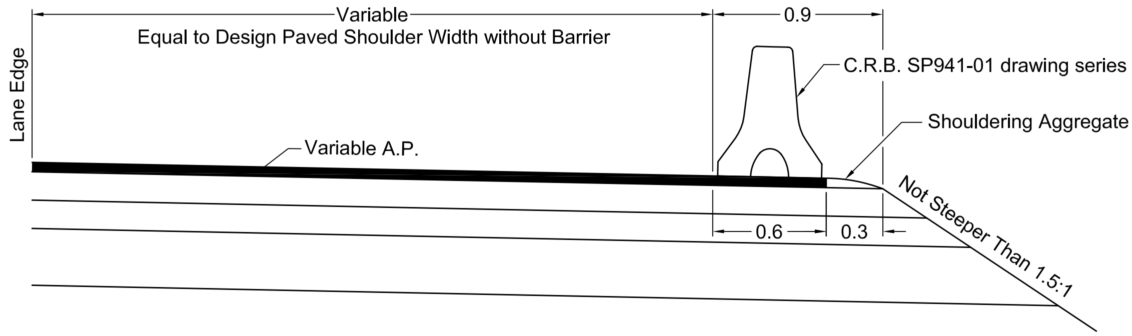
Notes:

1. Pavement depth reduction may not be appropriate for shoulders that are less than 2.5 m, consider using full depth pavement for the entire shoulder.

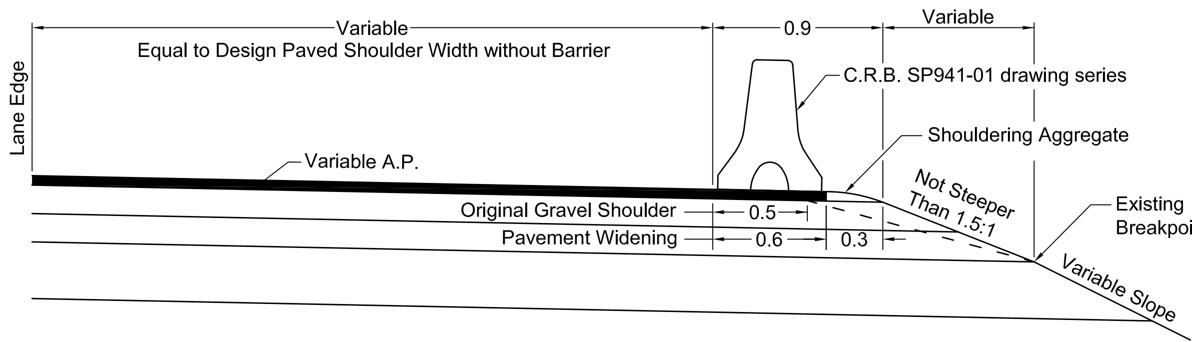
2. Levelling material may be 19 mm Shouldering Aggregate or 25 mm CBC, subject to the ability to properly compact the material.

Figure 440.F Shoulder Detail with Roadside Barrier or Drainage Curb

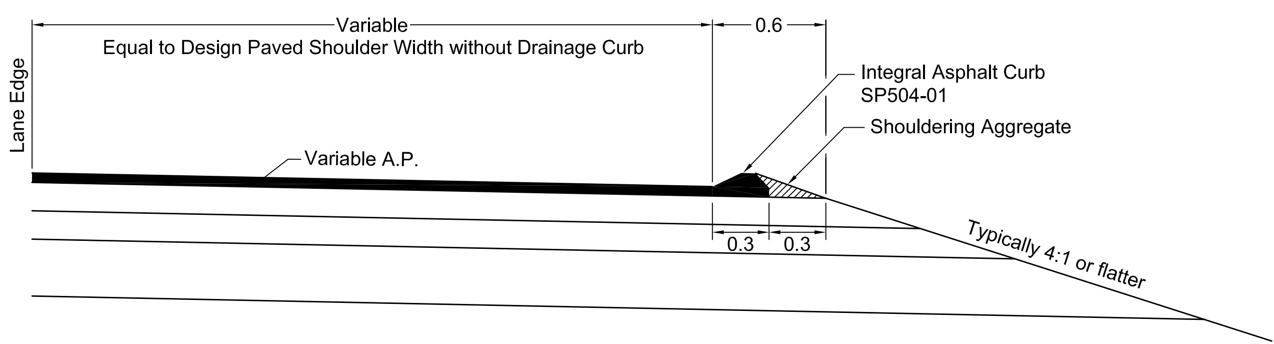
N.T.S.



TYPICAL FOR NEW ROADWAY CONSTRUCTION



TYPICAL FOR WIDENING AN EXISTING ROADWAY



TYPICAL FOR NEW ROADWAY CONSTRUCTION

Notes:

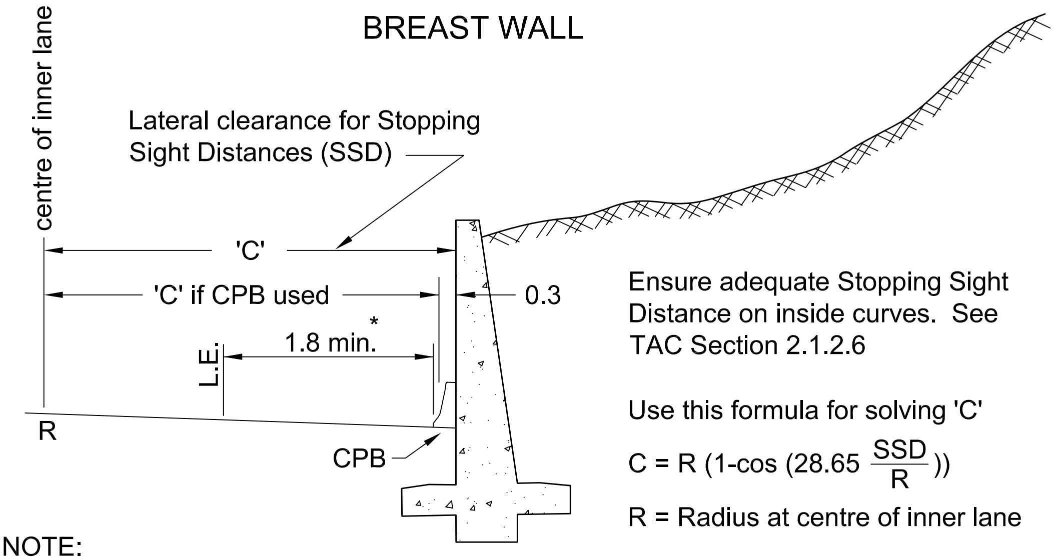
1. Barrier and/or curbing on truck lanes should match the existing shoulder width; however, the width may be up to 1.0 m less than the normal shoulder width, but must be at least 1.5 m wide where cyclists are present or 1.3 m wide where there are no cyclists.

2. Curbing shall not be used behind roadside barrier.

MoT Section	440		TAC Section	Not Applicable

Figure 440.G Typical Wall Sections

N.T.S.



Ensure adequate Stopping Sight Distance on inside curves. See TAC Section 2.1.2.6

Use this formula for solving 'C'

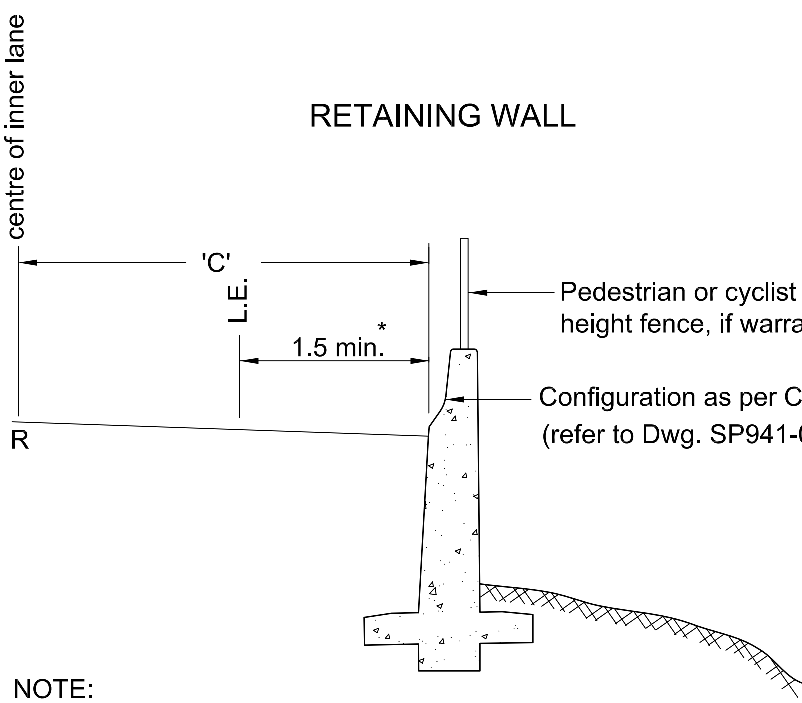
$$C = R\left(1 - \cos\left(28.65\,\frac{SSD}{R}\right)\right)$$

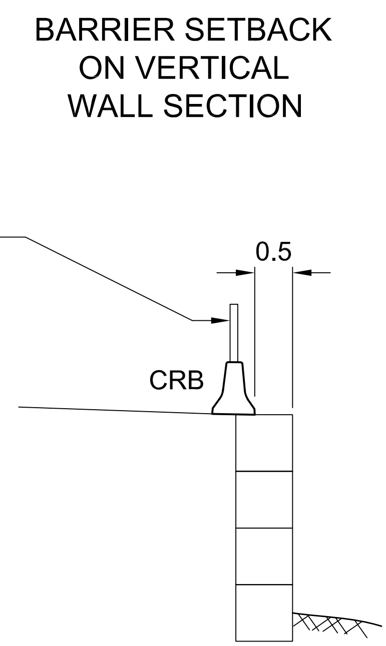
R = Radius at centre of inner lane

NOTE:

The addition of Concrete Pier Barrier (CPB) should be considered when designing a Breast Wall. If CPB is used, the 'C' distance shall be measured to a point 0.3 m from the wall.

(refer to Dwg. SP941-02.01.05 to -02.01.07)





NOTE:

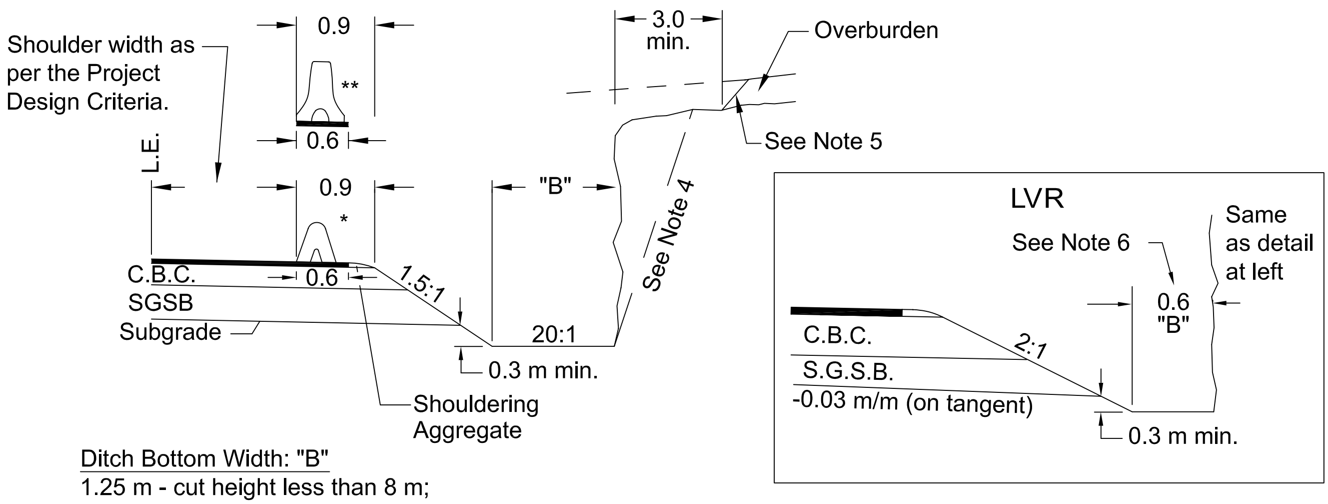
Increase lateral clearance to accomplish SSD.

* Desirable width is the same as the paved shoulder. This drawing is for lateral clearance only. Consult other sources for wall designs.

Figure 440.H Solid Rock Cut Sections

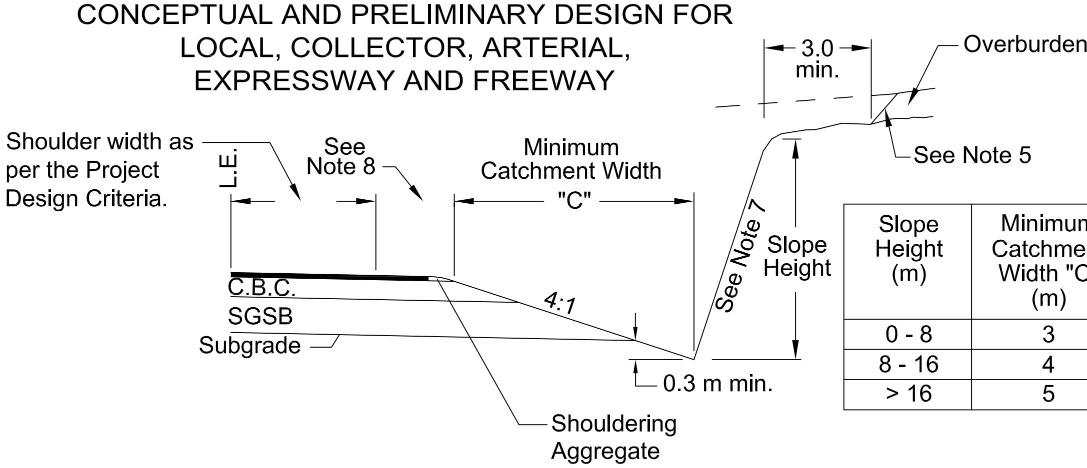
N.T.S.

CONCEPTUAL AND PRELIMINARY DESIGN FOR
LOCAL, COLLECTOR, ARTERIAL,
EXPRESSWAY AND FREEWAY



Ditch Bottom Width: "B"
1.25 m - cut height less than 8 m;
1.25 m - cut height up to 10 m for less than 100 m along alignment;
2.75 m - cut height of 8 m or more except as stated above.
Cut height greater than 8 m requires a Geotechnical site specific design.
* Use on inside curve only. See Standard Specification SP941-01.01 drawing series.
** Use on outside curve or tangent. See Standard Specification SP941-01.02 drawing series.

ALTERNATE
CONCEPTUAL AND PRELIMINARY DESIGN FOR
LOCAL, COLLECTOR, ARTERIAL,
EXPRESSWAY AND FREEWAY



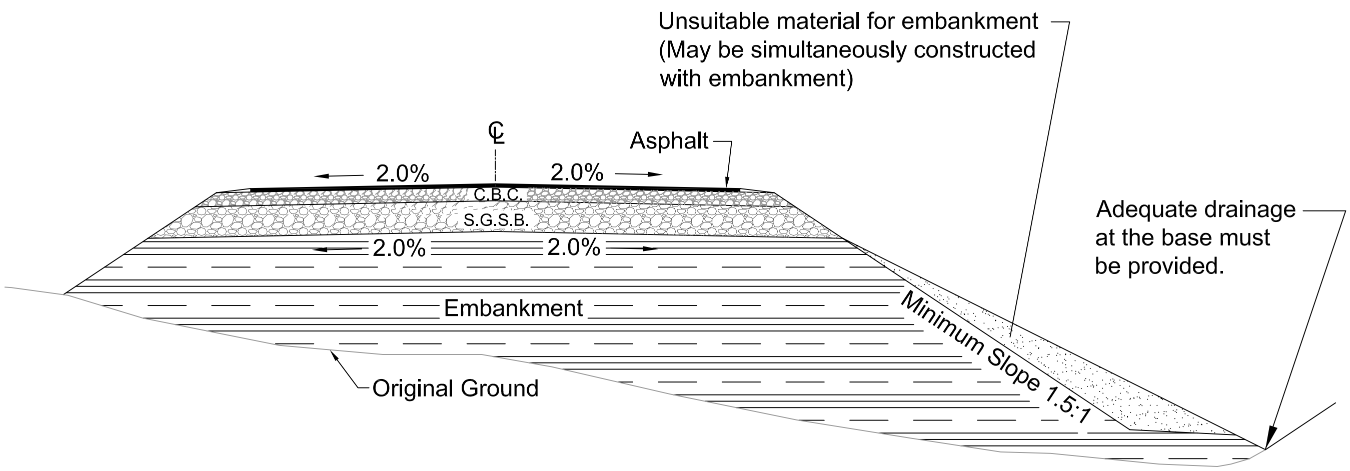
Slope Height (m)	Minimum Catchment Width "C" (m)	Remediation Stabilization Requirement (See Note 9)
0 - 8	3	No
8 - 16	4	Above 10 m
> 16	5	Yes

Notes:
1. Rock cut height is measured from the outside ditch point to the top of the rock face, excluding overburden.
2. All cuts to be excavated to subgrade line.
3. A geotechnical investigation is to be carried out for all cuts greater than 8 m and for all cuts where geohazards may exist (i.e. within or beyond construction cross section limits).
4. Use a vertical backslope unless a flatter slope is recommended in the geotechnical report.
5. Overburden slope is normally 1.5:1, but may vary depending upon the type of material.
6. Increase the "B" dimension to ensure lateral clearance for SSD in curves.
7. Use 0.25:1 backslope unless a different slope is recommended in the geotechnical report.
8. Barrier, clear zone and drainage requirements will be reviewed during the detailed design phase.
9. Remediation/slope stabilization design involves potentially the application of mesh to 10 m above road grade, pattern bolt installation, shotcrete application and/or catch fence/barrier.

MoT Section	440		TAC Section	Not Applicable

Figure 440.I Disposal of Waste Excavation

N.T.S.



Notes:

1. Material considered unsuitable for embankment construction may be disposed within the right-of-way as shown in the diagram.
2. The unsuitable material shall be deposited below the base of the select granular subbase (SGSB) so that SGSB drainage is not compromised.
3. In the case of rock fill embankment, adequate drainage shall be provided through the unsuitable material so that no pore pressure can build up within the rock embankment.
4. The unsuitable material placed on the embankment slope must be stable against sloughing.

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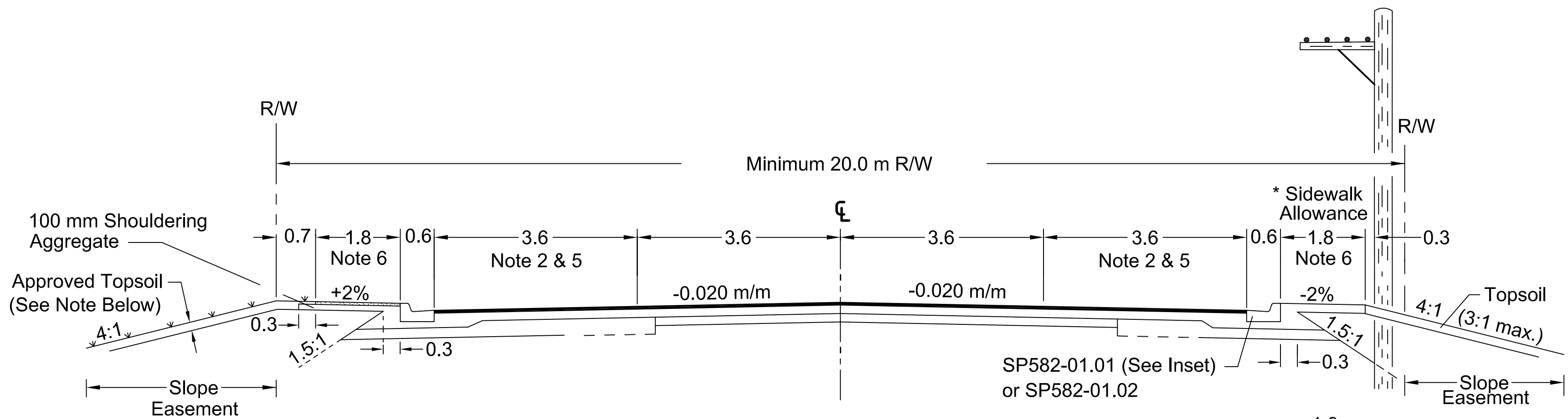
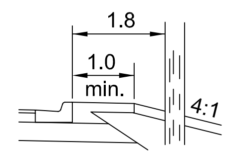
Figure 450.A Typical Urban Fill Section

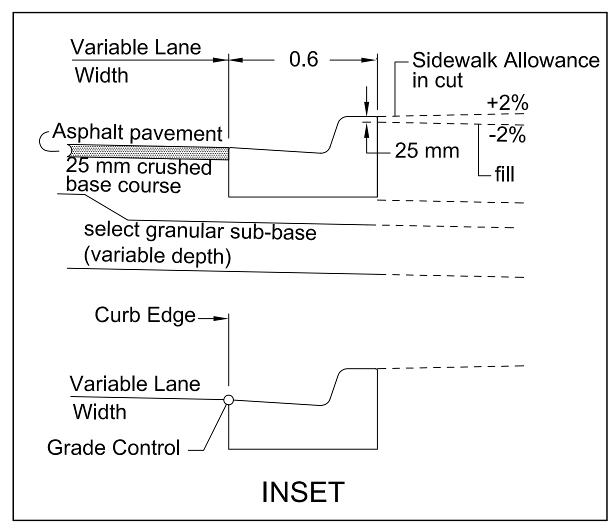
N.T.S.



FILL SECTION



* WITHOUT SIDEWALK ALLOWANCE



SLOPE DETAILS

When slope easements cannot be obtained, construct wall or obtain R/W required to control slope as follows:

- 2:1 when cut/fill is 0.0 m to 3.5 m above/below top of curb
- 1.5:1 when cut/fill is over 3.5 m above/below top of curb

Topsoil all cuts and fills:

- 150 mm depth on slopes 3:1 or flatter
- 100 mm depth on slopes steeper than 3:1

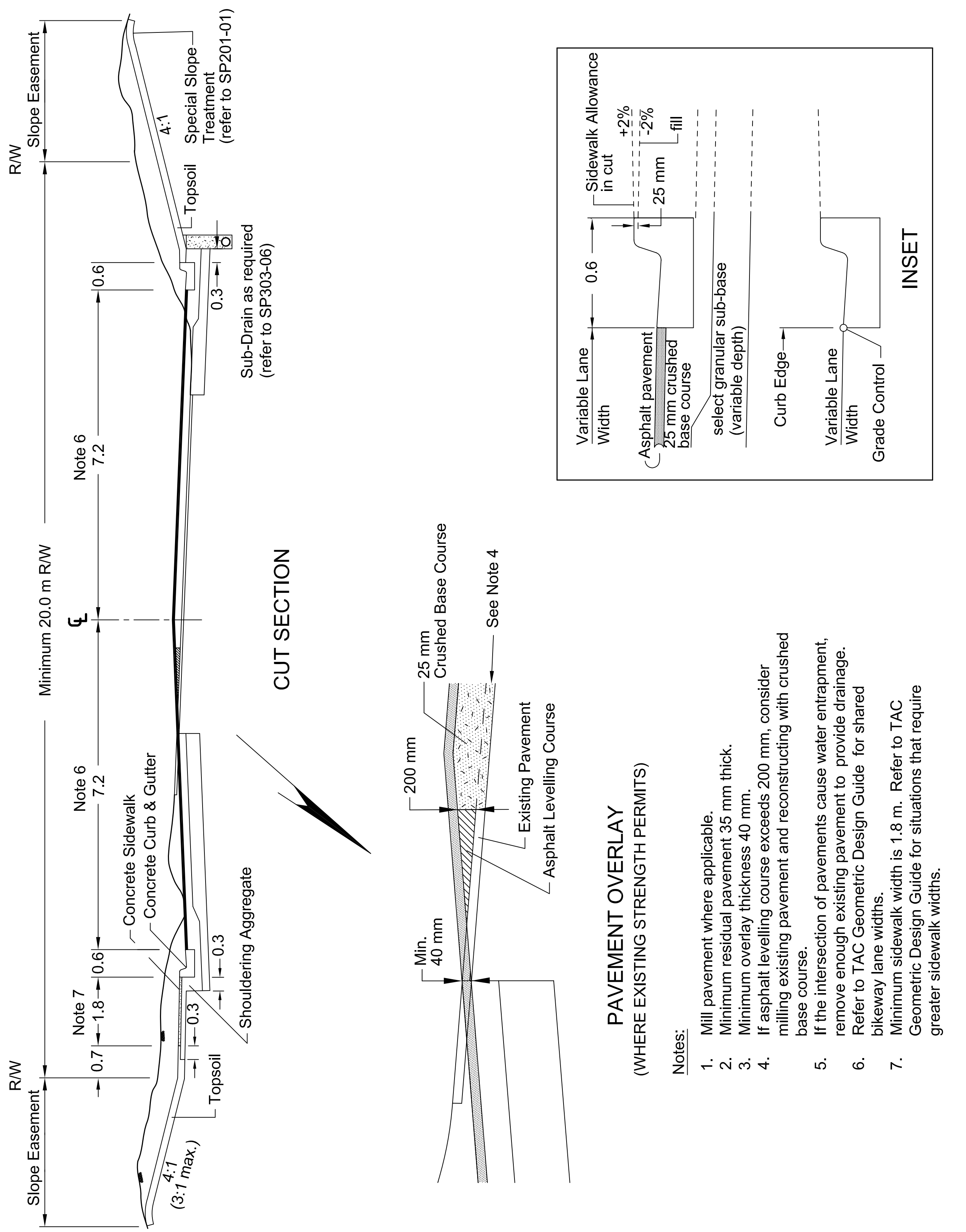
LANE DETAILS

1. Two way left turn lane:
   - used when design speed is 60 km/h or less
   - minimum width 3.6 m
2. Increase outside curb lane to 3.8 m when design speed is 70 km/h
3. Increase inside lane to 4.0 m when adjacent to raised median
4. Parking lane 2.5 m
5. Refer to TAC Geometric Design Guide for shared bikeway lane widths
6. Minimum sidewalk width is 1.8 m. Refer to TAC Geometric Design Guide for situations that require greater sidewalk widths.

MoT Section	450		TAC Section	2.2.13

Figure 450.B Typical Urban Cut Section

N.T.S.



500 LOW-VOLUME ROADS CHAPTER

500 LOW-VOLUME ROADS CHAPTER

TABLES

500 LOW-VOLUME ROADS CHAPTER

FIGURES

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510
LOW-VOLUME ROADS

Where there are existing agreements between the Ministry of Transportation and Highways and other parties, those agreements shall prevail.

510.01 GENERAL

The following is the design policy and practice of the Ministry of Transportation and Highways for Low-volume Roads (referred to as LVRs). The Transportation Association of Canada (TAC) Manual of Geometric Design Standards for Canadian Roads (referred to as the TAC Manual), 1986 Metric Edition may be used to supplement this chapter for design guidelines that cover subject areas on LVRs not covered by this Manual. The reader should consult the TAC Manual, Chapter H, Low-volume Roads and Appendix A, Basis of Standards, pages X26 to X34 for more background information and for design criteria not covered in the Highway Engineering Design Manual.

Definition

A low-volume road (LVR) is a road with an Average Daily Traffic (ADT) not exceeding 200 and whose service functions are oriented toward **rural road systems**.

A low-volume road may be to/or within an **isolated community**, a **recreation** road or a **resource** development road. LVRs do not include subdivision roads design standards.

Traffic Volumes

Daily traffic volumes on LVRs tend to vary significantly due to the seasonal nature of these roads which often are built to serve a single purpose. Use the average daily traffic for a time period corresponding to the season or periods of high use (this will be during summer in most cases; but may be during winter for low-volume roads accessing winter recreation areas such as ski hill access roads).

If the periods of high use are short but numerous (for example, two or three consecutive days for more than twelve times a year), an economic analysis may be required to determine whether to use the LVR or other higher standards.

If official land use planning reports are available, the designer may use future traffic volumes that are contained in these studies. All traffic projections used for design should meet the approval of the Ministry's Regional Planning and Traffic Engineering staff.

The designer should project volumes 20 years after construction to set the design volume. However, if traffic projections are too uncertain to justify the additional cost of using a higher design class, a shorter period such as the 10-year projection may be used. If low growth is expect (1% per year or less), the current ADT is appropriate.

Accommodating Cyclists

Because of the low traffic volumes encountered on LVRs, it is generally not cost-effective to design specifically for bikeways. The time gaps between the arrivals of opposing vehicles are large enough for advancing traffic to easily overtake cyclists by crossing the centerline.

However, in summer recreation areas where there is a documented, constant, heavy cycle traffic, a site specific evaluation may be undertaken to evaluate if the cycling traffic can be accommodated safely and cost effectively. Where the need for bikeways on LVRs is justified consult Table 910.A for bikeway design widths A bikeway should not be designed for a gravel road.

Most LVRs are designed for speeds of 80 km/h or higher. For these and for the few LVRs designed for 60 or 70 km/h, the shoulder bikeway is adequate. For the occasional LVR designed for 50 km/h or less, the 4.0 m shared roadway lanes (paved) may be used.

For further information on Bikeway Standards, refer to Section 910 of this manual.

510.02 TYPES OF LVRS

LVRs are categorized by TAC according to their traffic and land services:

Category A: Rural road system and roads to and within isolated communities. These roads serve both functions of providing direct access to adjacent properties and access to land in low density remote areas.

Category B: Recreational roads. These provide access to provincial and federal parks and resort developments.

Category C: Resource development roads. These roads provide a link from remote resource development areas to the provincial highway system and ports or railheads. They do not include private access roads and logging roads within a tree farm license which come under the jurisdiction of the Ministry of Forests.

In selecting design criteria for a particular LVR, the designer should consider its main service function. Should the road serve more than one function, the design standard corresponding to the highest service function should be used.

510.03 DESIGN SPEED

The single most important design decision for a LVR is the selection of the design speed. The width of the LVR is dependent on the design speed as are significant characteristics of the vertical and horizontal alignments.

In selecting the design speed, the designer should consider driver's expectations. Driver's expectations are governed by several factors such as the type of terrain, the road service function or category and the trip length.

For example: For a particular "Category A" road that provides short distance access from the highway system to a few farms in mountainous terrain, operating speeds of 30 to 70 km/h may be adequate. If the terrain is flat and the farms are spaced far in between, say one kilometre or more, a design speed of 80 or 90 km/h may be more appropriate to match drivers' expectations. Although both cases fall in the same service function, the choices for design speed are significantly different, so are the resulting alignments. A wrong selection of the design speed may have serious consequences to the construction and operational costs and the safety of road users. Table 510.A, following, gives a range of design speeds for various functions.

Table 510.A Design Speeds for Low-volume Roads

Service Type	Design Speed
Category A: Rural road systems and roads to or within isolated communities	30 - 90 (see note)
Category B: Recreational roads	
– primary	50 - 90 (see note)
– perimeter	30 - 80 (see note)
– internal	30 - 50 (see note)
Category C: Resource development roads	30 - 90 (see note)

Note:

Most LVRs serve a mix of short and long distance trips and have a legal speed limit at 80 km/h. Therefore, the design speed for LVRs should be 80 km/h or higher in most instances; particularly roads serving trips in excess of 5 kilometres in length and resource access roads used by heavy truck traffic in excess of 15 trucks per day. **The designer should not use design speeds less than 80 km/h without specific approval by the Regional Director or the project Technical Review Committee.** A typical road designed at less than 80 km/h, would be a short, discontinuous road less than 5 kilometres serving local, short distance trips.

510.04 ALIGNMENT ELEMENTS

For a general discussion on the basis for alignment elements, refer to Chapter 300 of this manual and Appendix A of the TAC design manual. The following is a brief listing of parameter values for alignment elements that are specific to LVRs.

Sight Distance

1) Stopping Sight Distance

The minimum SSD is similar to that of other roads (see Section 320.02 in this manual) and is listed in Table 510.B for the range of design speeds used for LVRs. Friction values for gravel roads are taken to be the same as that for pavements in poor condition under wet conditions. Table 510.C shows SSD corrections for various grades.

Table 510.B Min. SSD Low-volume Roads

Design Speed (km/h)	Minimum SSD (m)
30	30
40	45
50	65
60	85
70	110
80	140
90	170

Table 510.C SSD Corrections for Various Grades

Design Speed (km/h)	Decrease for Upgrade of: (m)					Increase for Downgrade of: (m)				
	3%	6%	9%	12%	14%	3%	6%	9%	12%	14%
30	0	0	0	0	0	0	0	5	5	5
40	0	0	5	5	5	0	5	5	10	10
50	5	5	10	10	10	0	5	10	15	20
60	5	5	10	10	*	5	10	15	25	*
70	5	10	15	15	*	5	10	20	35	*
80	10	15	20	*	*	10	15	30	*	*
90	10	20	25	*	*	10	20	40	*	*

(*) These grades are outside the range for LVR design (Refer to Table 350.A for maximum grades on LVRs.)

2) Minimum Passing Sight Distance (PSD)

Refer to Section 320.03 for a discussion of Passing Sight Distance. On two-lane two-way LVRs, the passing sight distance is not considered to be a crucial minimum design element. However, it is recommended and desirable to provide PSD as often as economically feasible on low-volume roads, most of which serve long distance trips and have a design speed of 80 km/h or higher. Table 510.D below gives the passing sight distances for LVRs.

To reduce opportunities for unsafe passing maneuvers on long sections without PSD, the designer may consider providing slow moving vehicle pull-outs.

Table 510.D Min. PSD Low-volume Roads

Design Speed km/h	PSD m
30	250
40	290
50	340
60	420
70	480
80	560
90	620

3) Decision Sight Distance (DSD)

Decision sight distance (DSD) is not a requirement which is cost-effective on LVRs. See Section 320.04 for discussion of DSD. DSD should be considered, particularly near intersections, if no additional costs are incurred.

510.05 HORIZONTAL ALIGNMENT

The same principles are used for LVRs as for two lane roads of higher classification. Refer to Section 330 for a general discussion on horizontal alignment.

Side friction factors for gravel roads are taken to be the same as the side friction factors for wet pavement conditions. Table 330.A gives the maximum values for safe side friction for speeds of 40 km/h and higher. The maximum side friction value used for a design speed of 30 km/h is 0.17.

Design superelevation rates are discussed in Section 330. The normal cross fall is 0.02 m/m on paved roads and 0.04 m/m on gravel roads. Maximum superelevation rates of 0.06 or 0.08 are used on LVRs.

Figures 510.E and 510.F show the superelevation and minimum spiral lengths where a maximum superelevation of 0.06 is used on LVRs with a normal cross fall of 0.02 and 0.04 respectively. Figures 510.G and 510.H are for a maximum superelevation of 0.08.

For consistency, use the same chart for all horizontal curves on the same highway or homogenous road section. A homogenous road section starts and ends when there is a clear break in the driving environment. This may happen at a major junction, a destination point such as a populated settlement or a major change in topography.

Intersections and accesses should not be located on curves which have a superelevation higher than 0.06.

On LVRs which are designed for speeds greater than 40 km/h, spirals should be used. For design speeds of 30 and 40 km/h, the use of spirals is optional. Refer to the TAC Figure H.3.3.1 for development of superelevation without spirals and Figure H.3.3.2 for development with spirals.

Figure 510.E Superelevation Chart for E Max. 0.06 m/m Normal Crown 0.02 m/m For Paved Roads

Speed	30		40		50		60		70		80		90		
Radius	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	Radius
8000	NC		NC		NC		NC		NC		NC		NC		8000
5000	NC		NC		NC		NC		NC		NC		NC		5000
3000	NC		NC		NC		NC		NC		RC	40	RC	50	3000
2000	NC		NC		NC		NC		RC	40	RC	40	0.023	50	2000
1500	NC		NC		NC		RC	40	0.020	40	0.024	40	0.029	50	1500
1200	NC		NC		NC		RC	40	0.023	40	0.028	40	0.033	50	1200
1000	NC		NC		RC	30	0.021	40	0.027	40	0.032	40	0.037	50	1000
900	NC		NC		RC	30	0.023	40	0.028	40	0.034	40	0.039	50	900
800	NC		NC		RC	30	0.025	40	0.031	40	0.036	40	0.042	50	800
700	NC		NC		0.021	30	0.027	40	0.033	40	0.039	40	0.045	50	700
650	NC		RC	30	0.022	30	0.029	40	0.035	40	0.041	40	0.046	50	650
600	NC		RC	30	0.023	30	0.030	40	0.037	40	0.042	40	0.048	50	600
550	NC		RC	30	0.025	30	0.032	40	0.038	40	0.044	40	0.050	50	550
525	NC		RC	30	0.026	30	0.033	40	0.039	40	0.045	40	0.051	50	525
500	NC		RC	30	0.027	30	0.034	40	0.040	40	0.046	40	0.052	50	500
475	NC		0.020	30	0.028	30	0.035	40	0.041	40	0.047	40	0.053	60	475
450	NC		0.021	30	0.029	30	0.036	40	0.043	40	0.049	50	0.054	60	450
425	NC		0.022	30	0.030	30	0.037	40	0.044	40	0.050	50	0.055	60	425
400	NC		0.023	30	0.031	30	0.038	40	0.045	40	0.051	50	0.057	70	400
380	RC	30	0.024	30	0.032	30	0.039	40	0.046	40	0.052	50	0.058	70	380
360	RC	30	0.025	30	0.033	30	0.041	40	0.047	40	0.053	50	0.059	70	360
340	RC	30	0.026	30	0.034	30	0.042	40	0.048	40	0.054	50	0.060	80	340
320	RC	30	0.027	30	0.035	30	0.043	40	0.050	40	0.056	60	Min R 340m		
300	RC	30	0.028	30	0.037	30	0.044	40	0.051	40	0.057	60			
290	RC	30	0.028	30	0.037	30	0.045	40	0.052	40	0.057	60			
280	RC	30	0.029	30	0.038	30	0.046	40	0.052	50	0.058	70			
270	0.020	30	0.030	30	0.039	30	0.047	40	0.053	50	0.059	70			
260	0.020	30	0.030	30	0.040	30	0.047	40	0.054	50	0.059	70			
250	0.021	30	0.031	30	0.040	30	0.048	40	0.055	50	0.060	70			
240	0.022	30	0.032	30	0.041	30	0.049	40	0.055	50	Min R 250m				
230	0.022	30	0.033	30	0.042	30	0.050	40	0.056	60					
220	0.023	30	0.034	30	0.043	30	0.051	40	0.057	60					
210	0.024	30	0.035	30	0.044	30	0.052	40	0.058	60					
200	0.025	30	0.036	30	0.045	30	0.053	40	0.059	60					
190	0.026	30	0.037	30	0.046	30	0.054	40	0.060	70					
180	0.027	30	0.038	30	0.047	40	0.055	40	Min R 190m						
170	0.028	30	0.039	30	0.048	40	0.056	50							
160	0.029	30	0.040	30	0.049	40	0.057	50							
150	0.030	30	0.041	30	0.051	40	0.058	50							
145	0.031	30	0.042	30	0.051	40	0.059	50							
140	0.031	30	0.043	30	0.052	40	0.059	50							
135	0.032	30	0.044	30	0.053	40	0.060	60							
130	0.033	30	0.044	30	0.054	40	Min R 135m								
125	0.033	30	0.045	30	0.054	40									
120	0.034	30	0.046	30	0.055	40									
115	0.035	30	0.047	30	0.056	40									
110	0.036	30	0.048	30	0.057	40									
105	0.037	30	0.049	30	0.057	50									
100	0.038	30	0.050	30	0.058	50									
95	0.039	30	0.051	30	0.059	50									
90	0.040	30	0.052	40	0.060	50									
85	0.041	30	0.053	40	Min R 90m										
80	0.042	30	0.054	40											
75	0.044	30	0.055	40											
70	0.045	30	0.056	40											
65	0.047	30	0.058	40											
60	0.048	30	0.059	40											
55	0.050	30	0.060	40											
50	0.052	30	Min R 55m												
45	0.054	30													
40	0.056	30													
35	0.058	30													
30	0.060	30													
	Min R 30m														

Figure510.F Superelevation Chart for E Max. 0.06 m/m Normal Crown 0.04 m/m For Gravel Surfaces

Speed	30		40		50		60		70		80		90		
Radius	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	Radius
8000	NC		NC		NC		NC		NC		NC		NC		8000
5000	NC		NC		NC		NC		NC		NC		RC		5000
3000	NC		NC		NC		NC		RC	40	RC	40	RC	50	3000
2000	NC		NC		NC		RC	40	RC	40	RC	40	RC	50	2000
1500	NC		NC		RC	30	RC	40	RC	40	RC	40	RC	50	1500
1200	NC		NC		RC	30	RC	40	RC	40	RC	40	RC	50	1200
1000	NC		NC		RC	30	RC	40	RC	40	RC	40	RC	50	1000
900	NC		RC	30	RC	30	RC	40	RC	40	RC	40	RC	50	900
800	NC		RC	30	RC	30	RC	40	RC	40	RC	40	0.042	50	800
700	NC		RC	30	RC	30	RC	40	RC	40	RC	40	0.045	50	700
650	NC		RC	30	RC	30	RC	40	RC	40	0.041	40	0.046	50	650
600	NC		RC	30	RC	30	RC	40	RC	40	0.042	40	0.048	506	00
550	RC	30	RC	30	RC	30	RC	40	RC	40	0.044	40	0.050	5	550
525	RC	30	RC	30	RC	30	RC	40	RC	40	0.045	40	0.051	50	525
500	RC	30	RC	30	RC	30	RC	40	RC	40	0.046	40	0.052	50	500
475	RC	30	RC	30	RC	30	RC	40	0.041	40	0.047	40	0.053	60	475
450	RC	30	RC	30	RC	30	RC	40	0.043	40	0.049	50	0.054	60	450
425	RC	30	RC	30	RC	30	RC	40	0.044	40	0.050	50	0.055	60	425
400	RC	30	RC	30	RC	30	RC	40	0.045	40	0.051	50	0.057	70	400
380	RC	30	RC	30	RC	30	RC	40	0.046	40	0.052	50	0.058	70	380
360	RC	30	RC	30	RC	30	0.041	40	0.047	40	0.053	50	0.059	70	360
340	RC	30	RC	30	RC	30	0.042	40	0.048	40	0.054	50	0.060	80	340
320	RC	30	RC	30	RC	30	0.043	40	0.050	40	0.056	60	**Min R 340m**		
300	RC	30	RC	30	RC	30	0.044	40	0.051	40	0.057	60			
290	RC	30	RC	30	RC	30	0.045	40	0.052	40	0.057	60			
280	RC	30	RC	30	RC	30	0.046	40	0.052	50	0.058	70			
270	RC	30	RC	30	RC	30	0.047	40	0.053	50	0.059	70			
260	RC	30	RC	30	RC	30	0.047	40	0.054	50	0.059	70			
250	RC	30	RC	30	RC	30	0.048	40	0.055	50	0.060	70			
240	RC	30	RC	30	0.041	30	0.049	40	0.055	50	**Min R 250m**				
230	RC	30	RC	30	0.042	30	0.050	40	0.056	60					
220	RC	30	RC	30	0.043	30	0.051	40	0.057	60					
210	RC	30	RC	30	0.044	30	0.052	40	0.058	60					
200	RC	30	RC	30	0.045	30	0.053	40	0.059	60					
190	RC	30	RC	30	0.046	30	0.054	40	0.060	70					
180	RC	30	RC	30	0.047	40	0.055	50	**Min R 190m**						
170	RC	30	RC	30	0.048	40	0.056	50							
160	RC	30	RC	30	0.049	40	0.057	50							
150	RC	30	0.041	30	0.051	40	0.058	50							
145	RC	30	0.042	30	0.051	40	0.059	50							
140	RC	30	0.043	30	0.052	40	0.059	50							
135	RC	30	0.044	30	0.053	40	0.060	60							
130	RC	30	0.044	30	0.054	40	**Min R 135m**								
125	RC	30	0.045	30	0.054	40									
120	RC	30	0.046	30	0.055	40									
115	RC	30	0.047	30	0.056	40									
110	RC	30	0.048	30	0.057	40									
105	RC	30	0.049	30	0.057	50									
100	RC	30	0.050	30	0.058	50									
95	RC	30	0.051	30	0.059	50									
90	RC	30	0.052	40	0.060	50									
85	0.041	30	0.053	40	**Min R 90m**										
80	0.042	30	0.054	40											
75	0.044	30	0.055	40											
70	0.045	30	0.056	40											
65	0.047	30	0.058	40											
60	0.048	30	0.059	40											
55	0.050	30	0.060	40											
50	0.052	30	**Min R 55m**												
45	0.054	30													
40	0.056	30													
35	0.058	30													
30	0.060	30													
	Min R 30m														

Figure 510.G Superelevation Chart for E Max. 0.08 m/m Normal Crown 0.02 m/m For Paved Roads

Speed	30		40		50		60		70		80		90		
Radius	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	Radius
8000	NC		NC		NC		NC		NC		NC		NC		8000
5000	NC		NC		NC		NC		NC		NC		NC		5000
3000	NC		NC		NC		NC		RC	40	RC	40	RC	50	3000
2000	NC		NC		NC		RC	40	RC	40	0.021	40	0.026	50	2000
1500	NC		NC		RC	30	RC	40	0.021	40	0.027	40	0.032	50	1500
1200	NC		NC		RC	30	0.020	40	0.026	40	0.031	40	0.038	50	1200
1000	NC		NC		RC	30	0.023	40	0.029	40	0.036	40	0.043	50	1000
900	NC		RC	30	RC	30	0.025	40	0.032	40	0.039	40	0.046	50	900
800	NC		RC	30	0.020	30	0.027	40	0.035	40	0.042	40	0.049	50	800
700	NC		RC	30	0.023	30	0.030	40	0.038	40	0.046	40	0.053	50	700
650	NC		RC	30	0.024	30	0.032	40	0.040	40	0.048	40	0.056	50	650
600	NC		RC	30	0.026	30	0.034	40	0.042	40	0.050	40	0.058	50	600
550	NC		RC	30	0.028	30	0.036	40	0.045	40	0.053	40	0.061	50	550
525	NC		RC	30	0.029	30	0.037	40	0.046	40	0.054	40	0.063	50	525
500	NC		0.021	30	0.030	30	0.039	40	0.048	40	0.056	50	0.064	50	500
475	NC		0.022	30	0.031	30	0.040	40	0.049	40	0.058	50	0.066	60	475
450	NC		0.023	30	0.032	30	0.042	40	0.051	40	0.059	50	0.068	60	450
425	NC		0.024	30	0.033	30	0.043	40	0.052	40	0.061	50	0.069	60	425
400	NC		0.025	30	0.035	30	0.045	40	0.054	40	0.063	50	0.071	70	400
380	RC	30	0.026	30	0.036	30	0.046	40	0.056	40	0.065	50	0.073	70	380
360	RC	30	0.027	30	0.038	30	0.048	40	0.057	40	0.066	50	0.075	70	360
340	RC	30	0.028	30	0.039	30	0.050	40	0.059	40	0.068	60	0.077	80	340
320	RC	30	0.029	30	0.041	30	0.051	40	0.061	40	0.070	60	0.078	80	320
300	RC	30	0.031	30	0.042	30	0.053	40	0.063	50	0.072	60	0.080	90	300
290	0.020	30	0.032	30	0.043	30	0.054	40	0.064	50	0.073	70	**Min R 300m**		
280	0.021	30	0.033	30	0.044	30	0.055	40	0.065	50	0.074	70			
270	0.021	30	0.033	30	0.045	30	0.056	40	0.066	50	0.075	70			
260	0.022	30	0.034	30	0.046	30	0.058	40	0.068	50	0.076	70			
250	0.023	30	0.035	30	0.048	30	0.059	40	0.069	50	0.077	70			
240	0.024	30	0.036	30	0.049	30	0.060	40	0.070	50	0.079	80			
230	0.024	30	0.037	30	0.050	40	0.061	40	0.071	60	0.080	80			
220	0.025	30	0.039	30	0.051	40	0.063	40	0.073	60	**Min R 230m**				
210	0.026	30	0.040	30	0.053	40	0.064	40	0.074	60					
200	0.027	30	0.041	30	0.054	40	0.066	40	0.075	60					
190	0.028	30	0.042	30	0.056	40	0.067	40	0.077	70					
180	0.029	30	0.044	30	0.057	50	0.069	50	0.078	70					
170	0.031	30	0.045	30	0.059	50	0.070	50	0.080	70					
160	0.032	30	0.047	30	0.061	50	0.072	50	**Min R 170m**						
150	0.034	30	0.049	30	0.063	50	0.074	50							
145	0.035	30	0.050	30	0.064	50	0.075	60							
140	0.035	30	0.051	30	0.065	50	0.076	60							
135	0.036	30	0.052	30	0.066	50	0.077	60							
130	0.037	30	0.053	30	0.067	50	0.078	60							
125	0.038	30	0.054	30	0.068	50	0.079	60							
120	0.039	30	0.055	30	0.069	50	0.080	70							
115	0.040	30	0.057	30	0.071	50	**Min R 120m**								
110	0.042	30	0.058	30	0.072	50									
105	0.043	30	0.059	30	0.073	50									
100	0.044	30	0.061	30	0.075	50									
95	0.046	30	0.062	30	0.076	60									
90	0.047	30	0.064	40	0.078	60									
85	0.049	30	0.066	40	0.079	60									
80	0.051	30	0.067	40	0.080	60									
75	0.052	30	0.069	40	**Min R 80m**										
70	0.054	30	0.071	40											
65	0.057	30	0.073	40											
60	0.059	30	0.075	40											
55	0.061	30	0.078	40											
50	0.064	30	0.080	40											
45	0.067	30	**Min R 50m**												
40	0.071	30													
35	0.074	30													
30	0.080	30													
	Min R 30m														

Figure 510.H Superelevation Chart for E Max 0.08 m/m Normal Crown 0.04 m/m For Gravel Surfaces

Speed	30		40		50		60		70		80		90		
Radius	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	Radius
8000	NC		NC		NC		NC		NC		NC		NC		8000
5000	NC		NC		NC		NC		NC		NC		RC		5000
3000	NC		NC		NC		NC		RC	40	RC	40	RC	50	3000
2000	NC		NC		NC		RC	40	RC	40	RC	40	RC	50	2000
1500	NC		NC		RC	30	RC	40	RC	40	RC	40	RC	50	1500
1200	NC		NC		RC	30	RC	40	RC	40	RC	40	RC	50	1200
1000	NC		NC		RC	30	RC	40	RC	40	RC	40	0.043	50	1000
900	NC		RC	30	RC	30	RC	40	RC	40	RC	40	0.046	50	900
800	NC		RC	30	RC	30	RC	40	RC	40	0.042	40	0.049	50	800
700	NC		RC	30	RC	30	RC	40	RC	40	0.046	40	0.053	50	700
650	NC		RC	30	RC	30	RC	40	0.040	40	0.048	40	0.056	50	650
600	NC		RC	30	RC	30	RC	40	0.042	40	0.050	40	0.058	50	600
550	RC	30	RC	30	RC	30	RC	40	0.045	40	0.053	40	0.061	50	550
525	RC	30	RC	30	RC	30	RC	40	0.046	40	0.054	40	0.063	50	525
500	RC	30	RC	30	RC	30	RC	40	0.048	40	0.056	50	0.064	50	500
475	RC	30	RC	30	RC	0	0.040	40	0.049	40	0.058	50	0.066	60	475
450	RC	30	RC	30	RC	30	0.042	40	0.051	40	0.059	50	0.068	60	450
425	RC	30	RC	30	RC	30	0.043	40	0.052	40	0.061	50	0.069	60	425
400	RC	30	RC	30	RC	30	0.045	40	0.054	40	0.063	50	0.071	70	400
380	RC	30	RC	30	RC	30	0.046	40	0.056	40	0.065	50	0.073	70	380
360	RC	30	RC	30	RC	30	0.048	40	0.057	40	0.066	50	0.075	70	360
340	RC	30	RC	30	RC	30	0.050	40	0.059	40	0.068	60	0.077	80	340
320	RC	30	RC	30	0.041	30	0.051	40	0.061	40	0.070	60	0.078	80	320
300	RC	30	RC	30	0.042	30	0.053	40	0.063	50	0.072	60	0.080	90	300
290	RC	30	RC	30	0.043	30	0.054	40	0.064	50	0.073	70	**Min R 300m**		
280	RC	30	RC	30	0.044	30	0.055	40	0.065	50	0.074	70			
270	RC	30	RC	30	0.045	30	0.056	40	0.066	50	0.075	70			
260	RC	30	RC	30	0.046	30	0.058	40	0.068	50	0.076	70			
250	RC	30	RC	30	0.048	30	0.059	40	0.069	50	0.077	70			
240	RC	30	RC	30	0.049	30	0.060	40	0.070	50	0.079	80			
230	RC	30	RC	30	0.050	40	0.061	40	0.071	60	0.080	80			
220	RC	30	RC	30	0.051	40	0.063	40	0.073	60	**Min R 250m**				
210	RC	30	RC	30	0.053	40	0.064	40	0.074	60					
200	RC	30	RC	30	0.054	40	0.066	40	0.075	60					
190	RC	30	RC	30	0.056	40	0.067	40	0.077	70					
180	RC	30	RC	30	0.057	50	0.069	50	0.078	70					
170	RC	30	RC	30	0.059	50	0.070	50	0.080	70					
160	RC	30	RC	30	0.061	50	0.072	50	**Min R 170m**						
150	RC	30	0.049	30	0.063	50	0.074	50							
145	RC	30	0.050	30	0.064	50	0.075	60							
140	RC	30	0.051	30	0.065	50	0.076	60							
135	RC	30	0.052	30	0.066	50	0.077	60							
130	RC	30	0.053	30	0.067	50	0.078	60							
125	RC	30	0.054	30	0.068	50	0.079	60							
120	RC	30	0.055	30	0.069	50	0.080	70							
115	0.040	30	0.057	30	0.071	50	**Min R 120m**								
110	0.042	30	0.058	30	0.072	50									
105	0.043	30	0.059	30	0.073	50									
100	0.044	30	0.061	30	0.075	50									
95	0.046	30	0.062	30	0.076	60									
90	0.047	30	0.064	40	0.078	60									
85	0.049	30	0.066	40	0.079	60									
80	0.051	30	0.067	40	0.080	60									
75	0.052	30	0.069	40	**Min R 80m**										
70	0.054	30	0.071	40											
65	0.057	30	0.073	40											
60	0.059	30	0.075	40											
55	0.061	30	0.078	40											
50	0.064	30	0.080	40											
45	0.067	30	**Min R 55m**												
40	0.071	30													
35	0.074	30													
30	0.079	30													
	Min R 30m														

510.06 VERTICAL ALIGNMENT

Refer to Table 350.A for maximum grades and Section 370 for limit conditions when minimum radii are used in combination with maximum grades.

Crest vertical curves are designed for SSD using 1.05 m for the height of driver's eye and 150 mm for the fixed object height.

Sag vertical curves are designed for SSD using the headlight control criteria.

See Table 510.I for minimum K values for Sag and Crest Vertical Curves on LVRs.

The minimum length of vertical curve should be equal to the Design Speed.

Table 510.I Vertical Curves on LVRs

Design Speed	Minimum SSD	Minimum Curve K	
km/h	m	Sag	Crest
30	30	4	3
40	45	7	5
50	65	12	11
60	85	17	18
70	110	24	30
80	140	32	50
90	170	40	90

510.07 CROSS SECTION ELEMENTS

Cross-section Types

The majority of LVRs built in British Columbia are two-lane, two-way LVRs. One-lane LVRs are very seldom designed and are, therefore, not covered in this chapter.

The designer should not design a one-lane LVR without the approval of the Chief Highway Engineer or the Regional Manager of Professional Services. Refer to the TAC Manual, Chapter H for additional design guidelines on One-lane LVRs.

A) Two-lane LVRs

The roadway widths are dependent on the design speed, the amount of truck traffic and the type of surface. The shoulder width is the minimum that will provide lateral support for the pavement. There is no allowance for emergency parking as there are ample gaps in the opposing traffic stream to permit a safe passage around parked vehicles.

B) One-lane LVRs

One-lane LVRs are not common but they may be suitable in very special circumstances when the R/W is limited, such as in very rough terrain. One-lane LVRs can be designed for one-way or two-way traffic.

Cross Section Elements for LVRs (also refer to Figure 510.P, page 510-14)

Refer to Figure 510.P with these two tables.

Table 510.J Cross Section Elements for Two-lane LVRs - Gravel Top

Design Speed (km/h)	Roadway Width[1] (m)		Normal X-Fall (m/m)	Fill Slope[2]
	ADTT > 15[3]	ADTT < 15[3]		
80 - 90	8.0	7.5[4]	0.04	2:1
30 - 70[5]	7.5[4]	7.0[4]	0.04	2:1

Table 510.K Cross Section Elements for Two-lane LVRs - Paved Top

Design Speed (km/h)	Lane Width[1] (m)		Unpaved[1] Shoulder (m)	Normal X-Fall (m/m)	Fill Slope[2]
	ADTT > 15[3]	ADTT < 15[3]			
80 - 90	3.6	3.5	0.5	0.02	2:1
50 - 60 - 70[5]	3.5	3.25[4]	0.5	0.02	2:1
30 - 40[5]	3.25[4]	3.25[4]	0.5	0.02	2:1

(1) Where CRB is used, widen the roadway or pavement by 0.6 m on the barrier side of the roadway.

(2) In mountainous terrain, when fill heights exceed 3.0 metres or when environmental, R/W or other economic constraints dictate, a slope of 1.5:1 may be appropriate. For high fill heights the traffic barrier warrant should be examined. Maximum side slopes of 1.25:1 are suggested for rock grading.

Maximum back slopes of 1.5:1 are suggested for earth grading if the stability of local soils permits. For cut sections in solid rock, refer to the appropriate drawing in Chapter 400.

(3) A truck is defined as a single unit (SU9) or larger vehicle. See the Design Vehicle Section in this Manual.

(4) To avoid shoulder degradation on paved LVRs and crossing of centreline on gravel LVRs, these widths should be increased on curves. The amount of additional widening is related to curvature and speed. See the Cross Section Chapter of the TAC Design Manual for discussion.

(5) Approval from the Regional Director or the project Technical Review Committee is required for design speeds less than 80 km/h.

510.08 CLEAR ZONE

There is no clear zone applied to LVRs with regards to slope treatment. However, the utility pole offset is applied. Utility poles must be placed within 2 m of the R/W or 3 m from the toe of fill which ever gives the greater offset from the lane edge.

510.09 BARRIER FLARES

The flares for both roadside barrier and bridge ends are a function of volumes under 200 ADT and are shown in Table 510.M. For the "2/3" flare, the flare rate or angle has been maintained, while the length and thus the offset have been reduced.

For the "1/3" flare, the "2/3" Ya has been kept, with the minimal Xa to develop the offset. This Xa is a function of the connection flexure between pieces of barrier. Figure 510.L shows the decision tree to the appropriate treatment.

Where a full flare or a "2/3" flare is required, the designer should evaluate the economics of using the required Xa with an attenuator and no flare. To simplify the comparison, evaluate capital costs of the flare vs. capital cost of the attenuator, without a flare. See 510.11 for flare adjustment rationale.

510.10 ROADSIDE BARRIER

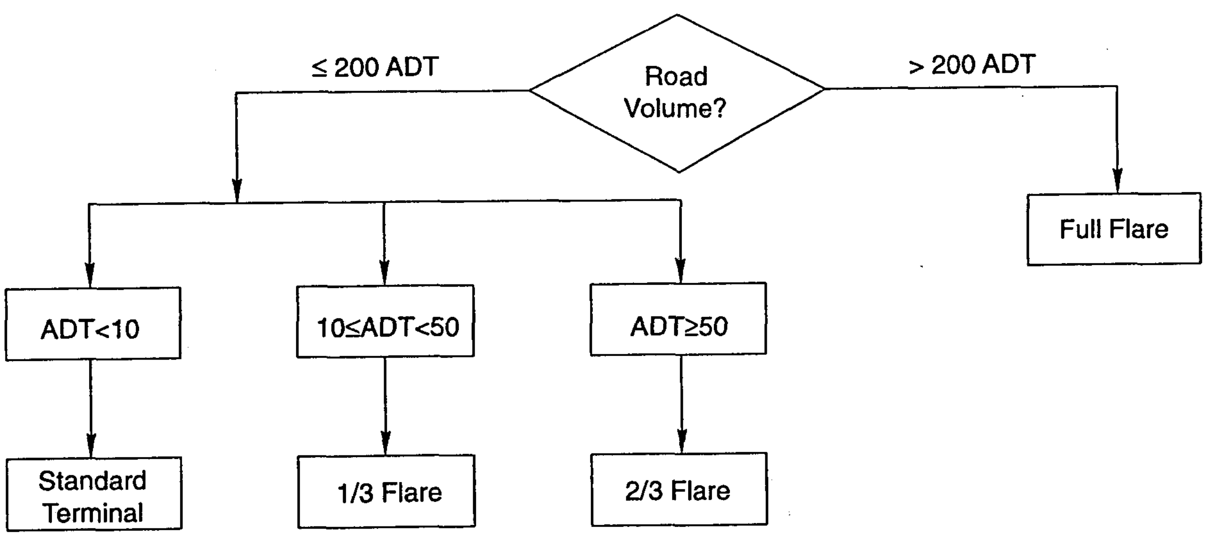
Barrier need is determined with the Roadside Barrier Index Warrant, in Chapter 600, Safety Elements. To accommodate the barrier, add 0.6 metres width to the side of the road where the barrier is to be placed.

510.11 LOW-VOLUME BRIDGES

All bridges shall have an end treatment. Figure 510.L is the decision tree to the appropriate treatment on bridges.

The Bridge Engineering Branch and Highway Safety Branch are to be contacted regarding connection details to various bridge ends.

Figure 510.L Barrier Flare Decision Tree



Full Flares are shown in Chapter 600: Figure HSE 82-07/A for Roadside Barrier and Figure HSE 83-01/B for Bridge Ends. Reduced flares are shown in Tables 510.M. The notations "2/3" and "1/3" are nominal descriptors; the actual lengths are a function of discrete barrier pieces, connection details and the ability to flex the barrier at their individual connections.

Table 510.M Adjusted Flares for Roadside Barrier

Speed	"2/3" Flare			"1/3" Flare		
km/h	Xa	Ya	# of CRBs	Xa	Ya	# of CRBs
40	12.3	2.0	5	4.9	1.0	2
40	14.8	2.0	6	14.8	2.0	6
50	17.4	2.1	7	14.8	2.1	6
60	22.4	2.1	9	14.8	2.1	6
70	27.4	2.2	11	14.8	2.2	6
80	32.4	2.3	13	15.0	2.3	6
90	37.4	2.3	15	17.5	2.3	7
100	39.9	2.3	16	20.0	2.3	8

Xa dimensions do not include a CTB-2 Transition piece and the need for pairs of CRBs (M&F) on Bridge End Flares. These are minimum dimensions and should be exceeded where feasible.

Contact Bridge Engineering for specific connection details. Should the connection detail not require a CTB-2, add an extra piece of CRB.

510.12 FLARE ADJUSTMENT

There may be cases where more barrier length should be used than that arrived at through Figure 510.L. This can be caused by specific site conditions.

For example, it may not be cost-effective to build the bridge end or embankment protection flare in the required location, because of the expense incurred in building the embankment for the flare.

In this case, it may be less expensive to have additional barrier, parallel to the road that extends further to a more acceptable location. See Figure HSE 83-03, in Chapter 600, for some sample treatments.

Where full size or "2/3" flares are required, consider using the required Xa with an attenuator and no flare.

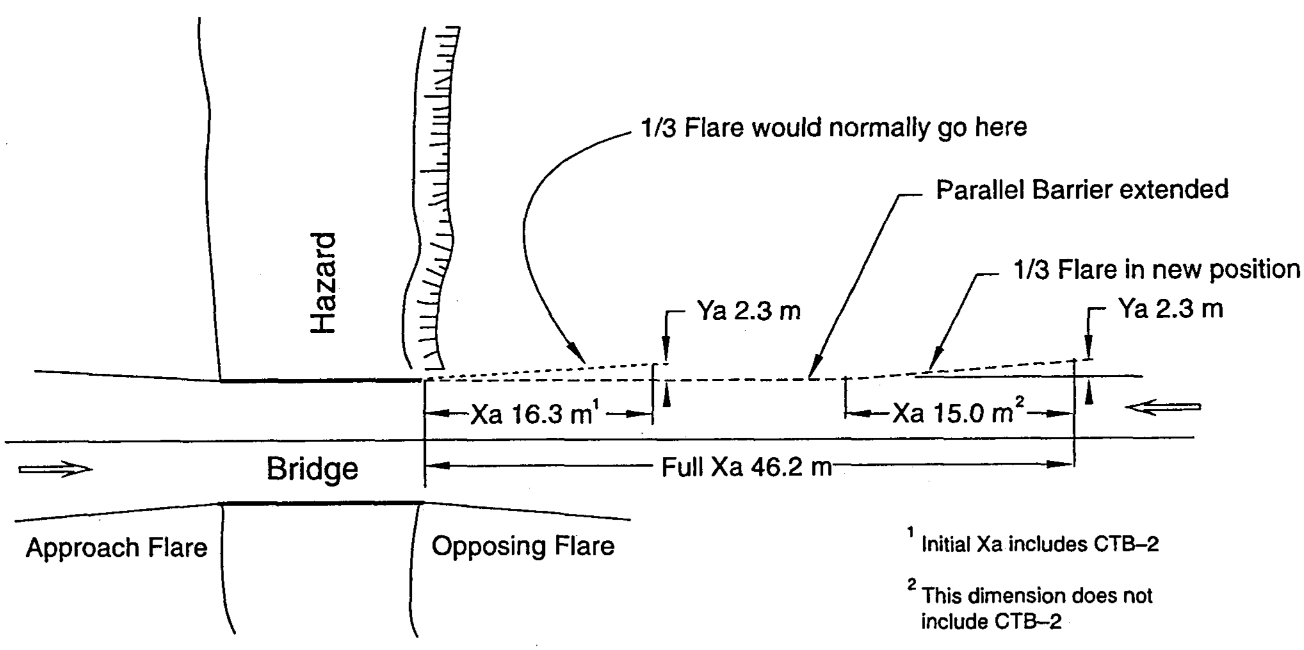
In another typical situation, there may be sufficient space for the flare at the bridge approach. However, the barrier may have to be extended to shield a hazard on the side of the road.

For this case, the barrier length should be extended, parallel to the lane edge, to prevent an errant vehicle that leaves the road from reaching the hazard. The required flare is simply shifted to the end of the parallel barrier and placed using the same Xa and Ya as would otherwise be used.

In the example shown in Figure 510.N, it is determined that a "1/3" flare is necessary for a bridge end treatment at 80 km/h. The Xa value is 15.0 m plus 1.3 m for CTB-2, the Ya is 2.3 m. However, there is a sharp drop-off to the river below. To prevent a vehicle that leaves the road in advance of the "1/3" flare bridge end treatment from reaching the drop off, the total length required is equal to the full Xa value of 46.2 m. The solution is to insert 12 pieces (30 m) of CRB at the bridge end after the CTB-2, parallel to the road, and to place the "1/3" flare at the end of this barrier run.

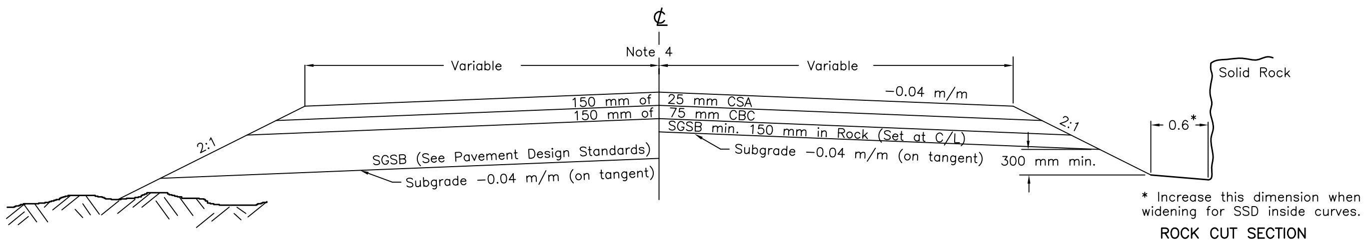
A prudent design should also recognize that barrier flare ends should not be placed at awkward locations in the alignment, such as just beyond vertical curves or on the outside of sharp horizontal at the end of tangent sections.

Figure 510.N Flare Adjustment to Shield a Hazard at an LVR Bridge Approach

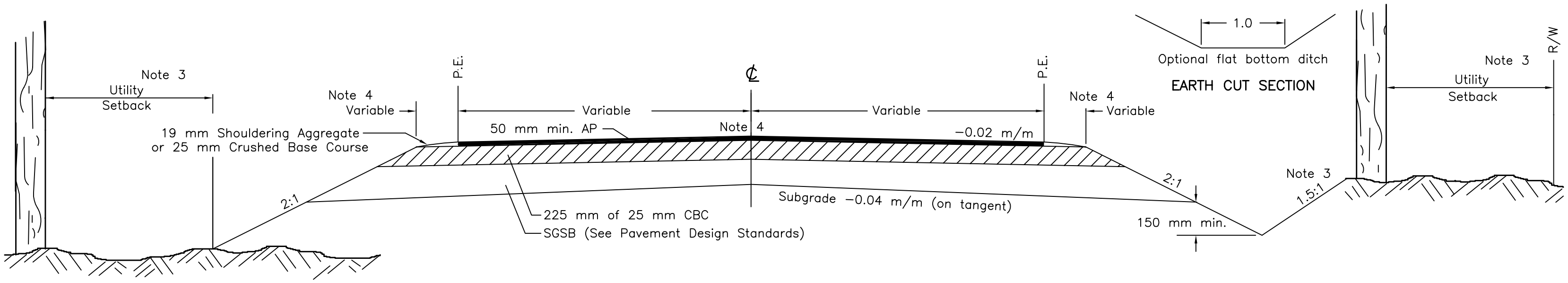


Because of the narrowness of LVR's, there is no difference between Approach and Opposing Flares.

Figure 510.O Cross Section for Low-Volume Roads



TWO–LANE TWO–WAY LVR – GRAVEL SURFACE



TWO–LANE TWO–WAY LVR – ASPHALT SURFACE

PAVEMENT DESIGN STANDARDS – When "Equivalent Single Axle Loads, (ESAL's)" are < 100,000. See 1410.07.02

– These are typical gravel and asphalt depths to be used in the absence of geotechnical investigation.

– MINIMUM 150 mm S.G.S.B. on Course Grained Subgrades (Unified Soils Classification System – GW/GP/GM/GC/SW/SP/SM/SC) where groundwater does not pose a drainage problem and frost penetration does not affect the structure.

– MINIMUM 300 mm S.G.S.B. on Fine Grained Subgrades (Unified Soils Classified System – ML/CL/OL/MH/CH/OH).

– No S.G.S.B. is required in exceptional circumstances where the following criteria have been met:
Structural Design Criteria is satisfied
and
Subgrade material consists of clean granular deposits that satisfy S.G.S.B. gradation and construction criteria (i.e. rutting criteria) in accordance with the latest version of the B.C. MoT Standard Specifications for Highway Construction – Section 202 "GRANULAR SURFACING, BASE AND SUB–BASES", (Subsection 202.06).

– MINIMUM 150 mm S.G.S.B. in Rock.

– All levelling materials applied directly to blasted rock cuts shall be of S.G.S.B. quality.

– THE FINAL S.G.S.B. THICKNESS MUST BE APPROVED BY THE REGIONAL GEOTECHNICAL AND MATERIALS ENGINEER.

Notes:

1. For bikeway design see Section 510.01
2. For roadside barrier and drainage curb details see Section 510.09
3. Utility setback is 2 m from the base fill/top of cut slope or 2 m from property boundary, whichever gives the greater offset from the road
4. For variable shoulder and top widths, refer to Tables 510.J and K
5. For rock ditches, see Figure 440.C
6. For gravel suface – see 202–B in Standard Specs. For future paving – see 202–C, D, E in Standard Specs.

Abbreviations:

AP Asphalt Pavement
CBC Crushed Base Course
SGSB Select Granular Sub–Base
CSA Crushed Surfacing Aggregate
SA Surfacing Aggregate

600 SAFETY ELEMENTS CHAPTER

600 SAFETY ELEMENTS CHAPTER TABLES

600 SAFETY ELEMENTS CHAPTER FIGURES

Figure 610.A Roadside Barrier Index Nomograph

N.T.S.

EXAMPLE

DATA:

Design Speed 90 km/h, Radius 340 m (Outside Curve), Fill height 2.4 m above H.W.M., Depth of still water 1.2 m, Fill slope 1.5 : 1, Shoulder width 3.0 m, S.A.D.T. 7000 vpd, Freezing moderate.

SOLUTION:

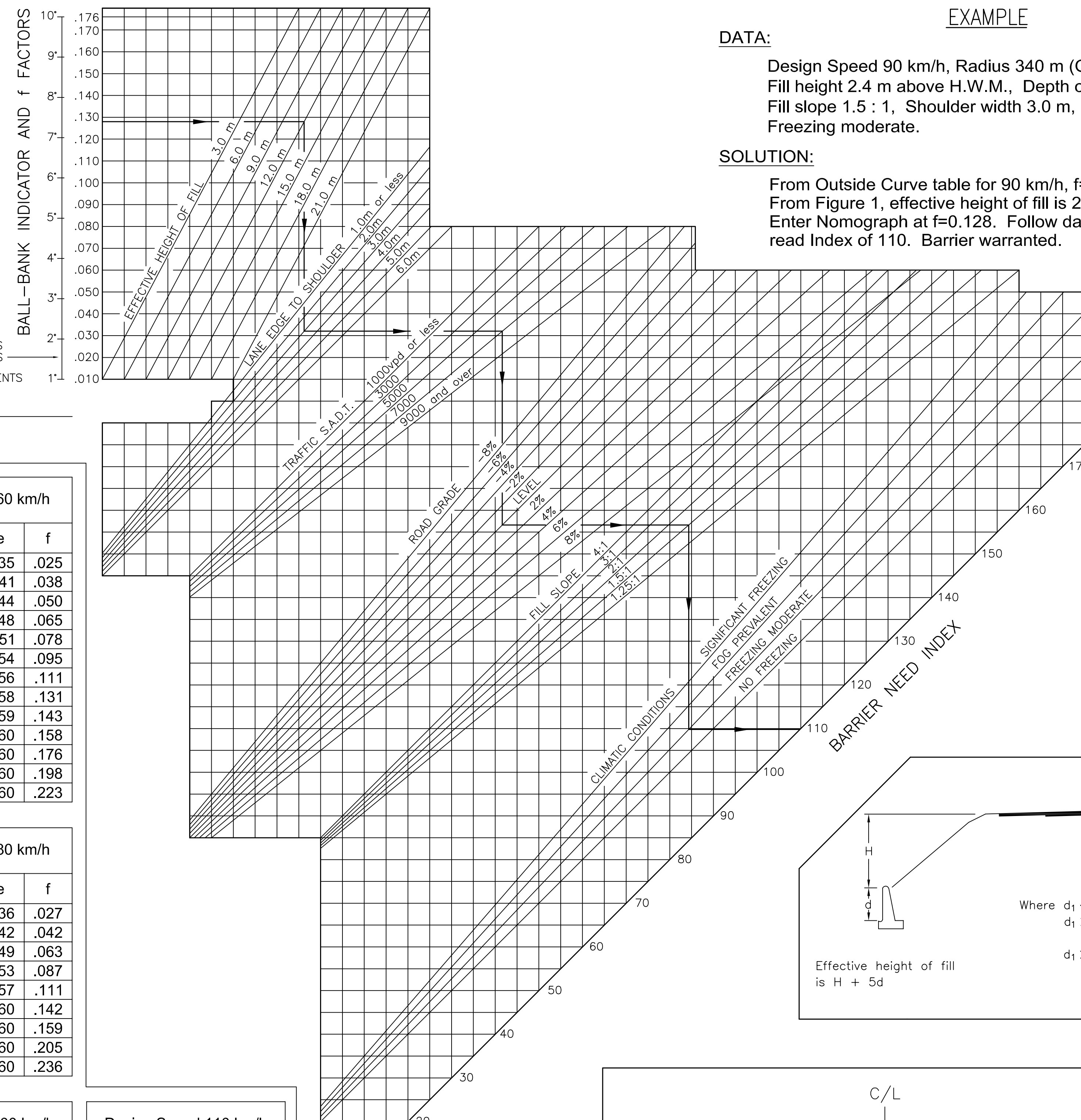
From Outside Curve table for 90 km/h, f=.128 for 340 m radius. From Figure 1, effective height of fill is 2.4 + (8 x 1.2) = 12 m Enter Nomograph at f=0.128. Follow dashed line through to read Index of 110. Barrier warranted.

BARRIER USUALLY NOT WARRANTED

1. When in a cut or on a fill with less than 3m effective height.
2. When fill slope is flatter than 4 to 1.
3. When Barrier Need Index is less than 90.

The Senior Highway Safety Engineer should be consulted when barrier is being considered for the above situations.

NOTE:
Do not extrapolate beyond the minimum or maximum values shown on the nomograph.



OUTSIDE CURVES

For 6% max. superelevation

Design Speed 50 km/h			
Radius	e+f	e	f
330	.060	.035	.025
300	.066	.037	.029
250	.079	.040	.038
220	.089	.043	.047
190	.104	.046	.058
170	.116	.048	.068
150	.131	.051	.081
130	.151	.053	.098
110	.179	.056	.122
*90	.219	.060	.159
80	.246	.060	.186
75	.262	.060	.202
70	.281	.060	.221

Design Speed 60 km/h			
Radius	e+f	e	f
475	.060	.035	.025
360	.079	.041	.038
300	.094	.044	.050
250	.113	.048	.065
220	.129	.051	.078
190	.149	.054	.095
170	.167	.056	.111
150	.189	.058	.131
140	.202	.059	.143
*130	.218	.060	.158
120	.236	.060	.176
110	.258	.060	.198
100	.283	.060	.223

Design Speed 70 km/h			
Radius	e+f	e	f
630	.061	.035	.026
450	.086	.042	.043
360	.107	.047	.060
270	.143	.053	.090
230	.168	.056	.112
*190	.203	.059	.144
170	.227	.060	.167
160	.241	.060	.181
150	.257	.060	.197

Design Speed 80 km/h			
Radius	e+f	e	f
800	.063	.036	.027
600	.084	.042	.042
450	.112	.049	.063
360	.140	.053	.087
300	.168	.057	.111
*250	.202	.060	.142
230	.219	.060	.159
190	.265	.060	.205
170	.296	.060	.236

Design Speed 90 km/h			
Radius	e+f	e	f
1050	.061	.036	.025
800	.080	.042	.038
600	.106	.048	.058
450	.142	.054	.088
380	.168	.058	.110
*340	.188	.060	.128
300	.213	.060	.153
250	.255	.060	.195
230	.277	.060	.217

Design Speed 100 km/h			
Radius	e+f	e	f
1250	.063	.037	.026
1000	.079	.042	.037
800	.098	.047	.051
600	.131	.053	.078
450	.175	.059	.116
*440	.179	.060	.119
380	.207	.060	.147
340	.232	.060	.172
300	.262	.060	.202

Design Speed 110 km/h			
Radius	e+f	e	f
1500	.064	.038	.025
1000	.095	.048	.047
800	.119	.053	.066
*600	.159	.060	.099
550	.173	.060	.113
500	.191	.060	.131
450	.212	.060	.152
380	.251	.060	.191
360	.265	.060	.205

* These curve radii are minimum values for new highway design.

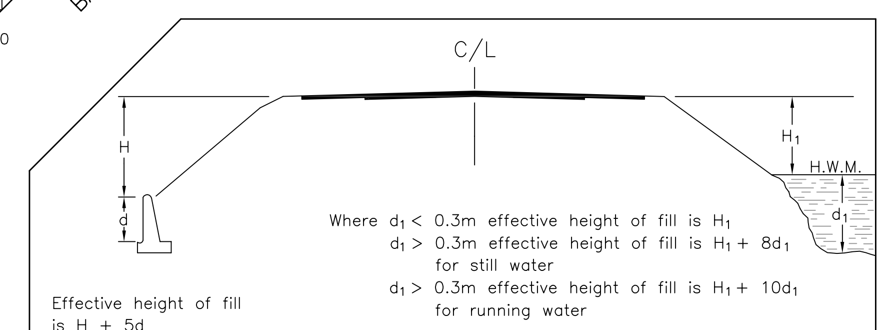


FIGURE 1

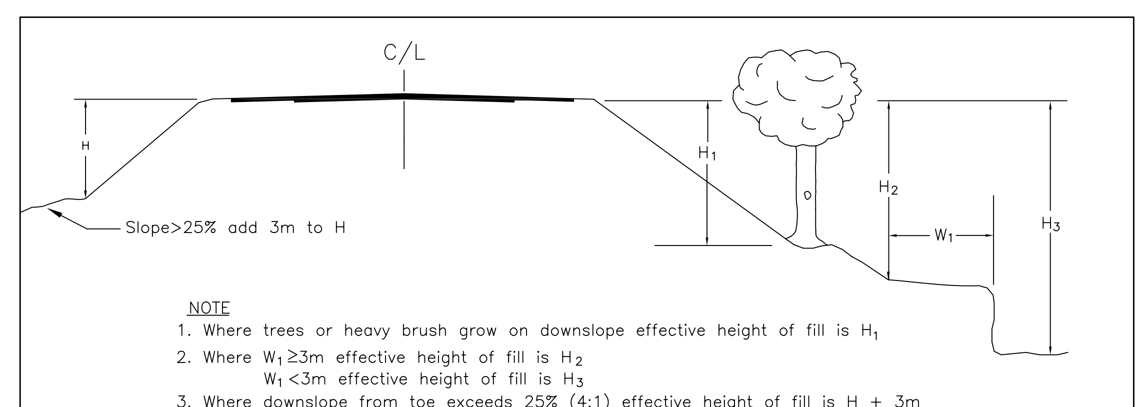


FIGURE 2

620
ROADSIDE SAFETY

620.01 INTRODUCTION

In highway design, the term Roadside Safety encompasses the area outside the travel portion of the roadway. This includes the shoulder, the side slopes, ditches and any fixed objects and water bodies that could present a serious hazard the occupants of a vehicle leaving the roadway.

Within the limits of the project's scope and budget, the highway designer has some measure of control in shaping the roadside environment to reduce roadside hazards.

The following clarifies the British Columbia Ministry of Transportation's design policy on the application of the most important design element of Roadside Safety which is called the Clear Zone.

This chapter supplements the Transportation Association of Canada's Geometric Design Guide for Canadian Roads which is the main reference manual used by the British Columbia Ministry of Transportation.

620.02 FORGIVING ROADSIDE

The designer should strive to achieve the "*Forgiving Roadside*". The following quote, taken from Transportation Research Board Circular 435, outlines the essence of the design concept that incorporates Roadside Safety:

"*Basically, a forgiving roadside is one free of obstacles that could cause serious injuries to occupants of an errant vehicle. To the extent possible, a relatively flat, unobstructed roadside recovery area is desirable, and when these conditions cannot be provided, hazardous features in the recovery area should be made breakaway or shielded with an appropriate barrier.*"

620.03 CLEAR ZONE

The Clear Zone includes the total roadside border area, starting at the edge of the outer through lane edge. This area shall consist of a shoulder, a recoverable slope, a non-recoverable slope, and/or a clear run-out area. The desired width is dependent upon the design traffic volume and speed and on the roadside geometry"

Note: Recovery zone is another term that is used interchangeably with clear zone.

620.04 DEFINITIONS

Average Annual Daily Traffic (AADT): Refer to the definition on page 3 of the glossary. The AADT for the design year should be used.

Back slope: Graded uphill slope up to the original ground and beyond the ditch in a cut. Sometimes written in one word as a "backslope" or referred to as a "cut slope".

Clear runout area: The area located beyond the toe of a non-recoverable slope that is free of fixed objects and available for an errant vehicle to come to a rest.

Clear zone distance: Distance in metres measured at ninety degrees from the outer through lane edge in the direction away from the traveled way. Within the boundaries outlined by the clear zone distance are usually the shoulder and a recoverable slope. In some situations a non-recoverable slope and/or a clear runout area may also be located within the clear zone distance.

Critical fill slope: Any fill slope steeper than 3:1. An errant vehicle traversing a critical fill slope is at much greater risk to overturn than on slopes at 3:1 or flatter.

Cut slope: See "Back slope".

Design Clear zone distance: The target value used for a specific highway design when the design speed and the design volume are known. This value is obtained from Table 620.A.

Fill slope: See "Front slope".

Fixed objects: Refer to section 620.06 item # 2.

Front slope: Graded downhill slope beyond the outside edge of the shoulder down to the ditch in a cut or to the original ground on a fill. This is sometimes called a "fill slope" or a "foreslope".

Hazard: A critical slope, fixed object, or body of water which, when hit or reached by a vehicle, may either cause the vehicle to overturn and/or injure occupants of the vehicle.

Major Reconstruction: For the purposes of this chapter, "major reconstruction" includes projects on existing highways that involve grading works to improve capacity.

New Construction: For the purpose of this chapter - Construction of a new highway horizontal or vertical alignment.

Non-recoverable slope: A slope on which an errant vehicle will continue until it reaches the bottom, without having the ability to recover control. Fill slopes steeper than 4:1, but no steeper than 3:1, are considered non-recoverable.

Recoverable slope: A slope on which the driver of an errant vehicle can regain control of the vehicle. Slopes that are 4:1 or flatter are considered recoverable.

Recovery zone: The target area used in highway design when a fill slope between 4:1 and 3:1 is used within the design clear zone distance.

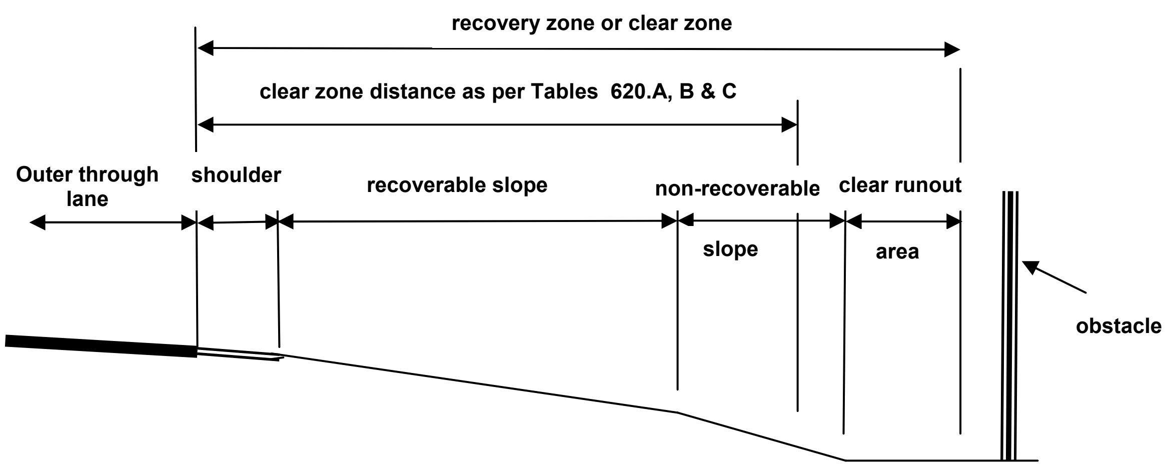
Rehabilitation: Often called 3R for resurfacing, restoration, rehabilitation, is to restore the existing highway to its initial condition. The project may include some safety enhancements. The primary objective of projects falling under a 3R program is to extend the service life and improve safety of an existing highway.

Traveled way: That part of a roadway intended for vehicle traffic. This excludes shoulders, parking lanes, rest areas and bus bays.

620.05 COMPONENTS OF CLEAR ZONE

Figure 620.A shows the components of the roadside Clear Zone using the TAC definitions. If the clear zone distance ends on a non-recoverable slope, a clear runout area is required. The desirable width of this area shall be equal to the portion of the clear zone distance overlapping the non-recoverable slope and typically should be a minimum of 2.0 m beyond the toe. Refer to Tables 620.A, B & C for Clear Zone distances. Also refer to note (**) in Table 620.A. The clear zone distance should preferably be located entirely within a recoverable slope thereby eliminating the need for a clear runout area.

Figure 620 .A Components of the Clear Zone design element



Source: Transportation Association of Canada, Geometric Design Guide for Canadian Roads, September 1999.

620.06 ROADSIDE DESIGN METHODS FOR NEW CONSTRUCTION AND MAJOR RECONSTRUCTION

New construction and major reconstruction are defined in section 620.04. The designer should refer to the Roadside Safety chapter of the TAC Geometric Design Guide for Canadian Roads for factors influencing the Clear Zone Design Domain and examples of calculations on shaping the side slopes for the area enclosed within the recovery zone.

This section clarifies BC MoT's policy on the treatment of hazards and mitigation methods within the recovery zone.

The first step is to identify the suggested clear zone distance as a function of the project design speed and the estimated design year volume for a selected slope. In the area enclose within the clear zone distance, there are three general categories of hazards that the designer should remove or mitigate: side slopes, fixed objects and bodies of water.

The designer must evaluate the potential risks presented by these hazards and proceed with any of these options in descending order of desirability based on an optimum net present value analysis:

i) Design the side slopes according to the Clear Zone Guidelines;

ii) Remove any hazard within the recovery zone;

iii) Shield the hazard with safety barrier or crash cushion;

iv) Use break-away devices or posts;

v) Take no action if all of the above actions are not cost effective (usually only considered on lower volume roads that are less than 750 AADT and/or low speed facilities with posted speeds of less than 60 km/h). However, in such a case, the obstacle should be properly delineated.

Shoulder Rumble Strips are not a substitute for clear zone design. Therefore, they cannot be used a reason to justify a reduction of the clear zone distance.

1) Highway Cross-section Slopes

A. Fill or Front Slopes
The designer should preferably design fill slopes of between 10:1 and 6:1. The minimum fill slope is 4:1. Fill slopes steeper than 4:1 are non-recoverable and require special attention from the designer to provide specific measures in the design to mitigate the hazard presented by such slope.

B. Cut or Back Slopes
Cut slopes of 3:1 and flatter that are free of fixed objects are usually less severe a hazard than a traffic barrier. In the case of a rock cut, it should either be outside the clear zone or shielded by a roadside barrier.

The designer should conduct an individual analysis for each rock cut or group of rocks cuts and document the reasons justifying the roadside safety design decision.

C. Transverse Slopes and Culvert Ends
Roadway features that introduce a transverse slope or exposed face within the clear recovery zone must either be shielded or designed to be traversable. These roadway features typically include: driveways, turnarounds in depressed median and earth berms.

Traversable transverse slope treatments are applied for slopes facing oncoming traffic on divided highways and on both sides for undivided highways. The designer should refer to the latest edition of the TAC Geometric design Guide for Canadian Roads for detailed design parameters to be used for transverse slopes and culvert end treatments within the clear zone.

2) Fixed Objects

The following are typical examples of fixed objects that require special analysis by the designer for roadside safety mitigation treatment:

- Non breakaway posts and light standards (note: all posts should be analysed including tall electrical power line posts as well as simple posts that support signs or mail boxes. Fire hydrants that are made of cast iron which will easily fracture on impact are considered as breakaway. Any other part of the base of a fire hydrant that is not frangible must not protrude more than 100 mm above ground);

- Trees which have a potential of growing to a diameter that exceeds 100 mm measured 150 mm above ground level;
- Any fixed object protruding more than 100 mm above ground. This includes but is not limited to boulders, curbs, culverts and pipe ends.
- Fencing should preferably be located outside the clear recovery zone or be designed and installed in a manner that will make it yield on impact without producing debris that could penetrate the errant vehicle and injure occupants. Refer to section 660 for guidelines to provide fencing for pedestrians and cyclists.

3) Water Bodies and High Fills

Regardless of the barrier need index obtained from Figure 610.A, the designer should analyze the risk presented by the following potential hazards when these are located within 15 m of the outside edge of the through traffic lane:

- water bodies with a permanent water depth of 300 mm or more
- slopes steeper than 3:1 exceeding a height of 3 m

620.07 COST-EFFECTIVENESS METHODOLOGY

Utilizing a cost-effectiveness approach will allow the Ministry to optimize the allocation of its resources to achieve better safety for the traveling public throughout the overall Provincial roadway system.

Further discussion on the explicit analysis of roadside safety features may be found in the TAC Geometric Design Guide for Canadian Roads, section 3.1.2.

Appendix A of the AASHTO Roadside Design Guide describes a cost-effectiveness methodology called Roadside Safety Analysis Program (RSAP). Copies of the NCHRP Report 492 Engineer's Manual, RSAP User's Manual and the RSAP program can be downloaded free from the TRB Web site at: http://www.trb.org/TRB/Publications/Publications.asp

620.08 PREAMBLE ON CLEAR ZONE DISTANCES

The Clear Zone Distances in Tables 620.A and 620.B in the following pages, are from AASHTO and TAC documents (see section 620.14 REFERENCES). The reduced Clear Zone distances in Table 620.C were adopted by BC MoT in 1995 based on a benefit-cost analysis

As stated in the AASHTO Roadside Design Guide: These tables "*only provide a general approximation of the needed clear zone distance*". They are "*based on limited empirical data that was extrapolated to provide information for a wide range of conditions, design speeds, rural versus urban locations, and practicality.*

Table 620.A Suggested [(¥)] Design Clear Zone Distances [(see note 1)] in metres
For New Construction and Reconstruction Projects on Rural Highways [(¥¥)]

Design Speed (km/h)	Design Year AADT (see note 2)	Front Slopes (Fill)			Back Slopes (Cut) [(see note 4)]		
		6:1 or flatter	5:1 to 4:1	3:1	3:1	5:1 to 4:1	6:1 or flatter
< 70	200 <AADT< 750 (see note 3)	2.0 – 3.0	2.0 – 3.0	**	2.0 – 3.0	2.0 – 3.0	2.0 – 3.0
	750 - 1500	3.0 – 3.5	3.5 – 4.5	**	3.0 – 3.5	3.0 – 3.5	3.0 – 3.5
	1501 - 6000	3.5 – 4.5	4.5 – 5.0	**	3.5 – 4.5	3.5 – 4.5	3.5 – 4.5
	> 6000	4.5 – 5.0	5.0 – 5.5	**	4.5 – 5.0	4.5 – 5.0	4.5 – 5.0
70 - 80	200 <AADT< 750 (see note 3)	3.0 – 3.5	3.5 – 4.5	**	2.5 – 3.0	2.5 – 3.0	3.0 – 3.5
	750 - 1500	4.5 – 5.0	5.0 – 6.0	**	3.0 – 3.5	3.5 – 4.5	4.5 – 5.0
	1501 - 6000	5.0 – 5.5	6.0 – 8.0	**	3.5 – 4.5	4.5 – 5.0	5.0 – 5.5
	> 6000	6.0 – 6.5	7.5 – 8.5	**	4.5 – 5.0	5.5 – 6.0	6.0 – 6.5
90	200 <AADT< 750 (see note 3)	3.5 – 4.5	4.5 – 5.5	**	2.5 – 3.0	3.0 – 3.5	3.0 – 3.5
	750 - 1500	5.0 – 5.5	6.0 – 7.5	**	3.0 – 3.5	4.5 – 5.0	5.0 – 5.5
	1501 - 6000	6.0 – 6.5	7.5 – 9.0	**	4.5 – 5.0	5.0 – 5.5	6.0 – 6.5
	> 6000	6.5 – 7.5	8.0 – 10.0*	**	5.0 – 5.5	6.0 – 6.5	6.5 – 7.5
100	200 <AADT< 750 (see note 3)	5.0 – 5.5	6.0 – 7.5	**	3.0 – 3.5	3.3 – 4.5	4.5 – 5.0
	750 - 1500	6.0 – 7.5	8.0 – 10.0*	**	3.5 – 4.5	5.0 – 5.5	6.0 – 6.5
	1501 - 6000	8.0 – 9.0	10.0 – 12.0*	**	4.5 – 5.5	5.5 – 6.5	7.5 – 8.0
	> 6000	9.0 – 10.0*	11.0 – 13.5*	**	6.0 – 6.5	7.5 – 8.0	8.0 – 8.5
≥ 110	200 <AADT< 750 (see note 3)	5.5 – 6.0	6.0 – 8.0	**	3.0 – 3.5	4.5 – 5.0	4.5 – 5.0
	750 - 1500	7.5 – 8.0	8.5 – 11.0*	**	3.5 – 5.0	5.5 – 6.0	6.0 – 6.5
	1501 - 6000	8.5 – 10.0*	10.5 – 13.0*	**	5.0 – 6.0	6.5 – 7.5	8.0 – 8.5
	> 6000	9.0 – 10.5*	11.5 – 14.0*	**	6.5 – 7.5	8.0 – 9.0	8.5 – 9.0

(¥) The designer may use lesser values than the suggested distances in this table only if these lesser values are justified using a cost-effectiveness analysis as outlined in section 620.07. The Design Clear Zone Inventory form in Figure 620.B must be filled-in by the designer and included in the design folder.

(¥¥) Rural highways are typically open ditch. Urban highways typically have curb and gutter with enclosed drainage. Refer to section 620.12 for a discussion of Clear Zone applied to an urban environment.

(*) Clear zones may be limited to 9.0 metres for practicality and to provide a consistent roadway template if previous experience with similar projects or designs indicates satisfactory performance.

(**) Since recovery is less likely on the unshielded, traversable 3:1 slopes, fixed objects should not be present in the vicinity of the toe of these slopes. Recovery of high-speed vehicles that encroach beyond the edge of the shoulder may be expected to occur beyond the toe of slope. Determination of the width of the recovery area at the toe of slope should take into consideration right-of-way availability, environmental concerns, economic factors, safety need and collision history. Also, the distance between the edge of the through travel lane and the beginning of the 3:1 slope should influence the recovery area provided at the toe of slope. While the application may be limited by several factors, the foreslope parameters which may enter into determining a maximum desirable recovery area are illustrated in Figure 620.A.

Notes:

1. All distances are measured from the outer edge of the through traveled lane. Where a site specific investigation indicates a high probability of continuing crashes, or such occurrences are indicated by crash history, the designer may provide clear zone distances greater than the clear zone shown in Table 620.A.
2. For clear zones, the "Design Year AADT" will be total AADT for both directions of travel for the design year. This applies to both divided and undivided highways.
3. For AADT≤200, the front slope is 2:1 or flatter, the back slope is 1.5:1 or flatter. The setback to fixed objects is the greater of the following two distances: - 4.0 m from the outside edge of the traveled lane or - 2.0 m from the lowest ditch point.
4. The values for "back slopes" only apply to a section where the toe of the slope is adjacent to the shoulder (enclosed drainage).
5. The values in the table apply to tangent sections of highway. Refer to Table 620.B for adjustment factors on horizontal curves.
6. Refer to the TAC Geometric Design Guide for Canadian Roads for worked examples of calculations.

Table 620.B Horizontal Curve Adjustment Factors for Clear Zone Distances (K_{cz})

Radius (m)	Design Speed (km/h)					
	60	70	80	90	100	110
900	1.1	1.1	1.1	1.2	1.2	1.2
700	1.1	1.1	1.2	1.2	1.2	1.3
600	1.1	1.2	1.2	1.2	1.3	1.4
500	1.1	1.2	1.2	1.3	1.3	1.4
450	1.2	1.2	1.3	1.3	1.4	1.5
400	1.2	1.2	1.3	1.3	1.4	
350	1.2	1.2	1.3	1.4	1.5	
300	1.2	1.3	1.4	1.5	1.5	
250	1.3	1.3	1.4	1.5		
200	1.3	1.4	1.5			
150	1.4	1.5				
100	1.5					

Notes:

1. Adjustments apply to the outside of a horizontal curve only.
2. No adjustment is warranted for curves that have a radius exceeding 900 metres.
3. The applicable clear zone distance on a horizontal curve is given by the following formula:
   $CZ_c = (K_{cz})(CZ_t)$
   where: CZ_c = clear zone distance on the outside of a curve in metres.
   K_{cz} = curve adjustment factor from Table 620.B.
   CZ_t = clear zone distance used on a tangent section as per Table 620.A.
   Rounding of the calculated Clear Zone distance is to the next higher 0.5 metre increment.
4. Use straight-line interpolation to calculate the adjustment factor for a curve radius other than those listed in the table.
5. The transition from Z_t on tangent to CZ_c in the curve is done by gradually increasing the Clear Zone over the length of the spiral.
6. Also refer to the TAC Geometric Design Guide for Canadian Roads for worked examples of calculations.

620.09 DEPRESSED MEDIAN TREATMENT

The British Columbia Ministry of Transportation has been using a minimum standard depressed median width of 13 metres. This width is the minimum width on four lane divided highways that will allow for adding lanes on the inside to achieve the standard 5.6 metre wide narrow median (two 2.5 m wide inside shoulders and a 0.6 m wide standard concrete median barrier) on a six lane divided highway.

The 13 metres depressed median is a minimum dimension. In some cases, such as on horizontal curves that have a radius between the minimum for the design speed and minimum plus 15%, the designer should consider a wider median. The desirable median width in such a case is the calculated clear recovery area multiplied by 1.5. On current highways that were built with a median width less than 1.5 times the calculated clear recovery zone distance, the designer should review the collision history to estimate the potential risk of head-on collisions at various locations and most particularly on curves. Typical mitigating measures recommended for locations with high potential of cross-over collisions are: - to widen the median or, as it is often more convenient; - to install on the edge of the shoulder on the outside of the curve or at another appropriate place within the wide median a flexible barrier (such as the high tension wire rope safety fence) or the rigid concrete roadside barrier.

Guidelines for the narrow median treatment are provided in section 630.

620.10 GUIDELINES FOR REHABILITATION TYPE PROJECTS

1) Context

Highways that are constructed to meet recognized design criteria and follow the guidelines provided in section 620.06 for new construction and major reconstruction provide measurable advantages for the motoring public. However, available finances do not always permit the reconstruction or rehabilitation of existing highways to a higher level. These projects are often initiated for reasons other than geometric design deficiencies (e.g., pavement deterioration), and they often must be designed within restrictive right-of-way, financial limitations, and environmental constraints. As a result, the design criteria and guidelines for rehabilitation and reconstruction are often not attainable without major adverse impacts.

For these reasons, it may be applicable to adopt clear zone values on existing highways that are, in many cases, lower than the values for new construction or major reconstruction. The guidelines in this section are therefore intended to find the balance among many competing and conflicting objectives. These include supporting the objective of improving BC's existing highways, minimizing the impact of construction on existing highways, and improving the greatest number of highway kilometres within the available funds. The intent of these guidelines is to assist the implementation of cost-effective construction that may reduce the number and severity of run-off-the-road collisions, typically by identifying locations where the greatest safety benefit can be realized.

2) Application

Highway improvement projects fall into one of four types: new construction; reconstruction; resurfacing, restoration, rehabilitation, often referred to as 3R; and maintenance.

Guidelines for the first two types, new construction and reconstruction, are provided separately in section 620.06. The guidelines provided here in section 620.10 are most applicable to 3R type projects where, for reasons outlined in section 620.10 - 1), the guidelines for new construction/reconstruction are not cost-effective

3R projects involve rehabilitation, restoration and resurfacing and primarily work on an existing roadway surface and/or subsurface. The purpose includes extending the service life of the roadway and enhancing the safety of the highway. To accomplish this objective, the focus should be on the most cost-effective safety improvements to improve safety where major reconstruction is not cost–effective.

3) Definitions

The following definitions apply to British Columbia 3R type projects:

Rehabilitation – The traffic service improvement and safety needs may be of equal importance to the need to improve the riding quality. Projects may involve intersection reconstruction, pavement widening, pavement replacement, shoulder widening, flattening foreslopes, drainage improvements and improvement of isolated grades, curves or sight distance by reconstruction. Some additional right-of-way may be necessary.

Restoration – This category is primarily for the major resurfacing or overlays of a nominal 100 mm or more which improve the strength and extend the life of the existing pavement. In addition, some pavement widening, short sections of pavement reconstruction, shoulder widening, flattening foreslopes on high fills and intersection reconstruction may be involved. Consideration may be given to improving isolated grades, curves, or sight distance by construction or traffic control measures. In some cases minor ROW acquisitions or easements may be required.

Resurfacing – Pavement resurfacing or overlays of less than a nominal 100 mm fall within this category. Other types of work such as pavement patching or short areas of reconstruction, joint replacement or repair, and shouldering may be included as part of the resurfacing project. Usually no additional right-of-way is required.

In general 3R improvements are made within the existing right-of-way and typically involve minimal changes to alignment or grade and no increase to capacity for the through lanes.

These guidelines are for 3R type projects as described above, and are intended to enhance roadway safety by helping to identify problem areas so that the adverse impact of run-off-the-road incidents can be reduced in a cost-effective way.

These guidelines are not intended for projects where the purpose and scope is intended to replace or expand the facility, in which case guidelines for major reconstruction should be applied.

4) General Guidance for Rehabilitation Type Projects

The guidelines for geometric improvements on existing highways are located in tab 13 of this manual. The following describes how to apply the "Corridor Ambient Geometric Design Element Guidelines" as defined in the context of clear zone principles.

The majority of existing highways were constructed before the application of clear zone as a standard. Accordingly, clear zone is not explicitly considered part of the ambient condition. The principal safety consideration in the ambient condition is the setback to utility poles and similar obstacles.

In terms of Ministry projects, recommended guidelines for pole locations are provided in Section 1120 of this manual. For open shoulder projects utilities should be located outside the clear zone, as per the appropriate design cross-section (and preferably within 2 m of the edge of the right-of-way) or protected by an approved barrier. However, section 1120.03 notes that the Ambient Guidelines policy replaces clear zone guidelines with Utility Setback language to ensure uniformity within the specific corridor under review.

On 3R projects, unless collision history, public complaint or site inspections indicate there is a safety problem, it may not be cost effective to fully comply with the typical clear zone requirements suggested for new construction/reconstruction. In addition, on many highways, the run-off-the-road collision rate may be too low to justify the cost of providing hazard free zones, as per section 620.06, throughout the length of the highway. Accordingly it may be appropriate to adopt clear zone values that are selective and generally "fit" conditions within the existing right-of-way and the character of the road.

For many projects, existing parallel slopes will generally remain the same, unless there is evidence of a problem at the site. This is in line with the application of the ambient conditions policy, outlined in tab 13, where the design principle is to maintain the ambient condition for the rehabilitation of a section of the corridor. Thus the elements of the rehabilitated section will essentially be the same as those of the ambient condition set for the corridor. Since most of the existing BC highways were constructed before the application of clear zone as a standard, this may mean that in many cases the roadside design does not fully comply with typical clear zone requirements. If no operational or safety problems are identified, and the roadway has been performing well, this may be acceptable. However, where cost-effective improvements can be made to the roadside area, they should be considered. Where any variation from the ambient condition is justified (for example for reasons as noted in the policy document located in tab 13), consideration should be given to improving the roadside geometry where this is cost-effective. In addition, where the existing right-of-way permits significant slope flattening or where grading within the right-of-way is necessary, the designer should consider flattening parallel earth slopes, particularly on the outside of horizontal curves. Also, transverse slopes at driveways and accesses shall be re-graded and protected as described in chapter 700 of this manual.

Where it may not be cost-effective or feasible to comply fully with the clear zone distances suggested in Table 620.A, application of a "reduced" clear zone value for 3R type projects may be both prudent and appropriate. Section 620.10 -5) below provides some minimum clear zone guidance where the simple application of the ambient conditions utility setbacks alone may not be appropriate.

5) Clear Zone Guidance

Where the application of the "full" clear zone requirements is not appropriate or cost-effective, a "reduced" clear zone application is proposed. In these cases, the designer may consider reducing clear zone distances from Table 620.A by as much as 40% with a minimum distance of 2 metres as per Table 620.C. These distances should be examined for the flattening of slopes and removal of obstructions. Where right-of-way is not restricted, front slopes should be 4:1 or flatter and back slopes 3:1 or flatter, but slopes may vary in relationship to prevailing conditions throughout the project and/or adjacent highway sections.

The designer should examine the possibilities to expand the roadway clear zone on the outside of relatively sharp horizontal curves to address the increased potential of vehicles running off the roadway at curves. Typically, this would normally be considered where collision histories indicate a need, or a site specific investigation shows a definite collision potential which could be significantly lessened by increasing the clear zone width, and such increases are cost-effective.

Table 620.C Suggested(¥) Minimum Design Clear Zone Distances in metres For Rehabilitation Type Projects on Rural Highways(¥¥)

Design Year AADT	Minimum Clear Zone Width (m) For Front Slopes 4:1 or flatter & Back Slopes 3:1 or flatter				
	Design Speed (km/h)				
	≤ 60	70 - 80	90	100	≥ 110
< 750	2.0	2.7	3.3	4.5	5.0
750 - 1500	2.7	3.5	4.5	6.0	6.5
1501 - 6000	3.0	4.5	5.5	7.0	8.0
> 6000	3.3	5.0	6.0	8.0	8.5

(¥) The designer may use lesser values than the suggested distances in this table only if these lesser values are justified using a cost-effectiveness analysis as outlined in section 620.07. The Design Clear Zone Inventory form in Figure 620.C must be filled-in by the designer and included in the design folder.

(¥¥) Rural highways are typically open ditch. Urban highways typically have curb and gutter with enclosed drainage.

Notes:

1. All distances are measured from the outer edge of the through traveled lane. Where a site specific investigation indicates a high probability of continuing crashes, or such occurrences are indicated by crash history, the designer may provide clear zone distances greater than the clear zone shown in Table 620.C.
2. For clear zones, the “Design Year AADT” will be total AADT for both directions of travel for the design year. This applies to both divided and undivided highways.
3. The values for “back slopes” only apply to a section where the toe of the slope is adjacent to the shoulder (enclosed drainage).
4. The values in the table apply to tangent sections of highway. Refer to Figure 620.B for adjustment factors on horizontal curves.
5. Refer to the TAC Geometric Design Guide for Canadian Roads for worked examples of calculations.

6) Roadside Hazards

In general, any obstructions within the suggested clear zone should be reviewed for removal, relocation, the use of breakaway supports, the provision of a barrier, or do nothing based on cost-effectiveness and safety considerations. This is especially relevant where “reduced” clear zone widths as described in previous section 5) are being considered. Reference should be made to the following section 7) for general guidance regarding various types of roadside hazards and specific considerations. Particular attention should be made to certain roadside hazards, such as poles, roadside barrier ends and trees, which are usually more threatening to vehicle occupants than others because of their positioning and structure, particularly in high speed environments. There is a general consensus that the minimum width for a clear zone to effectively reduce severe injury is 3 m.

Evaluation and selection of alternative treatments to mitigate hazardous roadside locations should be carried out using a cost-effectiveness methodology such as RSAP, discussed previously in section 620.07.

7) Identification of Problem Areas

Collision records, inspections of collision site, interviews with local officials involved in road safety such as local RCMP traffic detachment, Highway District Area Manager and citizen’s safety committee and other sources of data can act as a useful guide in pinpointing areas within the project that have identifiable safety problems related to clear zone width and where available resources can be most effectively directed.

In terms of identifying high roadside collision locations, the designer should review the crash history for the last 3 to 5 years (e.g. HAS data) with respect to frequency, rate, location, type and severity in order to identify any probable safety deficiencies. Sources of available data include collision report forms (e.g. BC’s MV 6020 Accident Report Form), BC collision databases (e.g. TAS and HAS), municipal collision databases, and ICBC claims data. However, the user needs to be aware of some of the problems and limitations of the data, including reduced reporting levels, inconsistent reduction in reporting levels, reliability of the data (especially for self reported incidents), accuracy of the collision data (at the scene/during data entry), timeliness of the collision data, and jurisdictional constraints. High roadside collision locations are considered to be those which exhibit higher potential for collisions than an established norm, for example where a collision frequency or rate exceeds a threshold value. A widely used statistical technique is to calculate a critical collision rate for the location, which represents a threshold value above which the occurrence of collisions may be attributed to site specific characteristics rather than random fluctuations in collision occurrence. Comparison of the calculated collision rate and the critical collision rate for similar facilities enables a "collision-prone" location to be identified. The HAS database itself can also be queried to identify collision prone locations and sections. The process of collision analysis is part of the procedural guidelines for determining ambient conditions under the BC policy, and enables safety or operational related problem areas to be identified.

In evaluating the collision history, the designer should look for possible concentrations of collisions that may justify construction of wider clear zones, similar to those required for new construction/reconstruction, over a short section of the project. If only a few isolated hazards exist within the desirable clear zone and if these hazards can be removed or relocated at a low cost, the plan should provide for removal or relocation. Normally, acquisition of right of way just to obtain the desirable clear zone is not cost effective.

620.11 WORKED EXAMPLES

In the application of the clear zone concept for British Columbia, the TAC Geometric Design Guide’s method used for Roadside Channels is not required. For examples of clear zone calculation, refer to the TAC Geometric Design Guide and the AASHTO Roadside Design Guide.

620.12 DESIGN CRITERIA SHEETS FOR CLEAR ZONE TREATMENT

Figure 620.B Design Clear Zone Inventory – New Construction & Reconstruction
Note: This sheet must be completed for all sections of the design project including those locations where clear zone is met.

British Columbia - Ministry of Transportation				Design Clear Zone Inventory
Location km to km	Distance from the traveled way (m)		Meet Guidelines (1)	Summary of reasons for not meeting the suggested guidelines and description of corrective actions taken. (2)
	Left	Right		

(1) Distances meet or exceed suggested guidelines in Tables 620.A & B.
(2) Include references to appropriate documents in the design folder that contain detailed analyses and calculations.

Figure 620.C Design Criteria Sheet for Roadside Design Review – Rehabilitation Projects
Note: This sheet must be completed for <u>all</u> sections of the design project including those locations where clear zone is met.

British Columbia - Ministry of Transportation	**Roadside Hazard Treatments Inventory**
List locations where the off-road collision history and/or an examination of potential roadside obstacles indicate the need for a review of the roadside geometry for cost effective safety improvement measures.	
Location km to km (1)	Summary of reasons for not meeting the suggested clear zone distances in Tables 620.B & C and description of corrective actions taken. (3)
Location km to km (2)	Locations where clear zone distances as per Tables 620.B & C are met. Indicate the achieved recovery zone distances.(3)

(1) Distances do not meet or exceed suggested guidelines in Tables 620.A and B.
(2) Locations where clear zone distances as per Tables 620.B & C are met.
(3) Include references to appropriate documents in the design folder that contain detailed analyses and calculations.

620.13 ROADSIDE SAFETY IN AN URBAN ENVIRONMENT

For the purpose of this section an urban highway section must be posted at 60 km/h or less and is defined as having at least one of the following traffic environments:

- Reduced speed zone in the vicinity of a residential or commercial subdivision;
- Highway section with curb-and-gutter or a sidewalk;
- The average spacing is less than 150 metres for driveways and 500 metres for intersections.

The Clear Zone in an urban environment with restricted right-of-way is:

- 4.0 m from the edge of the traveled lane in open ditch situations;
- The greater of the following clearances: 2.0 from the face of the curb in closed drainage situations or 0.3 m beyond the sidewalk.

The Clear Zone in an urban environment where right-of-way is not restricted is to be evaluated similar to a suburban or transition area as described below.

Sections of highway that are posted at 70 km/h are typically in suburban or transition areas. In these cases, the designer should do a risk review considering local traffic conditions before deciding to apply the rural or urban clear zone guidelines. In these cases, the designer should consider guidelines that are contained in the AASHTO Roadside Design Guide, 3rd Edition 2006, chapter 10 – Roadside Safety in Urban or Restricted Environments.

620.14 REFERENCES

References used specifically for this chapter:

The following reports commissioned by BC MoT were used to produce chapter 600 – Safety Elements:

- CH2MHILL, Review of Roadside Hazard Mitigation Practices used by North American Road Agencies and Professional Transportation Organisations. May, 2005

General References:

- AASHTO, Roadside Design Guide, 3rd Edition, 2006.
- Transportation Association of Canada, Geometric Design Guide for Canadian Roads, 1999 Edition.
- Transportation Association of Canada, Canadian Guide to 3R/4R. August 2001.

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630
MEDIAN TREATMENT

630.01 GENERAL

The primary use of median separation is to eliminate the risk of head-on collisions and to control access.

The standard median treatments are:

- no median separation (undivided road)
- narrow flush median with or without barrier
- depressed median with traversable slopes

630.02 GUIDELINES

Use the following guidelines and Figure 630.B when selecting a median treatment:

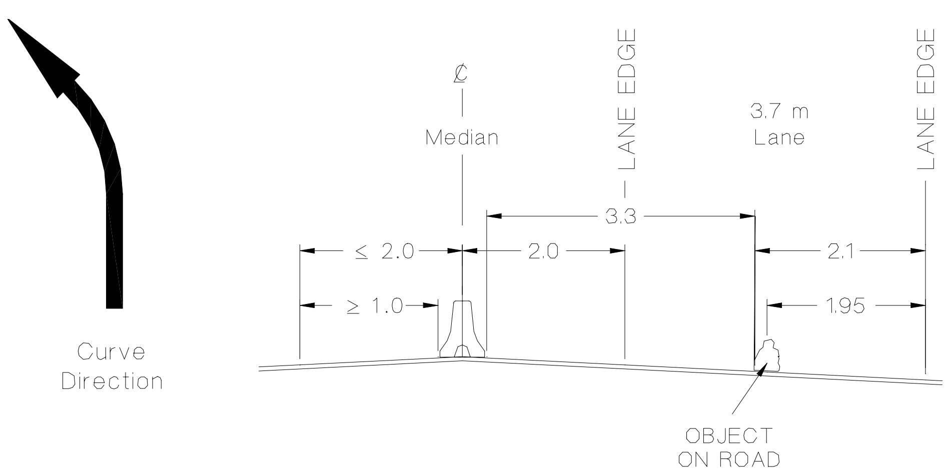
1. Median Barrier is not normally used and a median separation is optional on low speed multilane highways (posted speed less than 70 km/h).
2. For 4-lane rural arterials with less than 10,000 AADT[1], median barrier is not required unless indicated by accident history.
3. For 4-lane rural arterials with between 10,000 and 20,000 AADT[1], median barrier is not required unless indicated by accident history. However, the 2.6 m median without barrier should be used as a staged development, anticipating the future placement of barrier.
4. For rural arterials with 20,000 AADT[1] or greater, either the median barrier with narrow flush median, or the 13 metre wide depressed median should be used.
5. When barrier is to be installed on an existing facility which has less than the standard 2.6 m median, widening to 2.6 m is required to provide one metre of shy distance from the lane edge to the barrier.

   However, installation of median barrier on narrower medians may be approved by the Senior Highway Safety Engineer in special circumstances if safety, geometry, maintenance, and costs are adequately addressed.
6. Where sight distance may be restricted by tight curvature in conjunction with median barrier, the preferred treatment is to flatten the curves or use depressed median. However, these treatments may not be cost-effective when constructing in built up or mountainous areas.

   A modified median has been chosen to provide some additional sight distance and allow the driver some extra width to swerve safely around an object that partially obstructs the inside lane. See Figure 630.A.

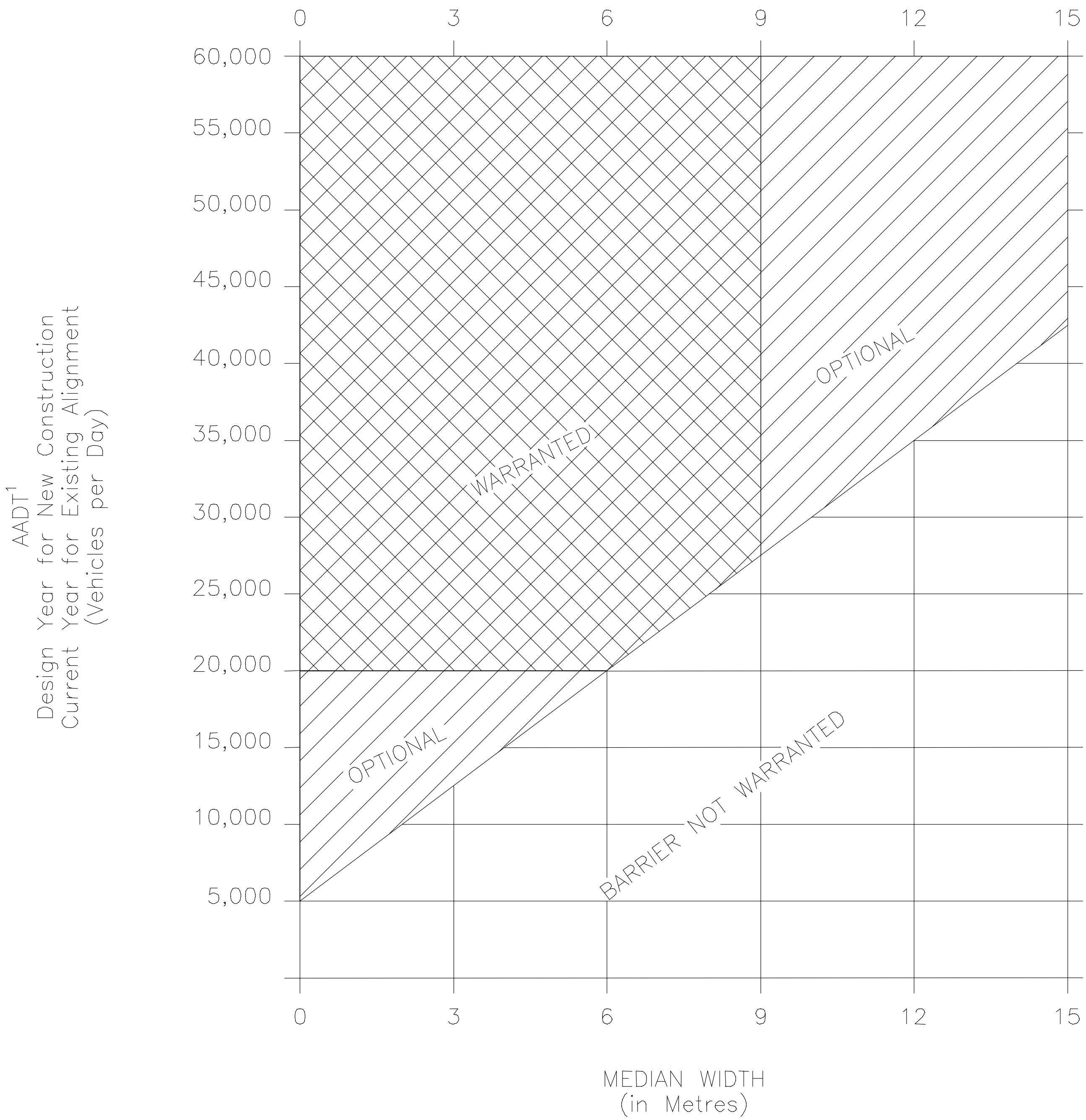
   The modified treatment has a symmetrical 4 m median separation; in very tight situations, you may consider leaving the median on the side without sight restriction with 1.3 m separation from the centerline.

Fig. 630.A Modified Median



[1] Contact Regional or Headquarters Planning for the SADT to AADT conversion factors for your projects.

Fig 630.B Guidelines for Median Barrier Placement



[1] Contact Regional or Headquarters Planning for the SADT to AADT conversion factors for your projects.

640
HIGHWAY SAFETY DRAWINGS

640.01 Dimensions of Roadside Barrier Approach and Opposing Flares on Rural Highways

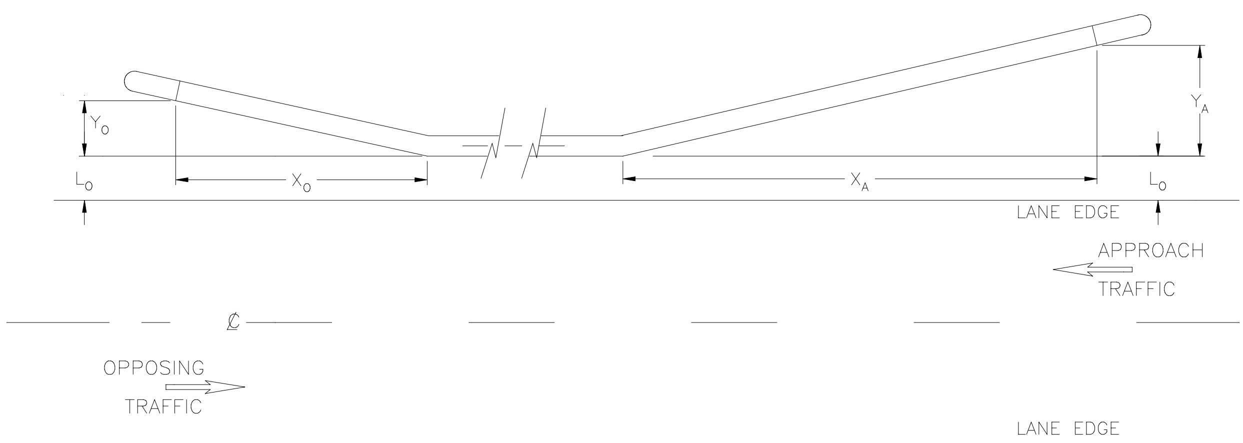
Several old drawings continue to be included from the Highway Safety Engineering (HSE) Section. This section gives the dimensions of roadside barrier approach and opposing flares that are applied to the HSE drawings.

Until they have been reviewed and revised, some of the old HSE drawings are provided in the original format and content.

In most drawings, only the headers and footers have been changed. Where the drawings were converted from manual to CAD drawings, some graphic re-arranging has occurred, as well as some additions to the tables for speeds of 110 km/h.

Where no CAD conversion has been done, the drawings have been scanned and inserted into the document.

Figure 640.A Roadside Barrier Approach and Opposing Flares



L_0 = Normal Paved Shoulder without Barrier; minimum width = 1.3 m (except on LVR)

The offset Y_A is dependent of the speed and volume; the length of need X_A is speed dependent only. (Refer to Tables 640.A and 640.B for Y_A and X_A dimensions.)

Table 640.A Barrier Approach Flare Dimensions on Rural Highways For New Construction and Major Reconstruction Projects

Barrier Approach Flare
Longitudinal dimension X_A & Lateral offset Y_A (metres)

		Design Speed (km/h)													
Design ADT	Assumed L_0 [1]	<60		60		70		80		90		100		110	
		X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A
≤ 200	0.0 [3]	See Note 3		See Note 3		See Note 3		See Note 3		See Note 3		See Note 3		See Note 3	
201 - 750	1.3 [2]	27.5	1.7	34.9	1.7	42.4	2.2	47.4	2.2	52.4	3.2	59.9	3.4	67.4	3.4
751 - 1500	1.5 [2]	27.5	2.0	34.9	2.0	42.4	3.3	47.4	3.4	52.4	3.4	59.9	3.4	67.4	3.4
1501 - 6000	2.0 [2]	27.5	2.5	34.9	2.5	42.4	3.3	47.4	3.4	52.4	3.4	59.9	3.4	67.4	3.4
> 6000	2.5 [2]	27.5	2.5	34.9	2.5	42.4	3.3	47.4	3.4	52.4	3.4	59.9	3.4	67.4	3.4
No. of CRB Units		11		14		17		19		21		24		27	

Notes:

1. L_0 = Normal Paved Shoulder width without safety barrier.
2. These are the assumed distances between parallel barrier sections and the edge of the travel lane. If the actual L_0 is less than the table value, the "Y_A" must be increased so that the total L_0+Y_A are the same as in the table. In all cases, L_0 must not be less than 1.3 metres. Correspondingly, if the L_0 happens to be greater than that listed in the table, the value of "Y_A" is decreased by the same amount.
3. Refer to Section 510.09 of the Low-volume Roads chapter.
4. When the shoulder is less than 1.3 m, the width of shoulder shall be increased so that the offset to the face of the parallel length of barrier is at least 1.3 m for all highways with an ADT > 200. The Y_A is measured from the face of the parallel length of barrier, not the lane edge line. Refer to Figure 640.A. For example, on an 80 km/h design with 2.0 m shoulders and a design ADT of 3,500, the shoulder is widened over the length of the barrier so that the offset to the barrier is still 2.0 m; the Y_A is added to the 2.0 m to provide 5.4 m of width between the lane line and the standard terminal section on the end of the approach flare.
5. Above and to the left of the heavy line, the $L_0 + Y_A$ value is equal to the higher value for Clear Zone distance listed in Table 620.A for front slopes 6:1 or flatter.
6. Below and to the right of the heavy line, the Y_A is based on the flare rates (which are speed dependent) shown in the AASHTO Roadside Design Guide. Clear Zone has no bearing on these Y_A distances.
7. Number of CRB units shown in the table may be increased but never reduced.

Table 640.B Barrier Approach Flare Dimensions on Rural Highways For Rehabilitation Projects

Barrier Approach Flare Longitudinal dimension X_A & Lateral offset Y_A (metres)															
		Design Speed (km/h)													
Design ADT	Assumed L_0[1]	<60		60		70		80		90		100		110	
		X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A
≤ 200	0.0 [3]	See Note 3		See Note 3		See Note 3		See Note 3		See Note 3		See Note 3		See Note 3	
201 - 750	1.3 [2]	27.5	0.8	34.9	0.8	42.4	1.4	47.4	1.4	52.4	2.0	59.9	3.2	67.4	3.4
751 - 1500	1.5 [2]	27.5	1.2	34.9	1.2	42.4	2.0	47.4	2.0	52.4	3.0	59.9	3.4	67.4	3.4
1501 - 6000	2.0 [2]	27.5	1.2	34.9	1.2	42.4	2.5	47.4	2.5	52.4	3.4	59.9	3.4	67.4	3.4
> 6000	2.5 [2]	27.5	1.2	34.9	1.2	42.4	2.5	47.4	2.5	52.4	3.4	59.9	3.4	67.4	3.4
No. of CRB Units		11		14		17		19		21		24		27	

Notes:

1. L_0 = Normal Paved Shoulder width without safety barrier.
2. These are the assumed distances between parallel barrier sections and the edge of the travel lane. If the actual L_0 is less than the table value, the "Y_A" must be increased so that the total L_0+Y_A are the same as in the table. In all cases, L_0 must not be less than 1.3 metres. Correspondingly, if the L_0 happens to be greater than that listed in the table, the value of "Y_A" is decreased by the same amount.
3. Refer to Section 510.09 of the Low-volume Roads chapter.
4. When the shoulder is less than 1.3 m, the width of shoulder shall be increased so that the offset to the face of the parallel length of barrier is at least 1.3 m for all highways with an ADT > 200. The Y_A is measured from the face of the parallel length of barrier, not the lane edge line. Refer to Figure 640.A. For example, on an 80 km/h design with 2.0 m shoulders and a design ADT of 3,500, the shoulder is widened over the length of the barrier so that the offset to the barrier is still 2.0 m; the Y_A is added to the 2.0 m to provide 5.4 m of width between the lane line and the standard terminal section on the end of the approach flare.
5. Above and to the left of the heavy line, the L_0 + Y_A value is generally based on the Clear Zone distance listed in Table 620.B.
6. Below and to the right of the heavy line, the Y_A is based on the flare rates (which are speed dependent) shown in the AASHTO Roadside Design Guide. Clear Zone has no bearing on these Y_A distances.
7. Number of CRB units shown in the table may be increased but never reduced.

640.02 Opposing Flare

640.02.01 For Highways with ADT ≤ 200

Because of the narrowness of Low-volume Roads that have an ADT ≤ 200, there is no difference in the design of approach and opposing flares. Although Clear Zone is not a design parameter for Low-volume roads, good safety practice requires consideration of dimensions for barrier offsets. As there is no minimum 1.3 m offset to the face of barrier for these roads, the flare requirements as shown in Table 510.M of the Low-volume Roads Interim Guidelines are recommended.

640.02.02 For Highways with ADT>200

The offset, from the centreline of the roadway, for the opposing guardrail end, must be equal to or greater than that of the approach end offset, as measured from the lane edge (see Figure 640.B). The minimum offset of the opposing end from the near lane edge, for two lane highways, without auxiliary lanes shall be 1.3 m or the normal paved shoulder, whichever is greater. The minimum for two lane highways with truck lanes shall be 1.3 m. The minimum for four lane undivided highways without auxiliary lanes shall be 1.3 m or the normal paved shoulder, whichever is greater. The minimum for 4-lane highways with auxiliary lanes shall be 1.0 m. All offsets are measured from the lane edge marking to the toe of the barrier.

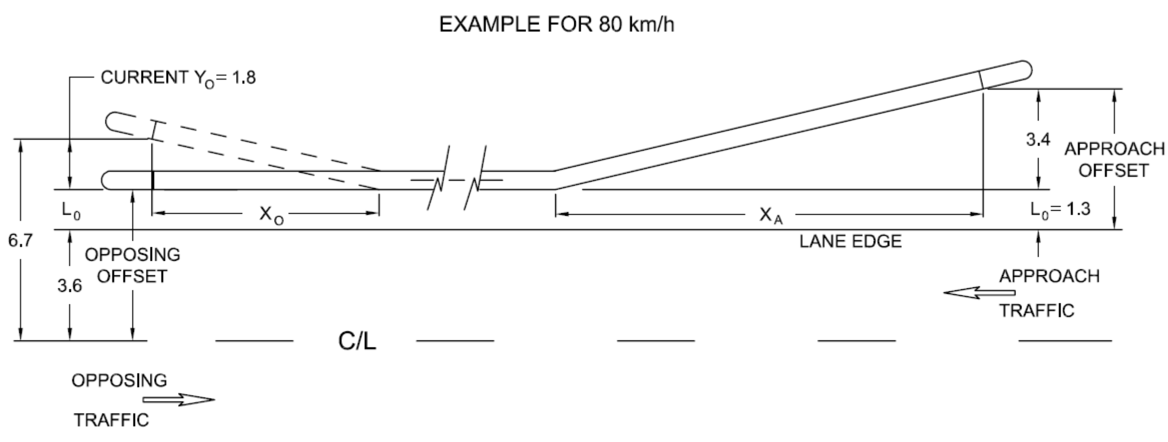
640.02.03 Caveat

The previous procedure of using opposing flares for all 2-lane highways represented a standard that needed no further consideration for the likelihood of passing vehicles encroaching on the opposing direction flare. While the new treatment provides construction savings, its use needs to be tempered by the provision of passing opportunities. The designer needs to review for the potential of passing occurring in the vicinity of the reduced or eliminated opposing flare.

Because of exposure of opposing traffic to the end treatment, when passing on a 2-lane highway, care should be taken to ensure that either normal opposing flares are used or that the barrier is extended to a location on the inside of a curve or into a no passing zone.

If the barrier would normally end on the outside of a curve, the length of barrier should be extended through the curve and ended on tangent or on the inside of a curve.

Figure 640.B Roadside Barrier with No Opposing Flare



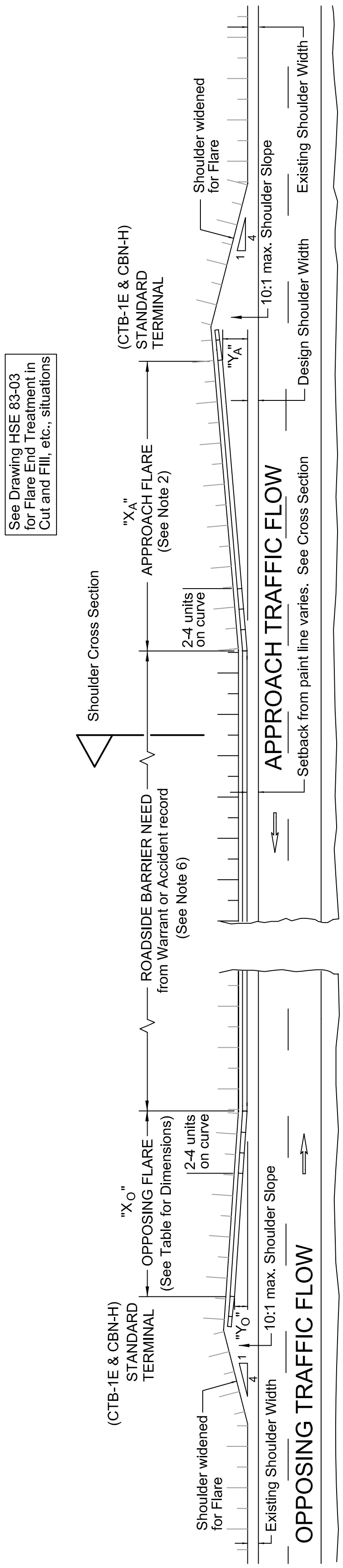
L_0 = Normal Paved Shoulder without barrier; minimum width = 1.3 m

Although Y_O is reduced, the length of need X_O is speed dependent and not to be reduced

MoT Section	640		TAC Section	Chapter 3.2

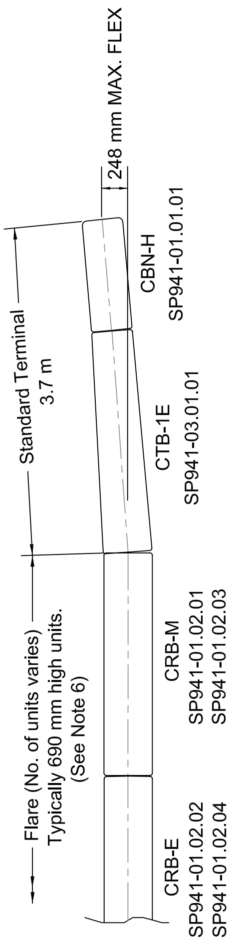
Figure 640.C Standard Layout of Flares and Terminals for Concrete Roadside Barriers

N.T.S. (old HSE 82-07A)

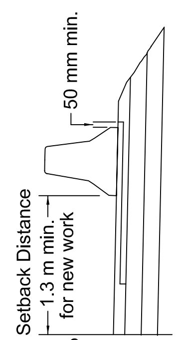


LAYOUT PLAN of PRECAST CONCRETE BARRIER FLARES

(For Assembly Elevations, see Drawing HSE 82-11 in BC MoT "Guardrail Placement Guidelines")



DETAILS OF STANDARD TERMINAL



SHOULDER CROSS SECTION
(See Figure 440.F)

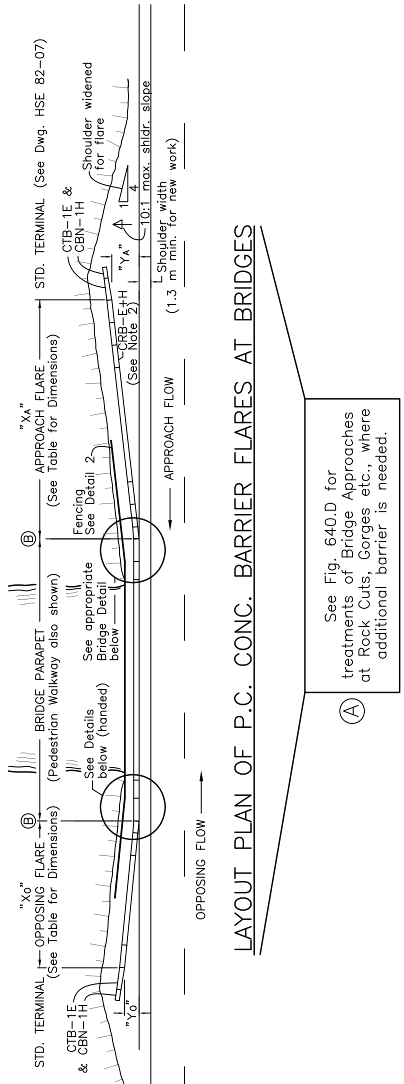
LAYOUT DIMENSIONS			
Travel Speed	OPPOSING FLARE		
km/h	X_O	Y_O	No. of Units
110	37.5	1.8	15
100	32.5	1.8	13
90	30.0	1.8	12
80	27.4	1.8	11
70	22.4	1.7	9
60	17.4	1.6	7
50	14.9	1.5	6

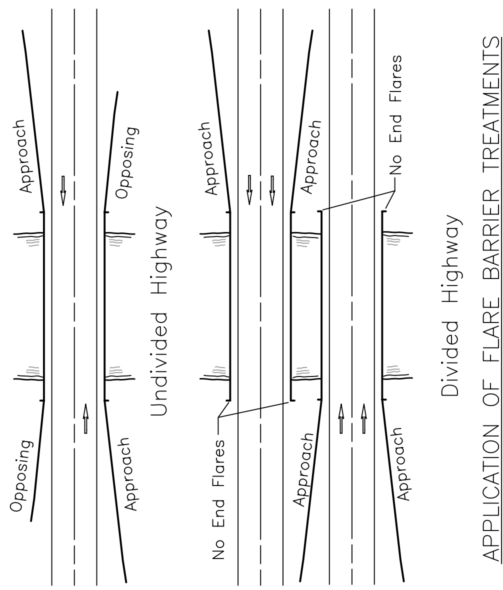
NOTES :

1. All dimensions in metres unless otherwise noted.
2. See Tables 640.A and 640.B for Approach Flare Layout Dimensions.
3. Table of layout dimensions is derived from 1977 AASHTO "Guide for Selecting, Locating and Designing Traffic Barriers."
4. Both Approach and Opposing Flares are required for Roadside Barrier on all undivided highways. Opposing Flare may not be required on a divided highway with Median Barrier in place or at locations that meet the criteria outlined in Section 640.02.
5. Number of units shown in table may be increased but never reduced.
6. Roadside barrier will usually be 690 mm high (CRB). In special cases, 810 mm high units (CMB) may be used. In this event, transition units (CTB-2) will be needed to link the CMB to the CRB.

Figure 640.D Standard Layout of Flares for Concrete Roadside Barriers at Bridge Ends

N.T.S. (old HSE 83-01B)



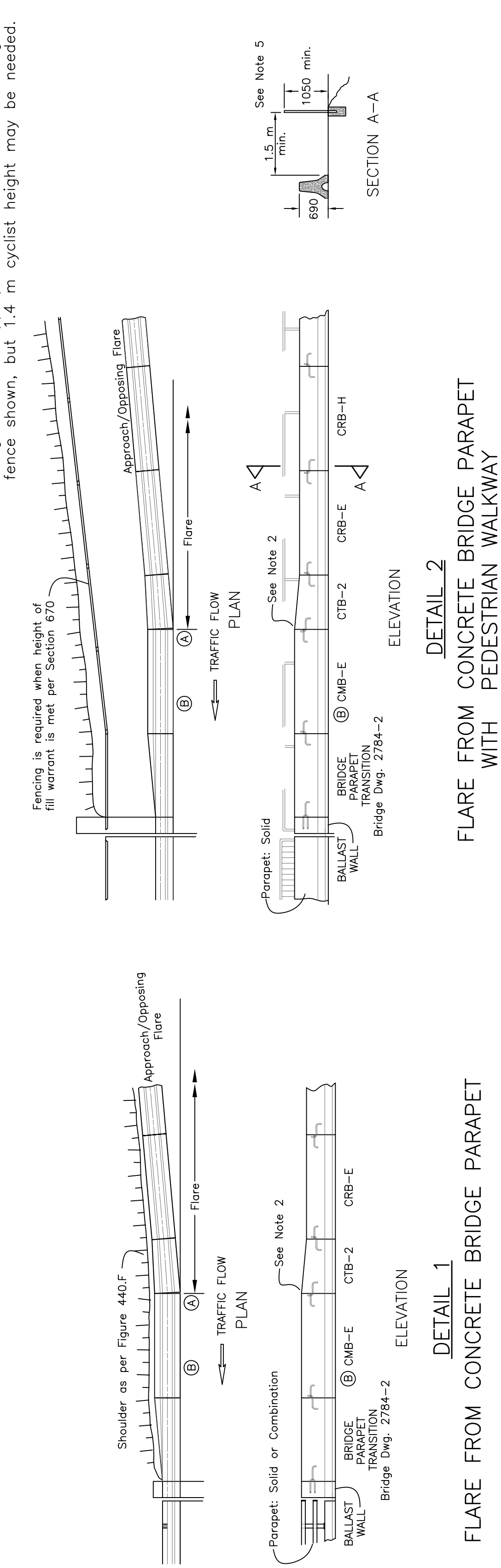


OPPOSING FLARE						
Travel Speed km/hr	See Note 3 X o (metres)	Y o (metres)	Bridge Transition & CMB−F	No. of Units in Flare CTB−2	CRB−F	CRB−M
110	36.3	1.8	(1 each)	1	7	7
100	31.3	1.7	(1 each)	1	6	6
90	31.3	1.9	(1 each)	1	6	6
80	26.2	1.7	(1 each)	1	5	5
70	21.2	1.6	(1 each)	1	4	4
60	21.2	1.9	(1 each)	1	4	4
50	16.2	1.6	(1 each)	1	3	3

APPROACH FLARE						
Travel Speed km/hr	X A (metres)	Y A (metres)	Bridge Transition & CMB−F	No. of Units in Flare CTB−2	CRB−F	CRB−M
110	See Table 640.A and 640.B for X_A and Y_A values. Add 1.3 m to the X_A values to account for the CTB−2 piece in the flare.		(1 each)	1	14	14
100			(1 each)	1	12	12
90			(1 each)	1	10	10
80			(1 each)	1	9	9
70			(1 each)	1	8	8
60			(1 each)	1	7	7
50			(1 each)	1	5	5

NOTES :

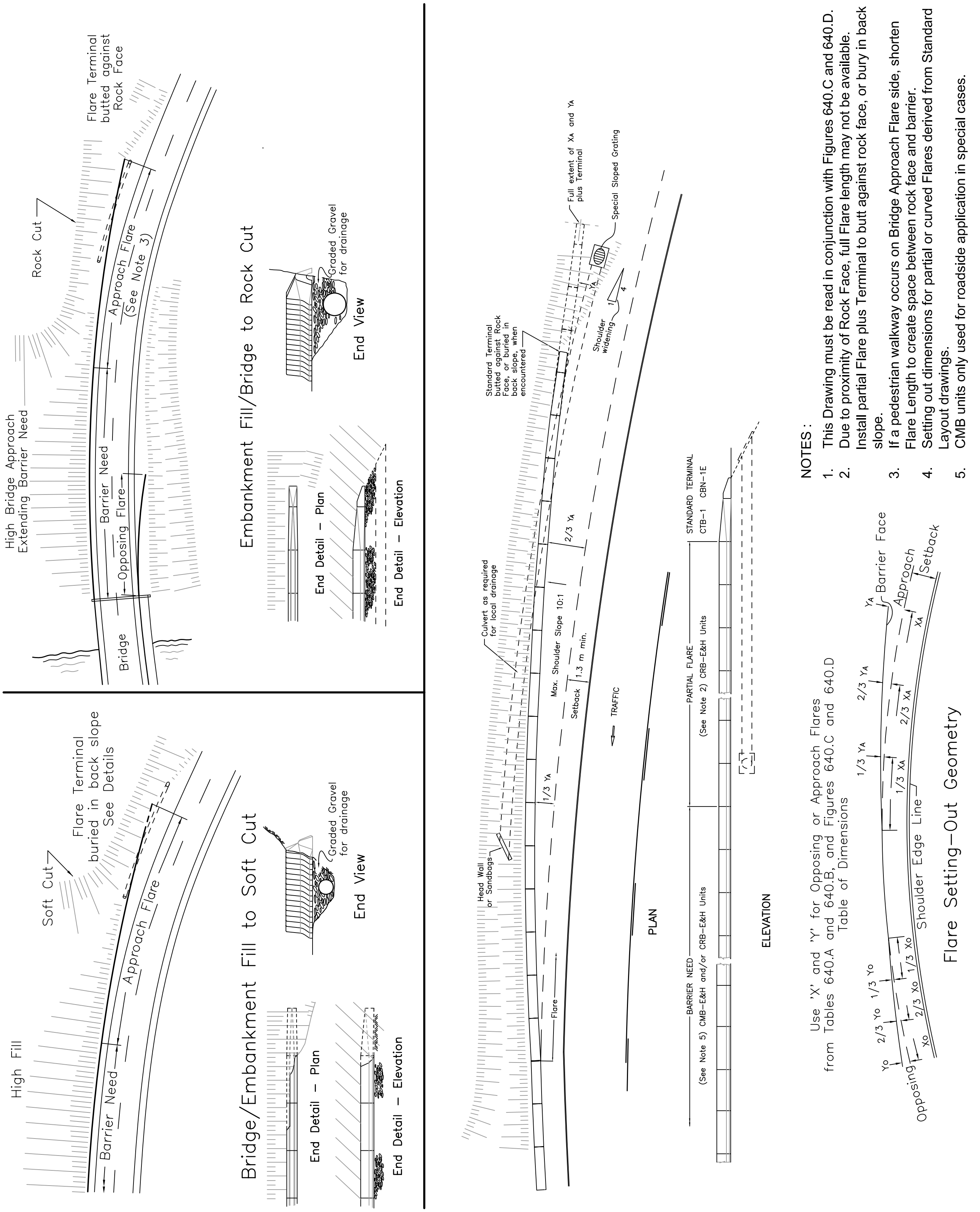
1. All dimensions in mm unless otherwise noted.
2. (B) Units in flare will normally be CRB (690 mm). Very high bridges and fill heights may require more 810 mm high CMB−F & M units between CTB−2 and Bridge Transition Unit.
3. Refer to Section 640.02 for discussion on opposing barrier installed without a flare.
4. Read with Bridge Contract, BC Supplement to TAC, & Highway Safety Drawings.
5. Refer to the BC Supplement to Canadian Highway Bridge Design Code for appropriate widths. Pedestrian height fence shown, but 1.4 m cyclist height may be needed.



MoT Section	640		TAC Section	Chapter 3.2

Figure 640.E Roadside Barrier Layouts at Cut & Fill, and Curves

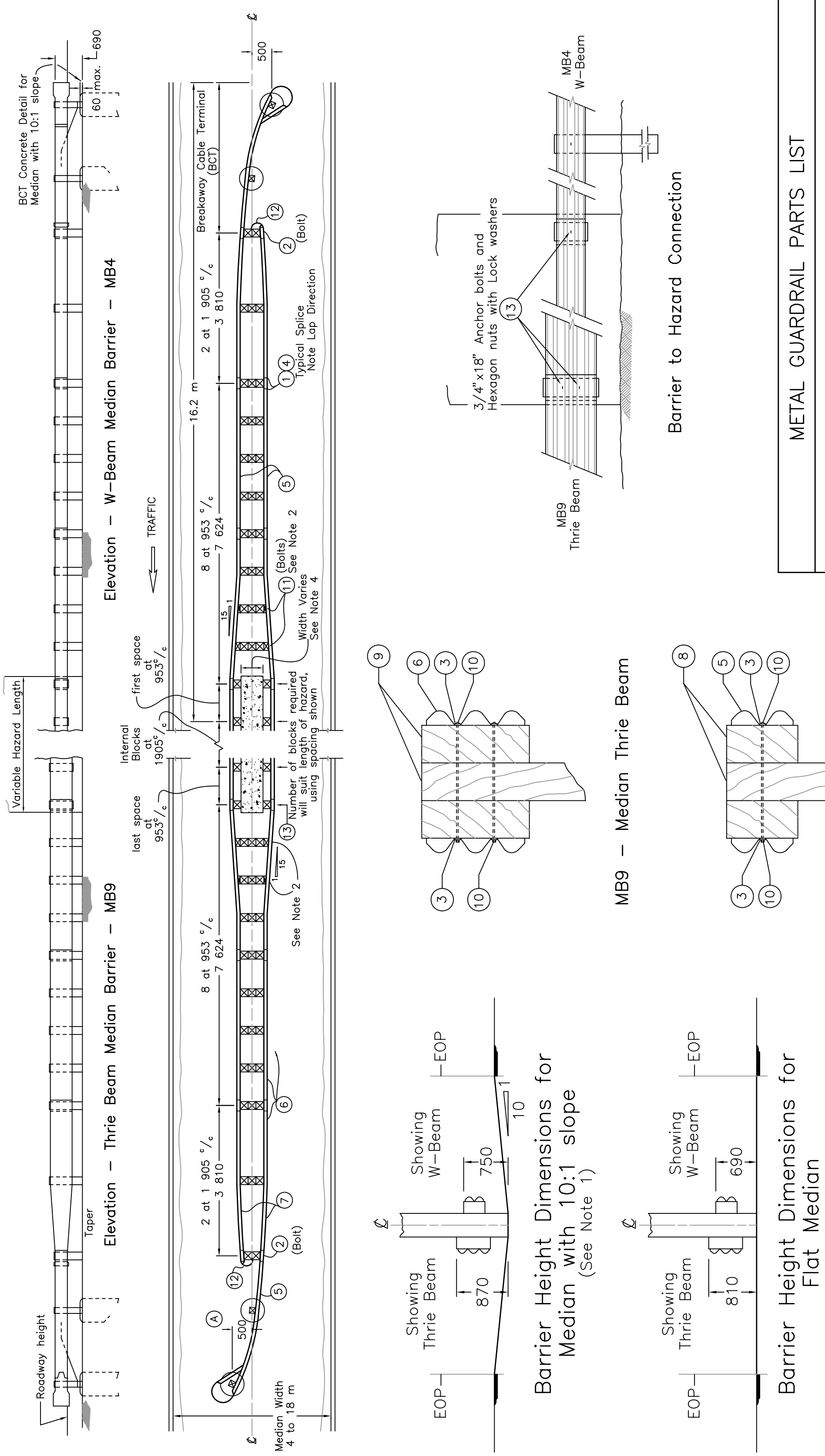
N.T.S. (old HSE 83–03)



MoT Section	640		TAC Section	Chapter 3.1

Figure 640.F MB4/MB9 Median Hazard Treatment in 4-18 m Undepressed Medians

N.T.S. (old HSE 83–13A)



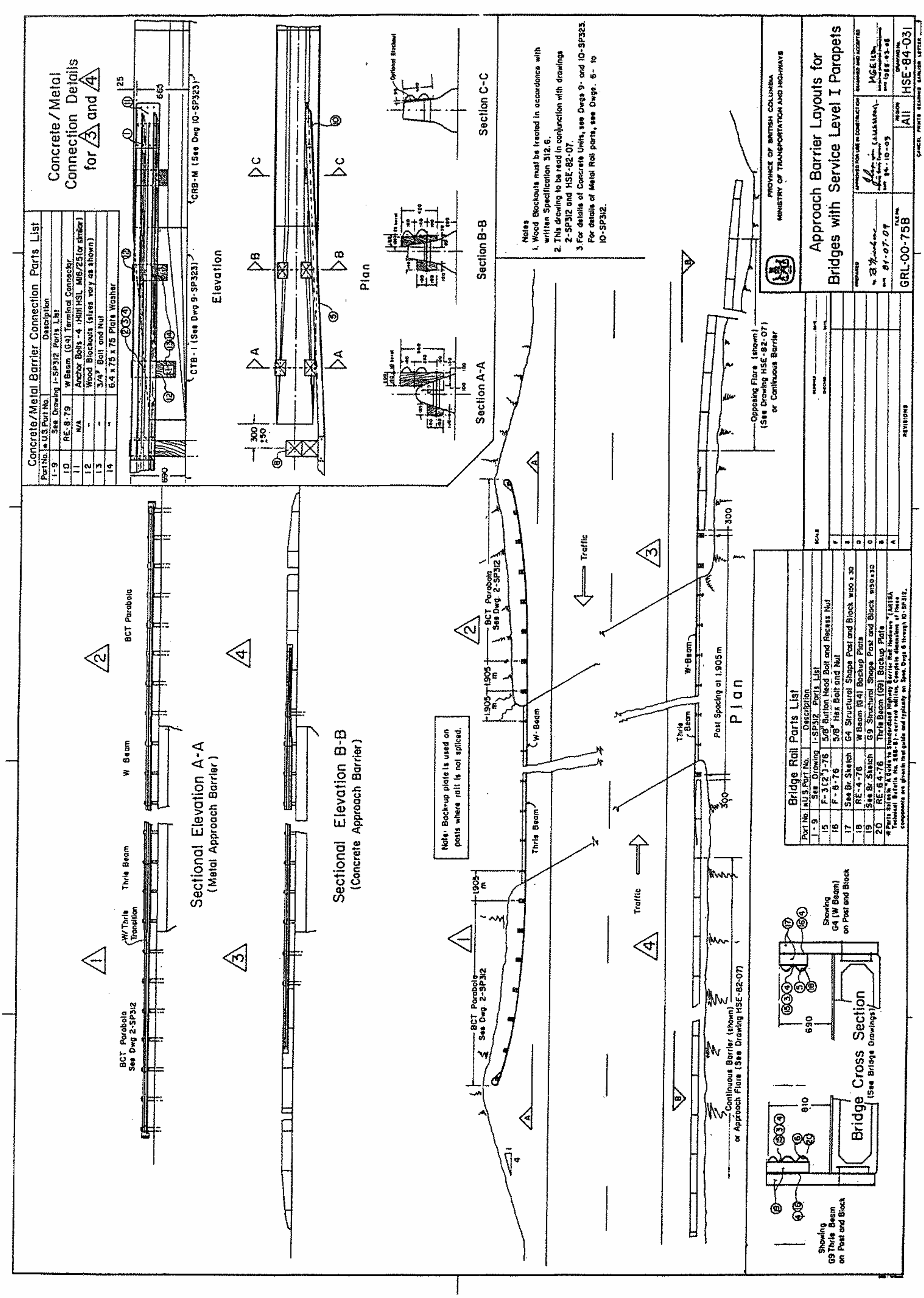
METAL GUARDRAIL PARTS LIST		
Part No.	* U.S. Part No.	Description
1–4	See Drawing 1–SP312 for listing and info (*) notes	
Ⓐ 5	RE–3 [4 at 3'–1 1/2" = 12'–6"] –73	G4 W Beam
Ⓐ 6	RE–63 [4 at 3'–1 1/2" = 12'–6"] –76	G9 Thrie Beam
7–9	See Drawing 1–SP312 for listing and info (*) notes	
10	F–3 [25"] –76	5/8" Button Head Bolt and Recess Nut
11	F–3 [suit length to site] –76	——— " ——— (See Note 2)
12	RE–6–79	W Beam End Section (Rounded)
13	(local parts)	3/4" x 18" (457 mm) Anchor Bolts and Hexagon nuts with Lock washers

NOTES :

1. Median slope affects placement height of barrier. Slopes steeper than 10:1 will require heights greater than shown. Contact the Senior Highway Safety Engineer.
2. Flares of 15:1 match vehicle speeds. Adjust block-out dimensions to suit this requirement and width of hazard by adding shaped pieces. Bolt lengths to suit.
3. See Drawing 1-SP312 for Metal Barrier (G4 and G9) details. See Drawing 2-SP312 for BCT details.
4. This arrangement for max. hazard widths of 670 mm. For wider, contact the Senior Highway Safety Engineer.
5. Ⓐ Median may require some grading to smooth irregularities and prepare site for beam installation.

Figure 640.G Approach Barrier Layouts for Bridges with Service Level I Parapets

N.T.S. (old HSE 84-03)



650
RUMBLE STRIPS

650.01 Shoulder Rumble Strips

Considerations

Shoulder Rumble Strips (SRS) should be considered on rural highways in the following cases:

1. New rural highway sections;
2. When re-paving, rehabilitating or reconstructing existing rural highway sections, which include the shoulders;
3. Other rural Highway Sections that are not part of a project but that would benefit from the installation of SRS in terms of decreasing the number of single vehicle off-road crashes. To assist Ministry Regions, a prioritized list of highway sections is available from Engineering Branch, which identifies possible candidate locations; however it does not limit SRS to only those locations. Funding and other resources for these stand-alone SRS projects are subject to availability and should be considered in the larger context of all safety initiatives.

SRS should not be used in urban areas. Good indications of urban highway sections are:

1. Speed Zone of 70 km/h or less in the vicinity of a settlement;
2. Highway section with curb and gutter or a sidewalk;
3. The average driveway spacing is less than 150 metres and intersection spacing is less than 500 metres.

The minimum shoulder depth of pavement required is 50 mm. SRS are not to be installed if pavement deterioration or cracking is evident. (NOTE: There is no concern with the outer edges of the SRS and the first lift of asphalt being at the same vertical location.)

All projects that involve SRS should be submitted for ICBC Cost-Sharing evaluation.

Application Guidelines

The Layout for Milled-in SRS is shown in Figure 650.A.

SRS should be installed on shoulders, in both directions, for rural two lane and four lane undivided highways.

On rural four lane divided arterials, expressways and freeways (RAD, RED & RFD), the SRS should be installed on both the outside and the median shoulders.

SRS should be installed, in both directions, on the median of rural highways with painted flush medians that are at least 2.0 m wide. This includes locations with existing median barrier if there is sufficient room for the milling machine to install the SRS. For widths less than 2.0 m, refer to Section 650.03 - Centreline Rumble Strips.

Shoulders that are to have SRS installed should be a minimum of 0.5 m wide where there is no cycling traffic on the shoulder. Shoulders with SRS that have cycling traffic should be at least 1.5 metres wide.

Alternatives to SRS

Should other audible delineation devices be approved, the use of such approved devices, which minimize the reduction of usable smooth paved shoulder, should be considered on the same cost-effective basis as SRS.

SRS Installation

Figure 650.A shows the Patterned SRS installation for outside shoulder locations. Discussion with cycling advocates suggests that regular gaps should be provided to facilitate movement to/from the shoulder. The patterned SRS should be installed in a repeating cycle consisting of approximately 15 m of rumble strips followed by approximately 3.5 m of gap.

Figure 650.A shows the Continuous SRS installation for median shoulder locations and painted flush medians.

SRS Interruptions

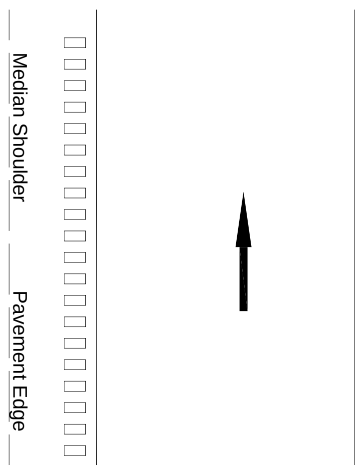
SRS are to be interrupted prior to driveways, intersections, ramps, shoulder constraints and wherever it is needed and required to allow cyclists to merge to the left of the SRS, as shown in Figures 650.B, 650.C and 650.D.

Shoulder rumble strips shall not be installed on bridge decks, overpasses or other concrete surface structures.

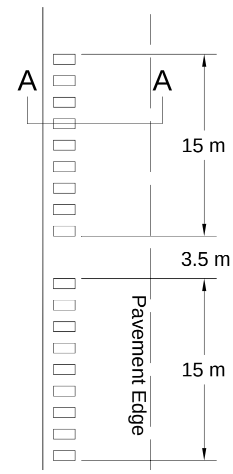
Paint Marking for SRS

To inform cyclists of the beginning of SRS, three white lines shall be painted approximately 5.0 m in front of the first milled rumble strip, as shown in Figure 650.E.

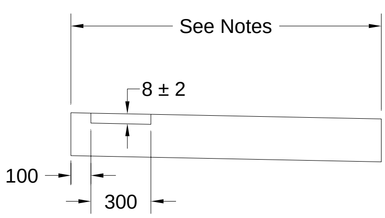
Figure 650.A Milled Shoulder Rumble Strips



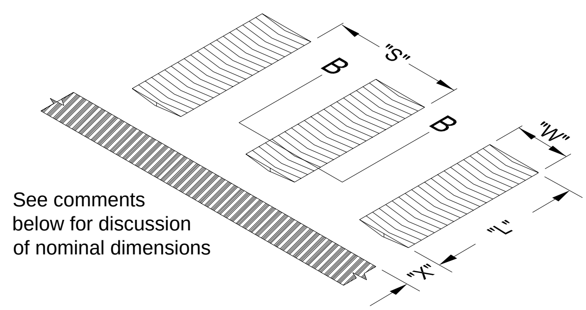
Continuous SRS

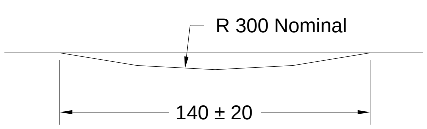


Patterned SRS



Section A-A





Section B-B

Offset "X" from the edge of the lane paintline is 100 mm ± 10 mm. This may be reduced to 0 mm to maintain cycling width.

Length of Rumble Strip "L" is 300 mm ± 10 mm.

Width "W" is nominally 140 mm ± 20 mm, based on the tolerance of the cut depth (8 mm ± 2).

Spacing "S" between strips is 300 mm.

NOTES:

1. Milled-in SRS are to placed on existing/new paved shoulders on:
   - 2-Lane highways with minimum 1.5 m shoulders
   - Multi-Lane undivided highways with minimum 1.5 m shoulders
   - Multi-Lane divided highways with minimum 0.8 m shoulders inside and 1.5 m outside.
2. The minimum shoulder depth of pavement required is 50 mm. SRS are not to be installed if pavement deterioration or cracking is evident.
3. Milled-in SRS are to placed on existing/new paved centre medians with a minimum 2.0 m painted width. This includes locations with existing median barrier if there is sufficient room for the milling machine to install the SRS. For widths less than 2.0 m, see Figure 650.F.
4. Patterned SRS installation is for outside shoulder locations. Continuous SRS installation is for median shoulder locations and painted flush medians.
5. Milled-in SRS may be placed where outside shoulders are less than 1.5 m if there is no cycling traffic on the shoulder.
6. Milled-in SRS are not to be placed through urban areas or in the presence of turning lanes.
7. Milled-in SRS are to be discontinued across private accesses and public road intersections. Refer to Figures 650.B and 650.C.
8. Milled-in SRS are to be discontinued in advance of all bridges and where minimum dimensions do not exist because of Roadside Barrier, Drainage Curb, Fencing, Rock Face, etc. Refer to Figure 650.D.
9. Shoulder rumble strips shall not be installed on bridge decks, overpass structures, or other concrete surfaced structures.

Figure 650.B SRS Interruptions at Intersections and Driveways

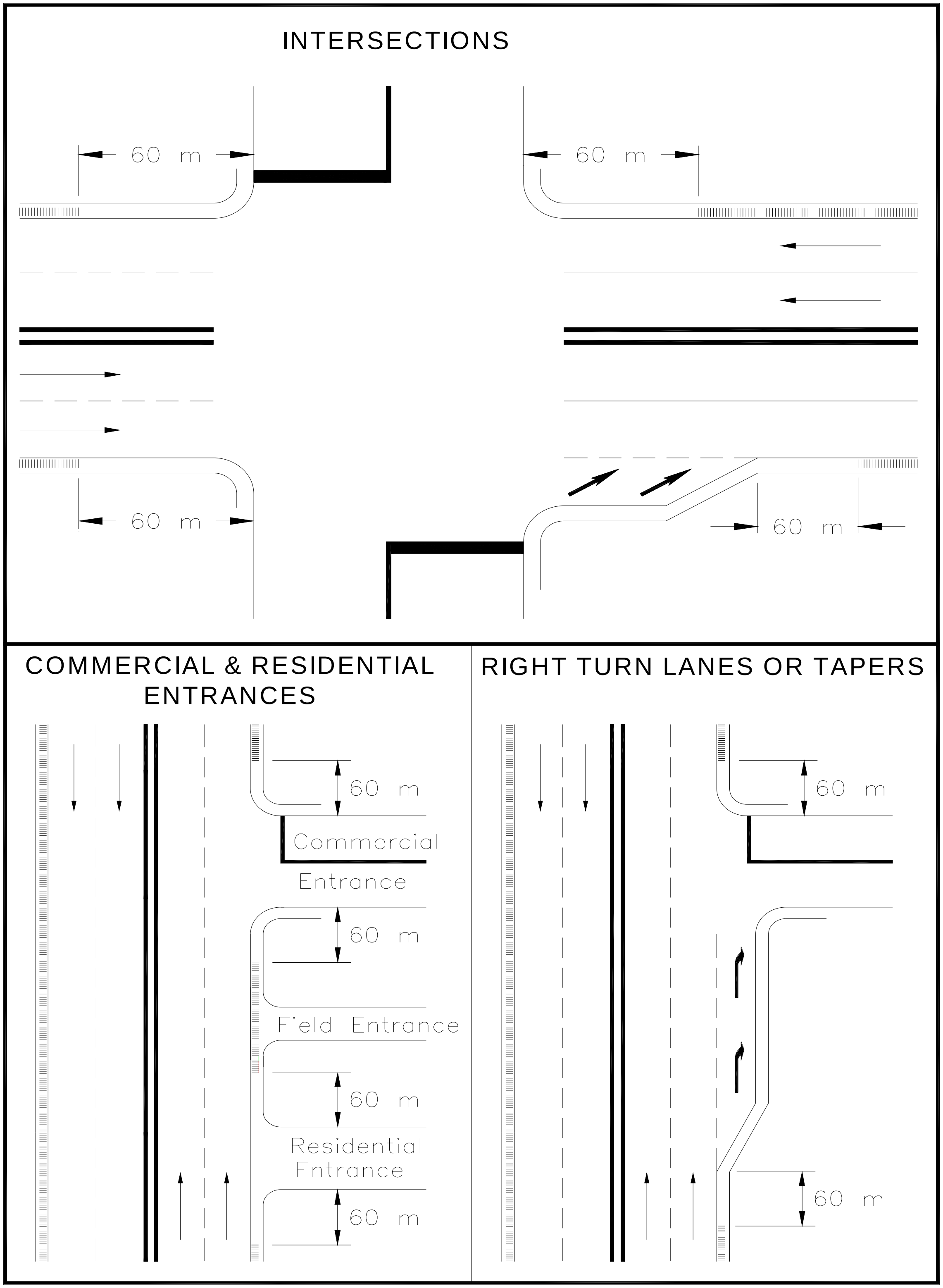
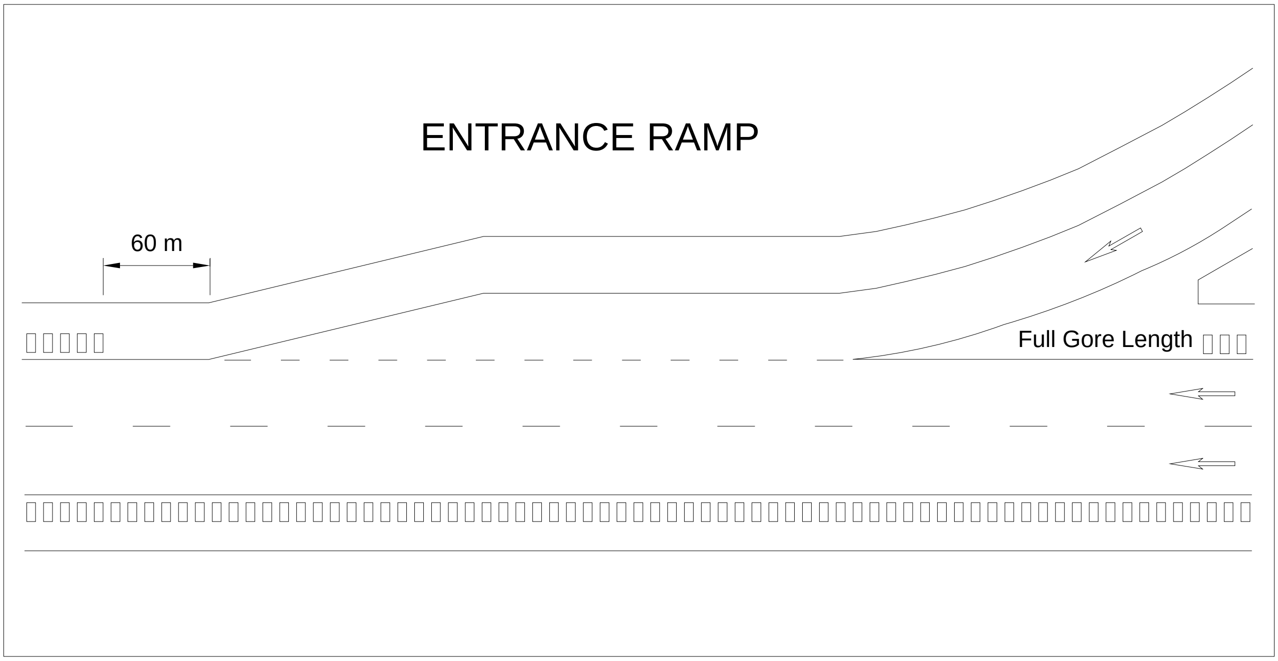


Figure 650.C SRS Interruptions at Exit and Entrance Ramps



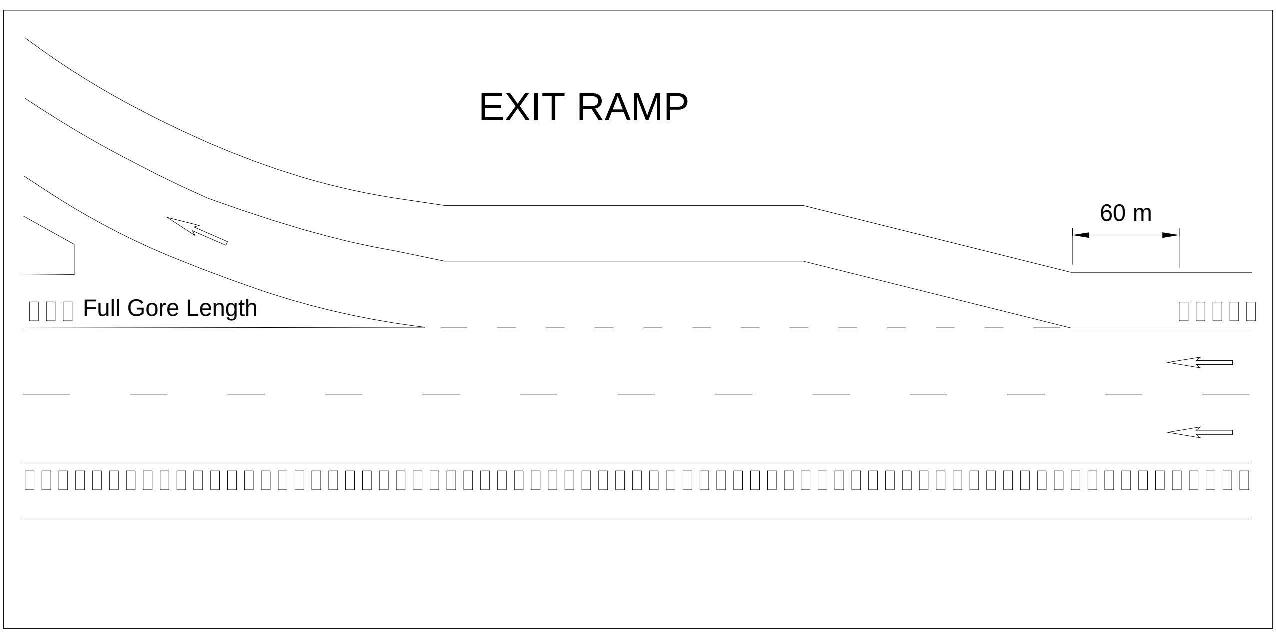
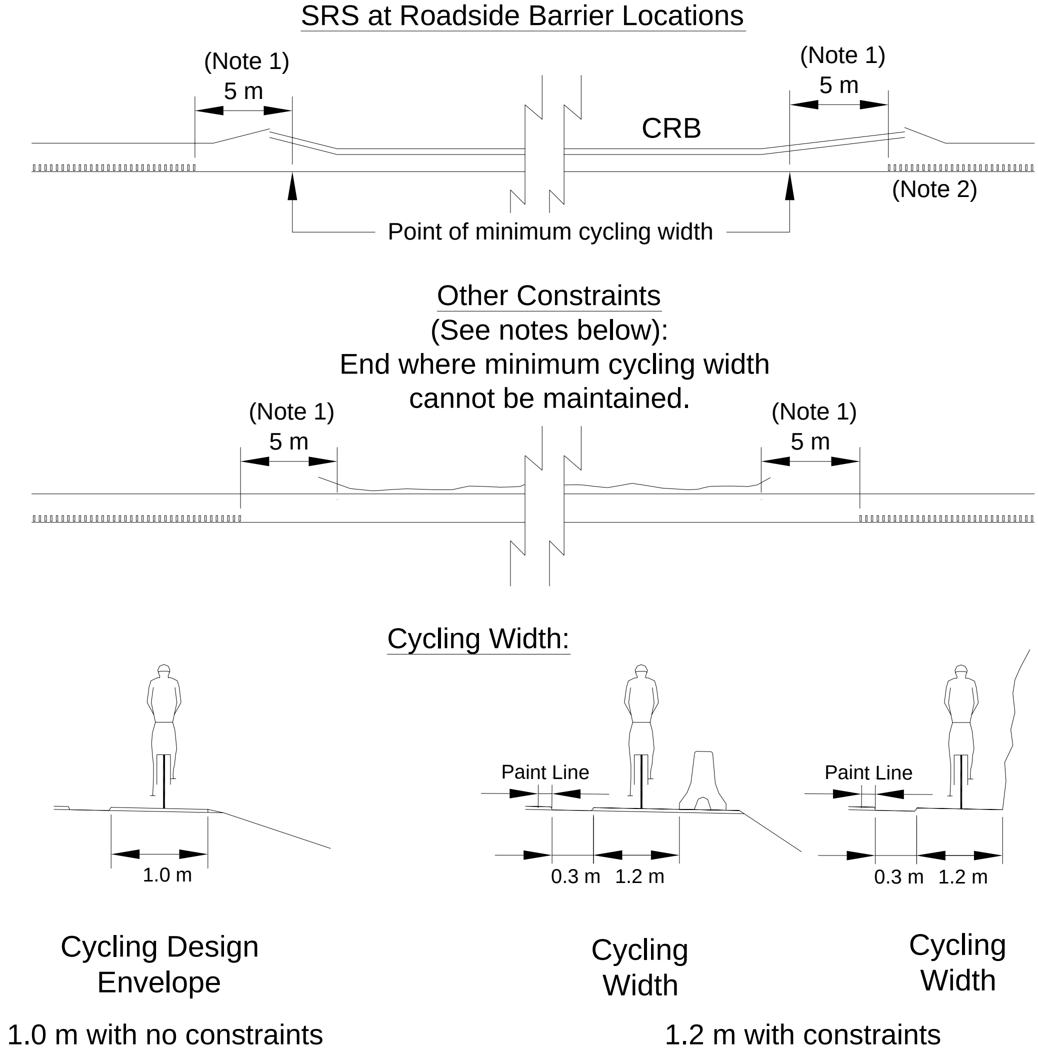


Figure 650.D SRS Interruptions at Shoulder Constraints



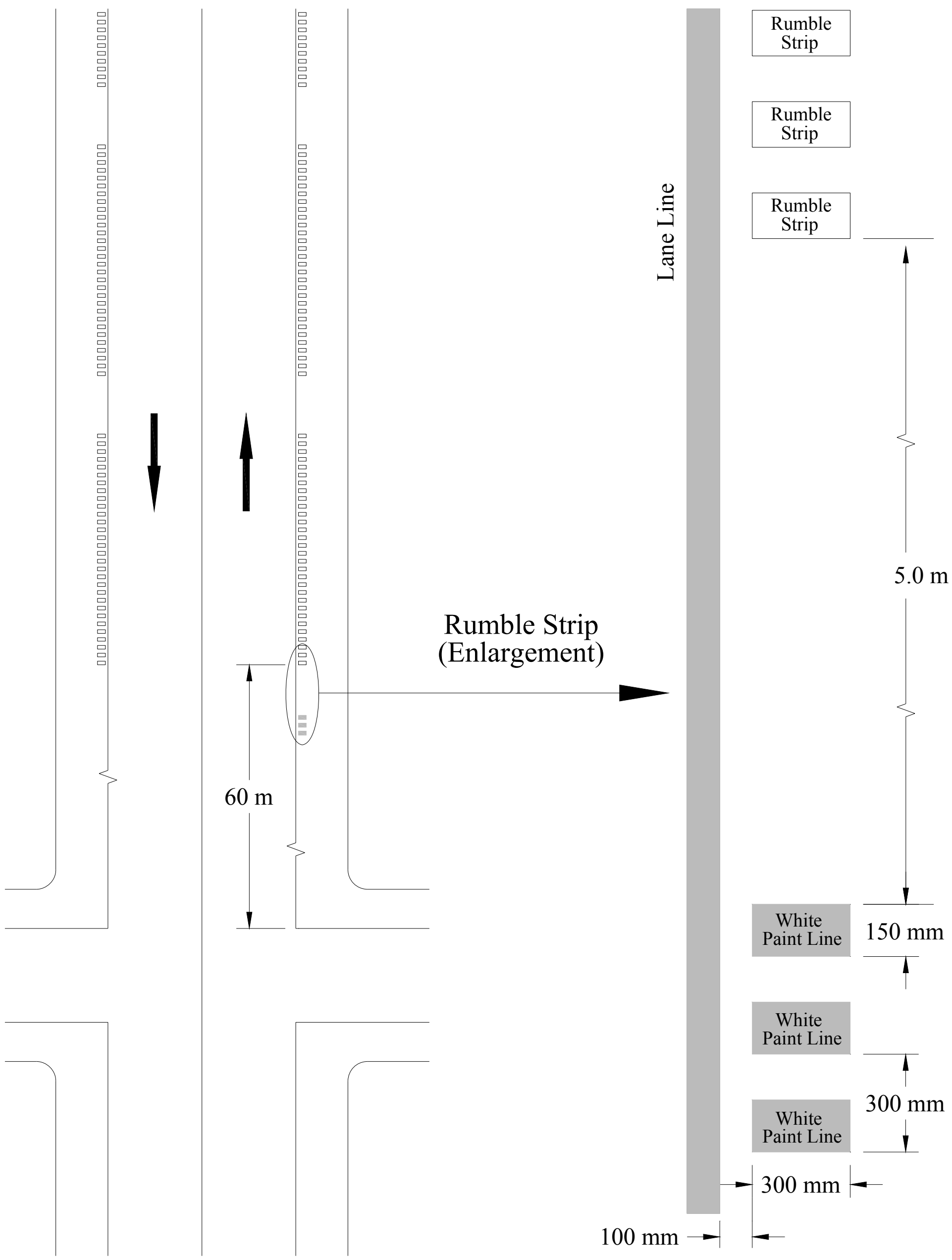
NOTES:

1. The minimum acceptable cycling width with a longitudinal obstruction is 1.2 m. The SRS should be discontinued 5 m before and restarted 5 m after where this width to longitudinal constraints cannot be maintained.
2. If there is adequate cycling width adjacent to a barrier, the SRS should not be discontinued.
3. SRS shall not be installed on bridge decks, overpasses or other concrete surfaces.

Figure 650.E Typical Paint Marking for SRS

To inform cyclists at the beginning of Shoulder Rumble Strips, three white lines shall be painted approximately 5.0 metres in front of the first milled rumble strip. The length of the lines shall be approximately 300 mm, the width shall be approximately 150 mm and the spacing shall be approximately 150 mm. The 3 white lines shall be painted at:

a) the beginning of SRS where numbered routes cross and/or at major signalized intersections
b) the beginning of SRS after an interruption of more than 1 km
c) the beginning of SRS installed along an isolated section of road.



650.02 Centreline Rumble Strips

Background

Centreline Rumble Strips (CRS) have started being used by an increasing number of highway agencies over the last few years. CRS are used as a means to counter the frequency of crossover centreline crashes due to driver fatigue, inattention, error and/or impairment. Early studies have shown noteworthy safety improvements.

Considerations

Centreline Rumble Strips should be considered on undivided, rural two-lane, three-lane, or four-lane highways in no passing zones (i.e. a double solid painted centreline) in the following cases:

1. New undivided, rural two-lane, three-lane, or four-lane highway sections;
2. When re-paving, rehabilitating or reconstructing existing undivided, rural two-lane, three-lane, or four-lane highway sections;
3. Other undivided, rural two-lane, three-lane, or four-lane highway sections that are not part of a project but would benefit from the installation of CRS in terms of decreasing the number of crossover centreline crashes. To assist Regions, a prioritized list of highway corridors prone to crossover crashes is available from HQ Engineering Branch, which identifies possible candidate locations; however, it does not limit CRS to only those locations. Funding and other resources for these stand-alone CRS projects are subject to availability and should be considered in the larger context of all safety initiatives.

CRS should not be used in urban areas. Good indications of urban highway sections are:

1. Speed Zone of 70 km/h or less in the vicinity of a settlement;
2. Highway section with curb and gutter or a sidewalk;
3. The average driveway spacing is less than 150 metres and intersection spacing is less than 500 metres.

The minimum centreline depth of pavement required is 50 mm. CRS are not to be installed if pavement deterioration or cracking is evident. Pavement should be in sufficiently good condition to accept the milling process without ravelling or deteriorating, otherwise the pavement should be upgraded prior to milling centreline rumble strips.

CRS are not to be installed if pavement is to be overlaid within 3 years.

Milling of CRS should be coordinated with traffic line painting operations to avoid milling newly applied traffic lines and to ensure that new yellow centrelines are installed within a short period of time after completion of the milling of the centreline rumble strips.

All projects that involve CRS should be submitted for ICBC Cost-Sharing evaluation.

Application Guidelines

The layout for Milled-in CRS is shown in Figure 650.F.

CRS should be installed on the centreline, for undivided, rural two-lane, three-lane, or four-lane highways in no passing zones.

For application of CRS on lane widths less than 3.4 m, an engineering review is required.

On rural two-lane, three-lane, or four-lane undivided highways, CRS should be installed in the following manner:

a) 300 mm CRS installed over the double solid painted centreline.

b) CRS installation shall begin at the start of the double solid painted centreline.

On highways with a painted flush median, CRS should be installed in the following manner:

a) For painted flush median < 2.0 m – apply CRS in the centre of the painted median;

b) For painted flush median ≥ 2.0 m – refer to Section 650.02 and follow application guidelines for continuous Shoulder Rumble Strips.

CRS Interruptions

CRS are to be interrupted prior to intersections, as shown in Figure 650.G.

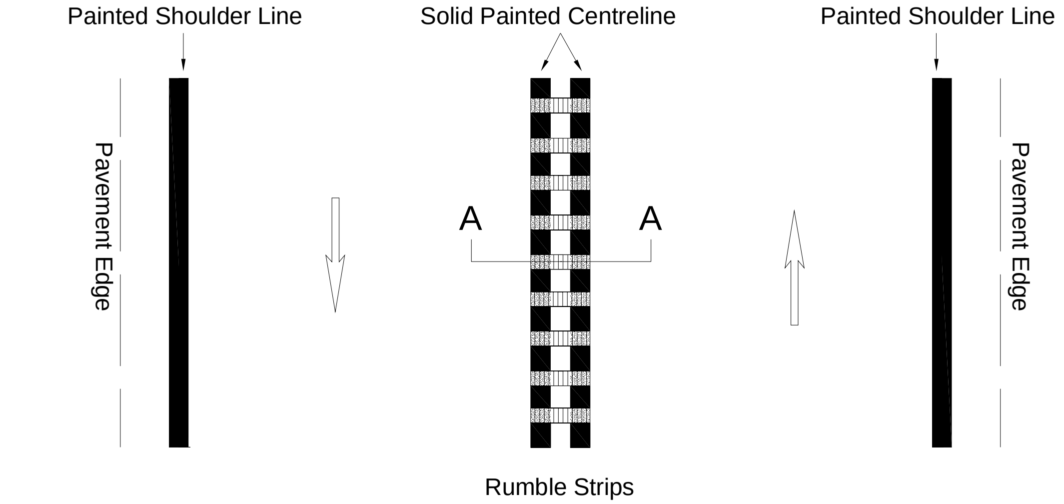
CRS are to be interrupted prior to commercial and residential entrances, as shown in Figure 650.H.

CRS shall not be installed on bridge decks, overpasses or other concrete surface structures, as shown in Figure 650.H.

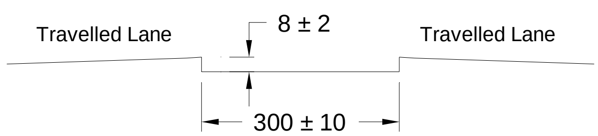
CRS should be discontinued within 200 m of a residential or urban area.

The minimum length of any individual section of CRS shall be 160 m.

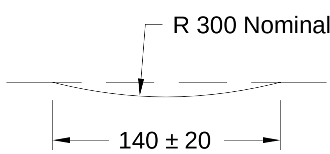
Figure 650.F Milled Centreline Rumble Strips



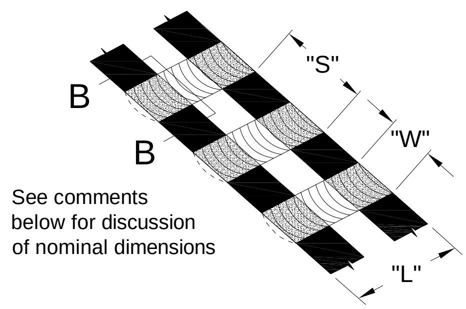
NOTE: ALL MEASUREMENTS SHOWN IN MILLIMETRES.



Section A-A



Section B-B



General Isometric View

Length of Rumble Strip "L" is 300 mm ± 10 mm.

Width "W" is nominally 140 mm ± 20 mm, based on the tolerance of the cut depth (8 mm ± 2 mm).

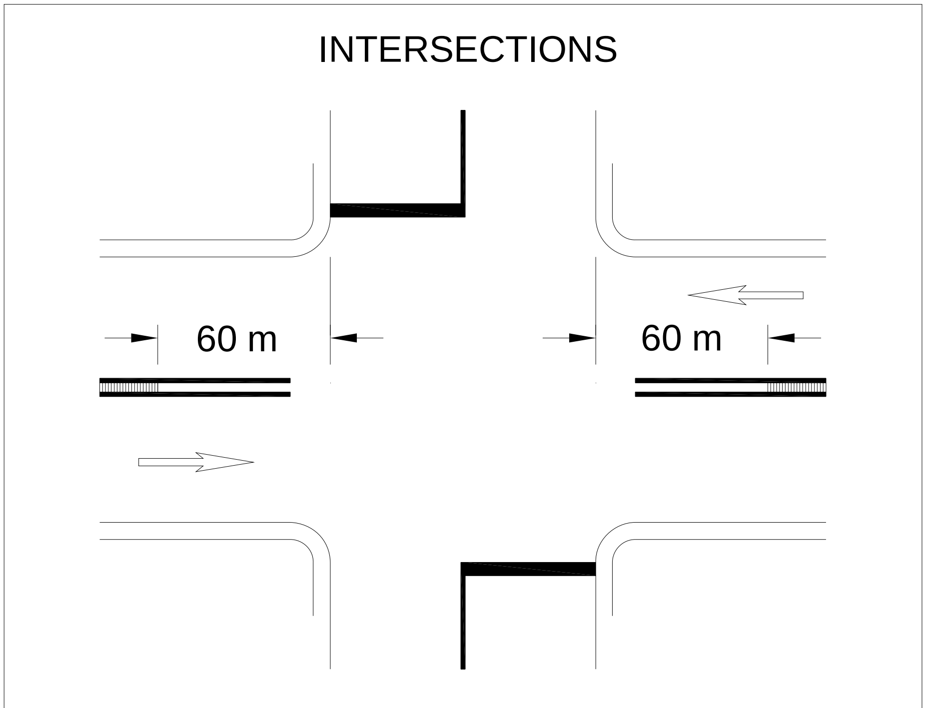
Spacing "S" between strips is 300 mm.

Lateral tolerance is ± 10 mm left or right of the outside edge of the paintlines.

NOTES:

1. Milled-in CRS are to be placed on new and existing paved 2-Lane, 3-Lane, or 4-Lane undivided rural highways in No Passing Zones.
2. Milled-in CRS are not to be placed through urban areas.
3. Milled-in CRS are to be discontinued across private accesses and public road intersections. Refer to Figure 650.H.
4. CRS are to be discontinued in advance of all bridges. Refer to Figure 650.H.
5. For new pavement, milling shall only be done after line spotting but prior to the installation of new centreline pavement markings.

Figure 650.G CRS Interruptions at Intersections



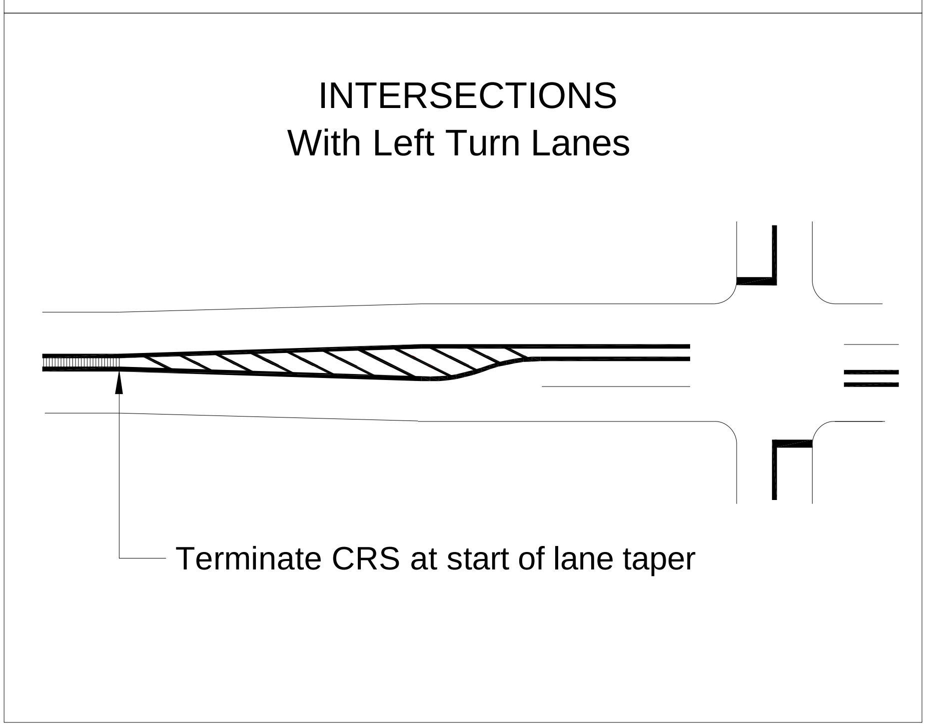
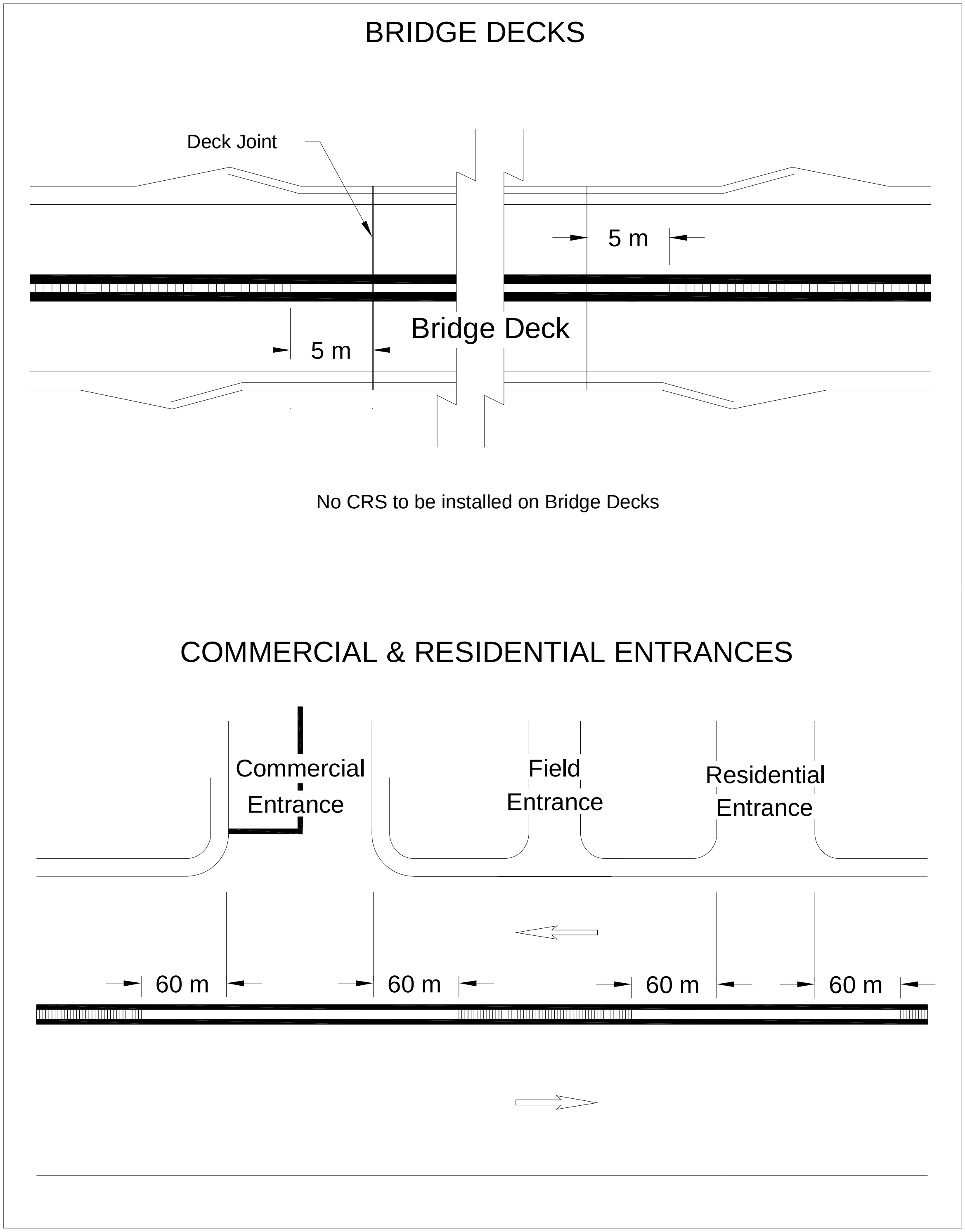


Figure 650.H CRS Interruptions at Bridge Decks and Accesses



660
FENCING FOR PEDESTRIANS AND CYCLISTS

660.01 BACKGROUND

The Ministry of Transportation has adopted a policy for the consideration of pedestrians and cyclists for works within the highway right-of-way.

The primary objective of the policy is to ensure that adequate care is provided for the safety of pedestrians and cyclists when planning, designing and project managing works within the highway right-of-way.

660.02 APPLICATION DOMAIN

These guidelines are for all construction work, other than pavement re-surfacing work, within the right-of-way of highways under Ministry of Transportation jurisdiction, whether it is carried out by the Ministry, a utility provider, a developer, a private property owner, or under a partnership agreement.

660.03 DEFINITION

The following section describes physical roadside environments within the right-of-way which could be hazardous to pedestrians and cyclists. An assessment of the need for fencing requires an evaluation of the both the nature of the hazard and the frequency of its exposure to pedestrians and cyclists. The frequency of exposure is a function of the location of the hazard and the volume of pedestrian and bicycle traffic nearby.

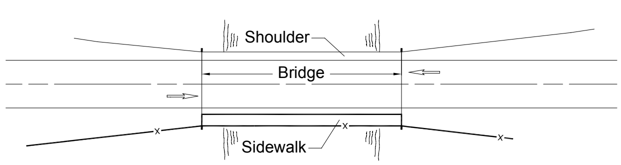
There are no definitive guidelines to determine what constitute significant numbers of pedestrians and bicycles. The designer should consult with the Ministry's Regional Traffic Engineer to determine whether and where there is significant pedestrian and bicycle traffic in the vicinity of the highway construction project.

660.04 APPLICATION AND INSTALLATION INSTRUCTIONS

The fence should be placed as far away as practicable from the traffic lanes or on top of a guardrail. The following figures and guidelines show and describe situations that can be construed as hazards requiring the installation of pedestrian or bicycle fencing.

Situation A

Figure 660.A Fencing on a Bridge



Description

Figure 660.A shows a bridge with a sidewalk and shoulder bikeway.

Guidelines

- Use the Standard Steel Sidewalk Fence (Bridge Dwg. 2891 - 1) along the edge of the sidewalk on the side of the water, ditch or gully.
- Use the Standard Steel Bicycle Fence (Bridge Dwg. 2891 - 2) when a significant number of cyclists use the sidewalk or if there is no sidewalk and a significant volume of cyclists use the bridge.
- Extend fence past the bridge abutments only if required as per Table 660.A and as shown in Figures 660.B and 660.C.

Situation B

Figure 660.B Fencing on a Fill Slope

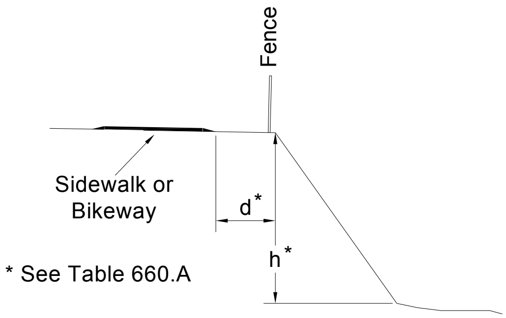
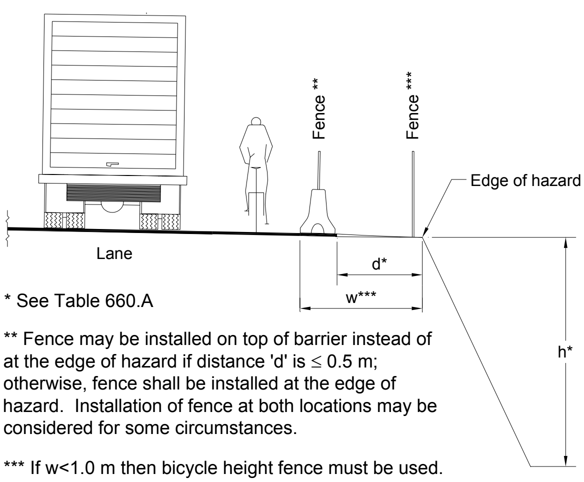


Figure 660.C Fencing Near a Steep Drop



Description

A constructed fill slope or original ground steeper than 1.5:1, a vertical drop or a structure such as a retaining wall or culvert within the right-of-way. This does not apply to most slopes adjacent to highway ditches which are 1.5:1 or flatter. Fencing is used when these hazards are:

- close to a sidewalk, bikeway, or trail, as illustrated in Figures 660.B and 660.C, known to be frequently used by pedestrians or cyclists (refer to preceding section 660.03), or
- close to a roadway; and
- for both of the above cases, when the height of the hazard meets the warrant in Table 660.A.

In these cases, the fence is required only when the sidewalk, bikeway, trail or edge of roadway pavement is located on the high side of the slope, drop or structure.

Table 660.A Hazard Warrant for Installing Fence

Distance from the outside edge of sidewalk, bikeway, trail or pavement: d (m)	Height of drop h (m)
d < 1.0	≥ 0.5
1.0 ≤ d < 2.0	≥ 1.0
2.0 ≤ d < 3.0	≥ 2.0
d ≥ 3.0	≥ 3.0

Guidelines

Use one of the following protections between the public and the hazard; according to the situation:

- the Sidewalk Fence (drawing SP741-07.01 in the Ministry “Standard Specifications for Highway Construction”) at the edge of a sidewalk or trail on the high side of the hazard;

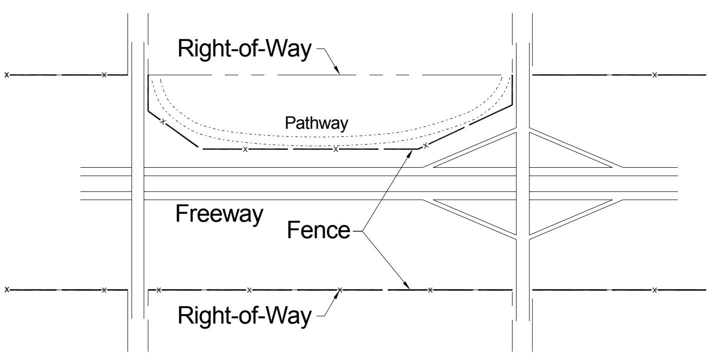
Guidelines (continued for Situation B)

- the Sidewalk Fence (SP741-07.01) to a height of 1.4 metres at the edge of a bikeway (or sidewalk or trail used by cyclists) on the high side of the hazard;
- the concrete roadside barrier with rails and posts fastened on top of the barrier to make it conform in height to the sidewalk fence or the bicycle fence;
- fencing as per the current Ministry "Standard Specifications for Highway Construction" - Type B, Standard Wire Fabric Fence or Type D, Chain Link Fence. In this case, the fence should be installed in a location which would prevent pedestrians and cyclists access to the hazard. This is preferably, but not necessarily always, right against the top of the hazard. In some cases, fencing along the right-of-way or the property line should be sufficient. For trails, fencing may be installed where it is most convenient between the trail and the hazard. Within the clear zone, use a fence that has frangible posts. If horizontal railings are used, they shall be designed such that they do not create a spearing hazard when impacted by a vehicle.

Important note: In locations where fencing is required and which are near a primary school or playground, or on a route used by children of primary school age or younger -- the vertical bars on the fence shall be spaced to a maximum of 150 mm for a height of at least 685 mm above the ground or sidewalk surface. For bikeways, the height required for the vertical bars spaced at 150 mm or less should be at least 985 mm.

Situation C

Figure 660.D Fencing Along a Pathway Inside Right-of-Way



Description

Along Freeways and Expressways as illustrated in Figure 660.D.

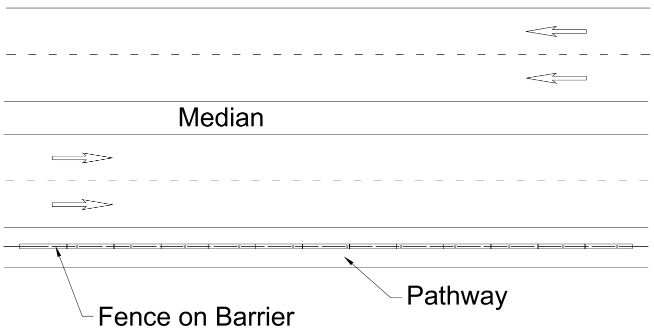
For urban and suburban freeways and expressways abutting residential subdivisions, commercial or industrial land, there is a need to separate the general population from the high speed traffic.

Guidelines

Use fencing as per the current Ministry "Standard Specifications for Highway Construction" - Type B, Standard Wire Fabric Fence or Type D, Chain Link Fence along roadway stretches between interchanges and intersections. Fencing is installed along the right-of-way or, in cases where there is a pathway within the right-of-way, the fence should be between the pedestrian or bicycle pathway and the roadway, as far as practicable from the edge of the roadway. Within the clear zone, use a fence that has frangible posts. If horizontal railings are used, they shall be designed such that they do not create a spearing hazard when impacted by a vehicle.

Situation D

Figure 660.E Fencing Along a High Volume Highway



Description

On roadways and bridges with a bicycle path or sidewalk where the AADT > 35,000 or SADT > 40,000 and a posted speed ≥ 70 km/h as shown in Figure 660.E.

Guidelines

Use fencing when the separation between the edges of the outside travel lane and the bike path or sidewalk is less than 2.1 metres (including the shoulder width). (Note: If the outside roadway travel lane is wider than 3.6 metres, this offset requirement between the bike path or sidewalk and the lane may be decreased by the same amount that the roadway lane is in excess of 3.6 metres.)

Use fencing when and where it is necessary to deter pedestrians from crossing the roadway.

Use the standard Concrete Roadside Barrier (CRB SP941-01.02.01/02) on the side of the roadway, between the roadway and the sidewalk or bike path. Rails and posts should be installed on top of the barrier to make it conform to the sidewalk fence height for a sidewalk. The bicycle fence height is used when a significant number of cyclists use the sidewalk or if the CRB is adjacent to a bike path. If the pathway next to a barrier is used by cyclists and pedestrians, the minimum width from the edge of barrier to the outside edge of pavement should be:

- 2.5 m for one-way bicycle traffic
- 3.5 m for two-way bicycle traffic

700 INTERSECTIONS and ACCESSES CHAPTER

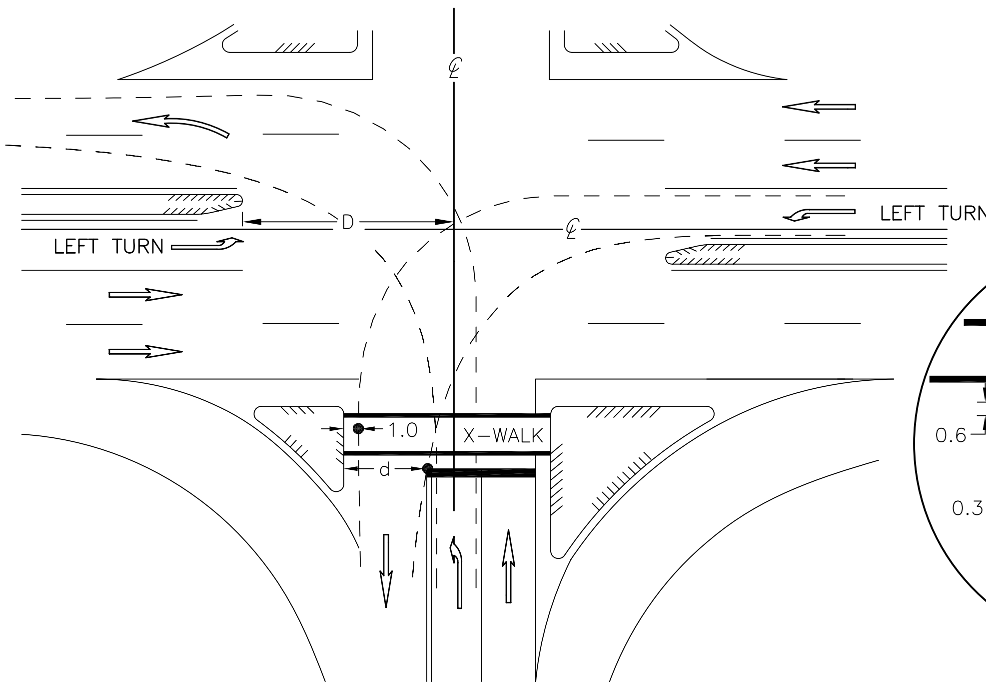
700 INTERSECTIONS and ACCESSES CHAPTER TABLES

700 INTERSECTIONS and ACCESSES CHAPTER FIGURES

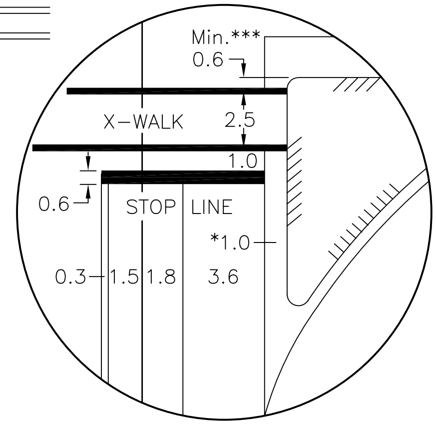
MoT Section	710		TAC Section	2.3

Figure 710.A Wheelpath Control Points

N.T.S.



4 LANE DESIGN



4 LANE
DESIGN DETAIL

Notes:

'd' VARIABLE – MINIMUM 6.0 m
'D' VARIABLE – MINIMUM 14.0 m
The actual Design Vehicle turning path template will govern.

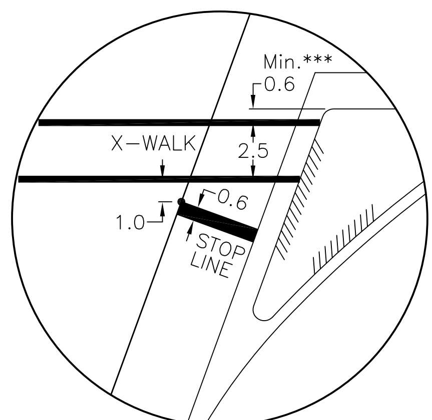
● Denotes Control Points

* For Bikeway Design, minimum 1.5 m

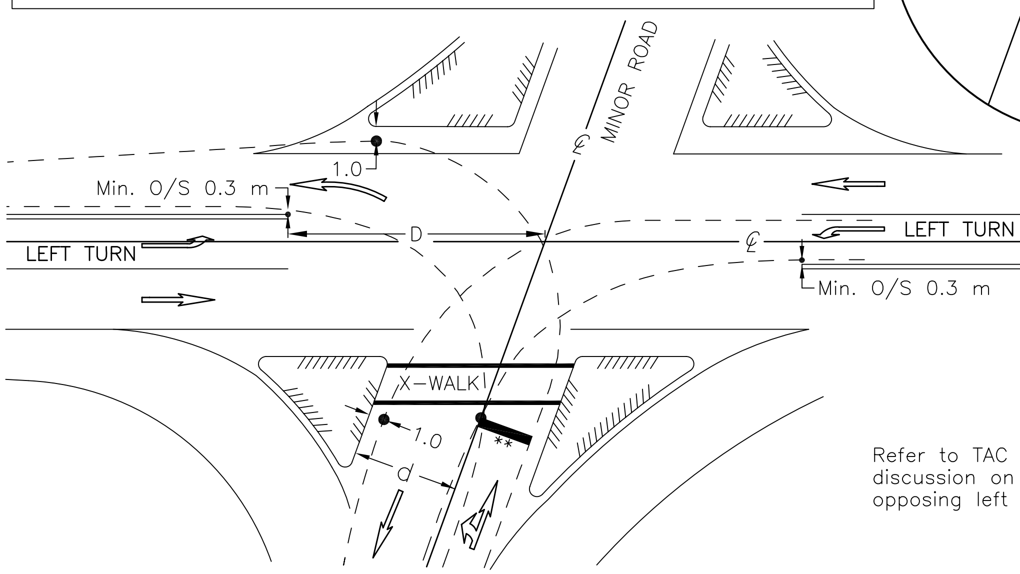
** Place stop bar to allow for crosswalk, existing or not.

*** If the quadrant islands have pedestrian ramps, the crosswalk should be centered on the ramp letdowns.

Hollow arrows for information only, they do not indicate pavement markings.



2 LANE
DESIGN DETAIL



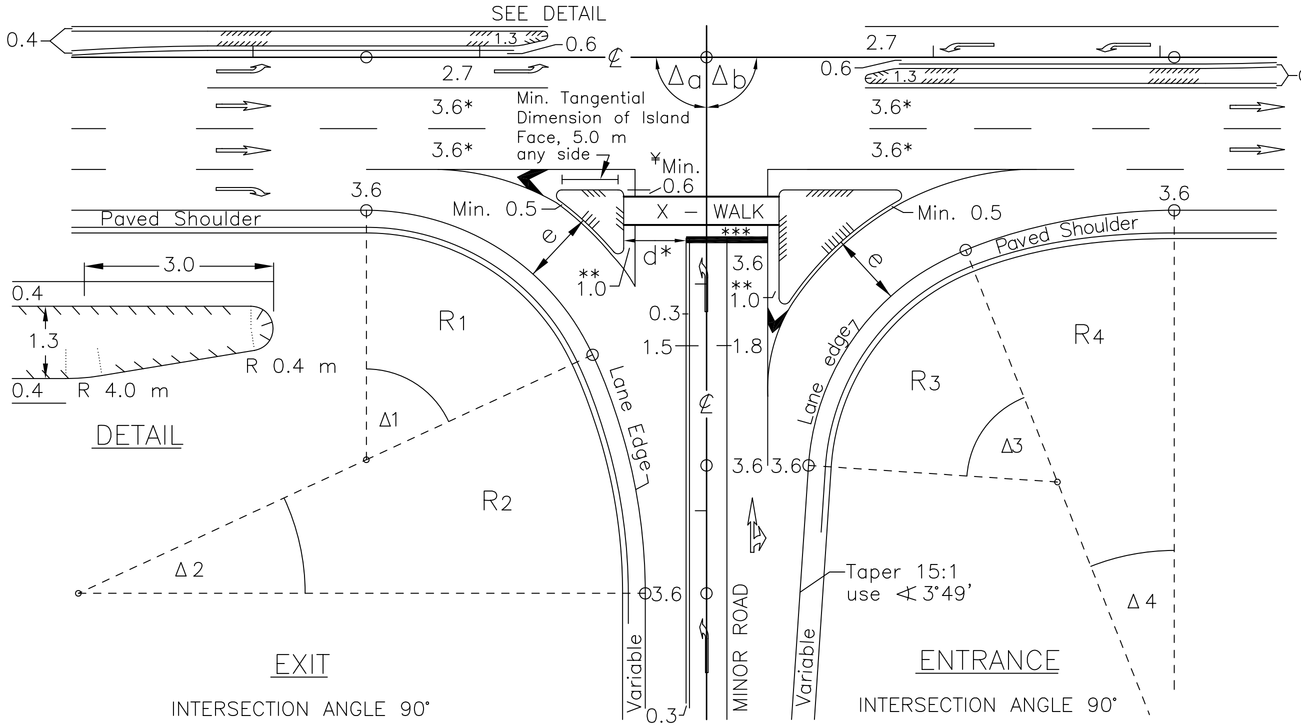
Refer to TAC Section 2.3.8 for discussion on clearance between opposing left turn movements.

2 LANE DESIGN

MoT Section	710		TAC Section	2.3

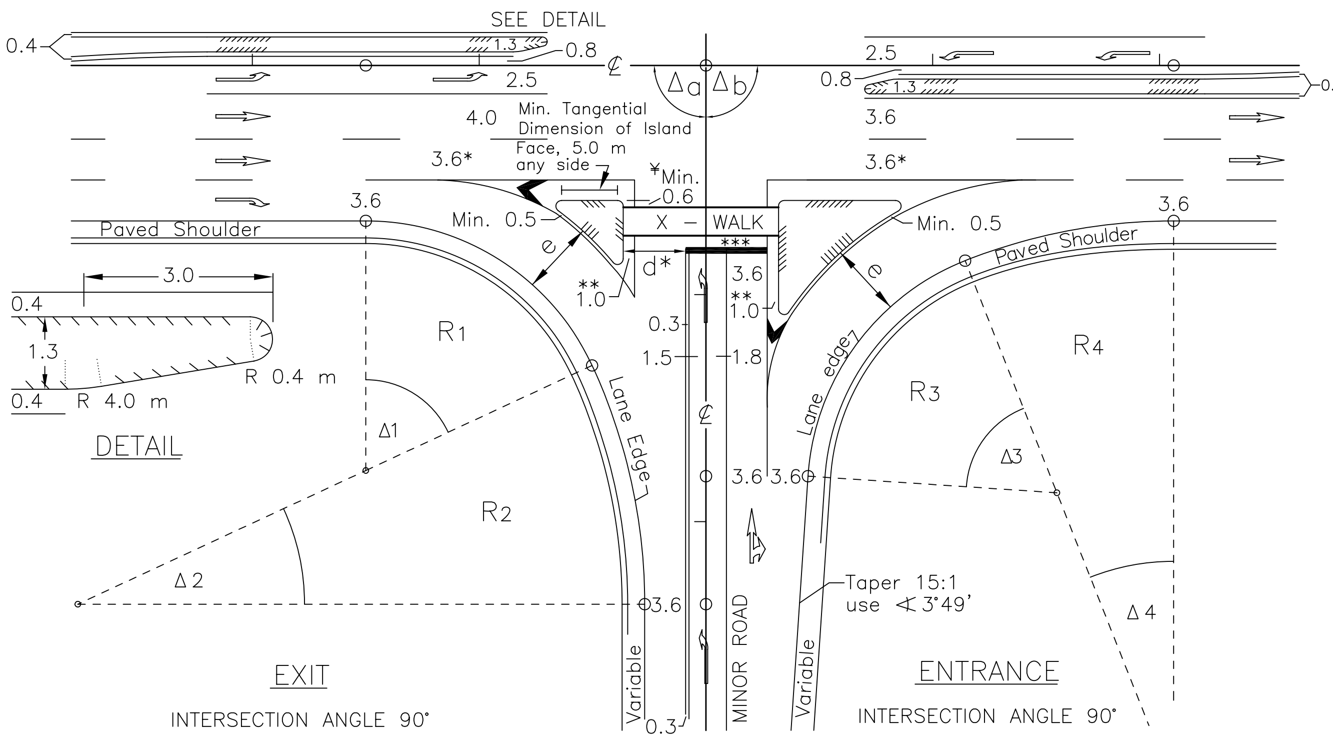
Figure 710.B.1 Intersection Layout - 4 Lane Design

N.T.S.



FOR DESIGN SPEED < 80 km/h

SEE FIGURE 710.B.2 FOR NOTES



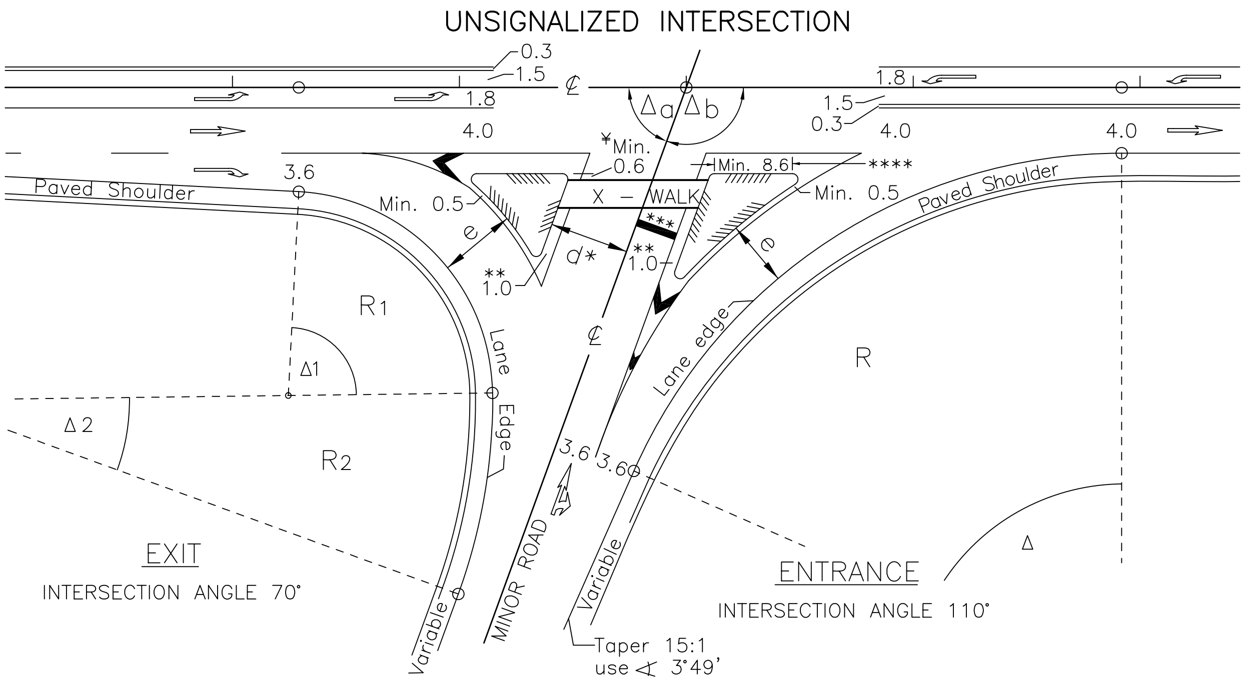
* – Refer to Table 430.A for lane widths

FOR DESIGN SPEED ≥ 80 km/h

MoT Section	710		TAC Section	2.3

Figure 710.B.2 Intersection Layout - 2 Lane Design

N.T.S.



Notes (for Fig. 710.B.1 and 710.B.2):

See Figure 710.A for wheelpath control points.

All curb radii to be 0.5 m when using extruded curb on quadrant islands.

Minimum 13.0 m Arc length (R_2 and R_4).

Radii to be determined by using the Design Vehicle wheelpath template.

Width 'e' is measured to the island face and will be determined by using the Design Vehicle wheelpath plus 1.0 m. Wheelpath tracking to be accommodated within the lane width.

¥ If the quadrant islands have pedestrian ramps, the crosswalk should be centered on the ramp letdowns.

* Turning Lane width 'd': use Design Vehicle wheelpath template plus 1.0 m (min. 6.0 m).

** For bikeway design, min. 1.5 m – refer to Table 430.B.

*** Place stop bar to allow for crosswalk, existing or not.

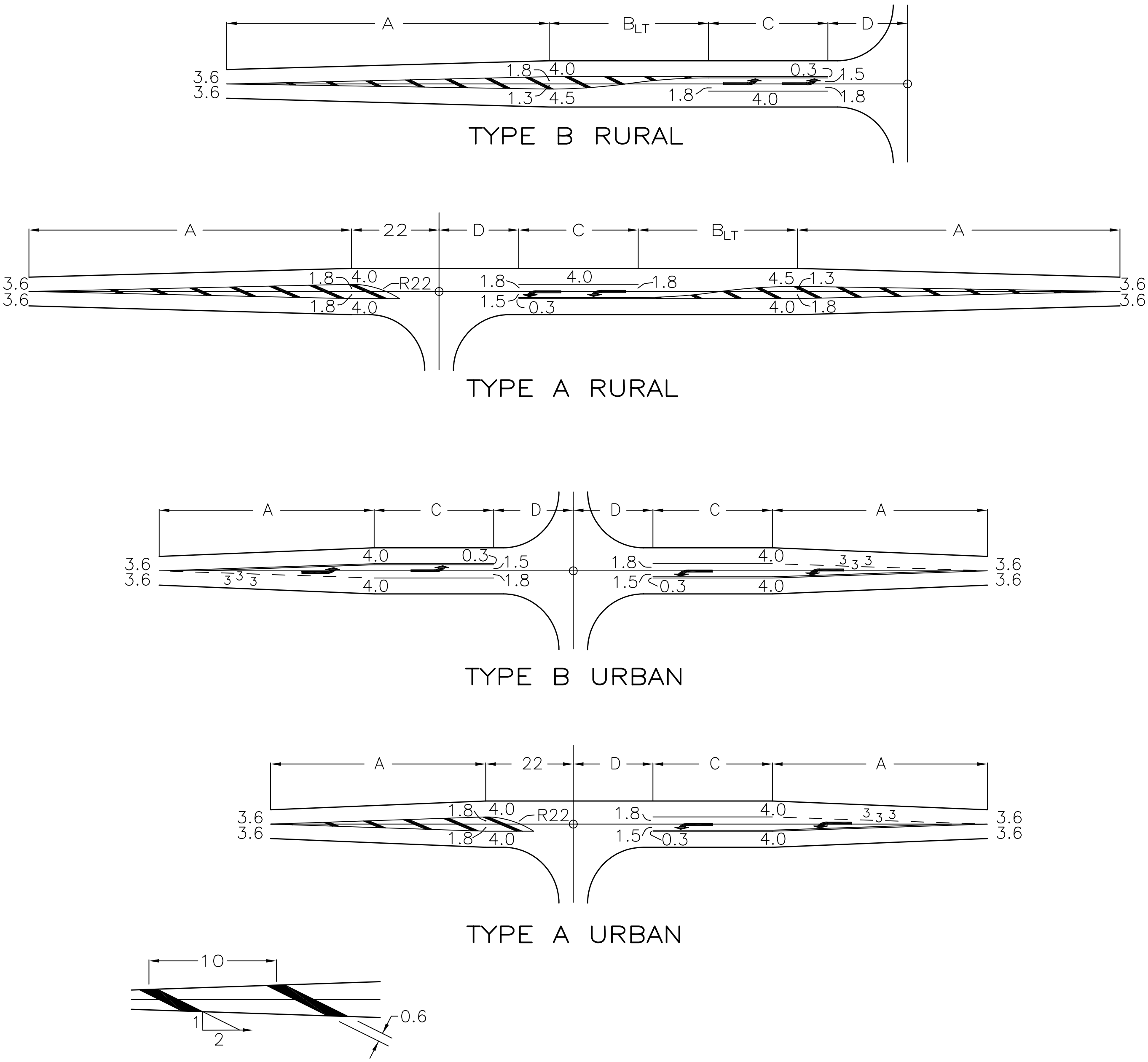
**** Initial design of islands should anticipate future modification to Minor Road left turn slots, if appropriate. (See Inset on Fig. 710.F) Otherwise, minimum tangential dimension of island face is 5.0 m on any side.

Hollow arrows for information only, they do not indicate pavement markings.

MoT Section	710		TAC Section	2.3

Figure 710.C Typical Left Turn Lane Layout

N.T.S.



URBAN

DESIGN SPEED	DIMENSION A	DIMENSION A* TAPER RATIO
50 km/h	54 m	30:1

RURAL

DESIGN SPEED	DIMENSION A	DIMENSION B_{LT}	DIMENSION A* TAPER RATIO
50 km/h	54 m	35 m	30:1
60 km/h	72 m	35 m	40:1
70 km/h	81 m	40 m	45:1
80 km/h	90 m	45 m	50:1
90 km/h	99 m	50 m	55:1
100 km/h	108 m	55 m	60:1

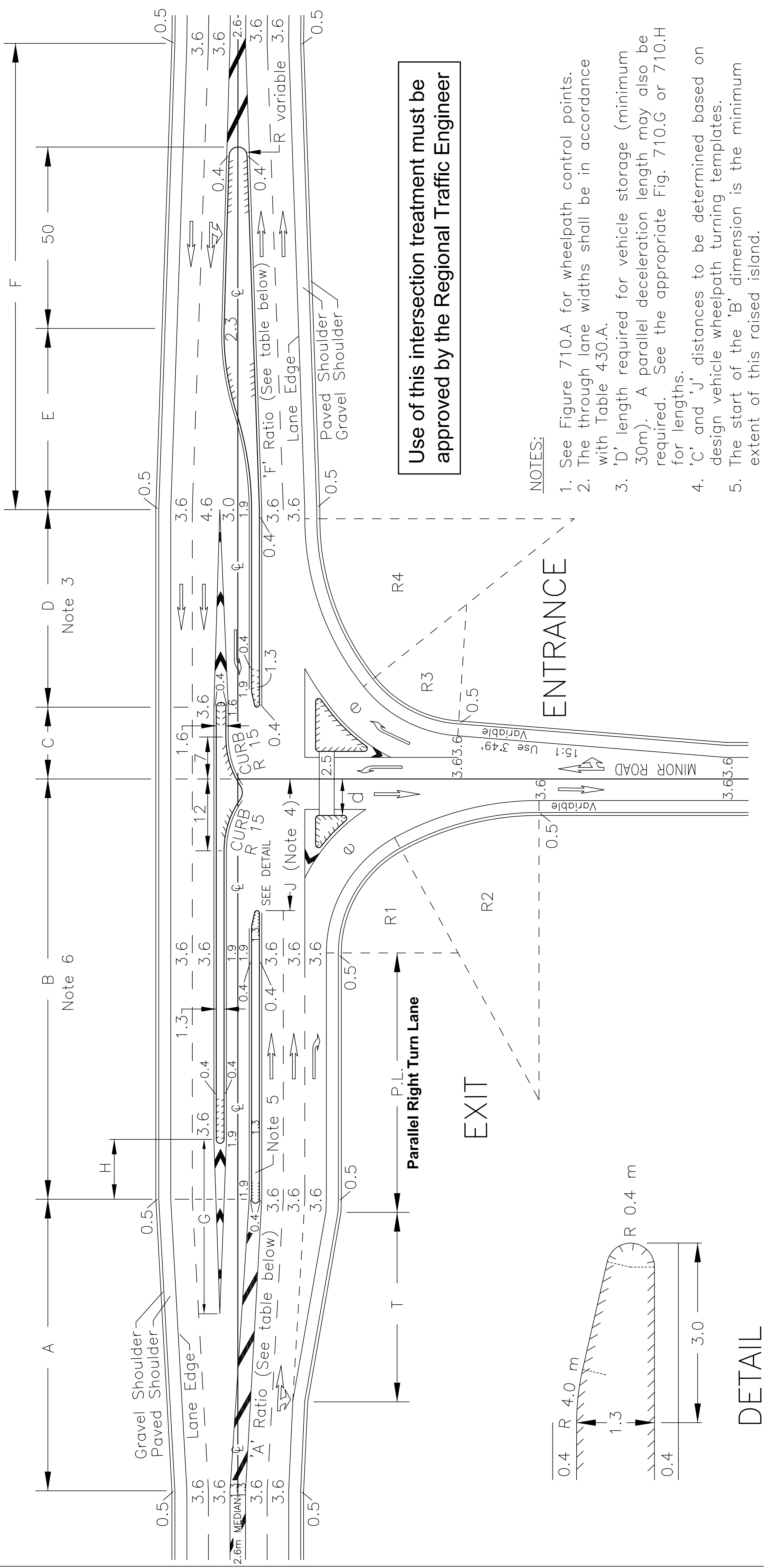
* When designing off-centre turn slots DIMENSION A is calculated using the taper ratio from the Urban or Rural Table.

DIMENSION C – Length required for Vehicle Storage.

DIMENSION D – Length required for Vehicle Turning Path.

Figure 710.D.1 Protected Left Turn Intersection (for AADT ≤ 12,000 v.p.d.)

N.T.S.



Use of this intersection treatment must be approved by the Regional Traffic Engineer

NOTES:

1. See Figure 710.A for wheelpath control points.
2. The through lane widths shall be in accordance with Table 430.A.
3. 'D' length required for vehicle storage (minimum 30m). A parallel deceleration length may also be required. See the appropriate Fig. 710.G or 710.H for lengths.
4. 'C' and 'J' distances to be determined based on design vehicle wheelpath turning templates.
5. The start of the 'B' dimension is the minimum extent of this raised island.
6. Adjustments to the 'B' dimension due to grade shall be as noted on Figure 710.L.

Note 6

DESIGN SPEED km/h	A	A Ratio	B for AADT* ≤12,000 vpd	G	H	T	P.L.
60	54	20:1	77	30	10	50	40
70	81	30:1	77	40	10	50	60
80	135	50:1	82	55	15	50	80
90	202	75:1	87	70	20	50	100
100	270	100:1	92	85	25	50	120

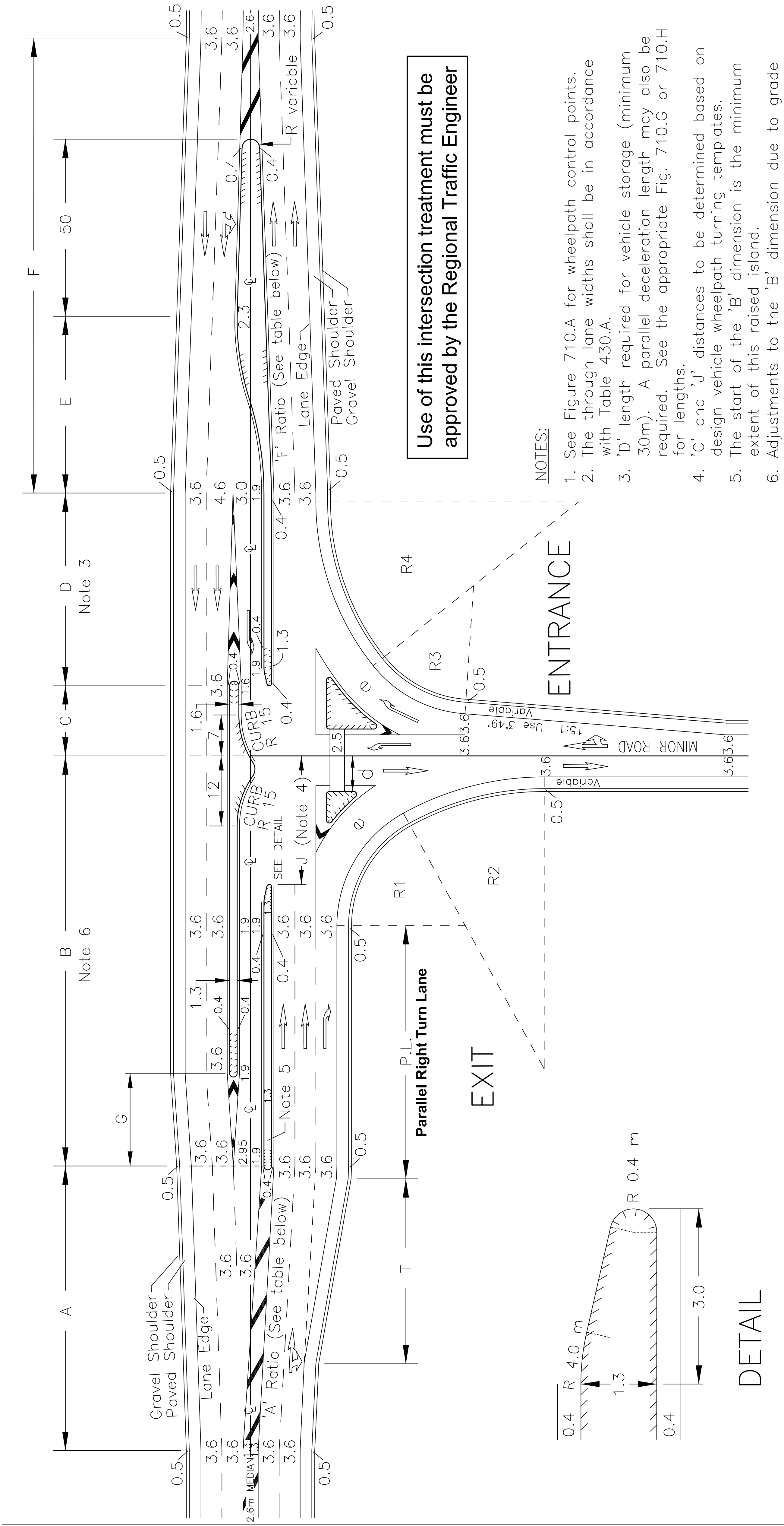
* – AADT is based on the 20 year design horizon

Note 4 Note 3

DESIGN SPEED km/h	C	D	E	F	F Ratio
60	12 min. for 90°	30 min. Variable	40	108	40:1
70			40	122	45:1
80			45	135	50:1
90			50	148	55:1
100			55	162	60:1

Figure 710.D.2 Protected Left Turn Intersection (for AADT > 12,000 v.p.d.)

N.T.S.



NOTES:

1. See Figure 710.A for wheelpath control points.
2. The through lane widths shall be in accordance with Table 430.A.
3. 'D' length required for vehicle storage (minimum 30m). A parallel deceleration length may also be required. See the appropriate Fig. 710.G or 710.H for lengths.
4. 'C' and 'J' distances to be determined based on design vehicle wheelpath turning templates.
5. The start of the 'B' dimension is the minimum extent of this raised island.
6. Adjustments to the 'B' dimension due to grade shall be as noted on Figure 710.L.

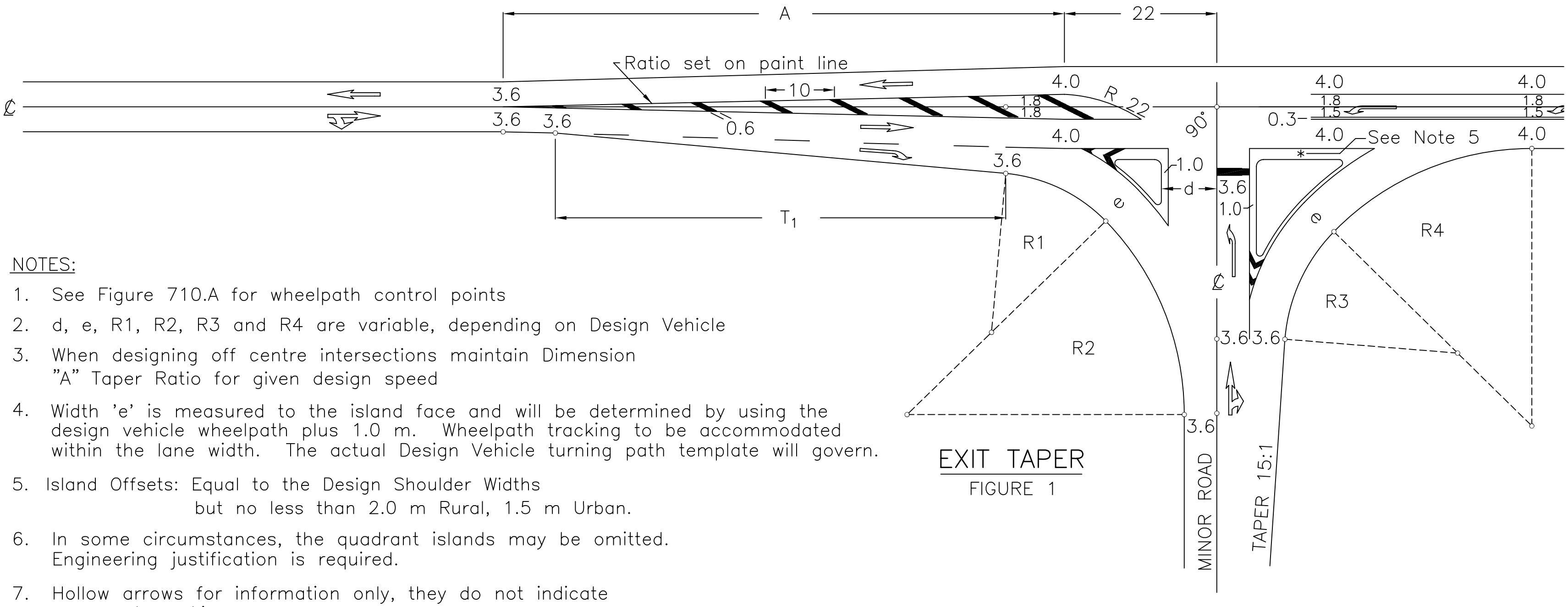
DESIGN SPEED km/h	C (Note 4)	D (Note 3)	E	F	F Ratio
60			40	108	40:1
70	12	30	40	122	45:1
80	min.	min.	45	135	50:1
90	for	Variable	50	148	55:1
100	90°		55	162	60:1

DESIGN SPEED km/h	A	A Ratio	B (Note 6) for AADT* >12,000 vpd	G	T	P.L.
60	54	20:1	77	30	50	40
70	81	30:1	85	40	50	60
80	135	50:1	150	55	50	80
90	202	75:1	210	75	50	100
100	270	100:1	280	100	50	120

* - AADT is based on the 20 year design horizon

Figure 710.E T Intersection

N.T.S.

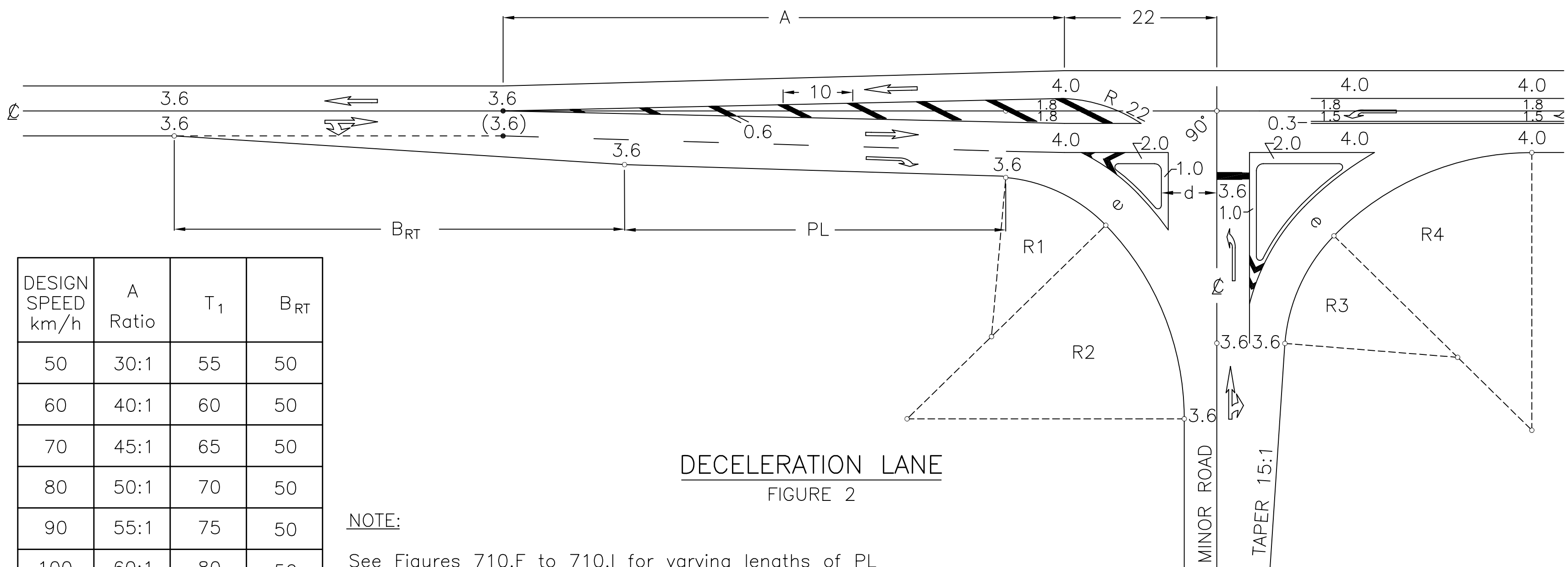


EXIT TAPER

FIGURE 1

NOTES:

1. See Figure 710.A for wheelpath control points
2. d, e, R1, R2, R3 and R4 are variable, depending on Design Vehicle
3. When designing off centre intersections maintain Dimension "A" Taper Ratio for given design speed
4. Width 'e' is measured to the island face and will be determined by using the design vehicle wheelpath plus 1.0 m. Wheelpath tracking to be accommodated within the lane width. The actual Design Vehicle turning path template will govern.
5. Island Offsets: Equal to the Design Shoulder Widths but no less than 2.0 m Rural, 1.5 m Urban.
6. In some circumstances, the quadrant islands may be omitted. Engineering justification is required.
7. Hollow arrows for information only, they do not indicate pavement markings



DECELERATION LANE

FIGURE 2

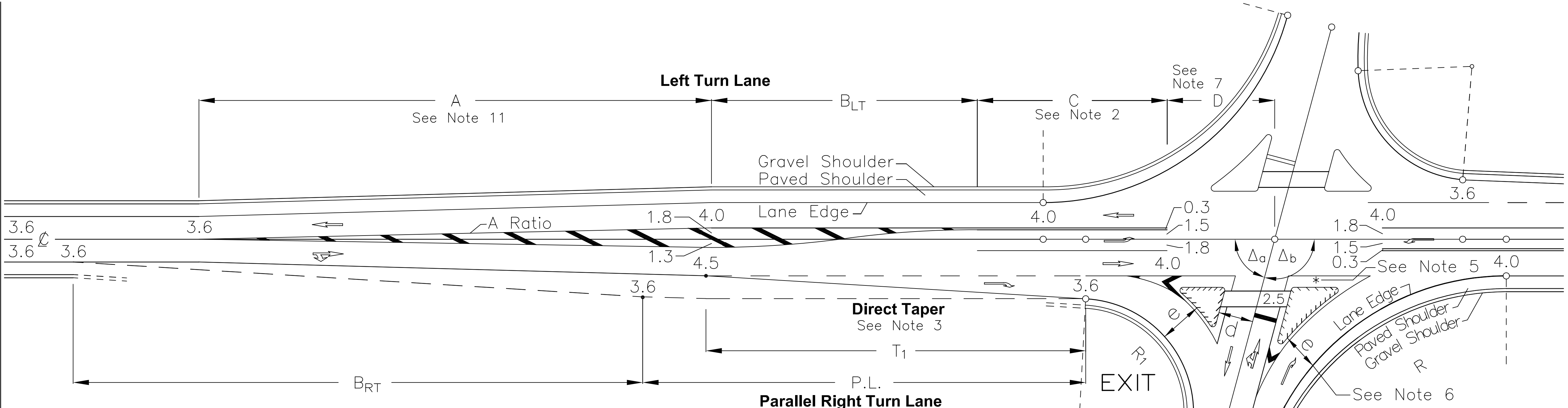
DESIGN SPEED km/h	A Ratio	T_1	B_{RT}
50	30:1	55	50
60	40:1	60	50
70	45:1	65	50
80	50:1	70	50
90	55:1	75	50
100	60:1	80	50

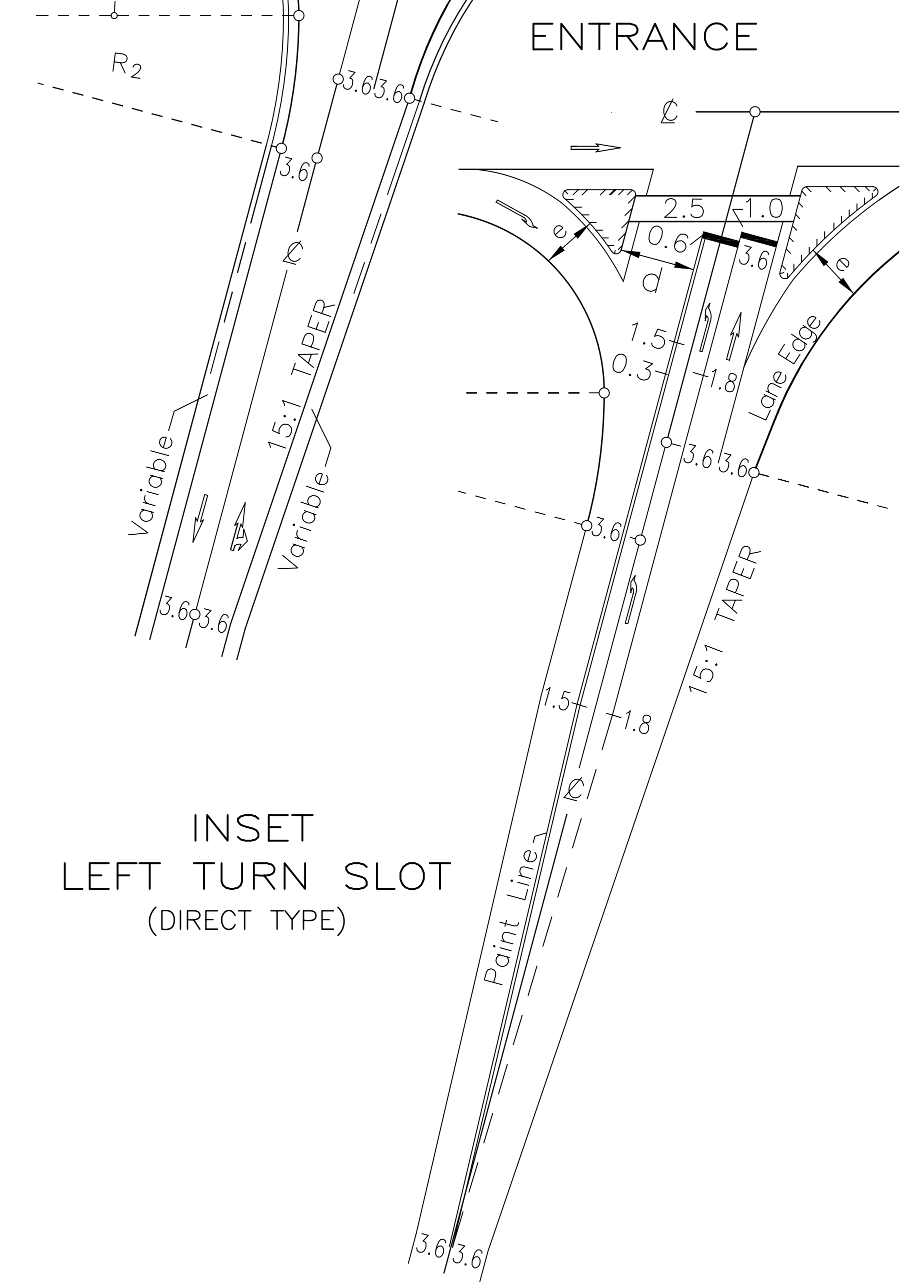
NOTE:

See Figures 710.F to 710.I for varying lengths of PL

Figure 710.F Rural Local Intersection

N.T.S.





LEFT TURN

DESIGN SPEED km/h	Note 11 A Ratio	B_{LT}	Note 2 C
50	30:1	35	30 MIN.
60	40:1	35	30 MIN.
70	45:1	40	30 MIN.
80	50:1	45	Var.

RIGHT TURN

DESIGN SPEED km/h	B_{RT}	Note 3 P.L.	T_1
50	50	30	55
60	50	40	60
70	50	50	65
80	50	60	70

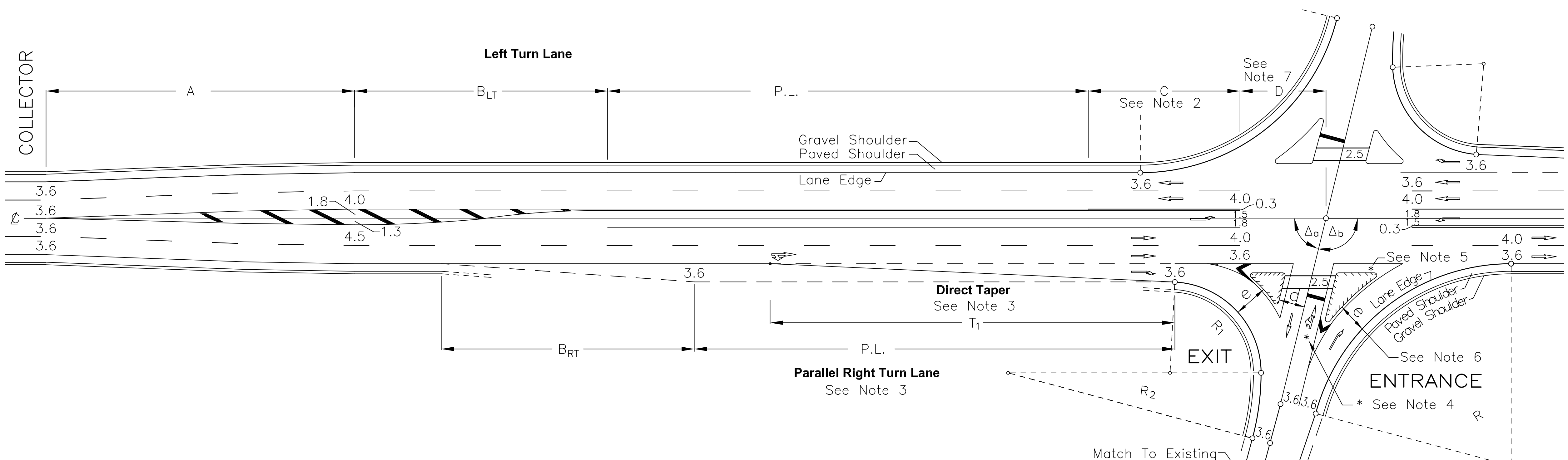
PARALLEL LANE
(shown thus: _ __ _)

Notes:

1. See Figure 710.A for wheelpath control points.
2. 'C' Length required for vehicle storage.
3. Traffic analysis will indicate when a parallel right turn deceleration lane is warranted.
4. Traffic analysis will indicate left turn requirements and type of treatment, (see inset).
5. Island Offsets: Equal to the Design Shoulder Widths but no less than 2.0 m Rural, 1.5 m Urban.
6. Width 'e' is measured to the Island face and will be determined by using the Design Vehicle wheelpath plus 1.0 m. Wheelpath tracking to be accommodated within the lane width.
7. The "D" & "d" distances are site specific and require the designer to overlay the appropriate Design Vehicle wheelpath turning template in each situation. "d" shall be 6.0 m minimum.
8. R, R1, and R2 are site specific and require the designer to overlay the appropriate Design Vehicle wheelpath in each situation.
9. Initial design of islands should anticipate future modification to Minor Road left turn slots if appropriate. (see inset) Otherwise, minimum tangential dimension of island face is 5.0 m on any side.
10. Deceleration is assumed to occur mostly in the through lanes. Turning lanes function mainly as storage areas.
11. When designing off centre intersections, maintain Dimension "A" Taper Ratio for given design speed.
12. Hollow arrows for information only, they do not indicate pavement markings.

Figure 710.G.1 Rural Collector Intersection

N.T.S.



Notes:

1. See Figure 710.A for wheelpath control points.
2. 'C' Length required for vehicle storage.
3. Traffic analysis will indicate when a right turn parallel deceleration lane is warranted. Storage may also be required at higher right turn volumes.
4. Traffic analysis will indicate left turn requirements entering collector. See Figure 710.F (Inset).
5. Island Offsets: Equal to the Design Shoulder Widths but no less than 2.0 m Rural, 1.5 m Urban
6. Width 'e' is measured to the Island face and will be determined by using the design vehicle wheelpath plus 1.0 m. Wheelpath tracking to be accommodated within the lane width.
7. The "D" & "d" distances are site specific and require the designer to overlay the appropriate design vehicle wheelpath turning template in each situation.
8. R, R_1, and R_2 are site specific and require the designer to overlay the appropriate Design Vehicle wheelpath in each situation.
9. Initial design of islands should anticipate future modification to Minor Road left turn slots if appropriate. See Figure 710.F (inset). Otherwise, minimum tangential dimension of island face is 5.0 m on any side.
10. Some of the necessary deceleration is assumed to occur in advance of the parallel lane.
11. High turning volumes may warrant a right turn acceleration lane. See Figure 710.L for lengths and grade adjustments.
12. Shoulder width on auxillary lanes may be 1.0 m less than normal shoulder width, but must be at least 1.5 m.
13. Hollow arrows for information only, they do not indicate pavement markings.

LEFT OR RIGHT TURN PARALLEL DECELERATION

DESIGN SPEED km/h	A RATIO	B_{LT}	B_{RT}	Note 3 P.L.	Note 2 C	$P.L._1$	$P.L._2$
60	40:1	35	50	20	As per TAC: min. 30 m	10	15
70	45:1	40	50	30		10	20
80	50:1	45	50	40		10	25
90	55:1	50	50	50		15	30
100	60:1	55	50	60		15	35

DIRECT TAPER

T_1
65
70
75
80

For upgrades > 5% SUBTRACT $P.L._2$ from P.L.

For upgrades > 3% SUBTRACT $P.L._1$ from P.L.

For downgrades > 3% ADD $P.L._2$ to P.L.

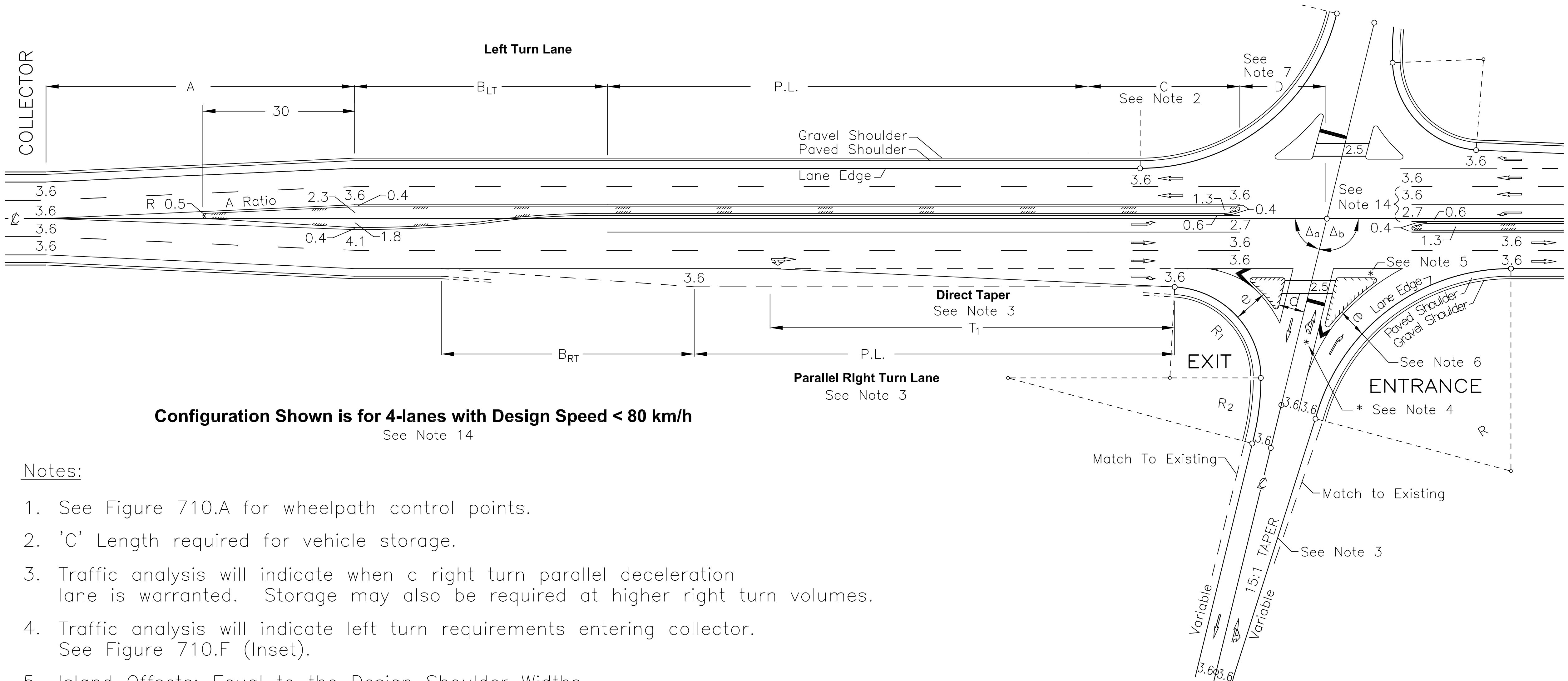
For downgrades > 5% ADD 2 x $P.L._2$ to P.L.

DECELERATION LENGTHS ARE APPLICABLE TO 2 OR 4 LANE DESIGNS

MoT Section	710		TAC Section	2.3

Figure 710.G.2 Rural Collector Intersection with Raised Median

N.T.S.



Configuration Shown is for 4-lanes with Design Speed < 80 km/h
See Note 14

Notes:

1. See Figure 710.A for wheelpath control points.
2. 'C' Length required for vehicle storage.
3. Traffic analysis will indicate when a right turn parallel deceleration lane is warranted. Storage may also be required at higher right turn volumes.
4. Traffic analysis will indicate left turn requirements entering collector. See Figure 710.F (Inset).
5. Island Offsets: Equal to the Design Shoulder Widths but no less than 2.0 m Rural, 1.5 m Urban
6. Width 'e' is measured to the Island face and will be determined by using the design vehicle wheelpath plus 1.0 m. Wheelpath tracking to be accommodated within the lane width.
7. The "D" & "d" distances are site specific and require the designer to overlay the appropriate design vehicle wheelpath turning template in each situation.
8. R, R_1, and R_2 are site specific and require the designer to overlay the appropriate Design Vehicle wheelpath in each situation.
9. Initial design of islands should anticipate future modification to Minor Road left turn slots if appropriate. See Figure 710.F (inset). Otherwise, minimum tangential dimension of island face is 5.0 m on any side.
10. Some of the necessary deceleration is assumed to occur in advance of the parallel lane.
11. High turning volumes may warrant a right turn acceleration lane. See Figure 710.L for lengths and grade adjustments.
12. Shoulder width on auxillary lanes may be 1.0 m less than normal shoulder width, but must be at least 1.5 m.
13. Hollow arrows for information only, they do not indicate pavement markings.
14. For 4–lanes with design speed ≥80 km/h, see Fig. 710.B.1 for lane widths. For 2–lane designs, see Fig. 710.B.2 for lane widths.

LEFT OR RIGHT TURN PARALLEL DECELERATION

DESIGN SPEED km/h	A RATIO	B_{LT}	B_{RT}	Note 3 P.L.	Note 2 C	$P.L._1$	$P.L._2$
60	40:1	35	50	20	As per TAC: min. 30 m	10	15
70	45:1	40	50	30		10	20
80	50:1	45	50	40		10	25
90	55:1	50	50	50		15	30
100	60:1	55	50	60		15	35

DIRECT TAPER

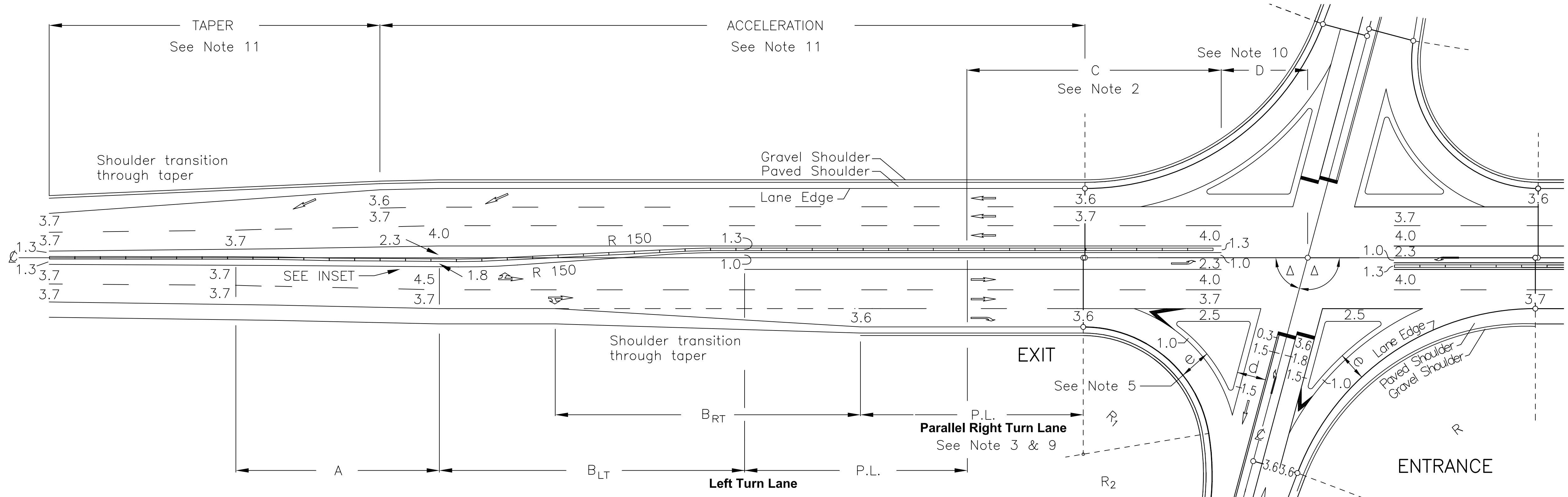
T_1
65
70
75
80

For upgrades > 5% SUBTRACT $P.L._2$ from P.L.
For upgrades > 3% SUBTRACT $P.L._1$ from P.L.
For downgrades > 3% ADD $P.L._2$ to P.L.
For downgrades > 5% ADD 2 x $P.L._2$ to P.L.

DECELERATION LENGTHS ARE APPLICABLE TO 2 OR 4 LANE DESIGNS

Figure 710.H Rural Arterial Intersection

N.T.S.



NOTES

1. See Figure 710.A for wheelpath control points.
2. 'C' Length required for vehicle storage.
3. Right Turn Vehicle Storage may also be required.
4. Bicycle safe grates must be used.
5. Width 'e' is measured to the island face and will be determined by using the design vehicle wheelpath plus 1.0 m. Wheelpath tracking to be accommodated within the lane width. R_1 shall be 25 m or larger.
6. Initial design of islands should anticipate future modification to Minor Road left turn slots if appropriate. See Figure 710.F (inset). Otherwise, minimum tangential dimension of island face is 5.0 m on any side.
7. Barrier placement and end treatment shall be as per Figure 710.K.
8. Maximum intersection skew range from 75° to 105°.
9. All deceleration is accomplished in the "B" and "P.L." distances.
10. The "D" & "d" distances are site specific and require the designer to overlay the appropriate design vehicle wheelpath turning template in each situation.
11. Refer to Figure 710.L for acceleration and taper lengths.
12. Shoulder width on auxillary lanes may be 1.0 m less than normal shoulder width, but must be at least 1.5 m.
13. Hollow arrows for information only, they do not indicate pavement markings.
14. For 4–lanes with design speed < 80 km/h, see Fig. 710.B.1 for lane widths. For 2–lane designs, see Fig. 710.B.2 for lane widths.

PARALLEL DECELERATION

DESIGN SPEED km/h	A	B_{LT}	B_{RT}	Note 3 P.L.	Note 2 C	$P.L._1$	$P.L._2$
60	40	35	50	40	As per TAC: min. 30 m	10	15
70	45	40	50	60		10	20
80	50	45	50	80		15	25
90	55	50	50	100		15	30
100	60	55	50	120		20	35

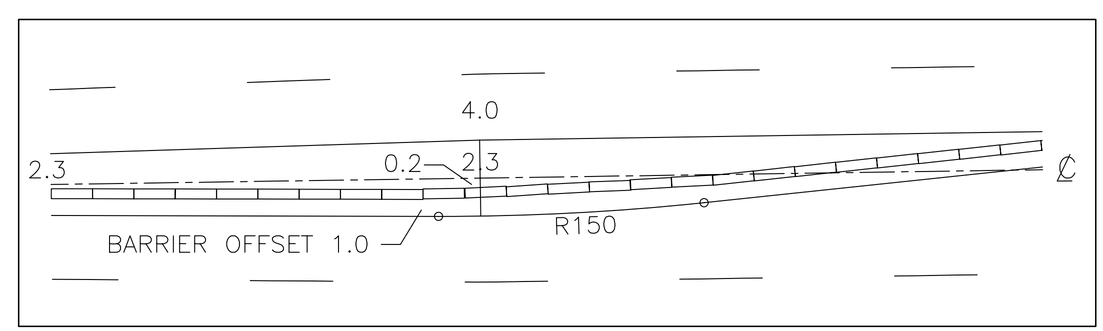
For upgrades > 5% SUBTRACT $P.L._2$ from P.L.

For upgrades > 3% SUBTRACT $P.L._1$ from P.L.

For downgrades > 3% ADD $P.L._2$ to P.L.

For downgrades > 5% ADD 2 x $P.L._2$ to P.L.

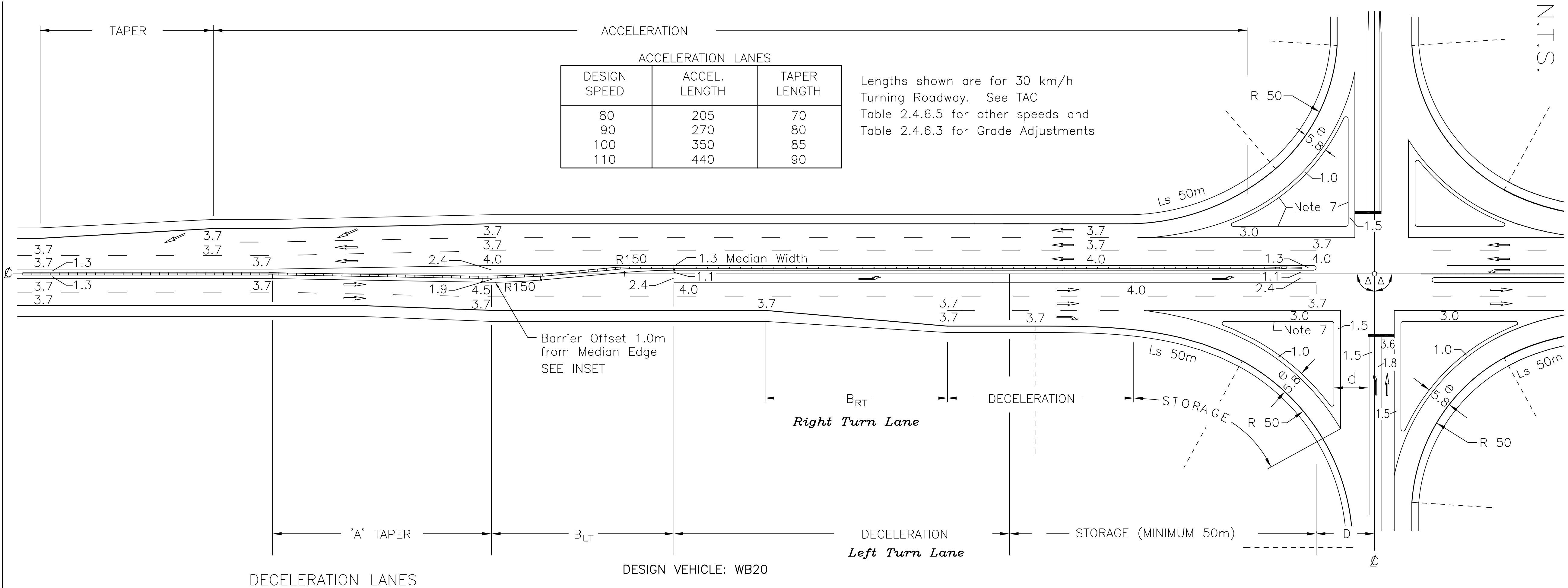
ACCELERATION & DECELERATION LENGTHS ARE APPLICABLE TO 2 OR 4 LANE DESIGNS



INSET

Figure 710.I Expressway Intersection - Narrow Median

N.T.S.



ACCELERATION LANES

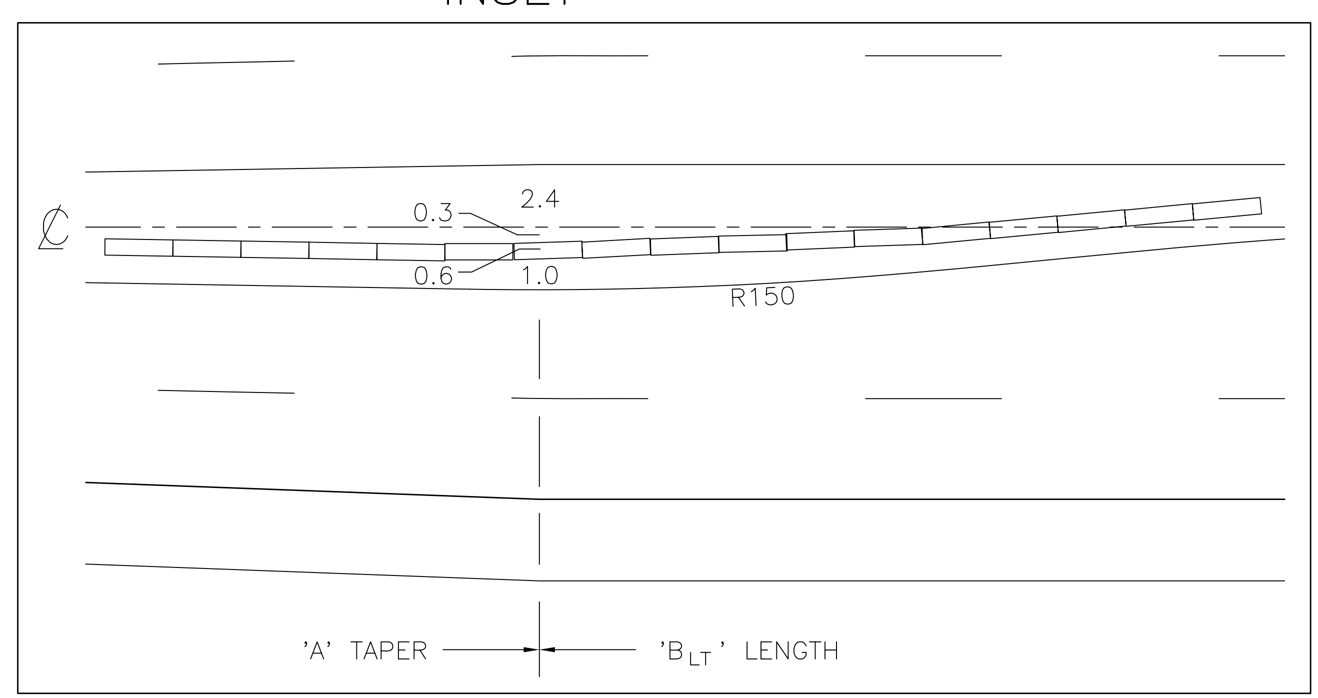
DESIGN SPEED	ACCEL. LENGTH	TAPER LENGTH
80	205	70
90	270	80
100	350	85
110	440	90

Lengths shown are for 30 km/h Turning Roadway. See TAC Table 2.4.6.5 for other speeds and Table 2.4.6.3 for Grade Adjustments

DECELERATION LANES

DESIGN SPEED km/h	'A' TAPER	B_{LT} LENGTH	B_{RT} LENGTH	DECEL. LENGTH	STORAGE LENGTH
80	50	45	50	130	As per TAC; min. 50 m
90	60	50	50	150	
100	70	55	50	170	
110	80	55	50	185	

INSET



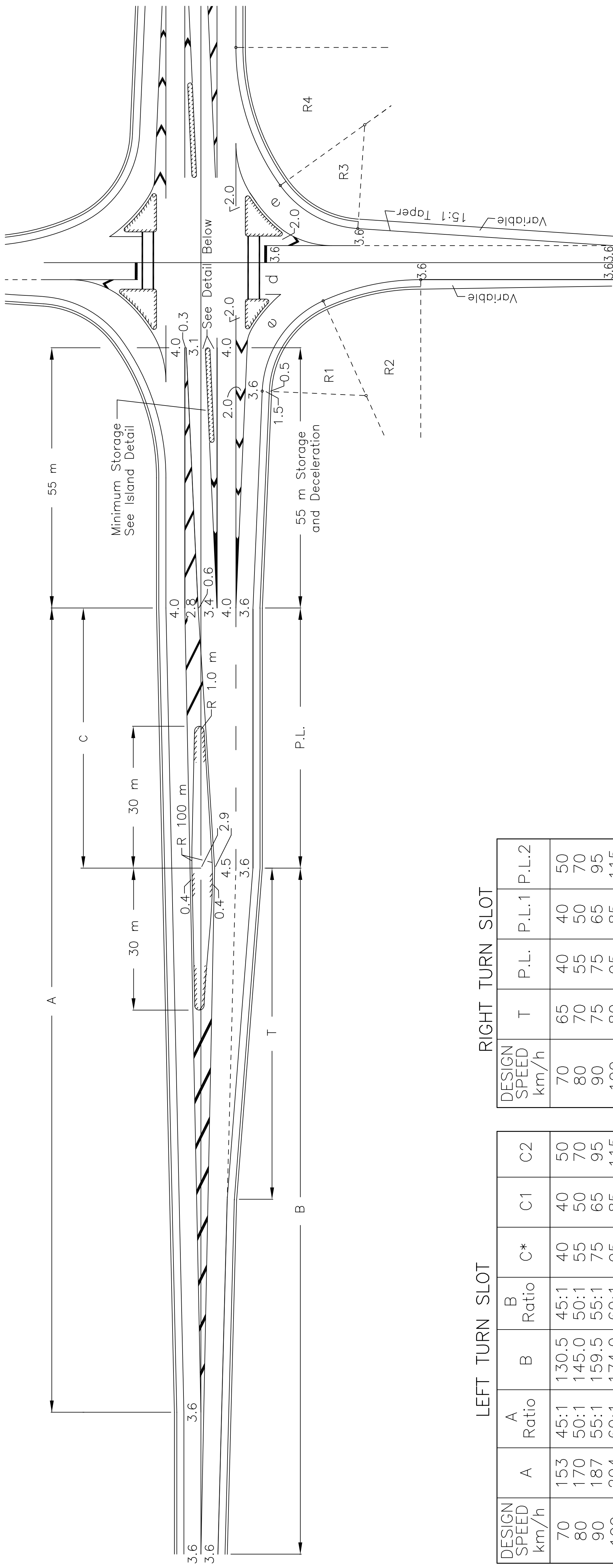
Notes:

1. Transition from 810 mm CMB barrier to CLB barrier should occur as close to 15 m from the start of the deceleration lane as the Hook and Eye pairings will allow, using CTB-1 & CTB-2, see SP941 for details.
2. The "D" & "d" distances are site specific and require the designer to overlay the WB20 design vehicle wheelpath turning template in each situation.
3. Use WB20 template + 1.0 m for "d" width. See Figure 710.A for wheel path control points.
4. Design width 'e' is for WB20 vehicles and is measured to the Island face.
5. Maximum intersection skew range 80° to 100°
6. All acceleration and deceleration occurs within the parallel auxiliary lanes.
7. All islands to be valley curbs, see SP582-01.03. Where superelevation or drainage problems prevent valley curbs, use mountable curbs, see SP582-01.02.
8. For barrier detail, refer to Figure 710.K
9. See TAC Table 2.4.6.3 for Grade Adjustment Factors for Accel and Decel Lanes

MoT Section	710		TAC Section	2.3

Figure 710.J LLT Intersection for 2-Lane Roads

N.T.S.



LEFT TURN SLOT

DESIGN SPEED km/h	A	A Ratio	B	B Ratio	C*	C1	C2
70	153	45:1	130.5	45:1	40	40	50
80	170	50:1	145.0	50:1	55	50	70
90	187	55:1	159.5	55:1	75	65	95
100	204	60:1	174.0	60:1	95	85	115

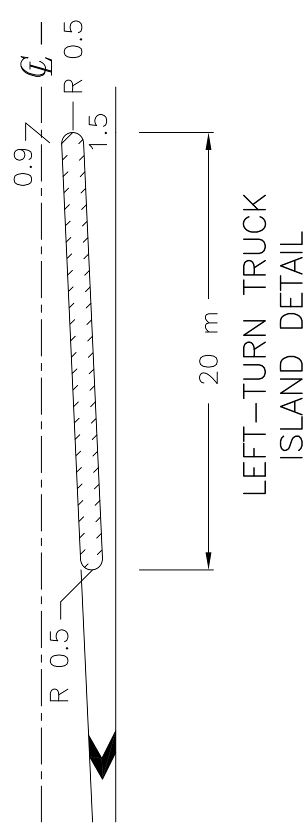
RIGHT TURN SLOT

DESIGN SPEED km/h	T	P.L.	P.L.1	P.L.2
70	65	40	40	50
80	70	55	50	70
90	75	75	65	95
100	80	95	85	115

Note:
C use for up and down grades less than 3%;
C1 use for upgrades of 3% or more;
C2 use for downgrades of 3% or more.

* For AADT ≤ 6000, use C values.
For AADT > 6000, use P.L. values and grade adjustments from Fig. 710.H for the C distances.

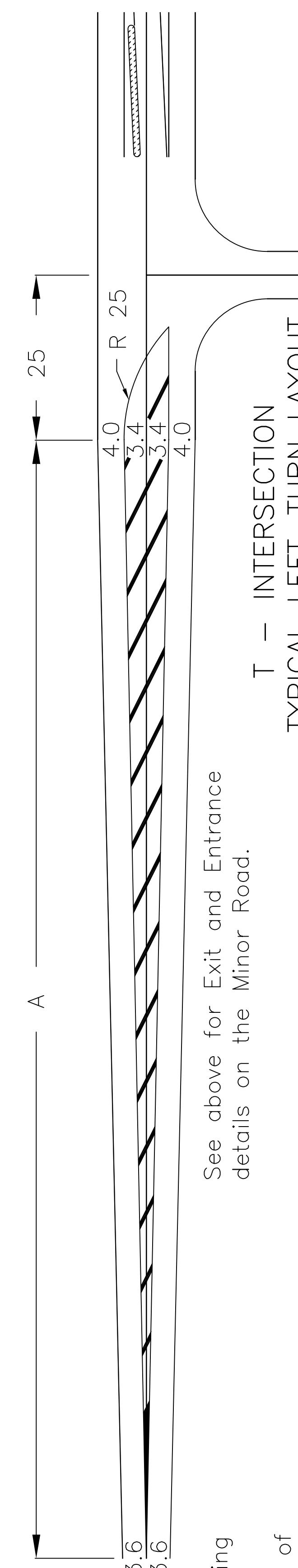
Note:
P.L. use for up and down grades less than 3%;
P.L.1 use for upgrade of 3% or more;
P.L.2 use for downgrade of 3% or more.



LEFT–TURN TRUCK ISLAND DETAIL

Notes:

1. 'd' variable. See Figure 710.A for Wheel Path Control Points. See Section 720 for discussion on LLT design vehicle.
2. 'e' is measured to the island face and will be determined by using the Design Vehicle wheelpath plus 1.0 m.
3. R1, R2, R3 & R4 are site specific and require the designer to overlay the appropriate Design Vehicle wheelpath in each situation. Wheelpath tracking to be accommodated within the lane width.
4. Whenever islands installed they shall be laid on top of finished pavement to allow for possible future removal.



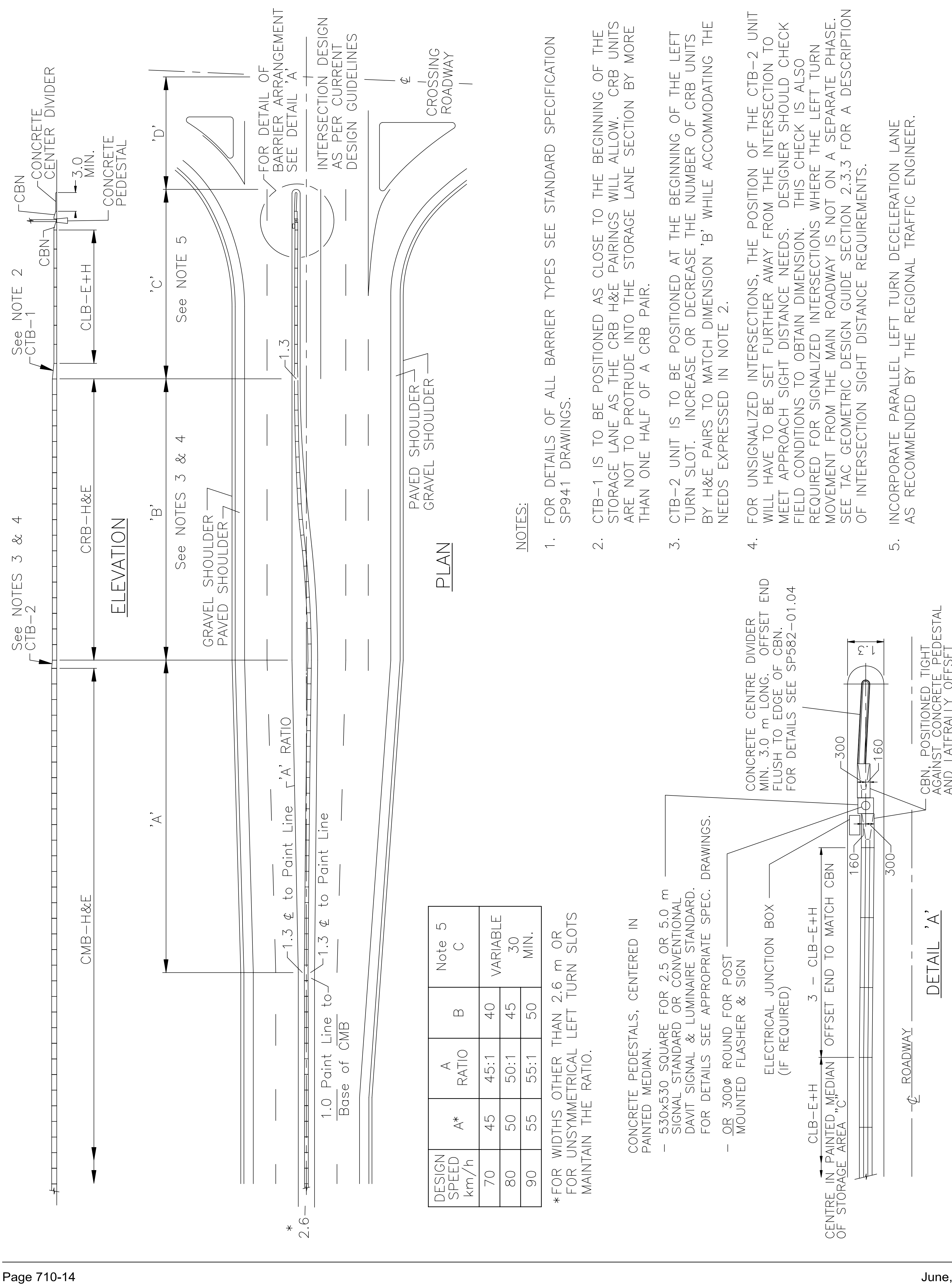
See above for Exit and Entrance details on the Minor Road.

T – INTERSECTION
TYPICAL LEFT–TURN LAYOUT

MoT Section	710		TAC Section	2.3

Figure 710.K Median Barrier Layout for Left-Turn Slots

N.T.S.



DESIGN SPEED km/h	A*	A RATIO	B	Note 5 C
70	45	45:1	40	VARIABLE 30 MIN.
80	50	50:1	45	
90	55	55:1	50	

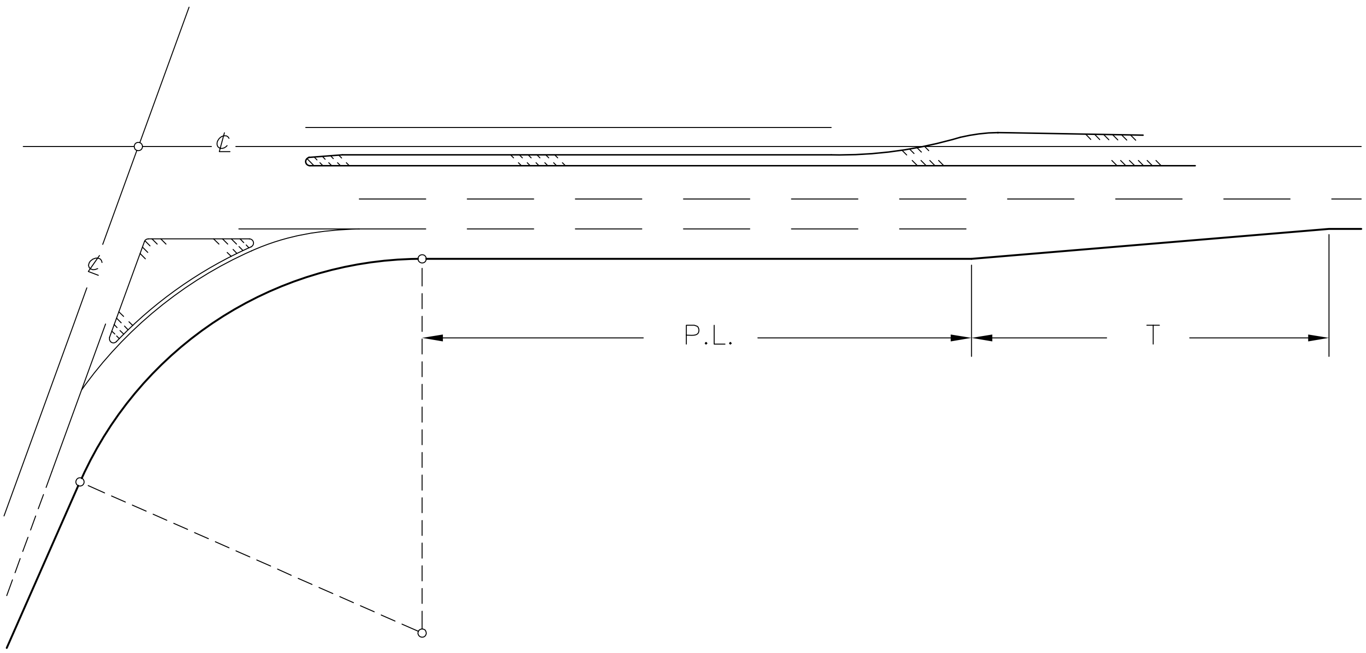
* FOR WIDTHS OTHER THAN 2.6 m OR FOR UNSYMMETRICAL LEFT TURN SLOTS MAINTAIN THE RATIO.

NOTES:

1. FOR DETAILS OF ALL BARRIER TYPES SEE STANDARD SPECIFICATION SP941 DRAWINGS.
2. CTB-1 IS TO BE POSITIONED AS CLOSE TO THE BEGINNING OF THE STORAGE LANE AS THE CRB H&E PAIRINGS WILL ALLOW. CRB UNITS ARE NOT TO PROTRUDE INTO THE STORAGE LANE SECTION BY MORE THAN ONE HALF OF A CRB PAIR.
3. CTB-2 UNIT IS TO BE POSITIONED AT THE BEGINNING OF THE LEFT TURN SLOT. INCREASE OR DECREASE THE NUMBER OF CRB UNITS BY H&E PAIRS TO MATCH DIMENSION 'B' WHILE ACCOMMODATING THE NEEDS EXPRESSED IN NOTE 2.
4. FOR UNSIGNALIZED INTERSECTIONS, THE POSITION OF THE CTB-2 UNIT WILL HAVE TO BE SET FURTHER AWAY FROM THE INTERSECTION TO MEET APPROACH SIGHT DISTANCE NEEDS. DESIGNER SHOULD CHECK FIELD CONDITIONS TO OBTAIN DIMENSION. THIS CHECK IS ALSO REQUIRED FOR SIGNALIZED INTERSECTIONS WHERE THE LEFT TURN MOVEMENT FROM THE MAIN ROADWAY IS NOT ON A SEPARATE PHASE. SEE TAC GEOMETRIC DESIGN GUIDE SECTION 2.3.3 FOR A DESCRIPTION OF INTERSECTION SIGHT DISTANCE REQUIREMENTS.
5. INCORPORATE PARALLEL LEFT TURN DECELERATION LANE AS RECOMMENDED BY THE REGIONAL TRAFFIC ENGINEER.

Figure 710.L Typical Parallel Acceleration Lane

N.T.S.



DESIGN SPEED (km/h)	T (m)	PARALLEL LANE – P.L. (m)				
		RAMP SPEED (km/h)				
		STOP	20	30	40	50
60	55	90	40	30	–	–
70	65	100	85	70	40	–
80	70	165	150	135	110	65
90	80	220	210	190	165	125
100	85	295	280	265	235	200
110	90	375	365	350	320	290

Notes:

1. All grades less than 3% use P.L.
2. Upgrades 3–5% use P.L. x 1.4
3. Upgrades over 5% use P.L. x 1.6
4. Downgrades over 3% use P.L. x 0.6
5. This figure is not to be used for expressway or freeway acceleration lanes. For Expressways, see Figure 710.I. For Freeways, see TAC Chapter 2.4.

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720
DESIGN VEHICLES

720.01 DESIGN VEHICLES

Design vehicles are selected motor vehicles with the dimensions and operating characteristics used to establish highway design controls. For geometric design, each design vehicle has larger physical dimensions and a larger minimum turning radius than almost all vehicles in its class. The principal dimensions of these vehicles are shown in the *TAC Geometric Design Guide for Canadian Roads*.

Good design practice requires that the geometric layout of an intersection and interchange should be checked to ensure that it can accommodate the principal class of vehicle using the road system.

In addition to the current suite of TAC vehicles, the Ministry continues to use a special long-load logging truck (LLT) design vehicle (see Section 720.02) and the WB-15 (BC) design vehicle which has been modified from the Ministry's previous version. The WB-15 (BC) vehicle now represents a tractor with a 48' (14.7 m) semi-trailer.

720.02 DESIGN VEHICLE SELECTION

The trend towards longer and heavier vehicles requires that the WB-20 Design Vehicle shall be used on all Freeways and Expressways and on those Arterials with a predominant mobility requirement as opposed to access.

Certain areas of the province have been identified as requiring intersection and/or interchange designs based on the specific needs of the logging industry to ensure the safety of the driving public. For such areas, the LLT design vehicle may be used for designing appropriate intersections on the logging routes.

The LLT design vehicle represents an envelope created by both the worst load sweep of all vehicles tested (LG3 Tractor Triaxle Trailer) and the worst offtracking of all vehicles tested (LG5 Tractor Tandem Jeep/Pole Trailer). This effectively addresses the path requirements for all currently permitted Long-load Logging Trucks in B.C. Figure 720.A provides the dimensions for the LG3 and LG5 vehicles so that they can be modelled in a vehicle tracking software program.

The WB-15 (BC) design vehicle represents a significant section of the truck fleet; therefore, it should be used for the balance of the road system, unless local fleet characteristics dictate otherwise. Figure 720.B provides the dimensions for the WB-15 (BC).

At a minimum, all turning movements should accommodate emergency vehicles; I-BUS, the TAC Inter-city bus is representative of such vehicles.

720.03 DESIGN VEHICLE TURNING CHARACTERISTICS

Although vehicle tracking software programs can allow for unlimited choices of radii, only a limited number of design radii should be used, to simplify intersection design and checking. The standard radii are indicated in Table 720.A and suggest the typical turning conditions for three speed ranges, i.e.:

1. The vehicle begins to turn from a stationary position and negotiates the turn at speeds up to 15 km/h;
2. The vehicle begins a turn at speeds from 15 km/h to 25 km/h as in a turning manoeuvre right or left from a main highway to a secondary road;
3. The vehicle begins a turn at speeds from 25 km/h to 35 km/h as on a separate turning roadway or ramp.

Table 720.A Turning Radii of Design Vehicles

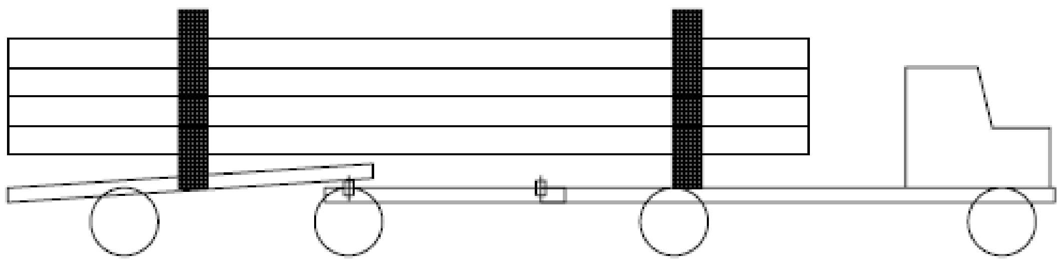
DESIGN VEHICLE	I-BUS	WB-15 (BC)	WB-20	LLT
SPEED	minimum radius[(1)] of outside front wheel			
0-15 km/h	15.2	13.7	14.5	13.6
15-25 km/h	19.8	17.7	17.7	17.7
25-35 km/h	19.8	22.3	22.3	22.3

1. Radii taken from 1995 BC MoTH Highway Engineering Design Manual.

Refer to the *TAC Geometric Design Guide* for the characteristics of other design vehicles.

Figure 720.A LLT Design Vehicle (use LG3 for sweep and LG5 for offtracking)

LG3 - MoT Tri-Axle Trailer Logging Truck



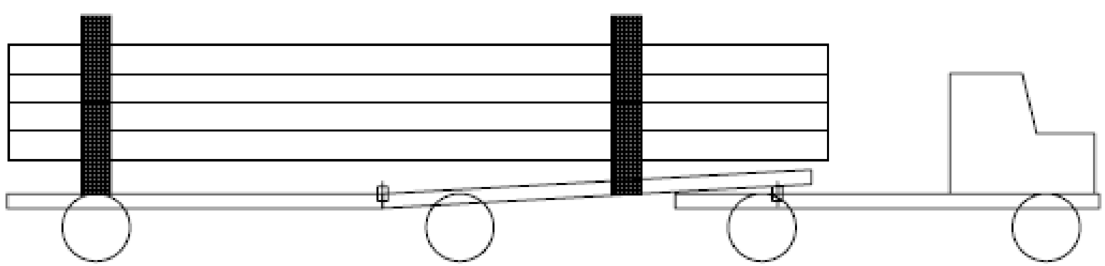
Trailer	Wheelbase	Front Overhang	Rear Overhang	Pin Offset
0	6.80 m	1.10 m	2.76 m	-2.76 m
1 *	3.99 m	0.50 m	0.50 m	0.00 m
2	4.65 m	0.50 m	2.42 m	

Tractor Width = 2.60 m
Trailor Width = 2.60 m
Log Width = 2.60 m

Distance Between Log Bunks = 10.35 m
Log Length FORWARD of Bunk = 2.50 m
Log Length AFT of Bunk = 3.85 m

** Trailer which telescopes to allow vehicle articulation*

LG5 - MoT Tractor Tandem Jeep / Pole Trailer



Trailer	Wheelbase	Front Overhang	Rear Overhang	Pin Offset
0	5.90 m	1.10 m	1.80 m	0.32 m
1	6.59 m	0.70 m	1.60 m	-1.60 m
2 *	5.95 m	0.00 m	1.85 m	

Tractor Width = 2.60 m
Trailor Width = 2.60 m
Log Width = 2.60 m

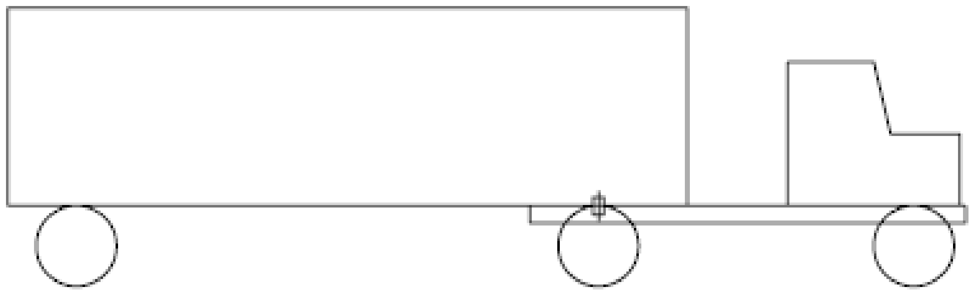
Distance Between Log Bunks = 10.80 m
Log Length FORWARD of Bunk = 4.20 m
Log Length AFT of Bunk = 1.80 m

** Trailer which telescopes to allow vehicle articulation*

Note: LG3 and LG5 are the designations used within the Ministry's PathTracker software program. The Ministry is no longer providing this software program to non-governmental agencies.

Figure 720.B WB-15 (BC) Design Vehicle

W15-BC – WB-15 (BC) Tractor Semi-Trailer



Trailer	Wheelbase	Front Overhang	Rear Overhang	Pin Offset
0	5.50 m	0.90 m	1.20 m	0.00 m
1	11.00 m	1.55 m	2.15 m	

Tractor Width = 2.60 m
Trailor Width = 2.60 m

Note: W15-BC is the designation used within the Ministry's PathTracker software program. The Ministry is no longer providing this software program to non-governmental agencies.

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730
PRIVATE ACCESSES

730.01 DEFINITION

A “private access” (or simply “access”) is a private driveway or a private road intersecting a public road. The following are not covered by Section 730 but should be designed according to Section 710 of the BC Supplement to TAC:

- accesses that have peak hour traffic (total of entering and exiting vehicles) that exceeds 100 vph;
- signalized accesses;
- all other types of intersections that do not meet the private access definition or that exceed a right turn volume from the highway of 30 vph.

730.02 ACCESS EVALUATION

1. Prior to finalization of a design project, a set of preliminary plans shall be submitted to the Regional Approving Officer with a copy of the memo to the Regional Manager of Engineering, requesting assessment of access. The plans shall show all cadastral and existing entrances, together with the proposed treatment of accesses.

2. A summary of all accesses and their proposed treatment shall accompany the above plans. State whether each individual entrance is retained, relocated, closed and/or connected to an existing or proposed access road.

3. A copy of the final summary shall be sent to the appropriate Regional Property Agent at the time the plans are submitted to the Regional Director for approval.

4. Major Projects that cross more than one Region must treat accesses in each Region separately and deal with each Regional Approving Office, Regional Manager of Engineering, and Property Agent.

730.03 ACCESS TYPES

Accesses should not generally be permitted where traffic exiting or entering the highway would be unsafe or compromise the operational characteristics associated with the specific Classification. Sight Distance and traffic volumes are major considerations in locating and designing driveway accesses.

Freeways and Expressways have no private access. As we move down the Classification System, access becomes a growing part of the character of the highway, finally being the prime function for a local road or street.

Some rationale is required to supply access without unduly impacting mobility requirements. Access treatments should vary according to the type and volume of traffic.

Table 730.A below indicates the appropriate right-off and right-on treatment type for various access conditions.

As well as the treatments shown, turning sight distances should be provided as documented in the current edition of the **TAC Geometric Design Guide for Canadian Roads**. Where these treatments are not feasible, advance notice and Stopping Sight Distance are required on the highway.

Table 730.A Access Types

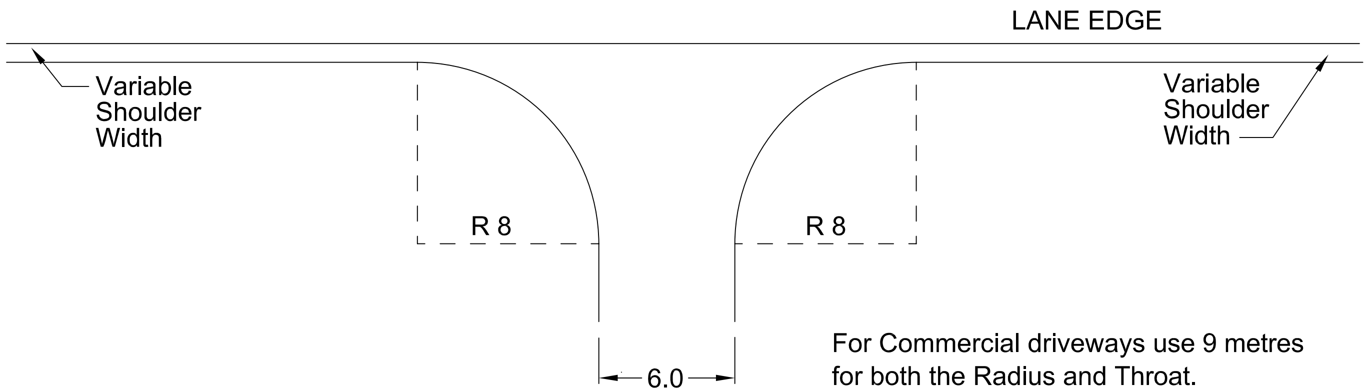
Peak hour Right-turn Volume from the Highway into the Access (Use only if peak entering plus exiting traffic is 100 vph or less)	**AADT on the Highway (Total of two directions)**		
	<1000	**≥1000**	**≥3000**
< 5 vph	1A	1A	1B
5 ≤ vph < 15	1A	1B	2B
15 ≤ vph ≤ 30	2A	2B	3

See Figures 730.A through 730.D for details of access types and typical cross sections.

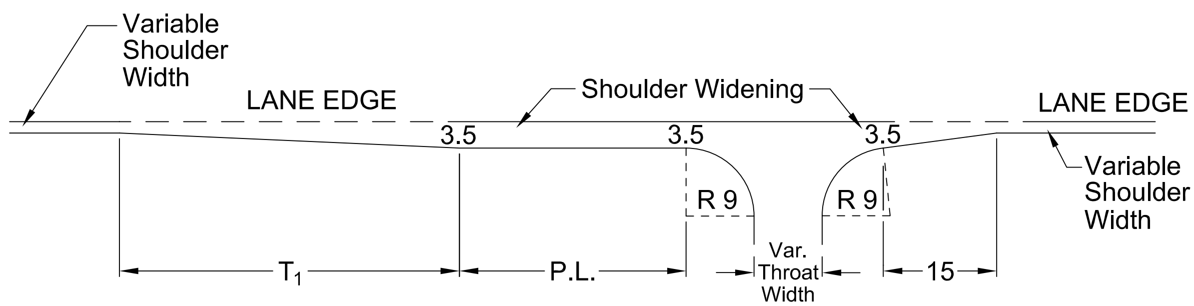
Figure 730.A Type 1 Driveways

N.T.S.

TYPE 1A



TYPE 1B



DESIGN SPEED (km/h)	T_1 (m)	P.L. (m)
50	20	0
60	30	0
70	40	0
80	40	10
90	40	25
100	45	30

Peak hour Right-turn Volumes	Throat Width
< 5 vph	6
5 ≤ vph < 15	9

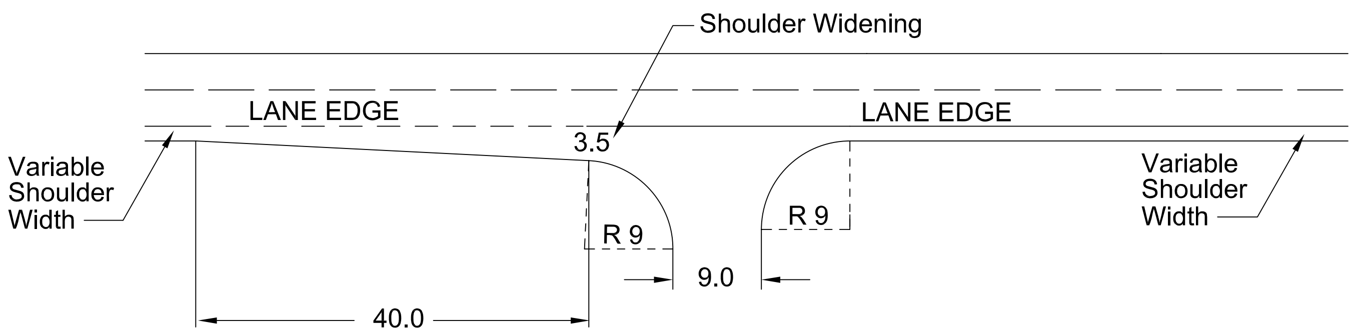
NOTE:

The radius and throat widths noted are minimum dimensions. A wheel path tracking template should be used to verify that the largest expected design vehicle that occurs with some frequency can be accommodated.

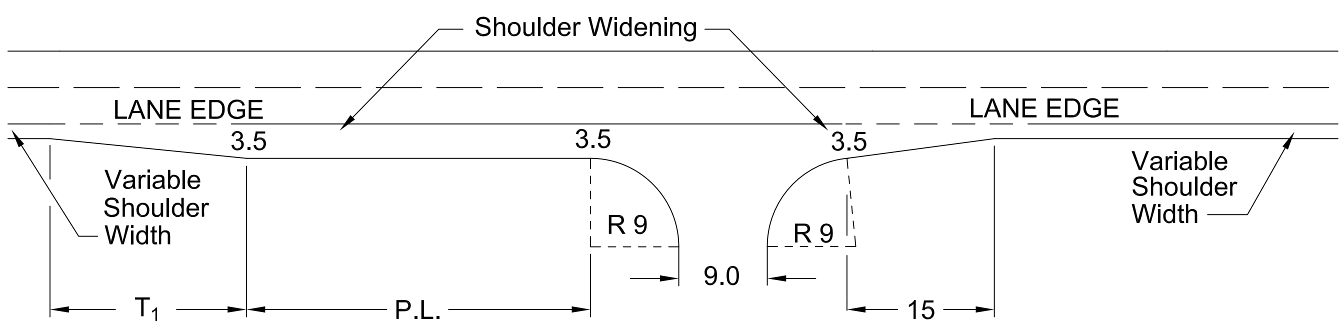
Figure 730.B Type 2 Driveways

N.T.S.

TYPE 2A



TYPE 2B



DESIGN SPEED (km/h)	T_1 (m)	P.L. (m)
70	20	35
80	30	40
90	50	40
100	50	55

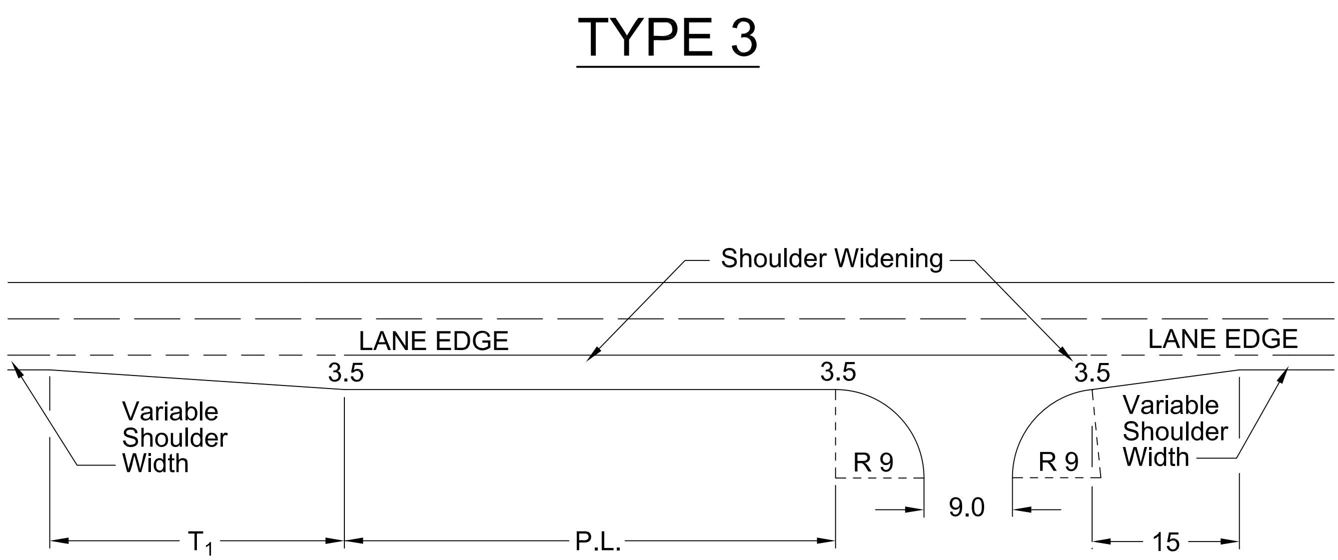
NOTE:

The radius and throat widths noted are minimum dimensions. A wheel path tracking template should be used to verify that the largest expected design vehicle that occurs with some frequency can be accommodated.

MoT Section	730		TAC Section	

Figure 730.C Type 3 Driveways

N.T.S.



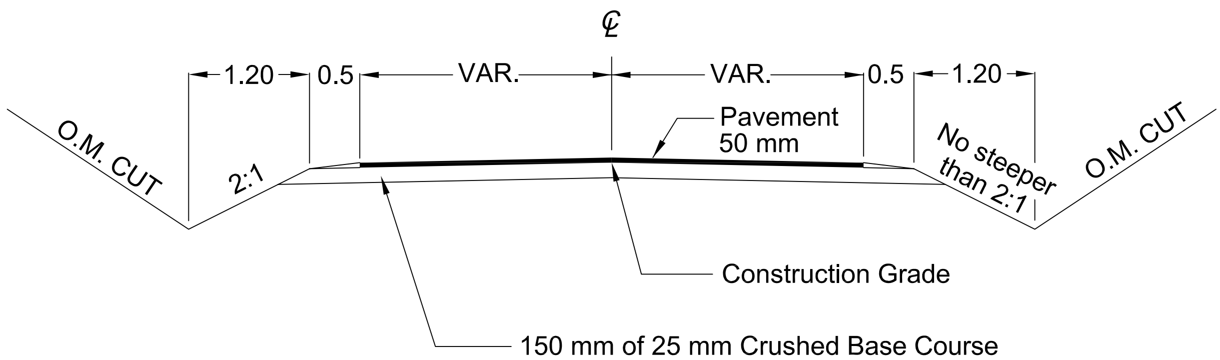
DESIGN SPEED (km/h)	T_1 (m)	P.L. (m)
70	30	50
80	50	55
90	55	75
100	60	100

NOTE:

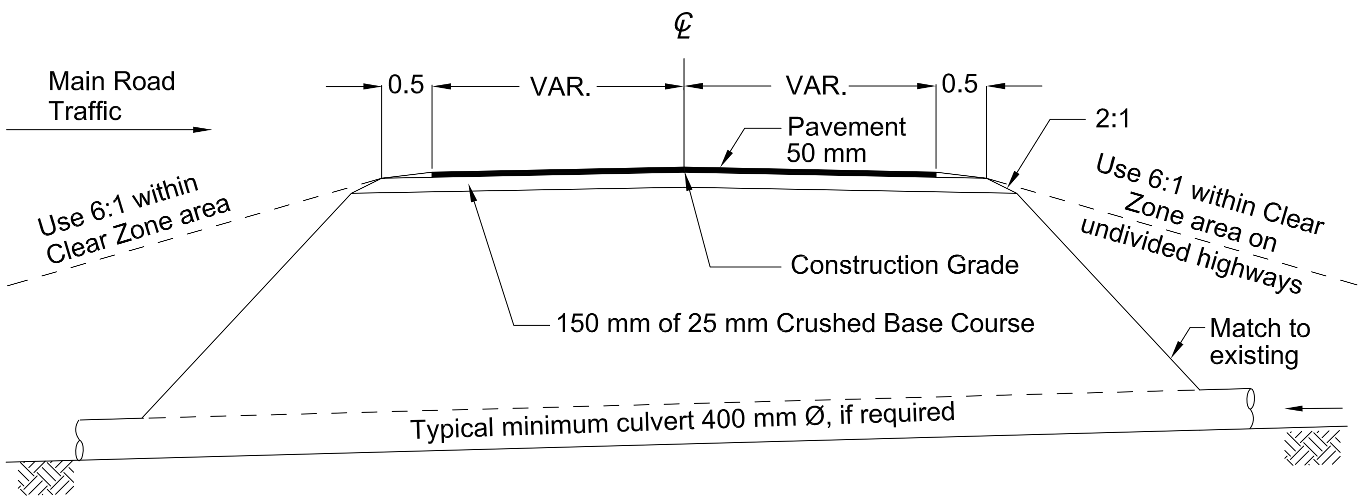
The radius and throat widths noted are minimum dimensions. A wheel path tracking template should be used to verify that the largest expected design vehicle that occurs with some frequency can be accommodated.

Figure 730.D Driveway Cross Section

N.T.S.



TYPICAL CUT SECTION



TYPICAL FILL SECTION

Notes:

1. Driveway width variable. Refer to Fig. 730.A to 730.C
2. See TAC Geometric Design Guide for end treatments for culverts ≥ 600 mm diameter.
3. The 6:1 slope is not required for opposing traffic on divided highways.

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740
ROUNDABOUTS

740.01 INTRODUCTION

The Ministry has selected the 2003 *Kansas Roundabout Guide* (KRG) as our primary resource. The KRG is a supplement to the FHWA publication *Roundabouts: An Informational Guide*. The KRG provides more recent information than the FHWA guide on roundabout design based on the ever evolving state of the art in North America.

The KRG, this chapter (740), and the Ministry's roundabout signing and pavement marking guidelines shall be utilized and applied to all roadways under BC MoT jurisdiction.

The KRG is available at:
http://www.ksdot.org/burtrafficeng/Roundabouts/Roundabout_Guide/RoundaboutGuide.asp

The FHWA guide is available at:
http://www.tfhrc.gov/safety/00068.htm

Many of the parameters in roundabout design publications are predicated on urban roadways where there are relatively few large trucks; however, the Ministry primarily deals with provincial and inter-provincial roadways that handle significant volumes of large trucks. Past experience has shown that trucks have not been given enough consideration with respect to designing an appropriate inscribed circle diameter (ICD) and truck apron. The recommendations in this chapter are intended to preserve mobility on Ministry roadways and improve accommodation of large trucks. This chapter also outlines some specific design guidelines for roundabouts in general.

740.02 GENERAL

Background:

The Ministry has gained and continues to gain experience with the principles of roundabout design. As roundabouts are still relatively new on provincial roads there is a benefit to be gained from including HQ engineering in projects and designs handled by MoT regions and districts whether they are from consultants, municipalities, land developers, or developed in-house. HQ's engineering role is to review and provide feedback on the geometric design, traffic signing, and pavement marking of roundabouts with the goal of achieving province wide harmonization for roundabouts. This process will also allow for 1) applying "lessons learned" to avoid past operational problems, and 2) providing designers with design principles, which due to the evolving nature of roundabout design, have yet to be included in the BC Supplement to TAC Geometric Design Guide.

Policy:

Roundabouts shall be considered as the first option for intersection designs where 4-way stop control or traffic signals are supported by traffic analysis. If an intersection treatment other than a roundabout is recommended, the project documentation should include a reason why a roundabout solution was not selected for that location. This roundabouts "first" policy supports the province's Climate Action Program of 2007.

Roundabouts shall be considered on all roadways including intersections at interchange ramps.

All roundabout designs must be reviewed by the Chief Engineer's Office for provincial consistency. The review starts at the **Conceptual Design** stage allowing for HQ engineering input prior to any roundabout drawings being developed.

Procedure:

After initial discussion with the MoT, all roundabout documentation is to be sent to the attention of the Ministry's contacts (the Senior Traffic Engineer and the Senior Geometric Standards Engineer) at Headquarters Engineering Branch. This shall be coordinated through the primary Ministry contact for a project in the Regional Design office (or District office). All comments and recommendations from HQ will be sent to the Ministry contact.

Submissions should include the following documentation:

1. Background information/history for need of traffic control
2. Intersection control analysis (Ministry's signal and/or 4-way stop control analysis)
3. *Roundabout Design Criteria Sheet* (including estimated volume by vehicle class and bicycle volume/route information)
4. Roundabout design drawings (in Adobe PDF and AutoCAD DWG format) including, but not limited to: the roundabout superimposed on an aerial photograph, if photos are available; design vehicle turning movements; geometrics and laning; profiles; typical sections; signing and pavement markings
5. SIDRA roundabout analysis provided to MoT with an electronic copy of project file, (include an analysis of emission rates, delay times, and fuel consumption between the use of a traffic signal and roundabout)
6. In British Columbia roundabouts are a relatively new form of traffic control which may lead to some resistance from the public on their use. Consequently, there should be a communication plan established for educating stakeholders and gaining acceptance of a roundabout in a community (e.g. discuss with elected officials, hold public meetings and open houses, distribute brochures, post roundabout information on City and Ministry websites, have computerized simulations of traffic operations, place newspaper advertisements, make Public Service Announcements, make presentations to seniors groups, provide all media outlets with background information, etc.)

The review carried out will deal with the traffic analysis and general layout of the roundabout, the geometric design of the roundabout, the traffic signing of the roundabout, and the pavement marking of the roundabout. Reviews will be done at the conceptual design stage for any proposed roundabout and will continue on through the submission stages until the final design submission.

This roundabout review process does not replace the designer's/design team's quality management process nor does it relieve the Engineer of Record of their responsibility. For consultant designs, the roundabout review by HQ does not preclude any requirements for review and acceptance of the entire project by the Regional Traffic and Design offices or the District office.

740.03 INTERSECTION ANALYSIS

Refer to KRG Section 4.1

The Ministry's software analysis tool is SIDRA. When roundabout drawings are submitted to the Ministry for review, a digital copy of the SIDRA project file is to be part of the submission.

For compatibility, contact the Ministry to find out what version of SIDRA is required.

740.04 GEOMETRIC DESIGN

Refer to KRG Chapter 6

Design Vehicle:

Refer to KRG Section 6.1

On all numbered highways, a roundabout shall be designed with a sufficient inscribed circle diameter and truck apron width to accommodate a WB-20 unless otherwise agreed upon by the Ministry and documented in the roundabout design criteria sheet. The design vehicle shall be determined based on several factors, including but not limited to, the classification of roadways involved, their location (e.g. urban or rural, commercial/industrial or residential), and the vehicle classes (i.e. % of trucks) and volume of vehicles using the intersection. In some instances, this may result in a design vehicle that is smaller or larger than a WB-20 (e.g. on a route that has the occasional permitted over-width or over-length load). Field testing for some roundabout designs may be needed to ensure the largest design vehicle can traverse the proposed roundabout. This can be achieved by laying out (in a large open lot) the central island, truck apron, and inscribed circle diameter (ICD) and having the design vehicle negotiate all possible movements.

Inscribed Circle Diameter:

Refer to KRG Section 6.1

The BC MoT recommended inscribed circle diameter ranges are as follows:

Table 740.A Recommended Inscribed Circle Diameter (ICD) Ranges

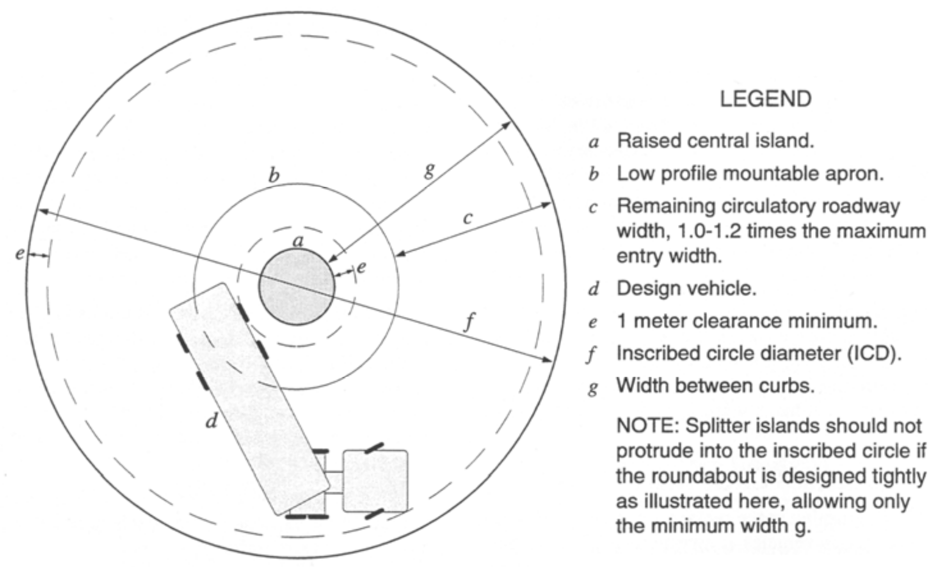
Site Category	Inscribed Circle Diameter Range*
Urban Single Lane	37 – 46 m
Urban Double Lane	46 – 67 m
Rural Single Lane	40 – 61 m
Rural Double Lane	53 – 76 m

* Assumes approximately 90-degree angles between entries and no more than four legs.

Figure 740.A provides turning width requirements for a WB-20 design vehicle for a variety of ICDs. The values provided in Figure 740.A are based on the Surface Transportation Assistance Act (STAA) design vehicle which is similar to the dimensions of the TAC WB-20 design vehicle.

Values in Table 740.A and Figure 740.A were derived by converting imperial measurements to metric.

Figure 740.A Required Turning Widths
(from "Roundabout Design Guidelines" Ourston Roundabout Engineering 2001)



Inscribed Circle Diameter (f) (metres)	Design Vehicle WB-20 (g) (metres)
79.2	7.2
73.2	7.5
67.1	7.8
61.0	8.1
57.9	8.4
54.9	8.7
51.8	9.0
48.8	9.3
45.7	9.8
42.7	10.1
39.6	11.1
36.6	12.2
33.5	13.7
30.5	**
29.0	**

** Design Vehicle requires larger ICD

Number of Lanes:

Refer to KRG Section 6.1

On two lane provincial numbered routes, the main highway approach legs shall be developed with two lane entries. The exit legs may be either one or two lanes depending on traffic volumes and turning movements. Figures 740.G, 740.H and 740.I are sketched examples of roundabouts with one and two lane approaches and exits. When utilized, two lane exits shall be carried a minimum of 175 m beyond the roundabout before tapering back to a single lane. Lengths less than 175 m must be approved as a design exception with the appropriate Ministry sign off.

(Note: a "numbered" route refers to a road that has an official guide sign route marker; ex. Hwy 3, Hwy 5, Hwy 97, etc.)

Single lane roundabouts are typically used on two lane un-numbered roadways under the jurisdiction of the Ministry.

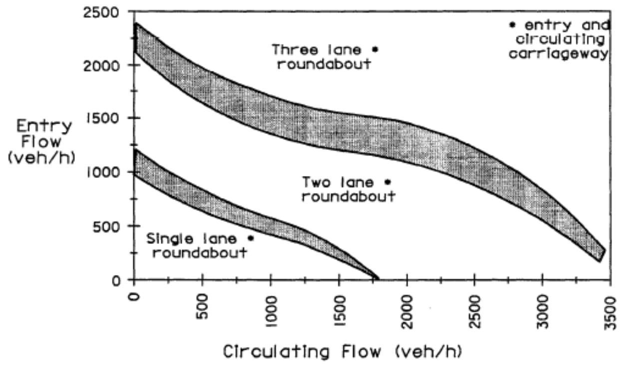
Four lane and six lane highways will have two or three entry and circulating lanes. Figure 740.J is an example of a roundabout with 3-lane approaches and exits on the primary route.

Bypass lanes are an option that should be considered when there are high volumes of right turn traffic (especially if there is a significant volume of tractor-trailer vehicles). If traffic projections warrant a bypass lane within 10 years from the opening date, the bypass lane should be constructed as part of the initial project. If a bypass lane will be warranted beyond 10 years, sufficient right-of-way should be protected to accommodate the future construction.

Figure 740.B provides an indication of expected capacities of single and multi-lane roundabouts. Figure 740.B is based on the acceptable degree of saturation being less than 0.8.

Figure 740.B Required Number of Entry and Circulating Lanes

(from the Austroads *Guide to Traffic Engineering Practice, Part 6 - Roundabouts*)



The shaded bands indicate conditions in which either treatment may be suitable depending on the geometry and acceptable operating conditions.

Circulatory Roadway:

Refer to KRG Section 6.1

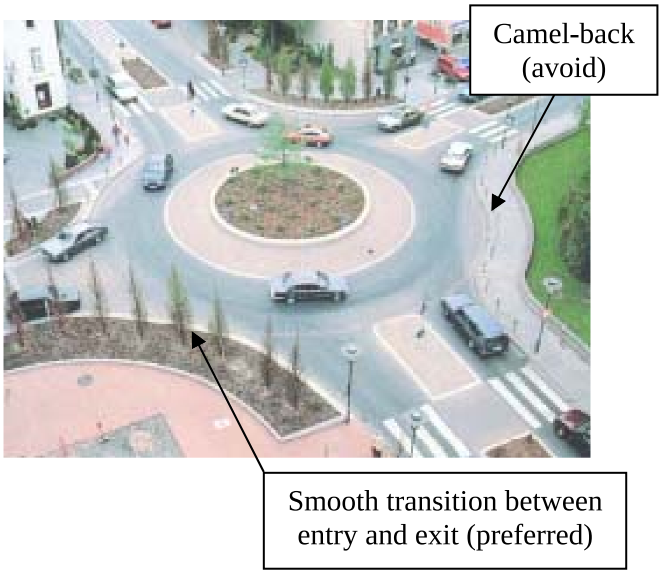
(Note: the gutter portion of curbing is not considered to be part of the circulatory width or ICD.)

For two lane roundabouts with significant truck volumes, the total circulatory (i.e. paved) width should, at a minimum, accommodate the largest frequent design vehicle (typically a WB-20) side by side with a passenger car. This does not necessarily mean that the truck must stay within its painted lane.

For single lane roundabouts, the paved circulatory width should accommodate an intercity bus (TAC I-BUS) which is also representative of large emergency vehicles (i.e. fire trucks). Vehicles larger than the TAC I-BUS are expected to utilize the truck apron.

Camel-backs should be avoided. Figure 740.C shows an example of where the circulatory roadway is not being utilized in the camel-back area. The natural drive path for right turning vehicles does not pass through the camel-back area. On multi-lane roundabouts, this will create a path overlap hazard.

Figure 740.C Example of a Camel-back
(see KRG Exhibit 6-25 for a larger picture)



Exits:

Refer to KRG Section 6.1

Contrary to the KRG discussion on exits, the exit path radius (R3) may be significantly greater than the circulating path radius (R2) provided that the entry and circulating paths have been designed to ensure a low operating speed.

"The designer should consider the driver's stopping sight distance and pedestrian decision and crossing time. The pedestrian needs to interpret the drivers' intentions (to exit or circulate) with adequate time to complete the crossing. With a relaxed exit path, the driver's intentions are apparent to the pedestrian earlier. The pedestrian crossing is also visible to the driver earlier, so the stopping sight distance is improved. If vehicle speed is reduced prior to the entry, and the Inscribed Circle Diameter (ICD) is smaller, cars will tend to circulate slower, and if the pedestrian is clearly visible (as they are on a more tangential exit), reasonable drivers do not accelerate at them as they begin their exit.

Exit speed can be calculated based on circulating speed and acceleration rate, starting from the circulating speed at the point where drivers round the central island and begin their exit path curve. On multi-lane roundabouts at off-peak times, the fastest-path exit speed depends not on R3 (too large to have any effect) but on the following:

- the circulatory radius, R2 ;
- the distance from the end of the R2 radius to the exit crosswalk; and
- the acceleration from the end of R2 to the exit crosswalk.

This assumes that drivers accelerate immediately as they reach the end of R2. (This is very aggressive and usually there is a time lag.) The acceleration rate is about 3.5 ft/sec/sec (it may vary depending on the initial R2 speed)." [1]

In most situations, the relatively short distance at the exit between the circulating roadway and the pedestrian crossing will typically result in an acceleration of 5 to 10 km/h. Figure 740.D shows an example of large radius exits. Due to the entry deflection (see Figure 740.F), the east bound exit speed was calculated to be only 30 km/h.

Figure 740.D Example of Large Radii Exits at a 3-Legged Roundabout
(Okemos, Michigan)

Note: Signing and lighting shown in this picture do not meet Ministry guidelines.

Multilane Entry Design:

Refer to KRG Section 6.2

The preferred design to increase entry deflection shall be an approach alignment "offset left" of the roundabout center as shown in KRG Exhibit 6-22 and Figure 740.E. When designing for large trucks, consideration should be given to using an entry curve radius that is large enough to avoid trailers dangerously overtracking into the adjacent lane prior to the yield line. This could require entry curve radii of 30 m or more, but it is also important that the radii not be so large as to allow excessive entry speeds.

Figure 740.E shows a 2-lane entry technique that will reduce the wheel path conflicts between cars and large trucks. A truck can utilize the gore area without encroaching into the adjacent lane.

Figure 740.E Example of Entry Lanes to Accommodate Truck Over Tracking (from New York DoT)

Vehicles should be directed into the proper circulatory lane at the approach entrance (yield) line. Lane lines should be designed tangential to the roundabout, as shown in KRG Exhibit 6-21.

Figure 740.F Example of Multi-lane Entry Deflection at a 3-Legged Roundabout (Okemos, Michigan)

East bound

Note: Signing and lighting shown in this picture do not meet Ministry guidelines.

Landscaping buffer, min. 0.6 m wide

Grading and Drainage:

Refer to KRG Section 6.3

In addition to the drainage guidance in the KRG and FHWA publications, special consideration may be required for roundabouts on flat terrain. It is suggested that the entire roundabout be tilted at 0.5% to 1.0% to ensure drainage is directed towards a specific catch basin location.

In consideration of low-boy trailers where ground clearance may be an issue, creating a crown in the roundabout perpendicular to the circulatory roadway should be avoided to prevent these trailers from high centering.

Curbs, Pavement Design, and Truck Aprons:

Curb and pavement designs shall be in accordance with the MoT Standard Specifications for Highway Construction. Where required, splitter island curbing should be designed to resist snowplow activity.

The outer edge of the circulatory roadway and the central island shall be constructed with combined curb and gutter in accordance with SP582-01.01. Modifications, as required, shall be made to the central island gutter slope to ensure drainage does not accumulate against the central island curb. Alternatively, the central island may be constructed with extruded concrete curb in accordance with SP582-01.04.

Along quadrants that do not have sidewalks, the minimum extents of curb and gutter on the outer edge of the roadway shall begin and end where the pedestrian crossing intersects the curb (i.e. about one car length from the entrance line).

A minimum 2.0 m wide central island truck apron shall be installed at all roundabouts (even at large roundabouts where a truck apron is not necessarily required). This will create a visually distinct feature for MoT roundabouts. Truck aprons should be sized to accommodate the design vehicle turning path with approximately 1.0 m clearance between the vehicle's tire track and the central island curb. There is no standard width for a truck apron; however, the designer should re-evaluate the design to ensure that the proper ICD size and geometric features are being provided if an apron is greater than 4.2 m in width.

In some situations, a very large truck apron may be an indicator that other geometric features are being compromised in the roundabout design.

Truck aprons shall be constructed with mountable curb and gutter in accordance with SP582-01.02 "Roundabout Truck Apron Mountable Curb". The mountable curb height shall be 50 mm.

The slope of the truck apron should typically be 2% away from the central island.

The apron shall be built with contrasting materials (texture and color) for better visibility during both day and night conditions. The texture and colour of the material used for the apron shall be different than the material used for the sidewalks so that pedestrians are not encouraged to cross the circulatory roadway. Textures vary from inlaid and stamped asphalt brick patterns to stamped concrete "cobblestones". Stamped stone patterns provide for a more audible and visual deterrent than brick patterns.

Pedestrian Considerations:

Refer to KRG Section 6.5

Detectable warning surfaces should be installed at the curb letdowns and at the entrances/exits of the pedestrian refuges in the splitter islands. See KRG Exhibit 6-29 for a detail of the detectable warning surface.

The width of sidewalks shall be 1.8 m minimum but the width must be increased where shared use by pedestrians and cyclists is expected. 3.0 m is the typical width provided for a shared use facility.

A landscaping buffer should be provided between the sidewalk and circulatory roadway (see Figure 740.F). This buffer will provide better delineation of the sidewalk for the visually impaired, will deter pedestrians from crossing to the central island, and will provide room for sign installations. The preferred set back distance for the buffer from the back of curb to the sidewalk is 1.5 m; however, a minimum set back distance of 0.6 m is acceptable. Right-of-way constraints at some locations may restrict the use of a buffer; however, this treatment should be utilized wherever possible. The width required for the placement of signs should be taken into consideration to prevent signs from intruding into the roadway or sidewalk space.

The area between the road and the sidewalk can be planted with grass, flowers, or low shrubbery. If the minimum 0.6 m set back is used, a coloured and/or stamped concrete/asphalt treatment may also be considered.

Landscaping Considerations

Pedestrian safety is paramount at roundabouts; therefore, landscape vegetation must be positioned so that sight lines to the pedestrians are maintained.

Vegetation (e.g. tall trees) must not cast shadows across the pedestrian crossing area.

Vegetation on Ministry roundabouts should be self sustaining. Irrigation provided in urban areas would be maintained by the local jurisdiction.

The use of landscaping at a roundabout is one of the distinguishing features that give roundabouts an aesthetic advantage over traditional intersections. Landscaping can provide an opportunity for gateway treatments that promote community themes/branding or identification.

Design Exceptions

All design exceptions to the above guidelines must be documented in the roundabout design criteria sheet and approved by the Ministry.

740.05 TRAFFIC DESIGN

Refer to KRG Chapter 7

Signing and Pavement Marking:

The Ministry's signing and pavement marking guidelines for roundabouts are available as a Technical Circular at:

http://www.th.gov.bc.ca/publications/Circulars/Current/T_Circ/2005/t07-te-2005-5.pdf

This Technical Circular is occasionally updated; therefore, the website should be checked for the latest version at the start of each project.

Central island monuments and other landscaping treatments must be designed to accommodate all regulatory signing requirements.

Lighting Guidelines:

The latest edition of the TAC *Guide for the Design of Roadway Lighting* is to be used for roundabout lighting designs.

740.06 REFERENCES

1. Baranowski, Bill and Waddell, Edmund. *Alternate Design Methods for Pedestrian Safety at Roundabout Entries and Exits: Crash Studies and Design Practices in Australia, France, Great Britain and the USA*, 2003

Figure 740.G Roundabout Layout Example – Intersection of Major Route with Minor Route

Two-Lane Entries and Exits on Major Route
One-Lane Entries and Exits on Minor Route

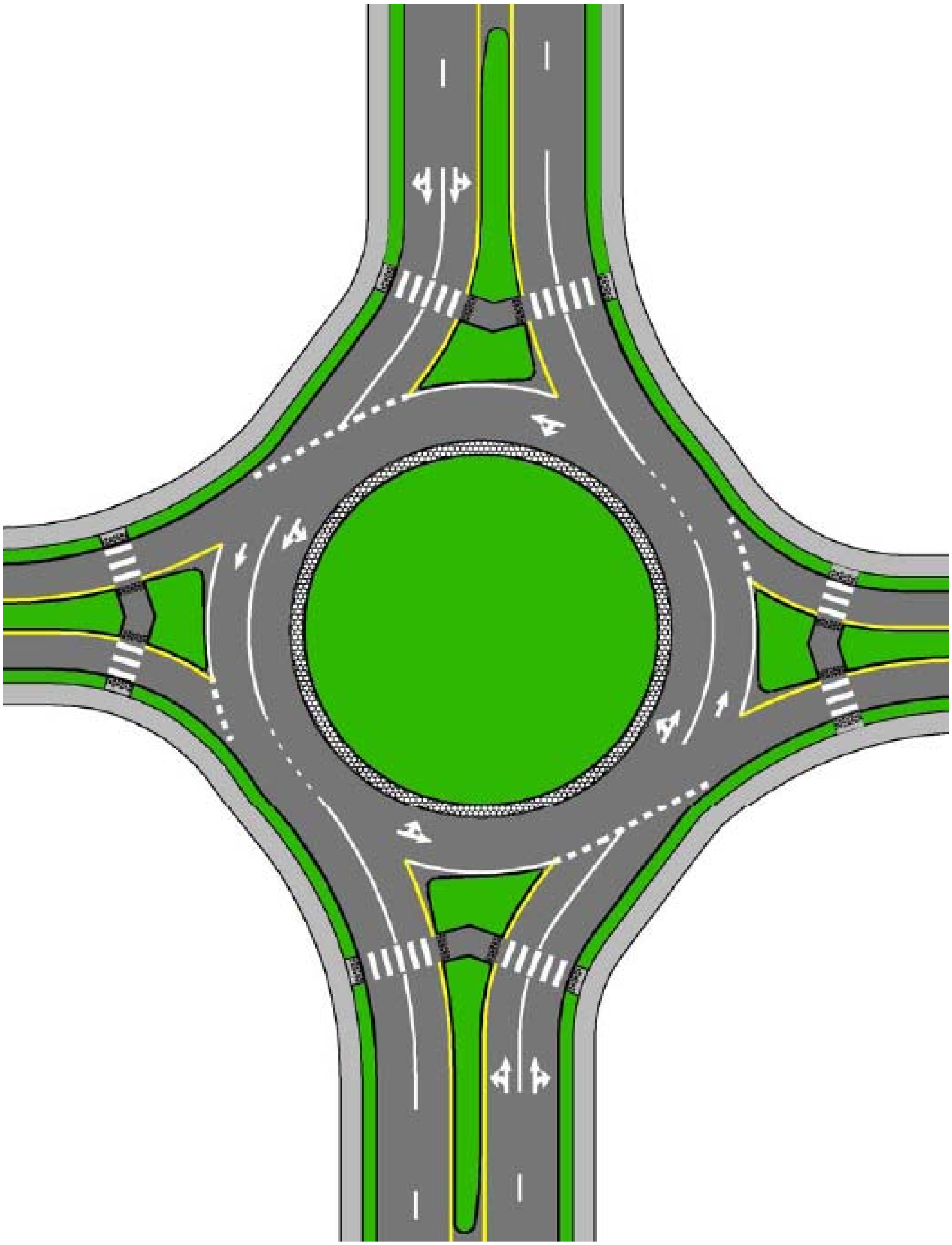


Figure 740.H Roundabout Layout Example – Intersection of Major Route with Minor Route

Two-Lane Entries and One-Lane Exits on Major Route
One-Lane Entries and Exits on Minor Route

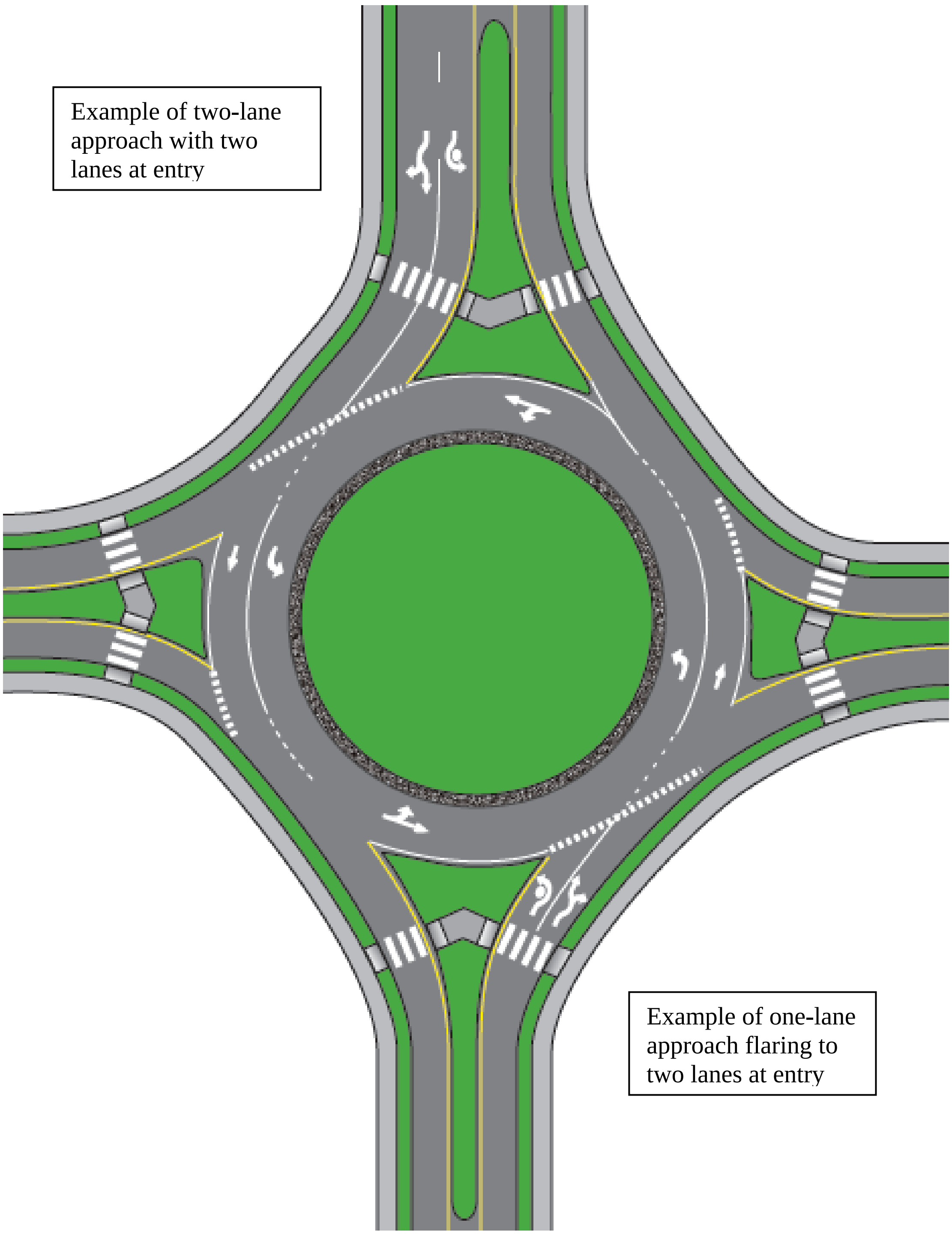


Figure 740.I Roundabout Layout Example – Intersection of Two Major Routes

Two-Lane Entries and One-Lane Exits on All Routes

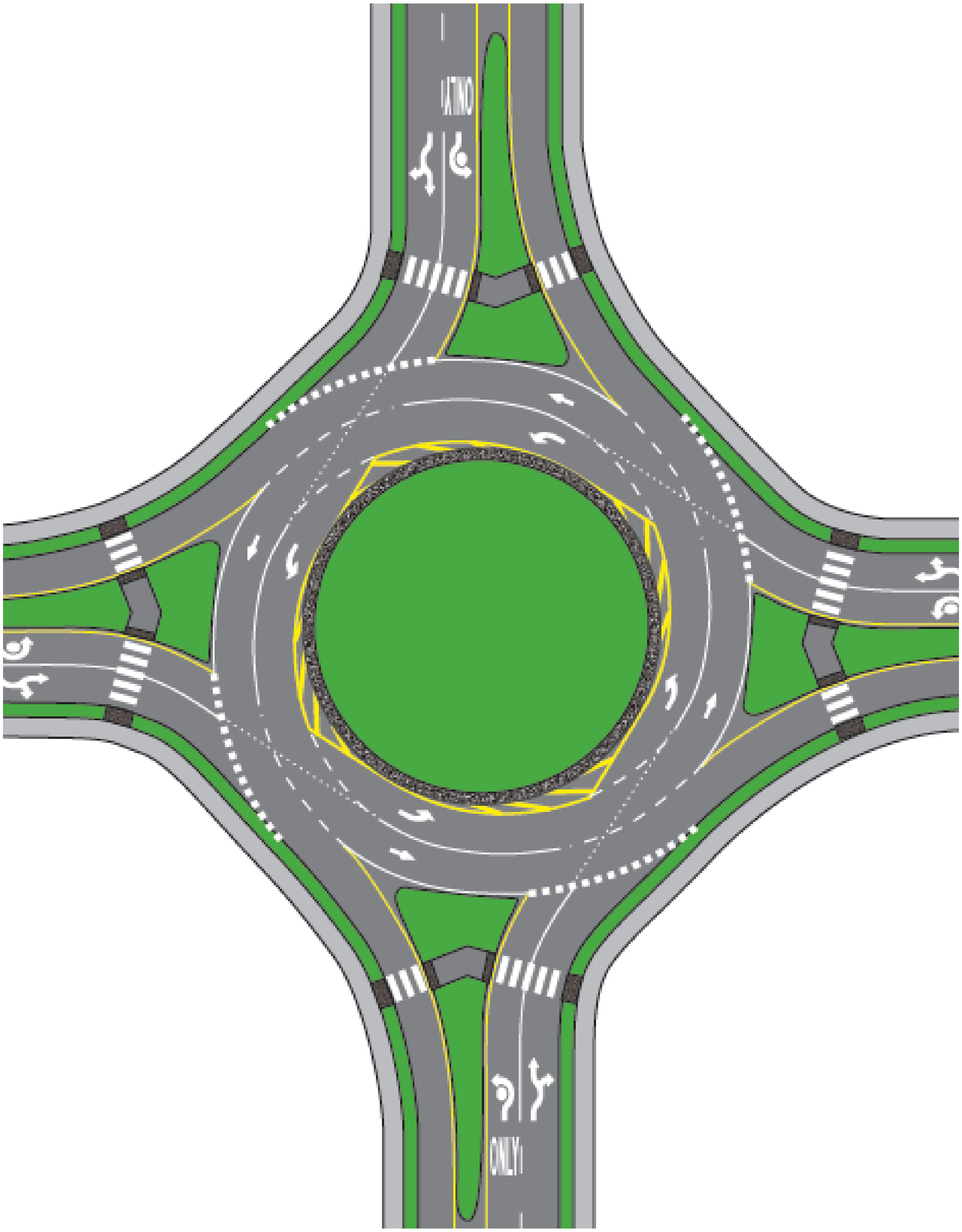


Figure 740.J Roundabout Layout Example – Intersection of Two Major Routes

Three-Lane Entries and Three-Lane Exits on Primary Route

(Sterling Heights, Michigan
18½ Mile Road and M-53)

900 AUXILIARY FACILITIES CHAPTER

900 AUXILIARY FACILITIES CHAPTER TABLES

900 AUXILIARY FACILITIES CHAPTER FIGURES

910
SLOW MOVING VEHICLE PULLOUT

910.01 INTRODUCTION

Slow Moving Vehicle Pullouts are primarily for "older" 2-lane highways where passing opportunities are limited and where slow moving vehicles impact the Level of Service and cause unacceptable platooning. These are predominantly summer recreational routes through areas where the cost of conventional passing or climbing lanes would be prohibitive, relative to the benefits. Some jurisdictions call these Turnouts.

910.02 GENERAL

When choosing a pullout location, you should balance the passing opportunities for each direction and avoid long no-passing sections. Signing and pavement marking are in accordance with the Ministry's Manual of Standard Traffic Signs & Pavement Marking[1]. Avoid Pullouts on downhill sections.

On long winding sections of roadway, locate the pullouts so as to reduce the length of the continuous "No Passing" zones to 15 km or less in mountainous terrain and 10 km or less in level or rolling terrain. Large trucks tend to avoid pullouts, especially on a grade. Pullouts should not be mixed with passing or climbing lanes. No accesses are permitted within pullouts and they should also be avoided opposite the pullout.

Pullouts may also be considered on long uphill grades when a truck climbing lane cannot be built and where speed reductions of at least 20 km/h below the posted or 85th percentile speed are encountered. Refer to TAC Geometric Design Guide for Canadian Roads **Figure 2.1.8.3** for heavy trucks' performance curves on grades.

910.03 GUIDELINES FOR INSTALLATION

Pullouts should be considered when Level of Service B cannot be maintained due to the presence of slow moving vehicles and insufficient passing opportunities. According to the Highway Capacity Manual (Transportation Research Board, HCM2000 metric edition, Chapter 20), at the Level of Service B/C interface the percent time spent following is 50% on class I highways, for which efficient mobility is paramount.

When the percentage of no passing zones exceeds 60% and the accident history or field observations indicate that there is an excessive amount of dangerous passing manoeuvres due to driver frustration, pullouts should be considered even though Level of Service B is not exceeded during peak hours. (The peak hour in rural situations can be interpreted to be a summer mid-day hour, typically about the 100th highest hourly volume of the year).

Table 910.A, below, gives hourly directional volumes (V_{APP}), bi-directional Average Annual Daily Traffic (AADT) and Summer Average Daily Traffic (SADT) with the corresponding distance over which it is likely that queues (delayed vehicles) exceeding 5 vehicles (platoon of 6 vehicles including the slow vehicle) would develop. This represents the spacing of Pullouts. Intermediate values can be interpolated.

Table 910.A is derived from a Queue catch-up model provided by ADI Ltd[2]., using the following assumptions:

- The directional volume is the peak hourly flow rate in a 60/40 traffic split.
- There are 20% slow moving vehicles (at 20 to 10 km/h below the desired speed of 80 km/h)
- The peak hour is 15% of the AADT.
- The SADT is 1.5 times the AADT.

Table 910.A Pullout Spacing Recommendations

V_{APP}	Pullout Spacing (km) (20/10 km/h below) (desired speed)	SADT	AADT
20	30/50	400	250
40	15/25	700	450
60	10/17.5	1050	700
80	7.5/12.5	1350	900
100	6/10	1750	1150

910.04 DESIGN ASSUMPTIONS

The following design assumptions were used to obtain the dimensions listed in Table 910.B - Pullout Lengths.

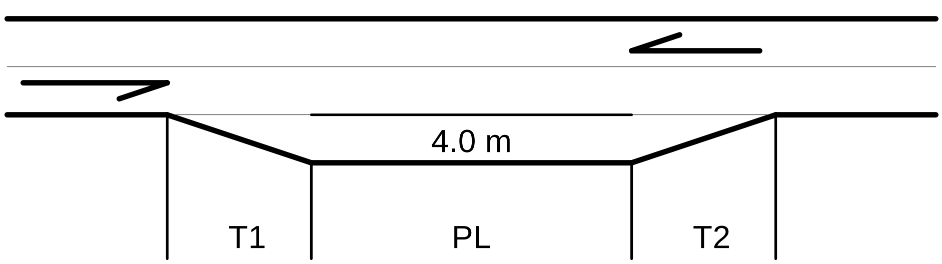
- Reference Speed: posted speed or 85th percentile speed, whichever is greater;
- Slow moving vehicles are going 20 km/h less than the reference speed;
- Minimum PL: The slow moving vehicle (SMV) brakes safely to a stop within the PL;
- Desirable PL: The SMV reduces speed to 35 km/h less than the reference speed through the start taper, T1;
- Maximum PL: This is the limit above which the pullout becomes a passing lane. The assumption for the maximum length is that the SMV continues at 20 km/h below the reference speed as they drive through the pullout and let 5 vehicles go by. If there are more than 5 vehicles passing, then the SMV's will have to slow down and come to a stop or merge when safe to do so;
- No Access within the length of the pullout or opposite the pullout;
- Speed of all vehicles other than SMV's is the reference speed. There are 5 passing vehicles;
- Stopping Sight Distance for the reference speed should be available through the entire length.

Table 910.B Pullout Lengths

Reference Speed km/h	T1 m and (Ratio)	Minimum PL (m)	Desirable PL (m)	Maximum PL (m)	T2 m and (Ratio)
50	30 (7.5:1)	30	70	200	30 (7.5:1)
60	40 (10:1)	45	120	300	40 (10:1)
70	50 (12.5:1)	65	190	500	50 (12.5:1)
80	60 (15:1)	85	270	600	60 (15:1)

Note: Use the ratio if Pullout width is other than 4.0 m. Minimum width is 4.0 m. This is a shoulder widening. The minimum width is to avoid pavement degradation by off-tracking or wide vehicles. Pavement design should be as per travel lanes.

Figure 910.A Typical Pullout Configuration



Note: Minimum Pullout width is 4.0 m. This is a shoulder widening. Parking should be prohibited in the pullout area. The minimum width is to avoid pavement degradation by off-tracking or wide vehicles. Pavement design should be as per travel lanes.

References:

[1] Manual of Standard Traffic Signs & Pavement Markings, BC Ministry of Transportation, Engineering Branch.
[2] Lyall, Peter D. and Jagannathan, R "Auxiliary Lane Warrants for Two-Lane Highways, Volume I: Report", ADI Limited, Victoria, BC. 1993.

920
TRUCK CLIMBING LANE WARRANTS & DESIGN

920.01 INTRODUCTION

Climbing lanes are introduced on steep upgrades to provide a lane for trucks and other slow moving vehicles whose speed drop because of the grade. Climbing lanes are warranted by specific grade effects on Level of Service and/or operating speed, rather than a lack of passing opportunity over a long stretch of a two lane highway. Climbing lanes may be added along with passing lanes as part of a corridor upgrade to improve the level of service by breaking up vehicle platoons. This is a planning exercise involving an operation analysis of long section of highway. When the technical warrants have been met the general procedure should be to: 1) determine the optimum planning and design parameters to fine-tune the location, start and end of the climbing lane; 2) estimate the costs of providing the climbing lane; and 3) do a benefit-cost analysis. For more information on the planning of passing and climbing lanes, refer to the ADI report[1]. For information on the design and co-ordination of passing lanes with climbing lanes refer to Section 930.

920.02 WARRANT

A climbing lane is generally recommended if all three of the following criteria are satisfied:

- A speed reduction of 15 km/h for a 180 g/w truck (300 lb/hp);
- Upgrade traffic flow exceeds 200 veh/h;
- Upgrade truck traffic exceeds 20 veh/h.

Information with regard to truck loading and haul direction will influence the decision to provide climbing lanes. The need for climbing lanes is reduced if truck traffic in the upgrade direction is predominantly empty backhaul.

920.03 DESIGN GUIDELINES

Use the TAC Geometric Design Guide for Canadian Roads, Figure 2.1.8.3 – Performance Curves for Heavy Trucks, 180 g/W, Decelerations & Accelerations (180g/W is equivalent to 300 lb/hp) to determine the approximate start and end points of the climbing lane, along with the following recommendations:

- Where a climbing lane would otherwise be located in an expensive cut or fill, it may be more cost-effective to substitute with a passing lane before or after the grade section.
- The TAC Geometric Design Guide for Canadian Roads (Section 2.1.8) method on long hills may be used to determine if the truck climbing lane is warranted.
- Intersections should be avoided within the climbing lane, particularly on the left side of the climbing lanes and at the following locations on both sides: within the decision sight distance (DSD) coming up to the merge end of the climbing lane, or within 300 metres past the diverge taper. Refer to Table 1.2.5.6 - TAC Geometric Design Guide for Canadian Roads for DSD. Where an intersection within the climbing lane section cannot be avoided, the intersection should be in the middle of the climbing lane section and away from the merge and diverge areas where weaving manoeuvres are occurring and driver workload is high. This is normally accomplished by moving the diverge location 300 metres prior to the intersection or 100 metres past it and/or extending the climbing lane merge beyond the intersection for a distance equivalent to the DSD.
- Where traffic volumes are moderate to high (SADT greater than 1000 veh/day), driver reaction to short climbing lanes is generally negative. The minimum climbing lane should allow about 30 seconds of passing opportunity, which is equivalent to 700 m at 80 km/h. At traffic volumes lower than 1000 SADT a minimum climbing length of 500 m is recommended.
- The minimum climbing lane width is 3.6 m. The shoulder adjacent to the climbing lane may be up to 1.0 m less than the shoulder adjacent to the 2-lane section, but no less than 1.5 m. If this is part of a staged development to 4-lane, the climbing lane shoulder width should match the ultimate 4-lane shoulder width.
- The diverge taper, merge tapers and signing shall be done in accordance to the Ministry's Manual of Standard Traffic Signs & Pavement Markings[2] Advance signing of a climbing lane ahead should be considered to encourage drivers to wait, rather than perform a hazardous passing manoeuvre.

- DSD ahead to the middle of the diverge taper is desirable from an operation perspective, but not critical from a safety perspective. Good sight distance means that the climbing lane will be used more effectively since traffic can see the climbing lane coming, encouraging earlier separation of slow and fast moving vehicles into their respective lanes.
- Sight distance from the start of the merge taper ahead, should be equal to the minimum barrier line passing sight distance in the Manual of Standard Traffic Signs & Pavement Markings. This allows for a pass initiated at the end of the climbing lane to be safely completed or aborted if the overtaking vehicle is forced into the opposing lane.

920.04 MULTILANE HIGHWAYS

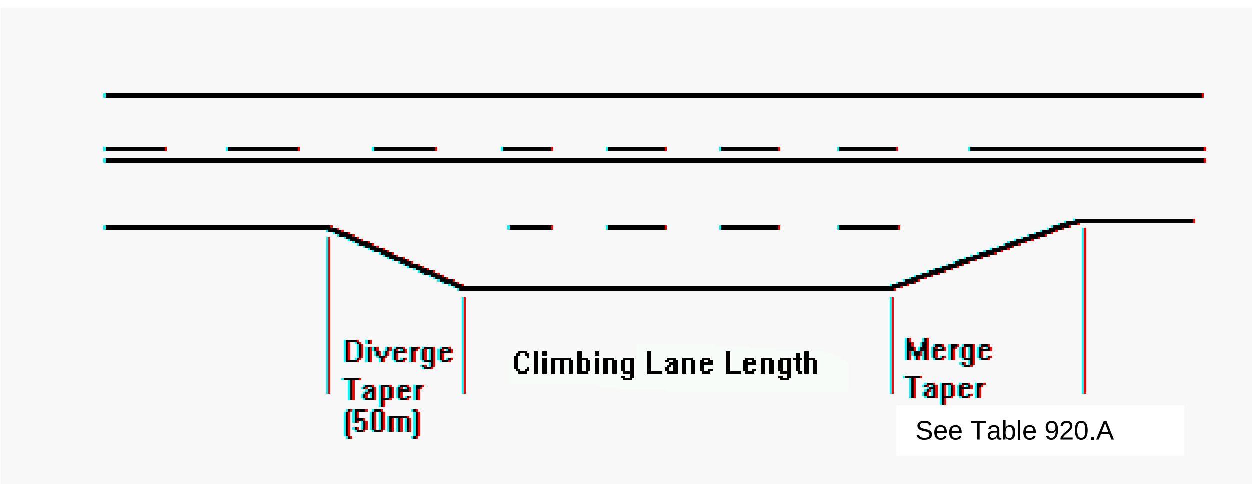
Climbing lanes on multilane highways also serve to separate slower vehicles from faster ones and thereby help maintain a high level of service on long grades. The analysis and determination if multilane climbing lanes are warranted is a Planning function that follows the methodology outline in page 20-28 of the Highway Capacity Manual, TRB (HCM 2000)[3]. A drop of one level of service or a speed reduction of 15 km/h on the upgrade is an indicator that a climbing lane may be required. This should be verified with an operational analysis of the approach segment and the upgrade. Should the analysis indicate that an additional lane is required on the upgrade, a climbing lane is warranted. The location and design of climbing lane on multilane highways follows the same Guidelines as for two lane. The corridor strategy is determined by the Ministry's regional planning staff. Detailed design rests with the Regional Design staff or design consultant. Close co-operation is required between planning and design as a team to ensure that the planning objectives are maintained as the design options are evaluated and selected. This close co-operation will improve the likelihood of funding approval.

Table 920.A Merge Taper Lengths

Posted Speed Limit (km/h)	Merge Taper (m)
50	110
60	130
70	150
80	175
90	195
100	215
110	240

.

Figure: 920.A Typical Climbing Lane Configuration



See the Ministry's Manual of Standard Traffic Signs & Pavement Markings [3] for additional information on Sign Placement and opposing lane passing restriction criteria.

[1] Lyall, Peter D. and Jagannathan, R "Auxiliary Lane Warrants for Two-Lane Highways, Volume I: Report", ADI Limited, Victoria, BC. 1993..
[2] "Manual of Standard Traffic Signs & Pavement Markings", BC Ministry of Transportation, Engineering Branch.
[3] Highway Capacity Manual, Transportation Research Board (HCM2000 - Metric).

930
PASSING LANE WARRANTS AND DESIGN

930.01 INTRODUCTION

Passing lanes are auxiliary lanes designed to improve passing opportunity on two lane highways except where an auxiliary lane is warranted by grades alone, in which cases climbing lanes are used (refer to Section 920).

Regional Planning performs corridor reviews for the purpose of maintaining or upgrading the quality of the provincial road network. Passing lanes are used to upgrade the level of service on a two lane highway where four laning is not contemplated at least at this stage of the planning. When the technical warrants have been met the general procedure should be to: 1) determine the optimum planning and design parameters; 2) estimate the costs of providing the passing lane; and 3) do a benefit-cost analysis. At the detailed design stage, design options are further analyzed for cost and operational efficiency. During this fine tuning exercise, the co-operation between regional planning staff and the designer is crucial to strike a balance between the planning objectives and the design/construction/operation realities.

Passing opportunity on a two lane highway is mainly governed by sight distance and traffic in the opposing direction. When there is insufficient passing opportunity, queues or platoons begin to build up, increasing driver frustration and workload which leads to an increase in risk taking manoeuvres and serious, high speed accidents. Conditions which lead to this type of platoon buildup requiring the consideration of auxiliary passing lanes include:

- long stretches with no-passing opportunities;
- circuitous alignment in rolling or mountainous terrain;
- sparsely developed local street network thereby forcing slow moving traffic to use the highway;
- a high percentage of long distance, high speed trips mixed with slow moving vehicles;
- a significant percentage of slow moving vehicles (heavy trucks & RVs) generating platoons;
- traffic volumes high enough to restrict passing but too low to warrant widening to four lanes.

930.02 LENGTH OF PASSING LANES

Analysis conducted by Harwood [1] on existing U.S. passing lanes shows that the most cost effective length for passing lanes increases with flow rate as follows:

Table 930.A Passing Lane Lengths

One-way Flow Rate (vph)	Optimal Passing Lane Length (km)
100	0.8
200	0.8 - 1.2
400	1.2 - 1.6
700	1.6 - 3.2

Some jurisdictions use a consistent 2.0 km length regardless of traffic volume. Although this is desirable, it is often not possible in BC due to roadside development or terrain constraints. It is recommended that 2.0 km be used where possible but shorter passing lanes be considered where necessary. The lane should allow for at least 30 seconds of passing opportunity in order to disperse platoons of 4 to 6 vehicles.

930.03 LANE FREQUENCY

Passing lane frequency (LF) is the distance from the start of one passing lane to the start of the next downstream passing lane in the same direction of travel. Passing lane spacing is the distance from the end of one auxiliary lane to the start of the next in the same direction.

Establishing the need for passing lane frequency is helpful prior to determining potential locations. It is also an indication of how practical it is to achieve desired levels of service. If passing lanes are required at very short intervals to maintain a desired level of service, it is an indication that alternatives to passing lanes should be considered.

The desired lane frequency varies depending on:

- passing lane length;
- traffic volumes;
- traffic composition; and
- downstream passing opportunities.

Following are some typical passing lane spacings (end of one lane to the start of the next) given as a function of AADT:

Table 930.B PASSING LANE SPACINGS

AADT	Spacing between passing lanes (km)
1001 -3000	9.6
3001 - 5000	8.0
5001 - 7000	6.4
7001 - 9000	4.4
>9000	4.0

Notes:

1. Minimum spacing between auxiliary passing lanes is a function of the time it takes for platoons to re-form. This is the basis of Table 930.B. The individual passing lane length includes tapers.
2. Low volume roads which may not warrant passing lanes based on the above criteria may still require some passing opportunities in the form of passing lanes or slow moving vehicle pullouts (see Section 910) if the highway has extended no passing zones. As a guideline, vehicles should have either a passing zone or a passing lane or slow moving vehicle pullout every 10 minutes to prevent drivers from overtaking in a no passing zone. Passing Lanes are auxiliary facilities; passing zones are locations where sight distance permits overtaking by use of the opposing direction lane and are marked with dashed lines.

930.04 LOCATION GUIDELINES

Locate individual passing lanes to ensure maximum safety and operational benefits from the investment. The designer should strive to follow these guidelines:

- Locate passing lanes where the minimum feasible construction cost occurs (avoid large cuts and fills, particularly in rock), subject to other constraints.
- Intersections should be avoided within the passing lane, particularly on the left side and in the vicinity of the merge and diverge tapers. Avoid intersections within the decision sight distance (DSD) upstream of the merge end of the passing lane, or within 300 metres downstream of the diverge taper. Refer to Table 1.2.5.6 - TAC Geometric Design Guide for Canadian Roads for DSD.
- When an intersection in the passing lane section cannot be avoided, the intersection should be in the middle of the passing lane section away from the merge and diverge areas where other weaving manoeuvres are occurring and driver workload is high. The intersection should have a separate left turn lane regardless of traffic volume since a stopped left turn vehicle in the passing lane represents a high hazard to overtaking traffic. “T” Intersections on the passing lane side are more desirable than intersections on the opposing side; they do not generate left turn movements to or from the fast lane.
- Minimum DSD ahead to the middle of the diverge taper is desirable from an operation perspective, but not critical from a safety perspective. Good sight distance means the passing lane will be used more effectively since traffic can see the passing lane coming, encouraging earlier separation of slow and fast moving vehicles into their respective lanes.
- The sight distance to the middle of the merge taper should be at least equal to the minimum decision sight distance to allow for an overtaking vehicle to either complete a pass or adjust speed to that of the slower vehicle. The termination point should be visible to approaching traffic and allow a smooth and safe merge between slow and fast vehicle streams.
- Sight distance from the start of the merge taper ahead, should be equal to the minimum barrier line passing sight distance in the Ministry’s Manual of Standard Traffic Signs & Pavement Markings [2]. This allows for a pass initiated at the end of the climbing lane to be safely completed if the overtaking vehicle is forced into the opposing lane.

  Note that Barrier Line Sight distance is not the same as design passing sight distance. The former includes distance traveled by the overtaking vehicle while encroaching on the opposing lane plus half the distance traveled by an opposing vehicle while design passing sight distance includes barrier line sight distance plus a component for the initial decision/acceleration phase.
- Where possible, develop the diverge taper around a long flat horizontal curve. This facilitates separation of the fast and slow

streams of traffic and does not take away from any existing passing opportunity. Left hand curves offer the overtaking drivers a better view into the passing lane around the impeding vehicle. Right hand curves do not have the same sight distance, but do lead slower vehicles naturally into the slow lane since the normal driving tendency is to steer to the inside of the curve.

- Passing lanes after a long no-passing zone are more effective than one constructed before it. The upstream no passing zone causes platoon buildup prior to the passing lane and downstream passing opportunities help platoons to remain dispersed longer.
- The addition of passing lanes should not be detrimental to the passing opportunities for the opposing direction. Avoid passing lanes in locations where passing is already permitted by markings, unless the passing opportunity is significantly lessened due to high opposing volumes. The location of the passing lane should appear logical to the driver; its value is more obvious to the driver at locations where normal passing sight distance is restricted.
- Passing lanes are less effective where passing opportunity is already high. Horizontal curves and upgrades where no passing prevails are good locations.
- Passing lanes provide little benefit when constructed on long tangent sections and on long downgrades with low traffic volumes (AADT<3000) and low percentages of heavy trucks. In these cases, platoon leaders on such sections tend to speed up or not pull over, limiting the benefits from the passing lane.
- Passing lanes should be placed leading away from rather than into areas of traffic congestion. When placed on the outbound direction from a town (or development) they are helpful in dispersing platoons which have built up within the town. Passing lanes on the inbound direction just before a town are less effective and may also be undesirable by encouraging high speed passing just before a reduced speed zone.
- Avoid passing lanes near four-lane highway sections which effectively serve the same purpose.
- Passing lanes in the uphill direction of a highway on a sustained grade section are more effective than one on a level grade because of the greater speed differentials.
- Reduced speed (sub standard) curves, should be avoided in passing lane sections since there is a tendency for traffic to speed up in these sections. Horizontal curves should be at least equal to the minimum radius for the design speed of the highway (see Section 330).
- Physical constraints such as bridges and culverts should be avoided due to the additional cost and the lack of a continuous shoulder through the passing lane section.
- The total length of all auxiliary lanes in one direction should be less than half the roadway section length. Also, the passing opportunity should be equal in both directions.

930.05 GEOMETRY

Geometric design standards should be consistent with the following MoT guidelines and practice:

- The desirable length of passing lanes is between 1.5 km and 2.0 km. This range is long enough to be adequate for dispersing queues while still being short enough to be cost effective.
- The minimum lane width is 3.6 m. The shoulder adjacent to the passing lane should desirably be the same as the shoulder adjacent to the 2-lane section. If the shoulder must be reduced, the reduction should not exceed 1.0 m and the remaining width should be no less than 1.5 m. If this is part of a staged development to 4-lane, the passing lane shoulder width should match the ultimate 4-lane shoulder width.
- The diverge taper, merge tapers and signing shall be done in accordance with the Ministry's Manual of Standard Traffic Signs & Pavement Markings [2]. Advance signing (I-63 in Manual of Standard Traffic Signs & Pavement Markings) 2 km ahead of a passing lane ahead should be used to advise drivers to wait, rather than perform a hazardous pass. Benefit-cost analysis assumes a 3% reduction in accidents for this 2 km, due to the advanced signing alone.

Figure: 930.A Sketch Of Typical Auxiliary Passing Lane

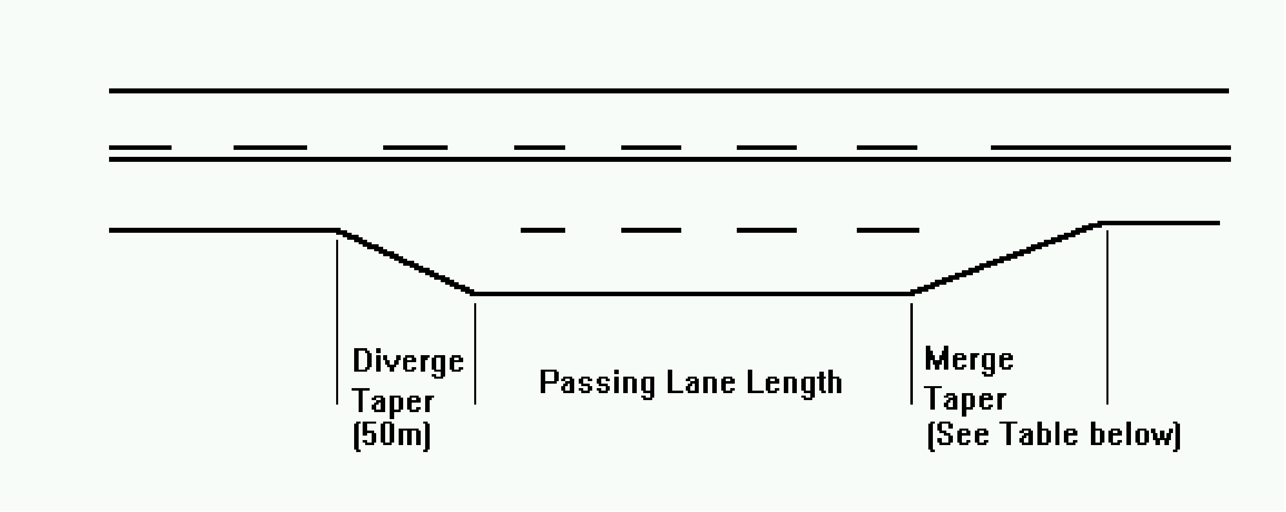


Table 930.C Merge Taper Lengths

Posted Speed Limit (km/h)	Merge Taper (m)
50	110
60	130
70	150
80	175
90	195
100	215
110	240

See the Ministry's Manual of Standard Traffic Signs & Pavement Markings [2] for additional information on Sign Placement and opposing lane passing restriction criteria.

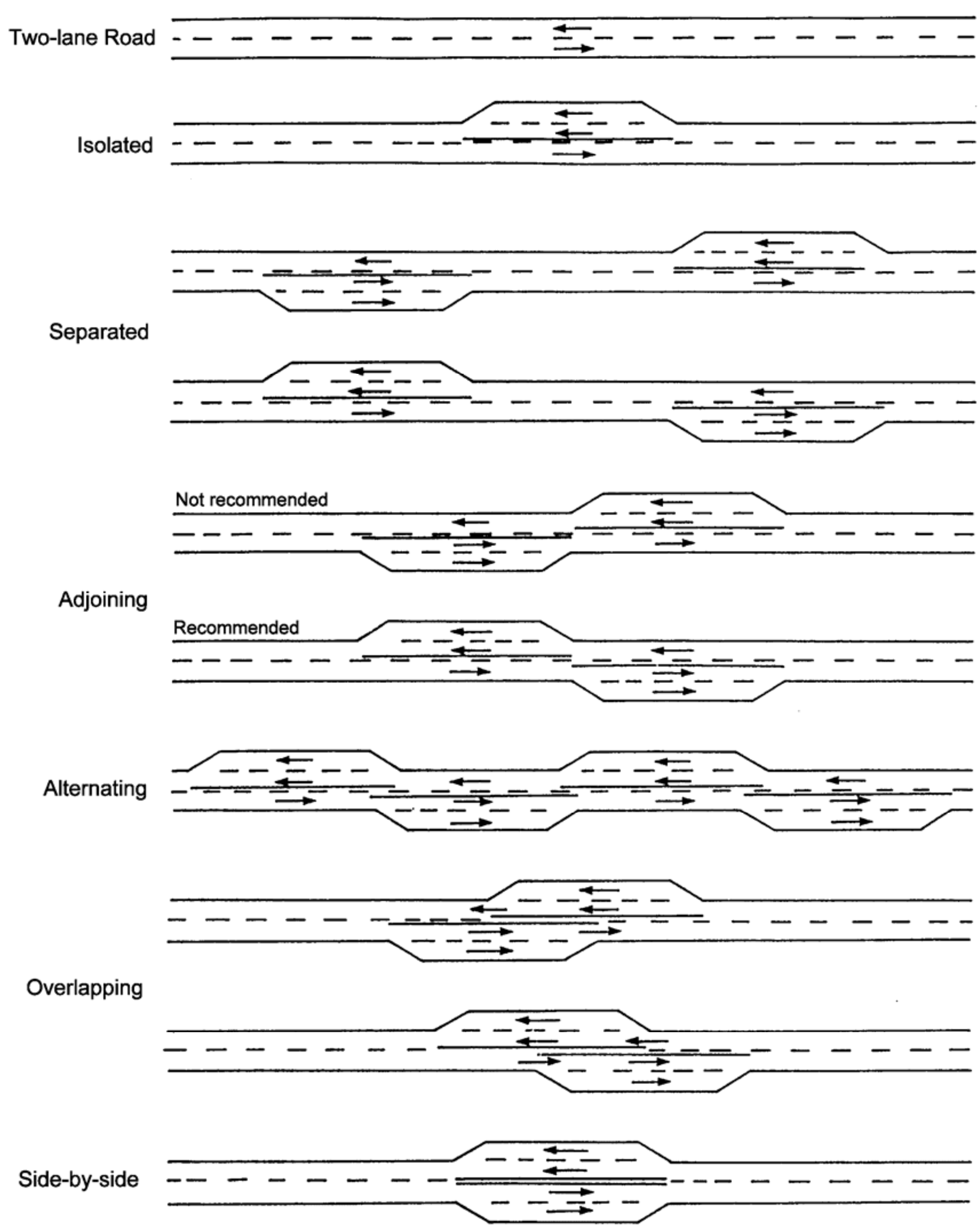
930.06 GUIDELINES FOR A SYSTEM OF PASSING LANES

On highways that are not constrained by development or terrain, there may be several sections that satisfy some or all of the location guidelines. The selection of an overall workable combination of passing lanes for both directions of traffic from these sections is an iterative process. The design options should be tested for their overall operational effectiveness as a system.

Figure 930.B shows schematically some ways to combine passing lanes in both directions as a unified system. Following is a suggested method to develop optional arrangements for review as a system:

- Initially, identify all potential passing lane locations in both directions, irrespective of desired lane frequency.
- With the climbing lane locations fixed and potential passing lane locations identified, select combinations of auxiliary lanes at (or close to) the desired passing lane frequency taking into account any existing auxiliary lanes. The frequency should be no less than four kilometres (including the length of auxiliary lane) apart.
- It is generally desirable to stagger opposing direction passing lanes to avoid the mistaken impression of a 4 lane highway. Some overlap is acceptable. Short four-lane sections are appropriate in valley sections where there is no other option or where the whole section would form part of an ultimate four-laning scheme.
- Do not overlap opposing auxiliary lanes through major intersections. This would require additional turning lanes resulting in a five-lane cross section (two-lane highway, two auxiliary lanes, and one turning lane) in an otherwise two-lane highway template. These types of intersections are confusing to through traffic and are also very difficult for left turn minor road traffic to negotiate due to number of conflicting lane movements on the major road.
- Where possible, place opposing auxiliary lanes tail-to-tail rather than head-to-head (the tail is the diverge). In the tail-to-tail configuration, the opposing direction auxiliary lane restricts advancing passing maneuvers upstream of the advancing lane rather than downstream. The head-to-head configuration may also be a safety problem in winter time when pavement markings are hidden by snow resulting in vehicles traveling in the oncoming passing lane.
- When dealing with high traffic volumes and limited passing opportunities, avoid placing a single auxiliary lane in a long section favoring one direction of traffic at the expense of the opposing traffic This may cause a race-track effect, where aggressive drivers tend to speed up to make use of the only passing opportunity available. Staged development of an auxiliary lane system may result in this situation, but it should be avoided in the ultimate development of the auxiliary lane system.
- Try to achieve balanced overall passing opportunities for both directions.

Figure 930.B Alternative Configurations for Passing Lanes:



930.07 ANALYTICAL METHOD FOR A SYSTEM OF PASSING LANES

The passing lane analysis, which follows is performed after climbing lane warrants have been considered. This is an estimation of level of service for the existing highway at design year using regression equations. These equations predict the percent following as a function of Assured Passing Opportunity (APO). The regression equations were derived from TRARR simulations.

The APO factor is defined as the percentage of time when one vehicle can safely pass another without restriction either by inadequate sight distance or the presence of opposing traffic. It is often used as the level of service measure for passing lane studies since it relates directly to the role of passing zones in reducing vehicle platoons. APO is calculated separately for each direction as:

$$APO = (PZL / L) * HF$$

where

PZL	= Passing Zone Length (km)
HF	= Headway Factor (%)
L	= Length of the highway segment (km)

PZL for a direction is the length of highway within a highway segment L which has passing zones (broken lines) and can be determined through viewing the Ministry of Transportation's photolog imaging system on the Internet. To obtain access to the photolog Internet site, contact the Data Program Coordinator, Highway Planning Branch, Victoria. For highways which have not yet been constructed, PZL must be estimated from plans and profiles using the Manual of Standard Traffic Signs & Pavement Markings [2] standards for barrier line passing sight distance. This dimension is different from Design Passing Sight Distance and is defined in the Manual of Standard Traffic Signs & Pavement Markings.

Headway factor, HF, is the percentage of time when headway between successive vehicles in the opposing lane is greater than 25 seconds. The 25 seconds criterion is based on the time taken for an overtaking vehicle for the initial maneuver (5 sec.) plus encroachment on the opposing lane (10 sec.) plus 5 seconds for an opposing vehicle appearing half way through the overtaking vehicle encroachment phase plus a 5 second clearance to the opposing vehicle at the completion of the pass.

Headway factor is approximated as:

$$\mathbf{HF = exp(-k * V_{0PP})}$$

where V_{OPP} is the volume of opposing direction traffic (veh/h) and k is a constant dependent on the terrain. For a given opposing volume, the percentage of time with gaps in the opposing direction greater than 25 seconds is typically higher for mountainous terrain than for a level terrain. In mountainous terrain, a higher proportion of vehicles will be in platoons; therefore, long gaps are introduced between platoons.

The following **k** constants are recommended:

- 0.002 for mountainous terrain (observations on Highway 99 by ADI Limited[5], and Alberta data)
- 0.004 for rolling terrain (Ontario)
- 0.006 for level terrain or highways with high access volumes (observations in Victoria, BC by ADI Limited).

Planners may wish to use the actual headway factors, measured in the field, for a given highway rather than an estimate based on the k constant. Where there is a high percentage of PZL, the calculated percentage following becomes more sensitive to the choice of k constants. Varying the k constant by 0.001 typically changes the percent following by about 5% (15% is equal to one level of service).

HF may be estimated from some of the Province's Weigh-in-Motion stations or manually by measuring the traffic opposing traffic volume (veh/h) and gaps greater than 25 seconds for groups of about 100 vehicles. The headway factor at the observed flow rate is calculated as follows:

$$HF = \frac{\left(\sum(\text{gaps} > 25\text{ sec}) - 25N\right)}{T}$$

The main objective is to relate the APO and the total auxiliary passing lane length (ALL) to the percentage of vehicles following (%FOLL) and thus, the level of service (LOS).

The frequency and length of platoons on a two-lane highway depends on the amount of available APO and the advancing traffic volume (**V_{adv}**). Regression analysis of percent following results from TRARR resulted in the following equations for the three terrain types:

$$\%FOLL = 0.000365 \times V_{adv} - 0.89278 \times \%APO + 0.53 \quad \text{For Level terrain; } R^2 = 92\%$$

$$\%FOLL = 0.000346 \times V_{adv} - 1.09273 \times \%APO + 0.58 \quad \text{For Rolling terrain; } R^2 = 94\%$$

$$\%FOLL = 0.000330 \times V_{adv} - 1.86374 \times \%APO + 0.67 \quad \text{For Mountainous terrain; } R^2 = 92\%$$

where %APO and %FOLL are expressed as decimals. 2. The equations are shown as the upper graphs of Figures 930.C to 930.F. Note that these equations assume there are no existing auxiliary lanes.

Simulations were then repeated on the same road sections with the addition of auxiliary lanes and these results are also shown in the lower graphs of Figures 930.C to 930.F. The total length of auxiliary lanes (ALL) in a direction is expressed in these graphs as a percentage of section length (L). These graphs can be used to estimate the effect of existing auxiliary passing lanes in reducing percent following.

930.08 Estimation of Level of Service

The method to estimate level of service for each direction is as follows:

1. Calculate the APO for the design year volume. The passing zone length PZL in this equation is the length of passing lines in the advancing direction and the headway factor HF is calculated as shown above.
2. Use the calculated APO and the advancing traffic volume to estimate percent following from the upper graphs of **Figures 930.C to 930.F** as appropriate. This is the percent following in the absence of any auxiliary lanes.
3. If there are existing auxiliary lanes, calculate %ALL = ALL / L where ALL is the length of auxiliary lanes.
4. Read the reduction in percentage following using %ALL and the adjustment factors in the lower graphs of **Figures 930.C to 930.F**.
5. Apply the appropriate reduction to the original estimated percent following to get the new value which takes into account the existing auxiliary lanes.
6. Obtain the level of service corresponding to estimated percent following using **Table 930.D**.

930.09 Warrants

The Highway Capacity Manual (HCM3) defines "percentage following" (%FOLL) as the percentage of vehicles which are traveling in platoons at headways of less than 5 seconds. The level of service (LOS) of 2-lane highways can be related to the %FOLL, as shown in the following table:

Table 930.D Percentage Following and Level of Service

%FOLL	LOS	Traffic characteristics
0 ≤ %FOLL < 30	A	• Highest quality of traffic service • Drivers at their desired speeds • Passing demand well below passing capacity
30 ≤ %FOLL ≤ 45	B	• Significant passing demand • Passing demand approximately equals passing capacity • No noticeable increase in platoon sizes
45 < %FOLL ≤ 60	C	• Noticeable increase in platoon formation and platoon size • Increased frequency of passing impediment • Passing demand exceeds passing capacity
60 < %FOLL ≤ 75	D	• Passing demand increases dramatically • Passing capacity approaches zero • Mean platoon sizes of 5-10 • Fraction of passing zones has little influence on passing
75 < %FOLL < 100	E	• Passing is virtually impossible • Platooning becomes intense • Highest attainable volume defines the capacity of the highway
%FOLL = 100	F	• Heavily congested flow • Traffic demand exceeds capacity • Speeds well below capacity speed

Percent Following		
Rural Arterial Highways Design goal = LOS *C* (i.e. <60% following)	**Rural Collector Roads Design goal = LOS D (i.e. <75% following)**	**Inference**
< 45%	< 60%	Passing lanes are of low priority and no further consideration is required.
45% to 60%	60% to 75%	Need for passing lanes is marginal. Accident history review may justify improvements.
> 60%	> 75%	Passing lanes are warranted. Reg'l Design & Planning Staff to determine optimal/possible locations and cost estimates.

Two Examples follow on the next page.

Example 1

Given:
Length of study area, L = 40 km
Mountainous terrain, no auxiliary lanes, 1.4 km of passing zones
DHV =562 vph, 85:15 split, V_{adv} = 478 vph, V_{opp} = 84 vph
Design goal of LOS C/D interface (60% Foll)

Calculate:
Headway Factor
HF = $e^{-0.002VOPP}$ = $e^{-0.002*84}$ = 0.845
PZL = 1.4 km
(APO) = (PZL/L) x HF = (1.4/40) x 0.845 = 0.030

From the mountainous terrain equation:
%FOLL = 0.000330(V_{adv}) - 1.86374(APO) + 0.67
=0.000330(478) - 1.86374(0.030) + 0.67
= 0.77 or 77%

Since %FOLL at the design goal is 60%, auxiliary lanes are required to reduce percent following from 0.77 to 0.60; i.e. by [(0.77-0.60)/0.77] = 22%

From Figure 930.F, a 22% reduction in percent following at a V_{adv} of 478 vph requires about 28% ALL which corresponds to 0.28 x 40 = 11.2 km of passing lanes.

Assuming a typical passing lane length of 2.0 km the desired lane frequency is:

LF = L/(ALL/2.0) = 40/(11.2/2) = 7.1 km

The upper graph of Figure 930.C shows the use of Figure 930.F for this example

Example 2

Given:
Length of study area, L = 40 km
Mountainous terrain, 7.7 km of auxiliary lanes, 1.4 km of passing zones
DHV =758 vph, 85:15 split, V_{adv} =644 vph, V_{opp} = 114 vph
Design goal of LOS C/D interface (60% Foll)

Calculate:
Headway Factor
HF = $e^{-0.002VOPP}$ = $e^{-0.002*114}$ = 0.796
PZL = 1.4 km
(APO) = (PZL/L) x HF = (1.4/40) x 0.796 = 0.028

From the mountainous terrain equation:
%FOLL = 0.000330(V_{adv}) - 1.86374(APO) + 0.67
=0.000330(644) - 1.86374(0.028) + 0.67
= 0.83 or 83%

Existing Percentage Auxiliary Lane Length (%ALL) = 7.7/40 = 19%

From the lower graph of Figure 930.F, we get:

25%ALL→ 17% reduction in percent following
0%ALL→ 0% reduction in percent following

Therefore, from interpolation:
19%ALL→ 19x17/25 = 13% reduction in percent following (Interpolated)

Percent following = 0.83 X (1 - 0.13) = 72%

Since %FOLL at the design goal is 60%, additional auxiliary lanes are required to reduce percent following from 0.72 to 0.60; i.e. by [(0.72-0.60)/0.72] = 17%

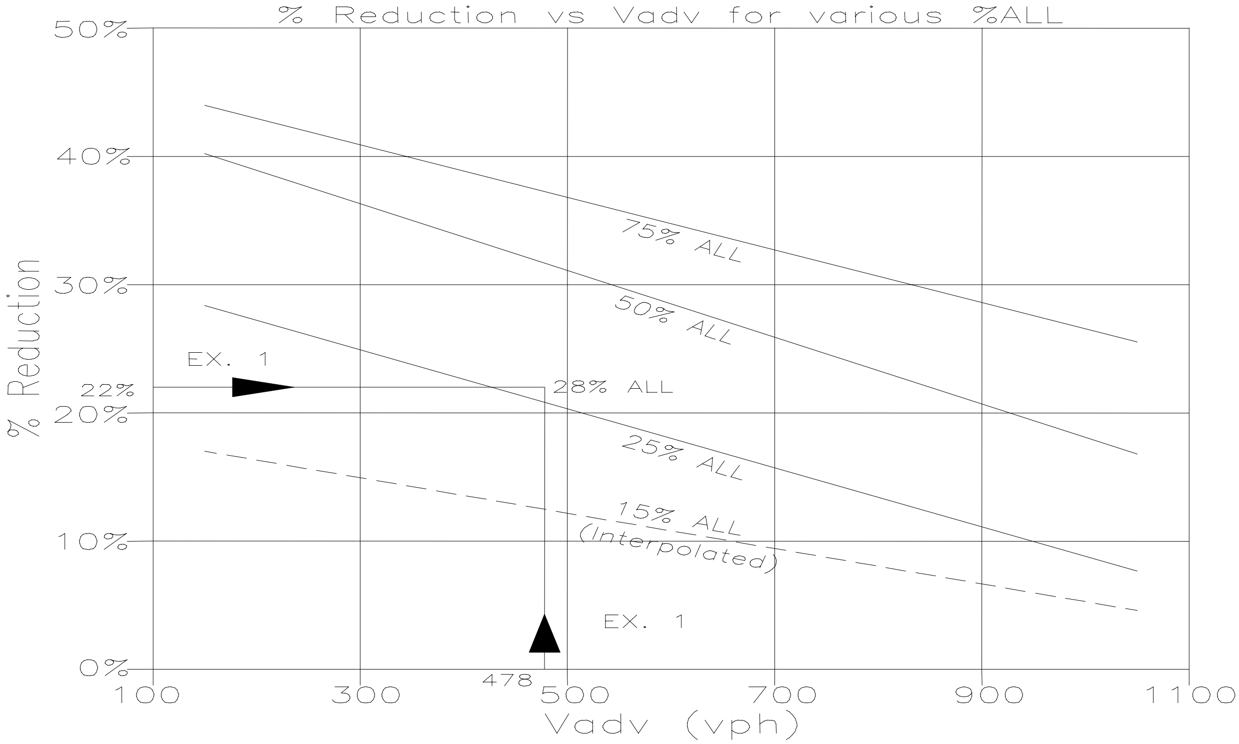
From Figure 930.F, a 17% reduction in percent following at a V_{adv} of 644 vph requires 25% ALL which corresponds to 0.25 x 40 = 10.0 km of passing lanes, in addition to existing 7.7 km of passing lanes.

Assuming a typical passing lane length of 2.0 km the desired lane frequency is:

LF = L/(ALL/2.0) = 40/(17.7/2) = 4.5 km

The lower graph of Figure 930.C shows the use of Figure 930.F for this example

Figure 930.C Examples 1 and 2



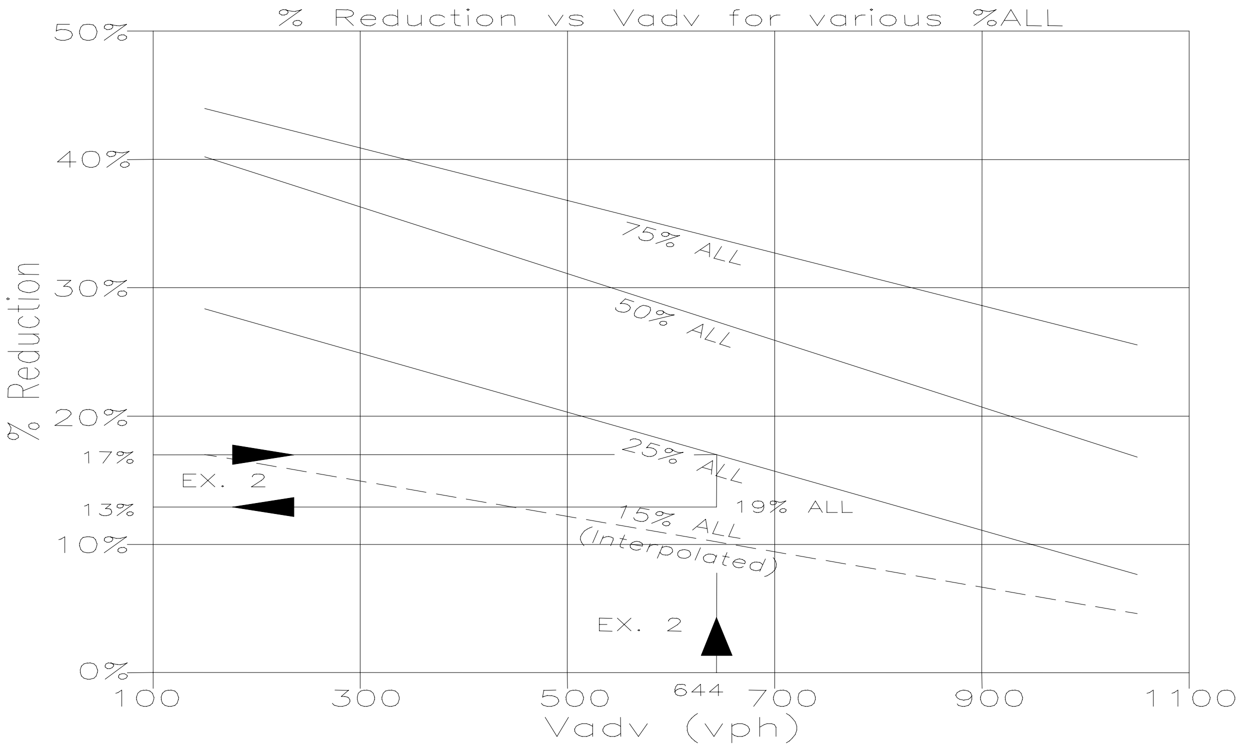
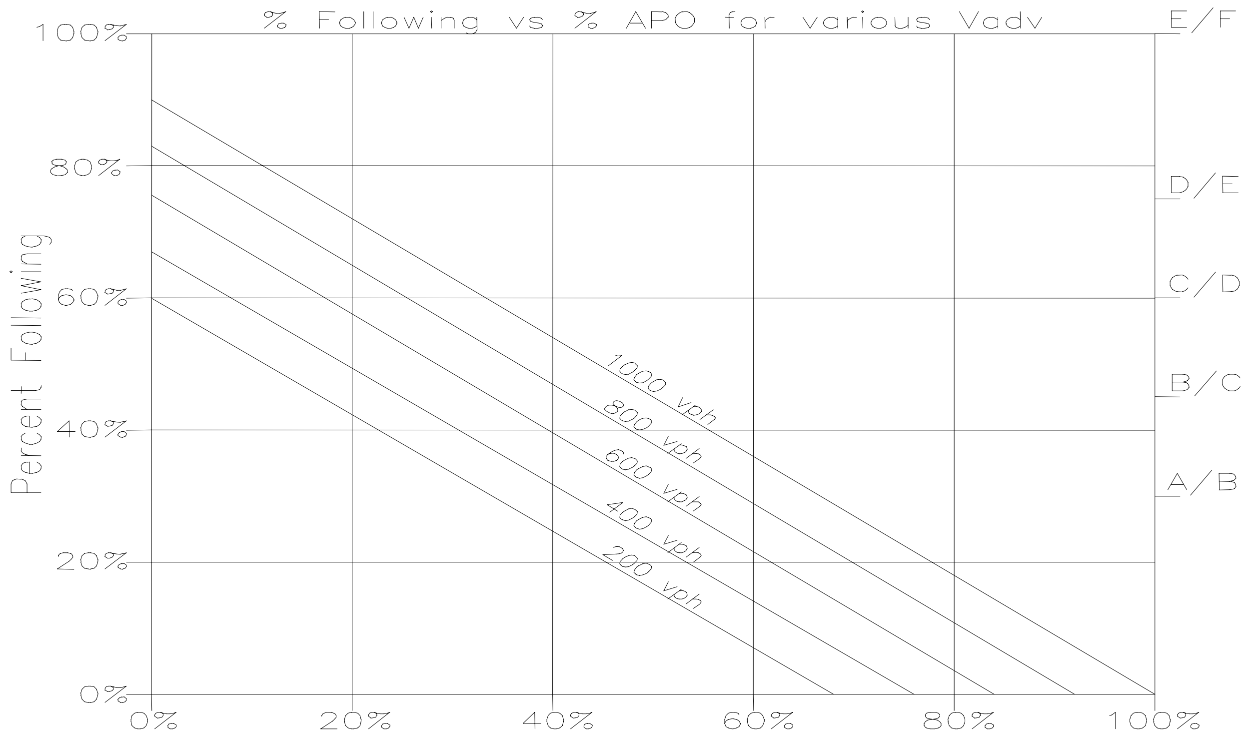


Figure 930.D Level Terrain Graphs



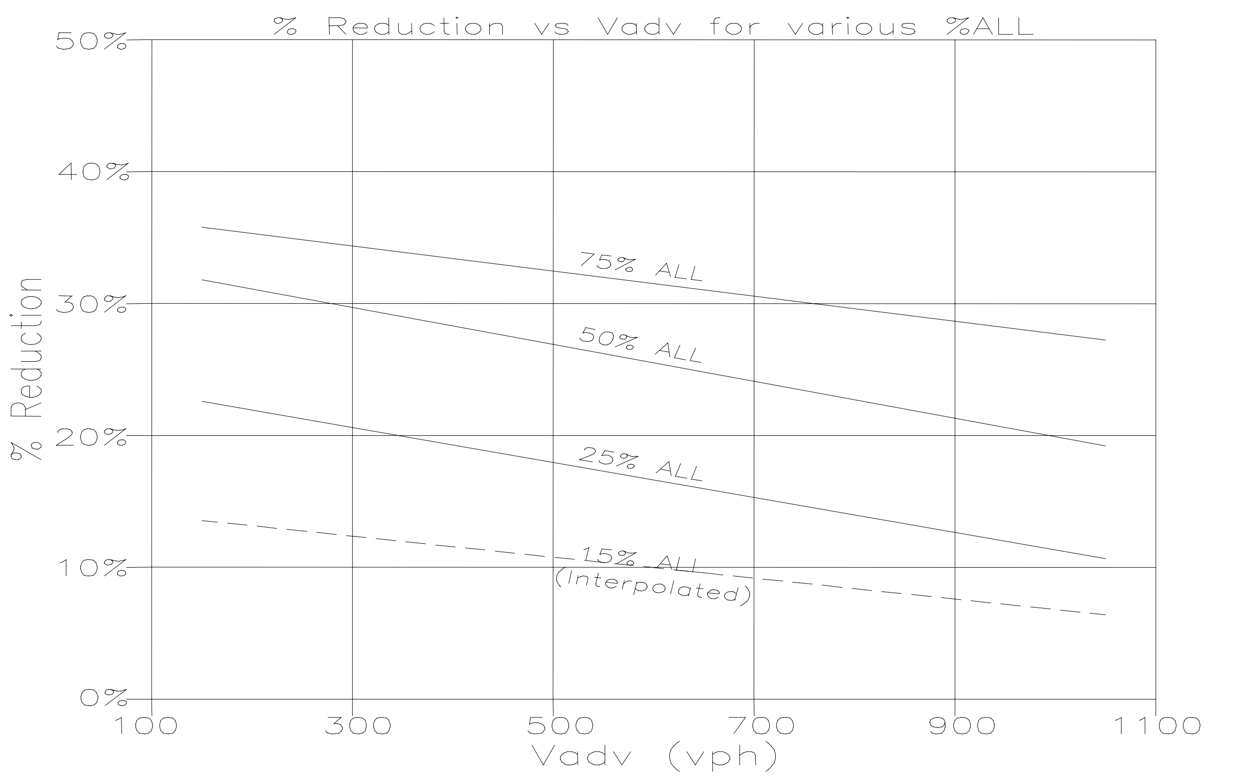
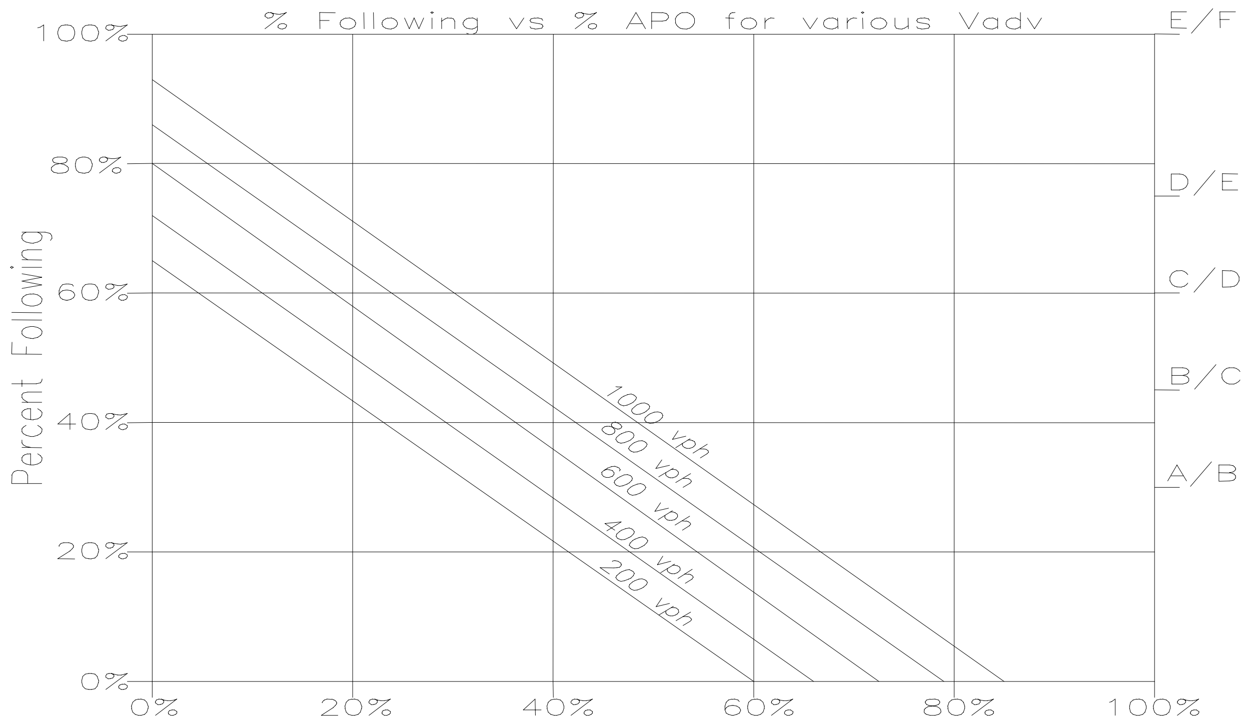


Figure 930.E Rolling Terrain Graphs



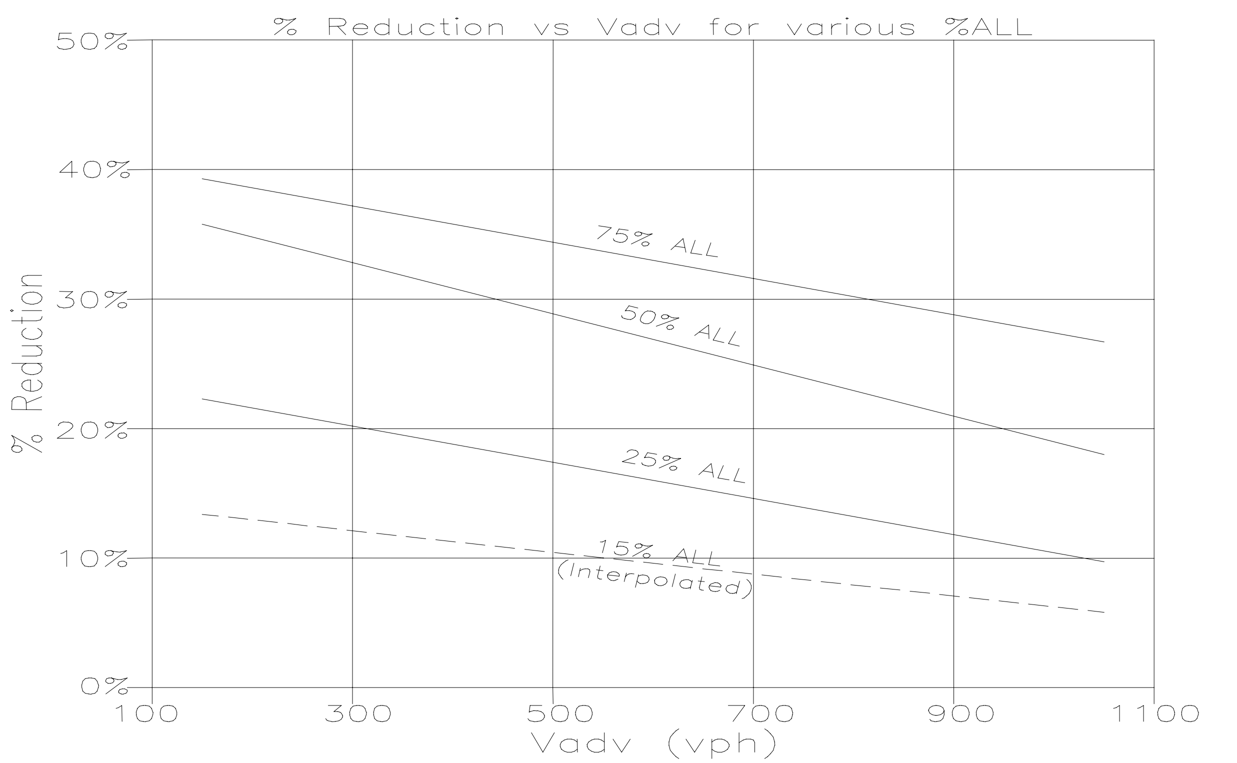
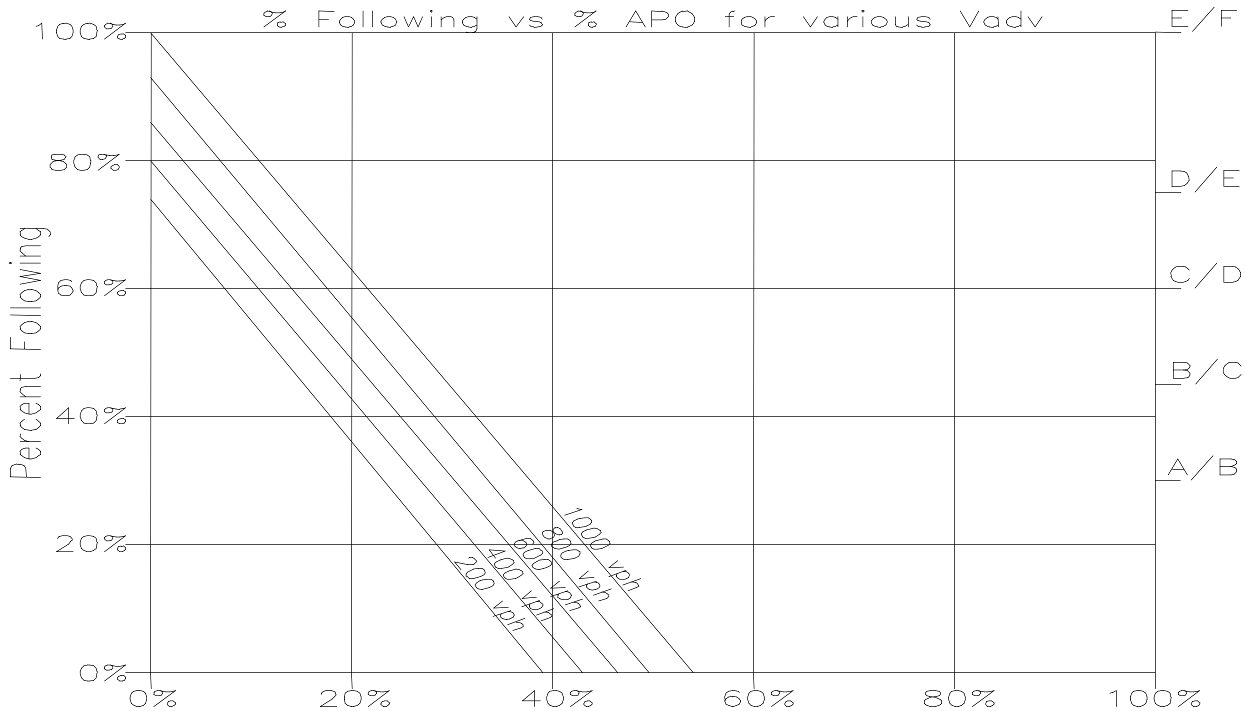
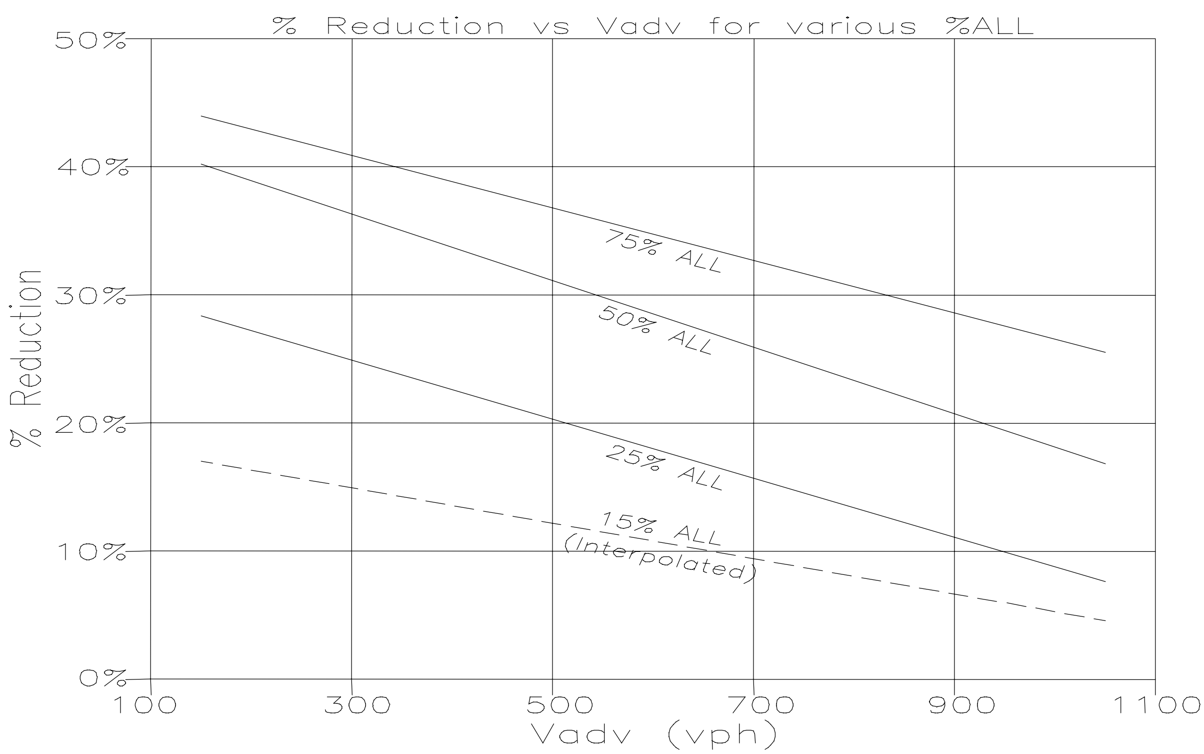


Figure 930.F Mountainous Terrain Graphs





References:

1. Harwood D.W., Hoban C.J., Warren D., “Effective Use of Passing Lanes on Two-Lane Highways”, Transportation Research Record 1195, Transportation Research Board, 1988.

2. “Manual of Standard Traffic Signs & Pavement Markings”, BC Ministry of Transportation, Engineering Branch.

3. Highway Capacity Manual, Transportation Research Board (HCM2000 - Metric).

4. Lyall, Peter D. and Jagannathan, R “Auxiliary Lane Warrants for Two-Lane Highways, Volume I: Report”, ADI Limited, Victoria, BC. 1993.

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940
COMMUNITY MAILBOX PULLOUT

940.01 INTRODUCTION

This document provides guidelines for locating Community Mailboxes adjacent to Ministry jurisdiction roadways. This section is used by highway district approvals staff, regional highway planning and professional services staff and Ministry staff or consultants working on a highway design project.

The main objective is to ensure that Community Mailboxes do not to interfere with the safe and efficient operation of roadways under Ministry jurisdiction.

940.02 SITE SELECTION

Some basic rules should be used when selecting a site. These are:

- No Mailbox Pullouts are to be installed on divided highways and major arterial highways where access control is exercised (Freeways, Expressways and Controlled Access Highways). The more important the highway, the higher the speed and/or the traffic volume. Therefore, the greater the impact a site will have on the operation and safety of the roadway;
- Give preference to installing community mailboxes on side roads that access residential subdivisions.
- In urban areas, where there is pedestrian traffic, the preferred location is on a street that has a sidewalk and has sufficient road width for on street parking. For all locations that are selected, stopping sight distance must be met on the roadway adjacent to the site.
- Give particular care to sites near a intersection so as not to interfere with the safe operation of the intersection. Visibility of traffic signs and signal should not be blocked. The site shall not encroach upon auxiliary right and left turn lanes at intersections and the sight triangle.

940.03 SITE LAYOUT

Geometry

The greater the importance of the road, the higher the safety requirements are for the Pullout. The site is composed of deceleration and acceleration tapers and a parking area. See **Figure 940.A** and **Table 940.A** for dimensions.

A 200 mm or larger culvert must be used for the ditch section under or between the mailbox pad and the roadway.

Crossfall for drainage must fall away from the road.

On all roads other than local residential subdivision streets, community Mailbox site tapers should not be closer than 30 m to:

- The beginning of the taper to a left-turn lane.
- The beginning or end of the taper to a right-turn lane or bus bay.
- The beginning of the radius to an intersection.
- The closest road edge of an access or exit not having a radius.

Parking

- Community Mailboxes consist of one or more modules, each of which contain a number of individual mailboxes.
- LVR, RLU and Subdivision Roads- one parking space for up to 80 mailboxes, two parking spaces for 81 to 160 mailboxes.
- RCU & RAU - two parking spaces for up to 50 mailboxes, four parking spaces for 51 to 100 mailboxes.
- When the number of mailboxes exceeds 160 along an LVR or RLU and 100 along an RCU or RAU, the Community Mailbox area is designed as a separate off-road facility with its own access and exit driveways.

Figure 940.A Mailbox Pullout Site Layout

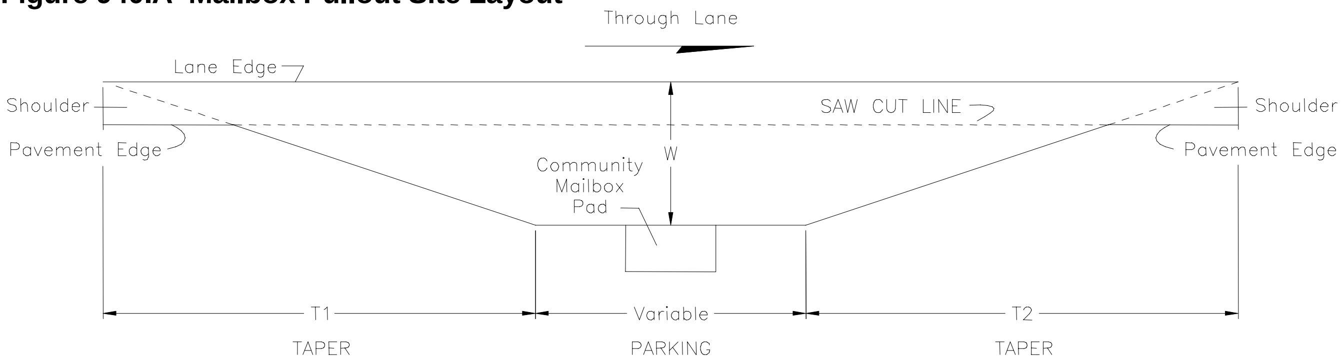


Table 940.A Canada Post Community Mailbox Pullout Dimensions

Road Classification	Design Speed (km/h)	T1* (m)	T2* (m)	W (m)			
LVR	30-50 60-70 80	6 12 20	6 12 20	3.0 3.0 3.0			
				Average Annual Daily Traffic AADT			
				Under 750	750 to 1500	1501 to 6000	Over 6000
RLU	30-50 60-70 80	12 24 40	12 24 40	3.0 3.0 3.0	3.0 4.0 4.0	4.0 5.0 5.0	5.0 6.0 6.0
RCU	50 60 70 80	20 30 40 50	20 30 40 50	3.0 3.0 3.0 3.0	3.0 3.0 4.0 4.0	4.0 4.0 5.0 5.0	5.0 5.0 6.0 6.0
RAU	70 80	60 70	50 50	3.0 3.0	4.0 4.0	5.0 5.0	6.0 6.0

* If barrier is required, change T1 and T2 taper ratio to suite required CRB flare.

LVR: Low-volume Road (traffic volumes ≤ 200 veh/day).
RLU: Rural Local Undivided.
RCU: Rural Collector Undivided
RAU: Rural Arterial Undivided.

Note: For local residential subdivision streets:

Where the posted speed is 50 km/h or less and where on street parking is permitted, the Community Mailbox pad is located:

- at least 1.5 metres away from the face of the curb where a curb is in place, or
- 3.0 m from the outside edge of the through lane in open ditch sections.

Where street parking is not permitted, use the LVR Taper and Parking dimensions.

On the far side of an intersection, the Mailbox Pullout (including taper, where no parking is permitted) must start at least 30 m from the end of the intersection radius. On the near side of an intersection, the Pullout must be at least 10 m from the beginning of the intersection radius. Near driveways, the Pullout must be at least 10 m from both road edges of driveways.

In all cases where the subdivision street is paved, the parking area and the area between the mailbox pad and the curb or through traveled lane is paved with a hard surface.

1000 HYDRAULICS CHAPTER

1000 HYDRAULICS CHAPTER TABLES

1000 HYDRAULICS CHAPTER FIGURES

1010
GENERAL DESIGN GUIDELINES

1010.01 GENERAL

This chapter has been prepared as a guide to the acceptable procedures and methods used in the development of hydraulic design plans for the design, construction and maintenance of British Columbia highways.

It is intended for the use of personnel competent to evaluate the significance and limitations of its content and recommendations, and who will accept responsibility for the application of the material it contains. The Ministry of Transportation disclaims any or all responsibility for the application of the stated guidelines.

This chapter is not intended to be a textbook of hydraulic engineering but a reference book of guidelines and instructions. It does not cover all conceivable problems that might arise or address all of the possible methodologies. The scope of the chapter is limited to relatively simple hydrology and hydraulics. Advanced or complicated analyses should be referred first to the Regional Offices, then to Engineering Branch, Headquarters.

The chapter is intended to meet BC conditions and design practices. The chapter is also to be used in conjunction with the following readings:

- *CSPI Handbook of Steel Drainage and Highway Construction Products (2002)*
- *CSPI Modern Sewer Design (1996)*
- *Atmospheric Environment Service (AES) Rainfall Frequency Atlas for Canada (1985, Hogg; Carr)*+
- *Department of Fisheries and Oceans - Land Development Guidelines for the Protection of Aquatic Habitat (1993)*
- *MoT Standard Specifications for Highway Construction*
- *RTAC Drainage Manual Volume 1 (1982) and Volume 2 (1987)**

\+ *Copies of the atlas are available upon request from Climate Services at Environment Canada: e-mail: climate.services@ec.gc.ca*

* *CD Rom can be purchased from Glen Cole, Manager, Technical Information Programs, TAC, Tel: (613) 736-1350 Ext 244, Email: library@tac-atc.ca, or directly from the website. http://www.tac-atc.ca/english/projectsandpublications/bookstore.cfm*

Updating this chapter is a continuing process and revisions will be issued as required.

1010.02 DESIGN GUIDELINES

Bridge and Culvert Hydraulic Design

Bridge and large diameter (≥ 3 m) culvert hydraulic design requires an understanding of the complex relationship between channel morphology, hydrology, bridge hydraulics, and scour protection and is beyond the scope of this guide. The BC MoT Bridge Standards and Procedures Manual shall be referenced for bridge hydrotechnical design and specifically, the hydraulic design of bridges, buried structures, culverts and associated works shall comply with the requirements of the Transportation Association of Canada (TAC) Guide to Bridge Hydraulics, (latest edition).

Design Flood Return Periods

The design flood return period criteria indicated in **Table 1010.A** shall be used for the design of highway drainage facilities, culverts and bridges.

The selection of the return period for storm sewers, highway ditches and culverts < 3 m span from the values specified in the table shall be determined by a professional engineer using risk assessment, general practice and professional judgment.

In some instances, there will be situations when the degree of risk is high enough to justify design return periods greater than those shown in the table for gutters, storm water inlets, storm sewers and highway ditches. Similarly, there will be situations when the degree of risk is low enough to justify smaller return periods.

When using design return periods other than those given in **Table 1010.A**, a documented risk assessment must be completed by a professional engineer and approval for the design return period must be obtained from the Chief Engineer.

It may also be necessary to design drainage facilities to conform to the requirements of local authorities.

When the upstream flood levels are critical, it may be necessary to design the hydraulic structure so as not to increase the upstream water levels. In some instances, it is important to recognize that the Ministry of Environment (MoE) uses the 1 in 200 year return period as a provincial standard to define the floodplain area and to control development near watercourses.

Where fish and fish habitat are involved, it may be necessary to design the hydraulic structure to meet the regulatory agencies approval. The designer will find that the Department of Fisheries and Oceans (DFO), Canada and the Ministry of Agriculture, Food & Fisheries (MAFF) are generally the regulatory agencies.

Table 1010.A - Design Return Periods for Hydraulic Structures (years)

Road Classification **Hydraulic Structures**	**Low Volume**	**Local**	**Collector**	**Arterial**	**Freeway**
Gutters	-	5	5	5	5
Stormwater Inlets	-	5	5	5	5
Storm Sewers	-	10 to 25	10 to 25	10 to 25	10 to 25
Highway Ditches	10 to 25	10 to 25	10 to 25	10 to 25	10 to 25
Culverts < 3 m Span[1]	50 to 100	50 to 100	100	100	100
Buried Structures & Culverts ≥ 3 m Span[2]	100	200	200	200	200
Bridges[2]	100	200	200	200	200
River Training and Channel Control Works	100	200	200	200	200

1 For drainage areas less than 1 ha, the 10-year return period storm can be used.
2 Design shall be in accordance with BC MoT Bridge Standards and Procedures Manual

1010.03 REQUIREMENTS FOR DRAINAGE DESIGNS

Land Development Drainage Design

Dual Drainage Concept

All drainage works shall be designed utilizing the dual drainage or minor/major system concept.

The minor or piped system consists primarily of the storm sewer system comprised of inlets, conduits, manholes and other appurtenances designed to collect and discharge into a major system for frequently occurring storms (e.g. less than 5 to 10 year return period).

The major or overland system will come into operation once the minor system's capacity is exceeded. Thus, in developments where the major system has been planned, the streets and ditches may act as open channels directing the excess storm water to nearby watercourses without endangering the public, damaging property or causing excessive erosion. The major system shall be designed to convey a 100 year return period peak discharge.

For information on the dual drainage system, refer to:

♦ *CSPI Modern Sewer Design (1996), p. 139.*

Discharge Rates for Land Development

All drainage systems must include run-off controls to limit post-development peak discharge rates to the pre-development rates for 5 year return period storms.

An additional Ministry requirement is an assessment of the receiving ditch or watercourse for peak flows greater than a 5 year return period up to a 100 year return period. The assessment must document the net change in water velocity in the ditch or receiving water, identify any potential impacts from increased peak flows, and make recommendations for mitigation. In other words, flows must be managed to ensure that no increase in flooding and stream erosion occur as a result of development storm drainage.

For information on Storm Drainage Design refer to:

♦ *Master Municipal Construction Document (MMCD) Design Guideline Manual (2005)*

♦ *Stormwater Planning, A Guidebook for British Columbia*

♦ *Water Balance Model for British Columbia*

Water Quality

Run-off quality treatment for highway or land development drainage is good practice, and is often mandated by Federal, Provincial or Regional guidelines or permits. Design considerations include: using catch basins to direct pavement run-off overland instead of direct discharge to streams, topsoil and sod lined ditches, filtration ditch blocks, and/or water quality ponds at ditch outlets to streams. A Registered Professional Biologist shall be involved with these designs.

Reports for Land Development Drainage

The Ministry recommends all Subdivision Development Drainage Reports contain the following information prior to submission:

- existing and proposed site description.
- site hydrology and hydraulic calculations including:
  - pre and post-development flows, return periods and contributing drainage areas;
  - design storm details or continuous simulation details;
  - a table showing the run-off and ditch capacity calculations;
  - detention/retention and other flow control requirements.
- plans/drawings including:
  - site plan with contours and scale noted;
  - existing plan with contours and the layout and identification of the existing system including roads, watercourses, major flow paths, storm sewers, catchbasins, culverts, ditches, etc.;
  - developed site plan with the layout and identification of the proposed drainage system including proposed land uses, lot grading, roads, storm sewers, catchbasins, culverts, ditches, etc.
- if necessary, a discussion of need for and design of special features such as detention, erosion and sediment control, water quality improvement ponds, lined channels, inlet/outlet structures, groundwater control, etc.
- listing of problem areas and/or unresolved issues with recommended course of action.

Detention Storage and Run-off Controls

Proposed works for a development should be designed using the following criteria:

- an increase in downstream flooding or stream erosion will not be allowed. Designs will achieve this requirement unless it can be demonstrated that these changes do not adversely impact property or the environment;
- a hydrograph method shall be used to calculate design run-off volumes;
- storage requirements must be checked for a number of storm durations to confirm the maximum storage requirements. (Storm durations that generate the critical peak flow may be different from the duration that generates the critical storage volume);
- 24 hour duration rainfall should be checked for coastal areas;
- alternatively, continuous simulations may be used in place of design storms for sizing storage volumes and assessing stream impacts;
- the detention ponds should be designed to reduce all post-development discharge rates up to the 5-year return period to the corresponding pre-development rates;
- un-attenuated flood waters in excess of the 5 year discharge that by-pass the detention facility must not adversely affect the receiving ditch or channel. Documentation of this assessment is required for all projects.
- an unconfined emergency spillway capable of passing a 100 year peak discharge should be provided to direct overflow safely into the downstream watercourse.

In areas where a Master Drainage Plan has been developed, all subsequent drainage designs should conform to the plan.

The Subdivision Development Drainage Report must provide sufficient information to allow the reviewer to understand the developer's objectives and to thoroughly assess the hydraulic impacts of the development.

For information on Storm Drainage Design refer to:

- ♦ *Master Municipal Construction Document (MMCD) Design Guideline Manual (2005)*
- ♦ *Stormwater Planning, A Guidebook for British Columbia*
- ♦ *Water Balance Model for British Columbia*

Highway Drainage Design

Channel and Culvert Profiles

Channel profiles are required to determine the design hydraulic gradient and critical hydraulic controls and it is good practice to prepare culvert profiles in the drainage details of the design drawing set. These profiles will help to develop ditch, channel and culvert design features such as: adequate depth of coverage for structural pipe design; clearances to utilities or walls; the excavation depth; the rock horizon for culvert trenching; traffic management around proposed excavations; culvert extension components; roadside safety end treatments; fish passage; upstream trash racks and debris flow protection; erosion protection for the outlet velocities and soil type to avoid erosion; and energy dissipation provided where needed.

The length of the profile survey upstream and downstream of a structure should be 10 to 20 bankfull channel widths or 150 m, whichever is greater.

Reports for Highway Drainage

Highway drainage design reports are required for small culverts (< 3 m diameter), pavement drainage and storm sewer design, and ditch in-filling. The report should include most information as noted above in "*Reports for Land Development Drainage*" and also:

- photos of existing culverts;
- a topographic map showing the run-off catchment areas with numbered culverts or drainage outlets/crossings;
- an inventory of culverts and water channels off the highway alignment and shown on the drawings, along with their interconnection to the proposed highway culvert system.

1020
HYDROLOGY

1020.01 MAPPING RESOURCES

Topographic Mapping

Many rural and urban areas have 1:5000 or 1:10000 topographic mapping with 2 m and 10 m contour intervals. TRIM mapping at 1:20000 and 20 m contour intervals, prepared by Base Mapping and Geomatic Services, Ministry of Sustainable Resource Management (MSRM),, are available in digital files or as paper prints. National Topographic Series (NTS) mapping at scales of 1:50000 and 1:250000 are also available.

Site inspections and air photo interpretation should also be used wherever possible.

For information on :
- Air Photos – contact Base Mapping and Geomatic Services, MSRM . See http://srmwww.gov.bc.ca/bmgs/
- Topographical and Trim Maps – contact Crown Publications Inc., Victoria, BC. See http://www.crownpub.bc.ca/

Floodplain Mapping

Floodplain maps are available for over one hundred locations throughout the Province and show the area affected by the 200-year flood. The maps are generally drawn to a scale of 1:5000 with one meter contour intervals. The maps also show natural and man-made features of the area.

For information on:
- Available Floodplain Maps – see http://srmwww.gov.bc.ca/aib/fpm/index.html#How
- Purchase of Floodplain Maps – See http://www.crownpub.bc.ca/

1020.02 WATERSHED CHARACTERISTICS

Drainage Area

The drainage area should be determined from contour maps assuming that water will flow at right angles to the contours. The influences of ditches and roads must be taken into account as well as other features that could divert runoff from the natural runoff channels shown by the contours. The drainage area is usually expressed in units of hectares (ha) or square kilometres (km^2).

Land Use

Official Settlement Plans, which may consider up to 20 years of future planning, are available from the Regional Districts.

Baseline Thematic mapping showing present land use at a scale of 1:250,000 is available in paper or digital format.

For information on Baseline Thematic mapping, contact:
- Base Mapping and Geomatic Services, MSRM.

Runoff Coefficients

In selecting the runoff coefficients (C), the land should be considered to be 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 of the runoff coefficients.

Table 1020.A was obtained from the MSRM, Resource Information Branch, Hydrology Programs and Standards and presents conservative C values for coastal type drainage basins where the maximum runoff occurs as a result of fall and winter rains.

Table 1020.A Maximum Runoff Coefficient Values For Coastal Type Basins

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
return period 10-25 years	+0.05	+0.02	+0.07	+0.05	+0.05
return period > 25 years	+0.10	+0.05	+0.15	+0.10	+0.10
snowmelt	+0.10	+0.10	+0.10	+0.10	+0.10

For small interior drainage basins where the critical runoff events are generally a result of summer rainstorms, the runoff coefficients can be selected from the following:

- *RTAC Drainage Manual Volume 1 (1982), Table 2.4.1-2.4.3, p. 2.22.*

For information on runoff coefficients, refer to:

- ♦ *RTAC Drainage Manual Volume 1 (1982), p. 2.22.*

SCS Soil Groups and Curve Numbers

Hydrologic soil groups and soil/land use curve numbers (CN) can be obtained from the following:

- Ministry of Environmnet (MoE) Soils Maps
- textural classifications provided by geotechnical investigations
- *CSPI Modern Sewer Design (1996), p. 67*
- *CSPI Handbook of Steel and Highway Drainage Products (2002), p.109.*

In areas where flooding is usually the result of winter precipitation (e.g. coastal areas), curve numbers should generally correspond to Antecedent Moisture Condition III (AMC III) to reflect the highest runoff potential. In areas where critical runoff values are the result of summer storms (e.g. interior areas), Antecedent Moisture Condition II should be assumed.

For information on SCS soil groups and curve numbers, refer to:

- ♦ *CSPI Modern Sewer Design (1996), p. 68 &69.*
- ♦ *CSPI Handbook of Steel Drainage and Highway Construction Products (2002),p. 108.*

1020.03 BASIN AND CHANNEL SLOPE

For small drainage areas, the slope of the drainage area can be estimated using the following formula:

$$s = \frac{h_1 - h_2}{L}$$

s is the average slope of drainage area, m/m
h_1 is the maximum elevation of drainage basin, m
h_2 is the minimum elevation of drainage basin, m
L is the maximum length of drainage path, m

Vertical drops such as falls and rapids, etc. should be deducted from the calculations.

For large or complex drainage areas, the main channel slope should be estimated using the Average Slope Method or the Equivalent Slope Method.

Average Slope Method

The Average Slope Method is recommended for normal use. It should give reasonable results for streams having short rapids or falls. However, it is not recommended for profiles which are strongly convex or concave for much of their length.

For information on the Average Slope Method, refer to:

- ♦ *RTAC Drainage Manual Volume 1 (1982), p. 2.11.*

Equivalent Slope Method

The Equivalent Slope Method is recommended for streams which have intermediate steep sections totaling over 10 percent of the overall length.

For information on the Equivalent Slope Method, refer to:

♦ *RTAC Drainage Manual Volume 1 (1982), p. 2.13*.

1020.04 TIME OF CONCENTRATION

For most drainage basins (e.g. those not effected by retention or detention), the "time of concentration" is defined as the time required for the surface runoff from the most remote part of the drainage basin to reach the point of concentration being considered. For very small basins, the following minimum times of concentration are recommended:

urban	5 minutes
residential	10 minutes
natural, undeveloped	15 minutes

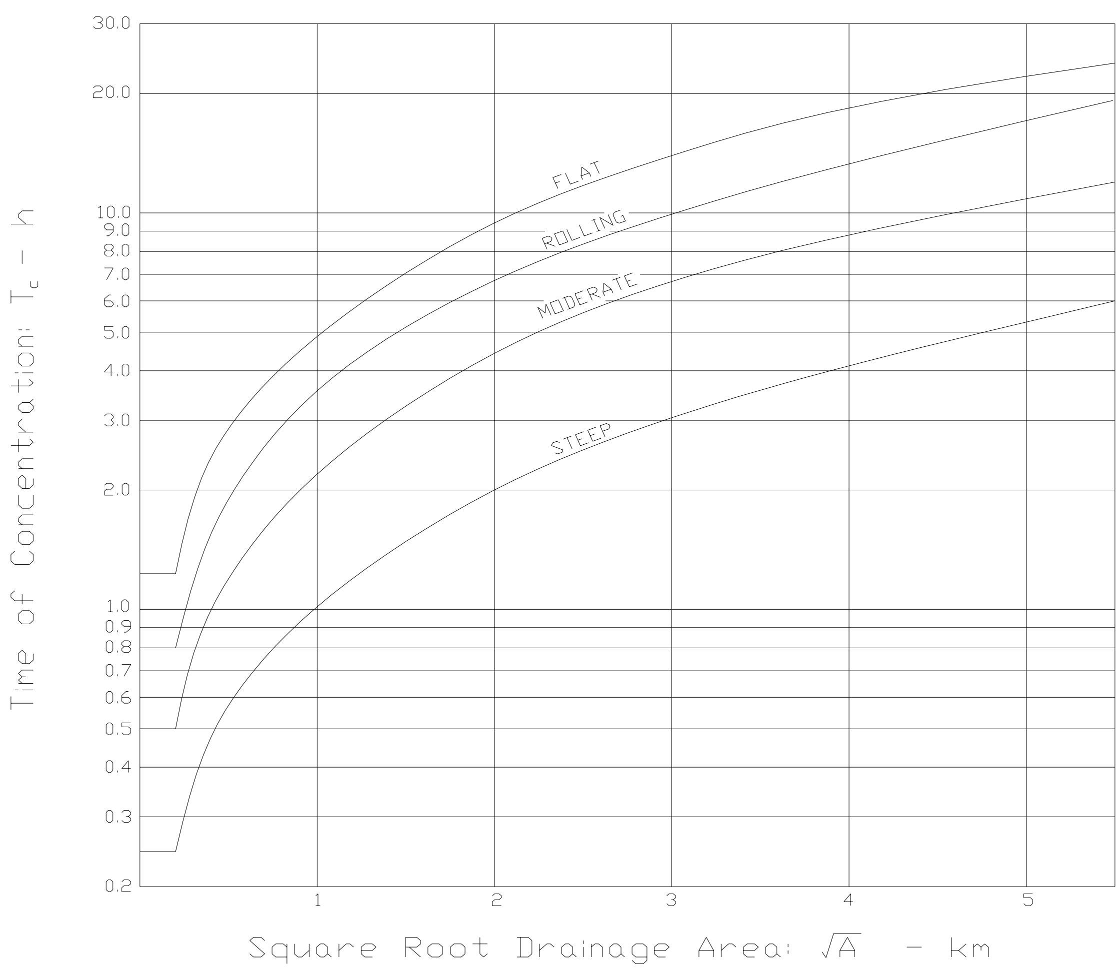
Water Management Method

This method was developed by the Ministry of Environment, Water Management Division, Hydrology Section and is shown in **Figure 1020.B**. This method is limited to drainage areas up to 10 km^2 when used with the BC Rational Formula and for drainage areas up to 25 km^2 for the SCS Unit Hydrograph Method. The time of concentration is dependent on the basin characteristics. The following parameters should 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 1020.B Time of Concentration



Kirpich Formula

This method can be used to estimate the time of concentration for natural basins with well defined channels, for overland flow on bare earth, and mowed grassed roadside channels. For overland flow, grassed surfaces, multiply t_c by 2. For overland flow, concrete or asphalt surfaces, multiply t_c by 0.4.

$$t_c = \frac{0.00032\ L^{0.77}}{S^{0.385}}$$

t_c is the time of concentration, hr
L is the total stream length from the most remote part of the basin as extended from the stream source to the divide, m
S is the average slope of the total stream length, m/m

For information on the Kirpich Formula, refer to:

♦ *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p. 116.*

Hathaway Formula

This method can be applied to small urban or agricultural catchments and to small interior basins with light forest.

$$t_c = \frac{(rL)^{0.467}}{1.65\ S^{0.234}}$$

t_c is the time of concentration, hr
L is the total stream length from the most remote part of the basin as extended from the stream source to the divide, km
S is the average slope of the total stream length, m/m
r is the roughness coefficient

The table below presents roughness coefficients which are recommended for use with the Hathaway formula.

Surface Cover	r
smooth, impervious	0.02
smooth, bare packed soil	0.10
poor grass, row crops	0.20
rough, bare soil	0.30
pasture, range land	0.40
deciduous timber land	0.60
coniferous timber land	0.70
timber land with deep litter	0.80

Other Methods

Other methods of estimating the time of concentration for small and large watersheds are:

- Uplands Method
- SCS Curve Number Method
- Bransby Williams Formula

Time of concentration in channels and conduits can be estimated using Manning's Equation, the Continuity Equation and first principles.

For further information on time of concentration and estimating the time of concentration, refer to:

♦ *RTAC Drainage Manual Volume 1 (1982), p. 2.23.*

♦ *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p. 114.*

1020.05 PRECIPITATION

Intensity Duration Frequency Curves

Rainfall intensities can be obtained from Intensity-Duration-Frequency (IDF) curves which are published by the Atmosphere Environment Service (AES) for urban centers in Canada. AES offers software and data for printing and plotting IDF data.

IDF curve data is not recommended in high elevation, mountainous areas or areas where snowmelt is a significant contributing factor to flood events.

For general information on IDF curves, refer to:

♦ *RTAC Drainage Manual Volume 1 (1982), p. 2.15.*

Remote Locations

For remote locations where IDF curves are not available, the Rainfall Frequency Atlas of Canada may provide the best interpolations of extreme rainfall statistics in BC.

Design Storm

A design storm or rainfall pattern, rather than a single point from IDF values, is required for many unit hydrograph methods and simulation models. The design storm pattern may be either historical (e.g. as actually recorded) or synthetic (e.g. as recreated from statistical summaries).

Research has shown that the SCS Type 1A, 24 hour rainfall distribution best represents conditions for coastal BC.

Synthetic design storms can be incorporated into the following methods to produce design hydrographs:

- BC Rational Formula Method
- SCS Curve Number Method
- SCS Triangular Hydrograph Method

For information on design storms, refer to:

♦ *RTAC Drainage Manual Volume 1 (1982), p. 2.19.*

1020.06 DESIGN FLOW CALCULATION METHODS

Small Drainage Areas

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

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

Q_p is the peak flow, m^3/s
C is the runoff coefficient
i is the rainfall intensity = P/T_c mm/hr
P is the total precipitation, mm
T_c is the time of concentration, hr
A is the drainage area, ha

For information on the Rational Formula Method, refer to:

♦ *RTAC Drainage Manual Volume 1 (1982), p. 2.21.*

For drainage areas less than 25 km^2, design flows can also be estimated using the following method:

- SCS Unit Hydrograph Method

For information on the SCS Unit Hydrograph Method, refer to:

♦ *CSPI Modern Sewer Design (1996), p.67.*

If the drainage areas approach the upper limits, efforts should 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.

Large Drainage Areas

For large drainage areas (>25 km^2), the recommended design flow calculation methods are:

- Station Frequency Analysis
- Regional Frequency Analysis

For the above noted calculation methods, the most commonly used distributions to describe extreme flows in BC are:

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

Annual peak daily and peak instantaneous flows are available from Water Survey of Canada (WSC) gauging stations.

For information on Station Frequency Analysis and Regional Frequency Analysis, refer to:

♦ *RTAC Drainage Manual Volume 1 (1982), p. 2.31, p. 2.35.*

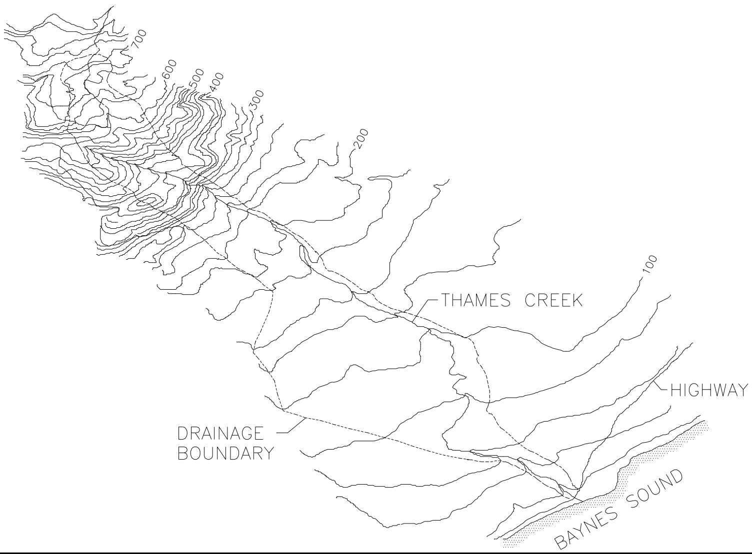
Design flow estimates can also be confirmed using the following methods:

- FLOOD - UBC, Civil Engineering Department
- Consolidated Frequency Analysis (CFA_3.1)
- Pre-Analyzed Basins - Resource Information Branch, MSRM.

Design Flow Estimate

In some instances, more than one design flow calculation method should be used. The designer should evaluate all the results and finally estimate a design flow based on the reliability of input data, past events, historic high flow records and experience.

1020.07 HYDROLOGY EXAMPLE



Background

Thames Creek is located on the east side of Vancouver Island near Denman Island.

Problem

Since the highway crosses Thames Creek, a bridge or culvert will be required. Estimate the 200-year (Q_{200}) flow.

Solution

Step 1 - Determine Basin Size and Creek Length

From the 1:50000 scale mapping, the following dimensions were measured:

A = 6.6 km^2 = 660 ha
L = 8.2 km

Step 2 - Determine Basin Slope

A profile of the main channel was plotted. Since the upper portion of basin is steep, the basin slope was estimated using the Equivalent Slope Method.

s = 0.051 m/m = 5.1%

Step 3 - Determine Land Characteristics

Design flows are estimated assuming worst case conditions. Considerations include basin slope, type of vegetation, recurrence intervals, snowmelt, antecedent moisture condition (AMC) etc. Since the Thames Creek basin is relatively low with light forest cover, the following land characteristic values were selected:

r = 0.60, deciduous timber land
CN = 85, forest land with good cover, Hydrologic Soil Group C, AMC III
C = 0.40, flat, forested

Step 4 - Determine Time of Concentration

There are numerous ways of estimating the time of concentration (t_c). A few different methods will be used and an "average" value will be selected.

Method 1 - BC Rational Formula Method

$$\sqrt{A} = \sqrt{6.6\text{km}^2} = 2.6\text{km}$$
$$t_c = 3.6\text{hr (interpolated)}$$

Method 2 - Hathaway Formula

$$t_c = \frac{(rL)^{0.467}}{1.65s^{0.234}} = \frac{((0.60)(8.2\,\text{km}))^{0.467}}{1.65(0.051\text{m}/\text{m})^{0.234}} = 2.6\text{hr}$$

Method 3 - SCS Curve Number Method

$$S_{CN} = 254\left(\frac{100}{CN} - 1\right) = 254\left(\frac{100}{85} - 1\right) = 44.8$$

$$T_L = \frac{L^{0.8}(0.039S_{CN} + 1)^{0.7}}{735\ s^{0.5}}$$

$$= \frac{(8200\text{m})^{0.8}(0.039(44.8) + 1)^{0.7}}{735(5.1\%)^{0.5}} = 1.7\text{ hr}$$

$$t_c = 1.7T_L = 1.7(1.7\text{hr}) = 2.8\text{hr}$$

Method 4 - Bransby Williams Formula

$$t_c = \frac{0.605L}{s^{0.2}A^{0.1}} = \frac{0.605(8.2\,\text{km})}{(5.1\%)^{0.2}(6.6\text{km}^2)^{0.1}} = 3.0\text{hr}$$

Taking an "average", it is assumed that t_c =3 hours.

Step 5 - Determine Rainfall Intensity

The nearest rainfall gauging station is located at Comox Airport (El. 24 m). Since the basin elevation varies from El. 20 m to El. 760 m, a precipitation gradient is expected. The 10-year rainfall intensity corresponding to the time of concentration will be used due to the increased reliability of rainfall data over more frequent return periods (e.g. 2-year). A previous hydrological study estimated the average intensity over the basin will increase at a rate of 5% per 100 m rise in elevation.

$$i = (9\text{mm/hr})\left(\left(\frac{740\text{m}}{100\text{m}}\right)(0.5)(0.05)+1\right) = 10.7\text{mm/hr}$$

Step 6 - Determine Design Flow

There are numerous ways of estimating the design flow. A few different methods will be used.

Method 1 - Rational Formula
Since the basin is small and there is limited data, the Rational Formula will be used to determine the 10-year flow. The 10-year flow will then be converted to a 200-year flow. Studies have shown that the Q_{200}/Q_{10} ratio is approximately 1.7 for this region.

$$Q_{10} = \frac{CiA}{360} = \frac{(0.40)(10.7\text{mm/hr})(660\text{ha})}{360}$$

$$= 7.9\text{m}^3/\text{s}$$

$$Q_{200} = 1.7Q_{10} = 1.7(7.9\text{m}^3/\text{s}) = 13.4\text{m}^3/\text{s}$$

Method 2 – SCS Peak Flow Method
For this creek, a 24-hour, Type 1A rainfall distribution will be used in the analysis. The 10-year 24 hour total rainfall volume will be obtained from the Comox Airport IDF curve. The estimated 10-year flow will be converted to a 200-year flow.

$$\text{Total Rainfall} = (3.2\text{mm/hr})(24\text{hr}) = 76.8\text{mm}$$

$$Q_{10} = 7.4\text{m}^3/\text{s}$$

$$Q_{200} = 1.7Q_{10} = 1.7(7.4\text{m}^3/\text{s}) = 12.6\text{m}^3/\text{s}$$

Method 3 - Regional Frequency Analysis
Hydrological studies have resulted in regional frequency curves for the area.

$$Q_{200} = (A)(\text{unit runoff})(\text{peaking factor})$$

$$= (6.6\text{km}^2)(1.8\text{m}^3/\text{skm}^2)(1.5) = 17.8\text{m}^3/\text{s}$$

Since the results do not vary significantly, an “average” will be taken. The 200-year flow is estimated to be 15 m^3/s.

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1030
OPEN CHANNEL DESIGN

1030.01 DESIGN RETURN PERIODS

For open channel design return periods, refer to Section 1010.02.

1030.02 OPEN CHANNEL CHARACTERISTICS

Highway ditch designs typically accommodate right-of-way drainage, which may include runoff from pavement areas, cut slopes and adjacent overland flow. Conversely, drainage channels are specifically designed for larger drainage basins and watercourses. Drainage channel design may incorporate the following considerations: hydraulic requirements, river engineering concepts, fisheries enhancement works, etc.

For typical earth ditch sections, ditch sections in solid rock cuts and median sections, refer to:
- ♦ *BC Supplement to TAC Geometric Design Guide, Fig. 440.A, B, C, D & G.*

For geometric properties of various open channels, refer to:
- ♦ *RTAC Drainage Manual Volume 1 (1982), p. 3.4.*

Grades

Roadside drainage ditch grades do not necessarily need to be the same as the road profile. The desirable minimum sustained grade for channels is -0.5%, with -0.3% allowed as an absolute minimum to ensure drainage and prevent "standing water". Steep channel grades should be checked for erodibility.

For information on ditch grades, refer to:
- ♦ *RTAC Drainage Manual Volume 1 (1982), p. 3.31.*

Channel Depth

The roadside drainage ditch depth should be designed such that the ditch invert is a minimum 0.30 m below the bottom of the SGSB layer. The ditch should also be designed such that the flow does not frequently make contact with the SGSB layer. The maximum allowable depth of flow in minor ditches is 0.6 m.

The recommended minimum freeboard is 0.3 m for small drainage channels, larger channels should have a greater freeboard allowance.

For information on ditch depth, refer to:
- ♦ *RTAC Drainage Manual Volume 1 (1982), p. 3.31.*

Channel Width

The bottom width of highway ditches varies and is dependent upon ditch shape, depth, slope, type of material and maintenance requirements. The bottom width of a roadside ditch should not normally be less than 1 m. However, for major roadways, this may be increased for safety purposes to approximately 2 m.

For information on channel width, refer to:
- ♦ *RTAC Drainage Manual Volume 1(1982), p. 3.31.*

Sideslopes

Typical channel sideslopes range between 1.5:1 (H:V) to 4:1. Ditch sideslopes steeper than 2:1 are generally difficult to maintain.

For information on sideslopes, refer to:
- ♦ *BC Supplement to TAC Geometric Design Guide, Fig. 440.A, B, C, D & G.*

Roughness Coefficients

Manning's roughness coefficients (n) are commonly used to describe channel and conduit characteristics.

For Manning's roughness coefficients, refer to:
- ♦ *RTAC Drainage Manual Volume 1 (1982), Table 3.2.3, p. 3.12.*

For information on Manning's roughness coefficients, refer to:
- ♦ *RTAC Drainage Manual Volume 1 (1982), p. 3.10.*

Assessment of Existing Channel

An existing channel should be analyzed to determine if there is sufficient capacity to accommodate the design flow. If channel capacity is insufficient, drainage problems may occur at unexpected locations during large flood events. In addition, channel stability and debris loads should also be assessed.

1030.03 FORMULAE FOR OPEN CHANNELS

Manual Calculations

Capacity, discharge, depth of flow and velocity for uniform and non-uniform sections such as conduits and channels can be approximated through an iterative process involving Manning's Equation and the Continuity Equation. A water surface profile can be approximated and is dependent on whether the flow depth, as determined by Manning's Equation, is greater or less than the critical flow depth for the channel.

The Manning's Equation is as follows:

$$v = \frac{R^{0.67} S^{0.5}}{n}$$

v is the average flow velocity, m/s
R is the hydraulic radius = A/P, m
A is the cross sectional area of flow, m^2
P is the wetted perimeter, m
S is the friction or channel slope, m/m
n is the Manning's roughness coefficient

For information on Manning's Equation, refer to:
- *RTAC Drainage Manual Volume 1 (1982), p. 3.10.*

The Continuity Equation is as follows:

$$Q = vA$$

Q is the discharge, m^3/s
v is the average flow velocity, m/s
A is the cross sectional area of flow, m^2

For information on the Continuity Equation, refer to:
- *RTAC Drainage Manual Volume 1 (1982), p. 3.3.*

Critical Flow

Subcritical flow occurs on mild slopes while supercritical flow occurs on steep slopes. The Froude number (F) will determine whether the flow is subcritical (F<1), critical (F=1) or supercritical (F>1). The Froude number formula is as follows:

$$F = \frac{v}{\sqrt{g y_h}}$$

F is the Froude number
v is the average flow velocity, m/s
g is the gravitational acceleration, m/s^2
y_h is the hydraulic depth = A/B, m
A is the cross sectional area of flow, m^2
B is the width of flow at the water surface, m

For information on critical flow, refer to:
- *RTAC Drainage Manual Volume 1 (1982), p. 3.5.*

Water Surface Profiles

Natural river channels tend to be highly irregular in shape so a simple analysis using Manning's equation, while helpful for making an approximation, is not sufficiently accurate to determine a river water surface profile. The following one-dimensional analysis programs are recommended:

- HEC-2
- HEC-RAS

The above numerical models have been developed by the US Army Corps of Engineers. Use your internet web browser to search for "Hec-Ras" and "Hec-2".

For information on water surface profiles, refer to:
- *RTAC Drainage Manual Volume 1 (1982), p. 3.15.*

1030.04 CHANNEL LINING

A variety of channel liners including grass and riprap are used where channel slopes are steep. If flow velocities are high, erosion may be a potential problem. The treatment of highway runoff may also be necessary. Where the grade is -1% and steeper, the erodibility of the channel material should be checked against the flow velocity. Methods used for the design of erodible channels include:

- maximum permissible velocity
- maximum permissible tractive force

For a qualitative evaluation of various types of channel lining, refer to:
- *RTAC Drainage Manual Volume 1(1982), Table 3.3.2, p. 3.25.*

Unlined Channels

Unlined channels exist during construction and may be a potential problem if erodible soils are present. Temporary ground protection or a sediment control plan may be required until sufficient vegetation has developed. Erosion and sediment control structures shall be designed according to DFO/MoE guidelines.

For competent mean velocities for cohesionless soils, refer to:
- *RTAC Drainage Manual Volume 1 (1982), Figure 3.3.1, p. 3.23.*

For information on erosion and sediment control, refer to:
- *Fisheries and Oceans - Land Development Guidelines for Protection of Aquatic Habitat (1993), p. 23.*

Grassed-Lined Channels

All cut and fill slopes are generally seeded. Small grass-lined channels usually require a minimum slope of -0.5% to function properly. Grass-lined channels are generally sufficient where the treatment of highway runoff is required.

For information on grass-lined channels, refer to:

- *RTAC Drainage Manual Volume 1 (1982), p. 3.24.*

Riprap Lining

Riprap is required where channel degradation and erosion is a concern. For ditches, the riprap will be placed on the sideslopes to a height of at least the design depth of the water. For creeks and larger watercourses, riprap is usually placed 0.3 m above the design depth of water. A proper toe or key must also be provided at the bottom of any riprap bank protection. Riprap classification can be determined using **Figure 1030.A.** The gradation of riprap shall conform to Table 205-A of the Standard Specifications for Highway Construction.

For information on riprap lining, refer to:

- *TAC Guide to Bridge Hydraulics, (latest edition)*
- *RTAC Drainage Manual Volume 1 (1982), p. 3.24.*
- *MoE Riprap Design and Construction Guide (March, 2000) http://www.env.gov.bc.ca/wsd/public_safety/flood/structural.html#riprap*

Filter Blanket

To protect fine grained bank material (less than 12 mm diameter) from scour and sloughing, wave action and groundwater flow from sideslopes, a filter blanket of coarse gravel (less than 100 mm diameter) or geotextile shall be placed between the bank and riprap.

1030.05 OPEN CHANNEL STRUCTURES

The design of open channel structures such as weirs and ditch blocks must address safety issues and also consider their location relative to the roadway.

Check Dams/Drop Structures

To prevent erosion and degradation of the stream beds, check dams or drop structures may be required in a channel where the topography is steeper than the desired channel slope. The structure should be lower in the middle than the edges (notched), and riprap protection should be provided to prevent erosion around the bank ends and undermining of the toe.

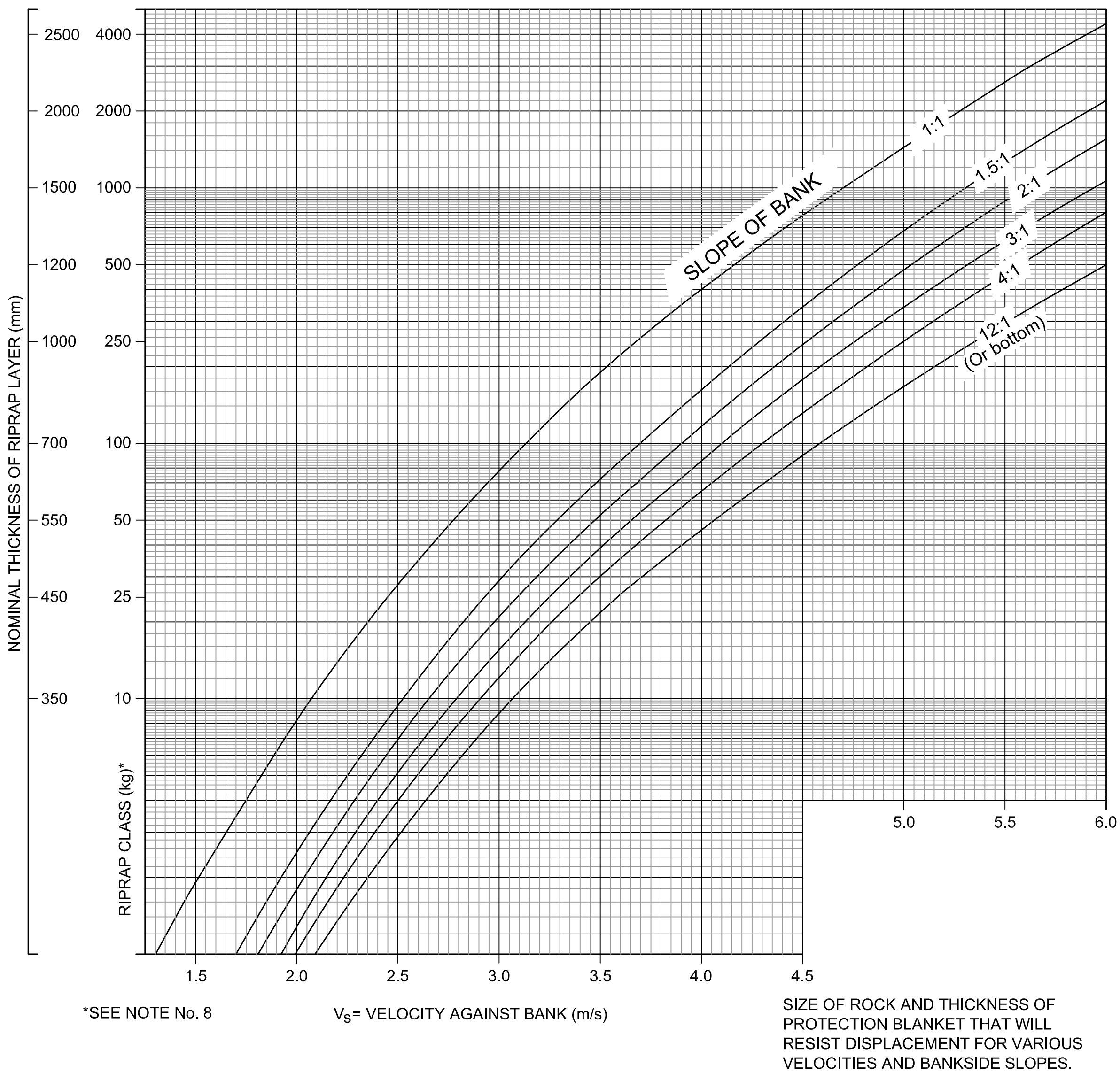
Ditch Blocks

Where the ditch grade is steeper than -2%, a ditch block should be located at the lower side of the culvert inlet to provide a sump and direct flows into culvert. Provision for a sump may require the sacrifice of the ditch slope, the cutslope or the ditch bottom width.

An option for creating a sump is to steepen up the road fill slope somewhat without varying the back cutslope location. Ditch blocks may be constructed using concrete filled sandbags or by using a berm protected with riprap.

Clear Zone requirements preclude the traditional vertical faced ditch block design. Barrier protection or traversable ditch blocks may be needed.

Figure 1030.A Riprap Design Chart



Notes:

1. Adapted from report of Sub-committee on slope protection, Am. Soc. Civil Engineers Proc. June 1948.
2. Density of stone assumed at 2,640 kg/m^3.
3. Enter graph at known velocity to intersection with desired slope curve. Move horizontally to required riprap class and thickness.
4. V_M= mean stream velocity.
5. For parallel flow along tangent bank; $V_S = 2/3\ V_M$
6. For impinging flow against curved bank; $V_S = 4/3\ V_M$
7. For direct impingement on the bank; $V_S = 2\ V_M$

*8. The riprap class No. is the mass (kg) of the 50% rock size (i.e., at least half of the riprap must be heavier than its class mass). For details regarding the rock gradation see Standard Specifications - Section 205.02

9. Do not interpolate between riprap classes. Use the next highest class.

1040
CULVERT DESIGN

1040.01 CULVERT DESIGNATION

Dimensions for culverts shall be shown in the following form for pipes up to 3000 mm diameter and equivalent:

XX m - YYY Ø ZZZ NN WT CC

Where XX is the total length of the culvert in metres; YYY is the Inside Diameter of the culvert in millimetres; ZZZ are the Initials for the Type of Culvert, which is normally:

CSP 68x13 Corrugated Steel Pipe
CSP 125x25 Corrugated Steel Pipe
SPCSP Structural Plate Corrugated Steel Pipe
SPCSPA Structural Plate Corrugated Steel Pipe Arch
SPCSA Structural Plate Corrugated Steel Arch
CONC Concrete Pipe
PVC Poly Vinyl Chloride Pipe
HDPE High Density Polyethylene Pipe

NN is the wall thickness (WT) in millimetres for steel pipe. The complete information shall be shown on the plan and profile drawings, although showing of the WT on the plan is optional. PVC and HDPE pipes shall have a minimum stiffness of 320 kPa.

CC is the coating type for CSP and mix type for concrete. PVC and HDPE shall not contain recycled materials. Typical coating materials are.

Gal Galvanized

AL2 Aluminized Type 2

PL Polymer Laminated

1040.02 CULVERT DESIGN CONSIDERATIONS

General

This section is intended for buried structures with spans less than 3000 mm. The Designer shall pay due regard to empirical methods, manufacturer's literature and solutions that have a proven record of success for small diameter culverts.

Specifications for materials, fabrication and construction of buried structures shall be in accordance with MoT Standard Specifications SS 303 Culverts and SS 320 Corrugated Steel Pipe, where applicable.

Design Return Periods

For culvert design return periods, refer to **Table 1010.A**.

Examples of when various return periods should be used are as follows:

50 year	For low volume roads with shallow fill in undeveloped areas.
100 year	Normal design except when the conditions stated for the 50 or 200 year return period are applicable.
200 year	For highways in areas where flood damage is critical and where requested by MoE.

Culvert Locations

Culverts shall be located at existing watercourses, at low points and where "day lighting" the culvert outlet is feasible. The culvert must discharge into a natural watercourse or a properly designed channel that terminates at a natural watercourse or body of water. Culvert outflows must not be allowed to find their own route to down slope watercourses. For highway ditches in cut, culverts are generally spaced every 300 m.

For information on culvert locations, refer to:

- *RTAC Drainage Manual Volume 2 (1987), p. 4.12.*
- *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p.193.*

Culvert Types

Common culvert types include circular, pipe arch and rectangular box. Culvert selection will depend on factors such as availability, material costs, ease of installation, headroom, durability etc.

For information on culvert types, refer to:

- *RTAC Drainage Manual Volume 2 (1987), p. 4.3.*

Culvert Size

The following minimum culvert diameters are recommended:

- The minimum size culvert under a highway or main road shall be 600 mm diameter.
- The minimum size frontage road culvert shall be 500 mm diameter.
- The minimum size driveway culvert shall be 400 mm diameter.

Skew

A skew angle shall be designated for all installations. The skew angle is the angle measured from the centerline of the highway ahead to the centerline of the culvert, measured in a clockwise direction. The normal range is from 45 to 135 degrees.

A cross culvert from a highway ditch in cut shall be installed on a skew to facilitate inlet pickup.

For information on culvert skew, refer to:

- ♦ *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p. 199.*

Slope

Culverts should generally be placed on the stream grade. If possible, culverts should ideally be placed slightly steeper than the critical slope for the size and type of pipe used. This is usually between 1.0 to 2.2%, however the desirable minimum gradient is 0.5% to prevent sedimentation. The desired maximum gradient is 20% for CSP and 10% for concrete pipes.

For culverts on steep grades, the stability of the upstream bed material should be reviewed to ensure the culvert invert is not abraded by the bed load. Additional features including thicker walls, wear resistant coatings, and armoured and paved inverts should be considered.

For culverts required to provide fish passage, the culvert slope may have to be less than 0.5% to minimize velocities. Special culvert enhancements to provide fish passage may also be considered.

In some instances a culvert may be located at a grade change in a channel bed (e.g. break point between steep mountain flow and floodplain flow). This is the worst place for debris deposition therefore mitigative measures such as a debris basin or smooth flow transition should be considered.

For information on culvert slopes, refer to:

- ♦ *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p.196.*
- ♦ *RTAC Drainage Manual Volume 2 (1987), pp. 4.12.*
- ♦ *Land Development Guidelines for the Protection of Aquatic Habitat (1993), p. 73.*

Invert Elevations at Streams

Culvert inverts should be at least one quarter of the rise below the average natural channel bed up to a maximum depth of 1 m. Exceptions to the recommended invert depth may be considered when site specific features would require special attention (i.e. fish passage; bedrock).

Length

Culverts shall extend at least 0.5 to 0.7 m beyond the toe of slope to accommodate possible sloughing. If riprap is to be placed at the culvert ends, the end extensions should be adjusted accordingly. The total culvert length shall be rounded up to the nearest 1.0 m. CSP stock pipe lengths are 6 m, however, other lengths are available.

For a SPCSP or concrete box culvert, the extension beyond the toe may be greater than 0.7 m due to the length of the prefabricated sections.

As part of final construction clean up, the embankment shall be built-up around the culvert end to limit protrusion to less than 150 mm. Culvert ends shall be step-bevelled, where appropriate.

For information on culvert length, refer to:

- ♦ *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p. 197.*

Wall Thickness and Height of Cover Requirements

The Canadian Highway Bridge Design Code (CHBDC) indicates that the provisions of Section 7 of the code apply only to buried structures with span (DH) greater than 3000 mm, but the CHBDC does not provide design guidance for smaller structures.

Buried structures with spans less than or equal to 3000 mm may also be designed to CHBDC S6-06 Section 7 (except that the design live load vehicle shall be the BCL-625 per the BC MoT Supplement to CHBDC S6-06), or the Designer shall use empirical methods, current practice and manufacturer's literature and solutions that have a proven record of success for small diameter culverts.

Maximum and minimum height of cover and minimum wall thickness shall be per manufacturer's specifications. CSP wall thickness and height of cover are shown in **Tables HC-1 to HC -12 in** the following:

- ♦ *CSPI Handbook of Steel Drainage and Highway Construction Products (2002),*

SPCSP, concrete pipe, and PVC/HDPE wall thickness shall be obtained from manufacturer specifications.

For culverts less than 3000 mm diameter, a minimum cover of 450 mm (measured from the finished shoulder grade) over the crown of the pipe is required. The minimum cover requirements may require a sump at the inlet. An increase in minimum height of cover may be required for heavy construction vehicle loading.

Durability Constraints

If not specified otherwise in a design assignment, the structural design life of a culvert shall be 50 years. The flow water chemistry is a significant factor relating to the durability of pipe materials; however, economical pipe materials and coatings are available that perform well in BC waters. Water hardness, pH and Resistivity values should be obtained at each site to confirm environmental conditions. If water resistivity values are <1500 or >8000 ohm-cm, specialist advice should be obtained. Where abrasion and corrosion interferes with durability, a suitable coating or pipe material must be selected. In some applications, such as creeks with high bed load, armoured inverts, open bottom arches on concrete footings or concrete box culverts are recommended.

For information on Durability, refer to:

- ♦ *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), Chapter 8;*
- ♦ *RTAC Drainage Manual Volume 2 (1987),.*

Manning's Roughness Coefficient

The following roughness coefficients (n) are recommended for culverts:

Table 1040.A Manning's Roughness Coefficient

Pipe Material	Manning's "n"
CSP	Varies ~ 0.021 to 0.027
SPCSP	Varies ~ 0.027 to 0.033
concrete	0.012
PVC	0.009

For CSP and SPCSP, the roughness coefficient will depend on the depth of flow, pipe material, corrugation dimensions and whether the pipe is annular or helical. The above Manning's roughness coefficients can be confirmed from:

- *RTAC Drainage Manual Volume 1 (1982), Table 3.2.3, p. 3.12.*
- *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), Table 4-6, 4-7, p. 145, p. 146.*

1040.03 CULVERT HYDRAULICS

The following design criteria are recommended for typical culverts:

- Inlet control headwater depth to diameter ratio (HW/D) shall not exceed 1.0 at the design flow.
- Outlet control headloss through a typical highway culvert shall be less than 0.3 m.

The minimum pipe gradient for inlet control and initial dimensions for circular steel pipe and steel pipe arch culverts can be determined using **Figure 1040.B** and **Figure 1040.C** respectively. A worked example for circular pipe is provided in **Figure 1040.D** and pipe-arch in **Figure 1040.E**.

The culvert operation must be checked for inlet and outlet control. The greater headwater depth (HW) will govern.

For information on culvert design procedures, refer to:

- ♦ *RTAC Drainage Manual Volume 2 (1987), p. 4.35.*

Culverts providing fish passage shall be designed with reference to the Land Development Guidelines.

For information on fish passage requirements, refer to:

- ♦ *Land Development Guidelines for the Protection of Aquatic Habitat (1993), p. 69.*
- ♦ *RTAC Drainage Manual Volume 2 (1987), p. 4.107.*
- ♦ *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p.9.*

Check For Inlet Control

Headwater depths under inlet control (HW_{in}) can be estimated using the following figures:

For circular CSP and SPCSP:

- *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), Figure 4-10, p. 151.*

A frequently used inlet control nomograph for circular pipes is presented in **Figure 1040.F**.

For CSP and SPCSP pipe arch:

- *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), Figure 4-12, 4-13, 4-14, p. 153, p.154, p. 155.*

For circular concrete pipe:

- *RTAC Drainage Manual Volume 2 (1987), Figure 4.7.7, p. 4.42.*

For concrete box culvert:

- *RTAC Drainage Manual Volume 2 (1987), Figure 4.7.3, 4.7.4, p. 4.38, p. 4.39.*

For further information on inlet control, refer to:

- ♦ *RTAC Drainage Manual Volume 2 (1987), p. 4.17.*
- ♦ *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p. 140.*

Check For Outlet Control

Headloss (H) for full flow conditions can be estimated using the following figures:

For circular CSP and SPCSP:
- *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), Figure 4-17, 4-18, p. 158, p. 159.*

For CSP and SPCSP pipe arch:
- *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), Figure4-19, 4-20, p. 160, p. 161.*

For circular concrete pipe:
- *RTAC Drainage Manual Volume 2 (1987), Figure 4.7.14, p. 4.48.*

For concrete box culvert:
- *RTAC Drainage Manual Volume 2 (1987), Figure 4.7.13, p. 4.47.*

Headloss (H) for partially full flow conditions can be approximated using the *equation* from the *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p. 146,* or *equation 4.5.4* from the *RTAC Drainage Manual Volume 2 (1987), p. 4.18.*

The headwater depth under outlet control (HW_{out}) can be estimated using *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p. 143*, or *equation 4.5.10* from the *RTAC Drainage Manual Volume 2 (1987), p. 4.20.*

For information on outlet control, refer to:
- ♦ *RTAC Drainage Manual Volume 2 (1987), p. 4.18.*
- ♦ *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p. 143.*

Hydraulic Programs

Hydraulic computer programs have distinct advantages over hand calculations or nomographs for determining normal depth, culvert velocity, hydraulic radius and area of flow for partially full flow conditions.

- *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p. 150.*

Critical Flow

For information on critical flow, refer to **Section 1030.03**.

Treatment of Inlet/Outlet Structures

Riprap, in combination with geotextile, is generally used for inlet and outlet protection. The average culvert velocity during the design flow should be used to determine riprap requirements. For information on riprap lining and filter blanket, refer to **Section 1030.04**.

To prevent scour around the inlet and outlet, riprap shall be placed in the channel bed and side slopes. The length of the inlet apron should be at least equal to twice the culvert rise while the length of the outlet apron should be at least equal to four times the culvert rise. The riprap should be placed to a height of at least 0.3 m above the high water level (HWL) or above the crown of the pipe, whichever is higher.

For information and details on concrete inlet and outlet structures, refer to:
- ♦ *Specification Dwg. No. SP303-01 to 04, MoT Standard Specifications for Highway Construction.*
- ♦ *RTAC Drainage Manual Volume 2 (1987), p. 4.25 and 4.103.*
- ♦ *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p.300.*

Figure 1040.B Hydraulic Design Chart For Circular Steel Pipe

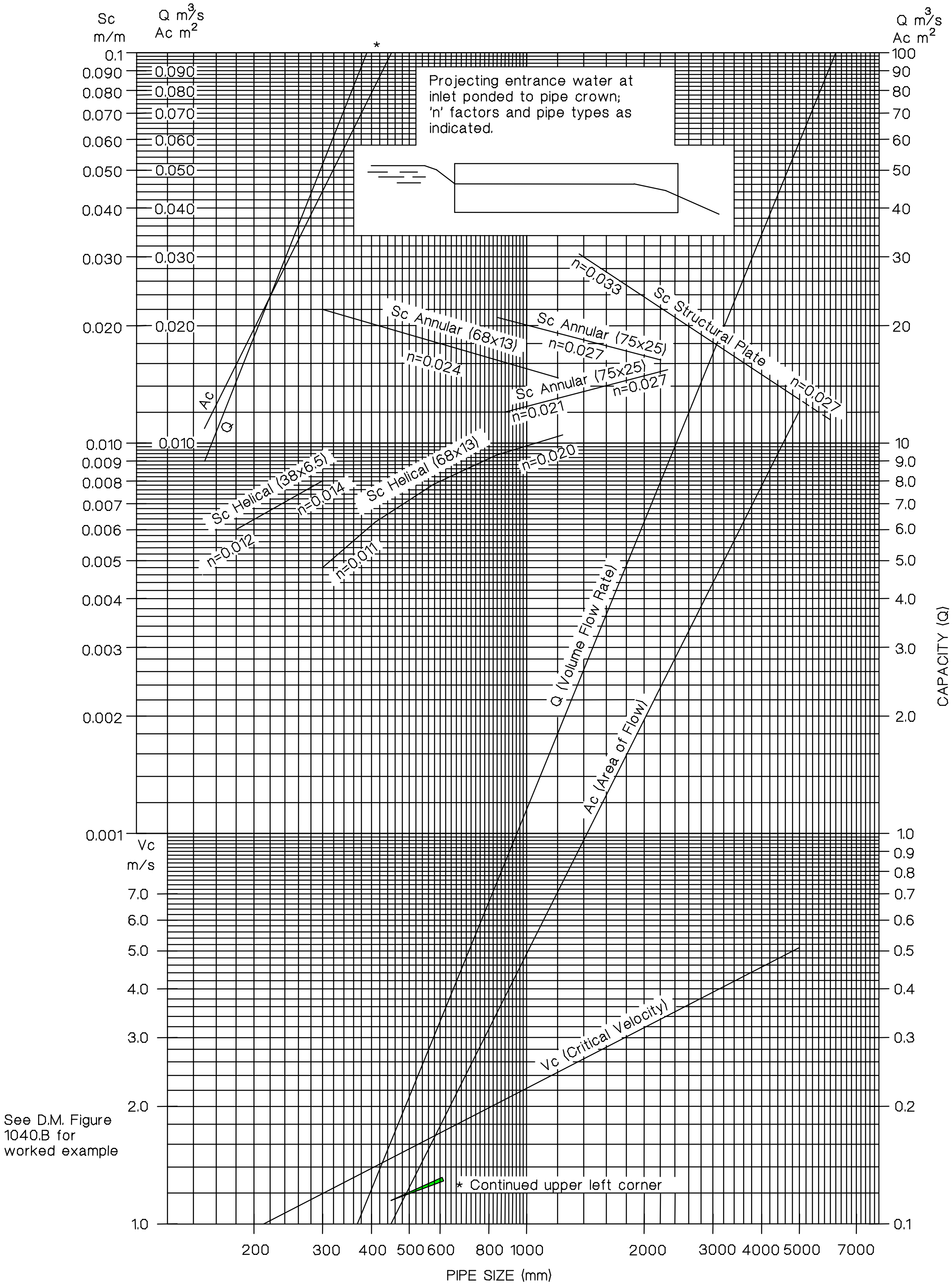


Figure 1040.C Hydraulic Design Chart for Corrugated Steel Pipe-Arch

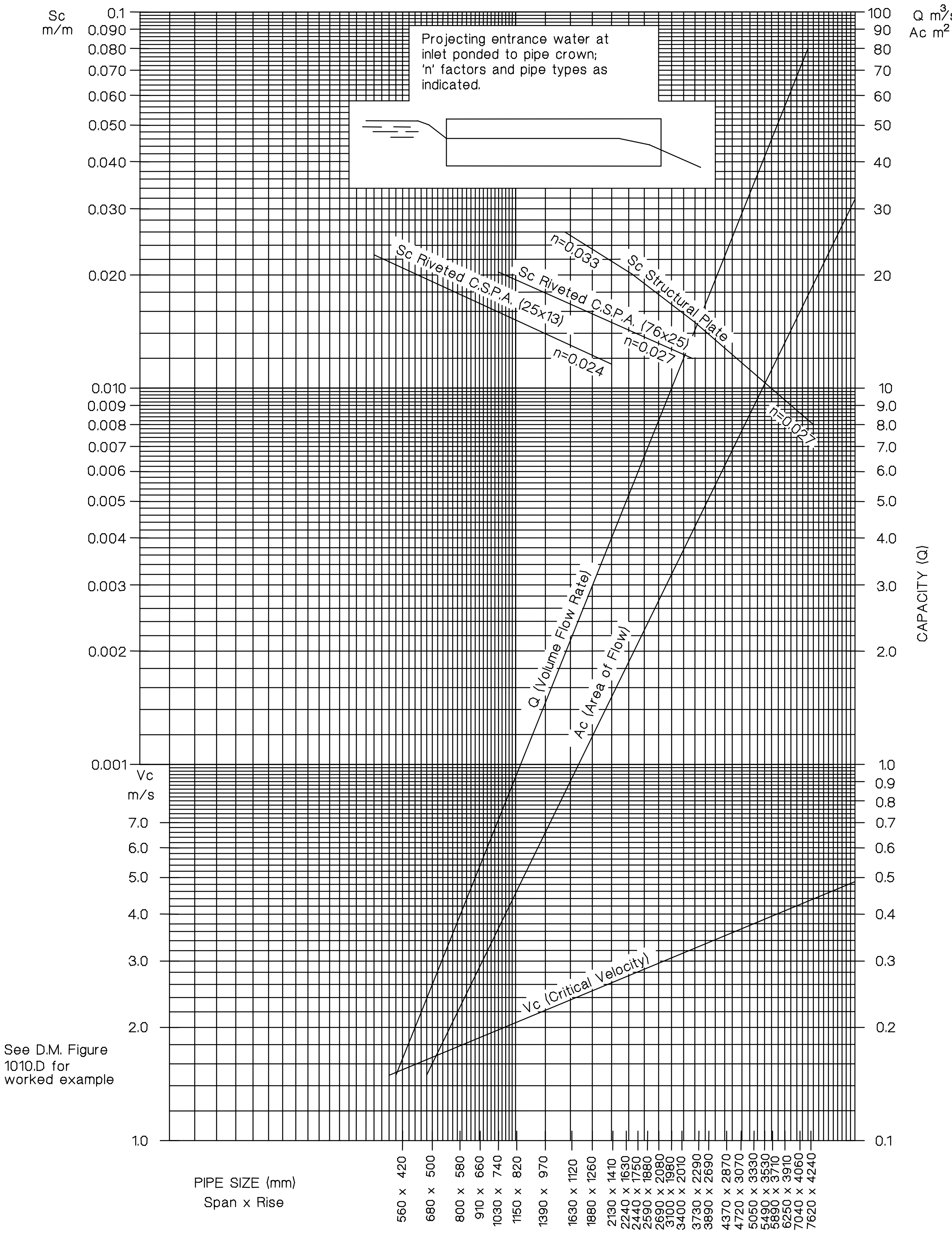
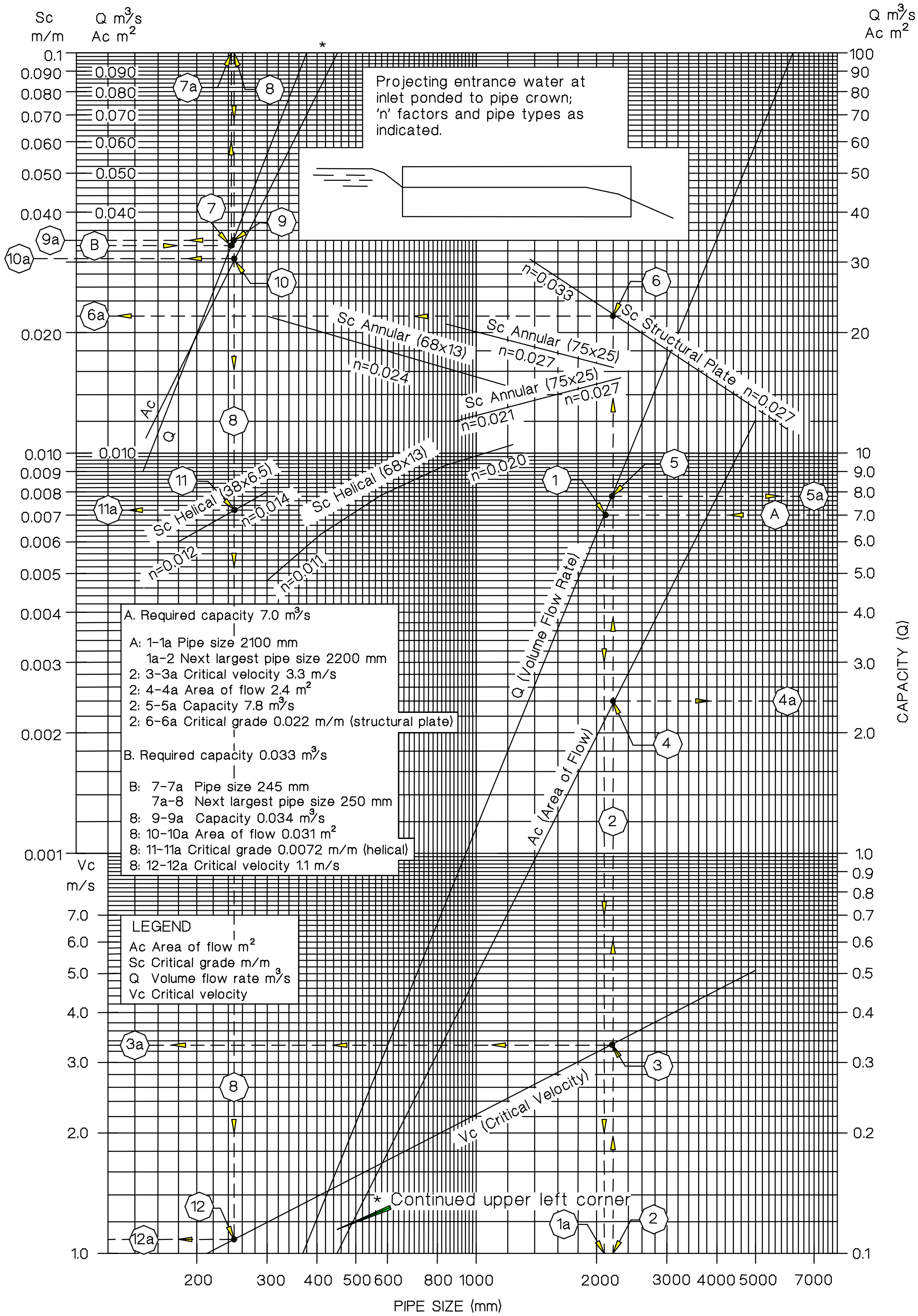


Figure 1040.D Hydraulic Sample Chart for Circular Steel Pipe



MoT Section	1040		TAC Section	Not Applicable

Figure 1040.E Hydraulic Sample Chart for Corrugated Steel Pipe-Arch

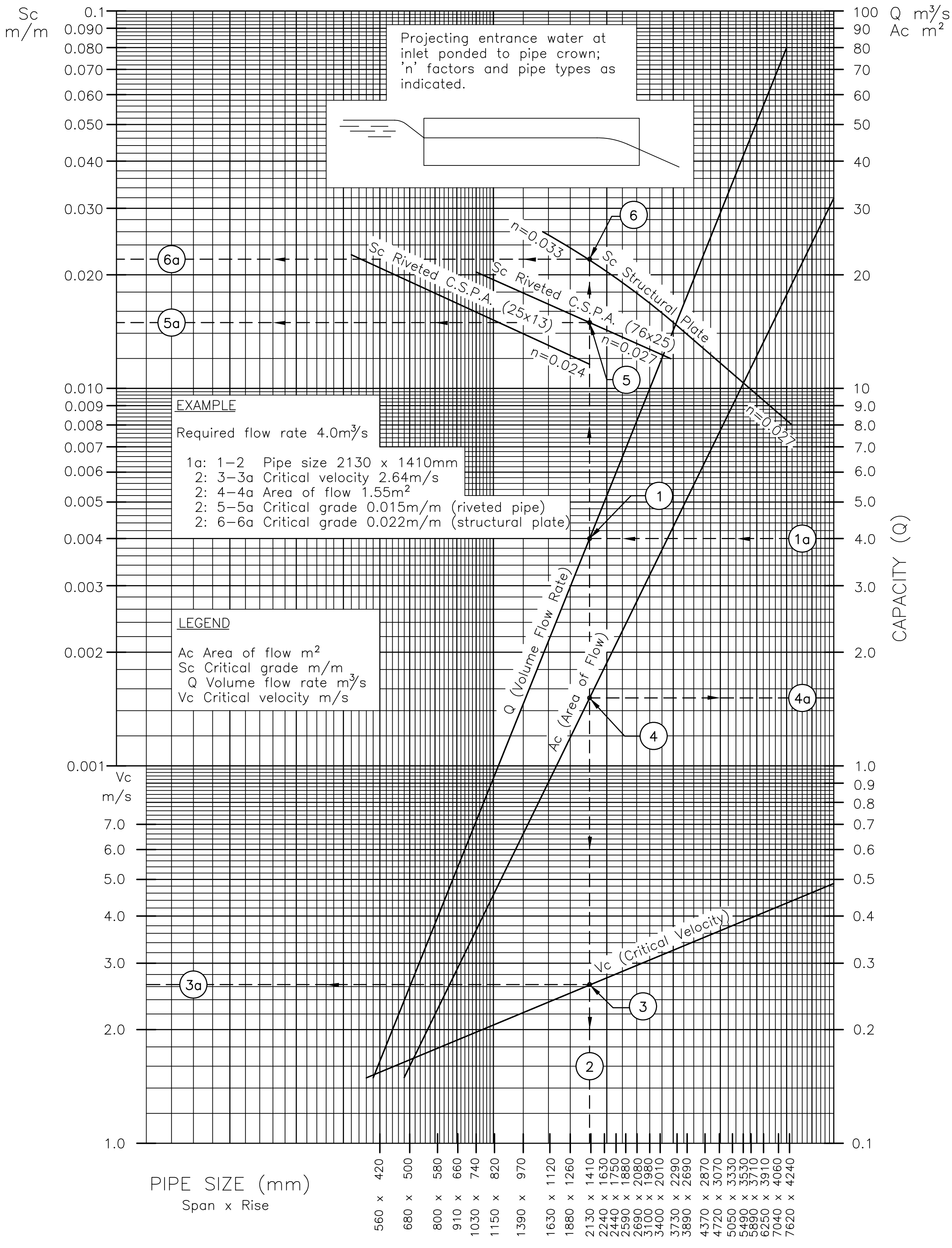
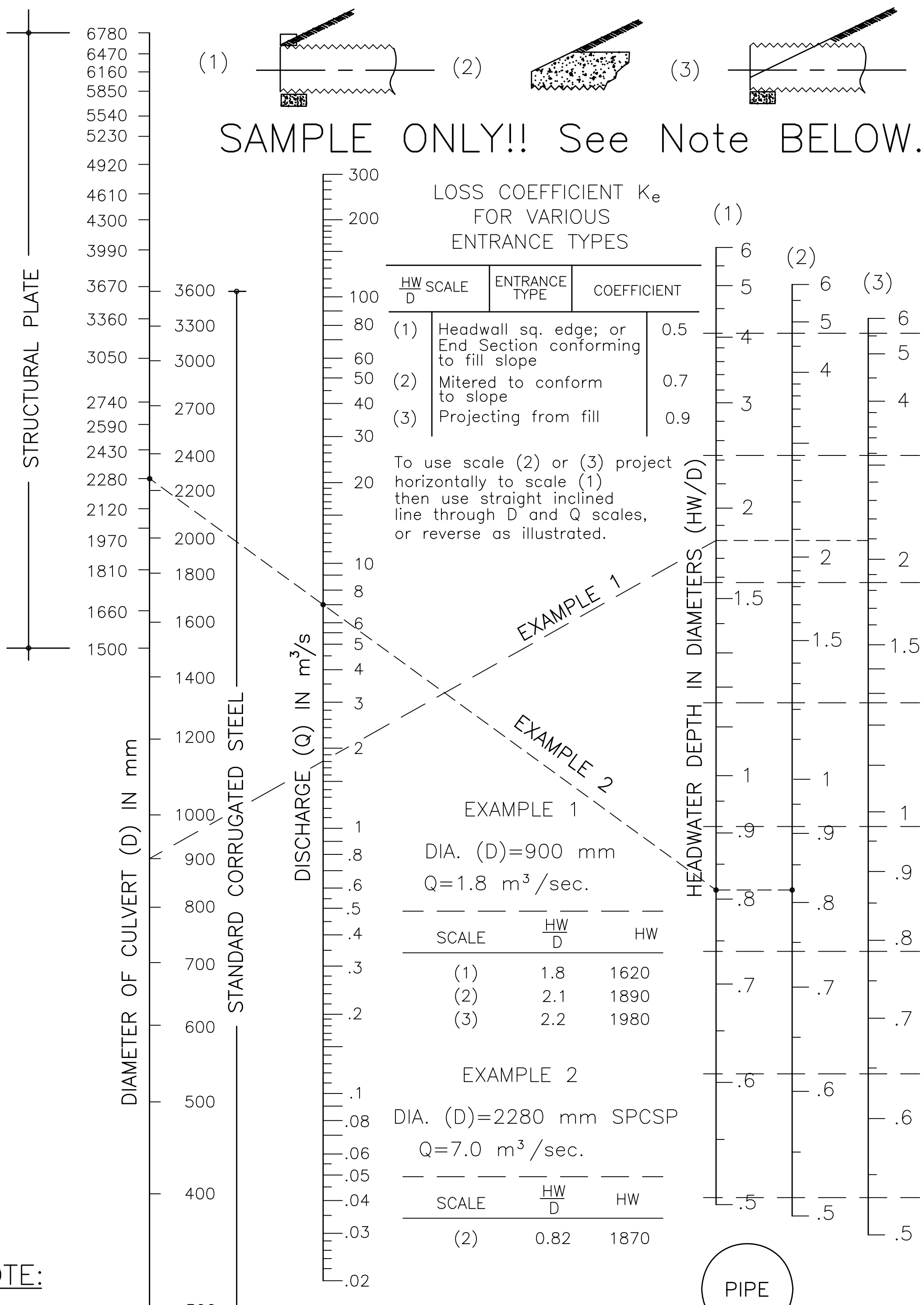


Figure 1040.F Inlet Control Nomograph



NOTE:

This is for ILLUSTRATION ONLY.
Use CSPI Handbook of Steel Drainage & Highway Construction Products (2002), Figure 4–10 on page 151

1040.04 CULVERT INSTALLATION

Some miscellaneous notes:

- Culvert Installation shall generally conform to the current MoT Standard Specifications for Highway Construction, Section 303.
- Designate re-corrugated culvert ends with annular couplers for helical CSP culverts where the installation will be on a gradient greater than 15%.
- Annular couplers shall be indicated on the drawings, the additional materials list, and the H741 and H742 forms.

Foundation Excavation/Base Preparation

Foundation excavations for culverts less than 3000 mm diameter are shown in **Figure 1040.G**. Special conditions apply to SPCSP.

For information on base preparation, refer to:

- ♦ The current MoT Standard Specifications for Highway Construction, Section 303.

Backfill/Bedding

For information on backfill or bedding, refer to:

- ♦ The current MoTH Standard Specifications for Highway Construction, Section 303.

Camber

In situations involving weak foundation soils or high fills, camber should be considered to account for anticipated settlement.

For information on camber, refer to:

- ♦ *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p. 309.*
- ♦ *RTAC Drainage Manual Volume 2 (1982), p. 4.14.*

Headwalls and Wingwalls

A culvert with mitered ends may require headwalls to provide reinforcement by securing the metal edges at the inlet and outlet against earth pressures and hydraulic forces. Headwalls may also be used to counter-weigh hydrostatic uplift and prevent end scour.

Wingwalls should be considered for culverts which require end extensions, improved inlet capacity or are in areas with debris or severe scour problems. The purpose of wingwalls is to retain and protect the embankment, and provide a transition between the culvert and the channel. Normally they will consist of flared vertical wingwalls, a full or partial apron and a cutoff wall.

For information on end structures, refer to:

- ♦ *RTAC Drainage Manual Volume 2 (1987), p. 4.104.*

Cutoff Walls

The inlets of CMP, PVC and HDPE culverts are susceptible to hydrostatic lift and may collapse due to this effect. To prevent undermining and uplift, concrete cut off walls shall be constructed at the ends of culverts equal to or greater than 900 mm diameter or span.

For information on typical cutoff walls, refer to:

- ♦ *CSPI Handbook of Steel Drainage and Highway Construction Products (2002),Fig. 6.27, p.300.*

Safety

For culverts larger than 2000 mm and located within the clear zone, the culvert ends can be made safe by the use of suitable grates, but only if the grates do not become a hazard by causing upstream flooding. Culverts in urban environments require grates to prevent human entry. Grates are generally not permitted on culverts which provide fish passage.

Grates are also installed to prevent debris from entering the culvert. For culverts providing fish passage, debris racks rather than grates, should be installed.

At locations where culverts ends cannot be located outside the clear zone and where grates would be impractical or unsafe, roadside barrier protection should be provided.

For information on safety measures, refer to:

- ♦ *RTAC Drainage Manual Volume 2 (1987), p. 4.15.*

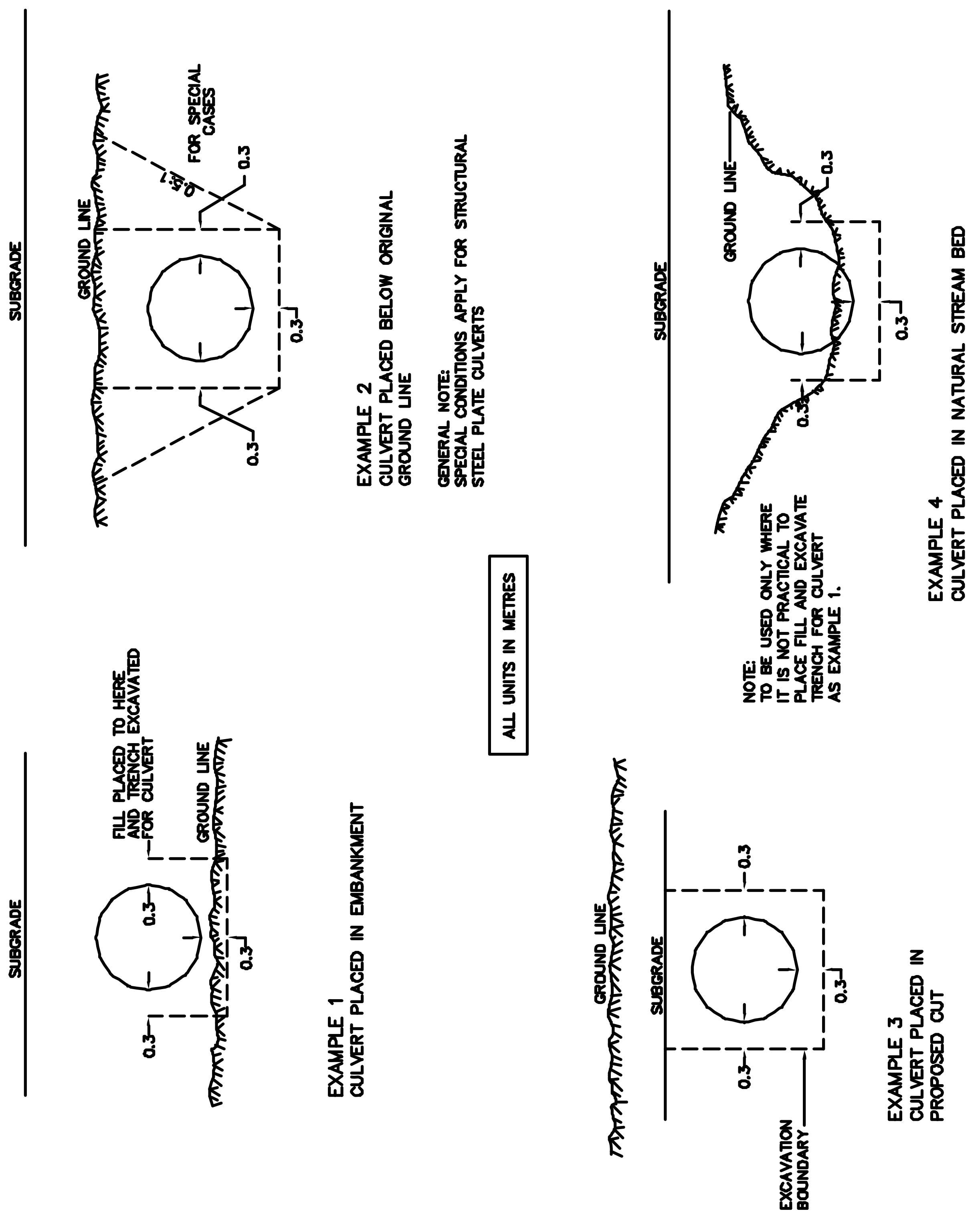
Multiple Installations

For multiple pipe installations, one inlet should be lower than the others so that at low to medium flows the water is concentrated in one pipe. This is conducive to fish passage and discourages silting up of the installation.

For multiple pipes and installations refer to:

- ♦ *CSPI Steel Drainage and Highway Construction Products (2002), p. 181, p. 336.*

Figure 1040.G Foundation Excavation for Culverts



1040.05 CULVERT DESIGN EXAMPLE

Problem

The design flow (Q_{200}) for the creek has been estimated as 7.0 m^3/s. The creek slope at the highway is -2.5%. Determine the culvert size and flow characteristics.

Solution

Step 1 - Preliminary Culvert Dimension and Hydraulics

The minimum pipe grade for inlet control and initial dimensions for SPCSP culverts can be determined using **Figure 1040.B**. A worked example (see **Figure 1040.D**) provides the following:

$$Q_{200} = 7.0 m^3 / s$$
$$D = 2200 \text{ mm}$$
$$A_c = 2.4 m^2$$
$$Q_{capacity} = 7.8 m^3 / s$$
$$S_c = 0.022 m / m$$
$$n = 0.031$$

Step 2 - Check Headwater Depth

The final culvert slope is -2.5%. The slope is steeper than the critical slope ensuring that the culvert will operate under inlet control. If the culvert were to be placed on a milder slope (say -1.0%), outlet control may govern and a backwater analysis would be required to determine the headwater depth.

Referring to **Figure 1040.F** (Example 2), if we assume a 2.28 m diameter SPCSP with the entrance mitered to conform to the slope (k_e=0.7) and a design flow of 7.0 m^3/s:

$$\frac{HW}{D} = 0.82$$
$$HW = (0.82)(2.28 \text{ m}) = 1.87 \text{ m}$$

The inlet configurations satisfy the inlet control design criteria which requires that the headwater depth to diameter ratio (HW/D) not exceed 1.0 at the design flow.

Step 3 **-** Determine Full Flow Characteristics

Using Manning's Equation and the Continuity Equation, the full flow characteristics of the culvert can be determined. See Table below

D	**A**	**R=D/4**	**$R^{0.67}$**	**n**	**S**	**$S^{0.5}$/n**	**$v_{full}=R^{0.67}S^{0.5}/n$**	**Q_{full}=vA**
(m)	(m^2)	(m)			(m/m)		(m/s)	(m^3/s)
2.28	4.1	0.57	0.69	0.031	0.025	5.1	3.5	14.4

Step 4 **-** Determine Partial Flow Characteristics

Since the culvert is operating under inlet control, the flow within the barrel will be partially full. Partial flow characteristics for the culvert were determined using a hydraulic element chart for a circular pipe.

$$\frac{Q}{Q_{full}} = \frac{7.0 m^3 / s}{14.4 \ m^3 / s} = 0.49$$
$$\frac{d}{D} = 0.5$$
$$d = (0.5)(2.28 \text{ m}) = 1.1 \text{ m}$$

$$\frac{v}{v_{full}} = 1.0$$
$$v = (1.0)(3.5 \text{ m / s}) = 3.5 \text{ m / s}$$

The average flow velocity in the culvert (v) should be used for outlet riprap design, while the average depth of flow (d) may be used for outlet control calculations.

1050
PAVEMENT DRAINAGE AND STORM SEWERS

1050.01 RETURN PERIOD

For design return periods, refer to **Section 1010.02**.

1050.02 PAVEMENT RUNOFF

The runoff for highway pavements is computed by the Rational Formula Method using a runoff coefficient (C) equal to 0.95 and a minimum time of concentration equal to 5 minutes.

1050.03 PAVEMENT GRADES

The desirable minimum sustained grade for curbed pavements is -0.5%, with -0.3% allowed for a curb and gutter section as an absolute minimum. If a level grade on a low-speed curbed road is unavoidable, false grading of the gutter may have to be provided to produce an absolute minimum slope of -0.3% to the inlets. Roadway design should try to limit the number of lanes which drain in one direction.

1050.04 PONDING WIDTHS

Gutters should generally be designed such that the maximum ponding width at the catchbasin or spillway is equal to 65% of the paved shoulder width with a minimum of 1.2 m. For low grade roadways, the ponding width may have to be increased to maximize the inlet spacing. However, encroachment of the gutter flow onto the traveled portion is discouraged due to the possibility of hydroplaning, soaking of pedestrians etc. Ponding widths should be measured from the face of the curb.

For information on gutter flow, refer to:
- ♦ *RTAC Drainage Manual Volume 2 (1987), p. 5.22.*

1050.05 MEDIANS AND CURBS

Median drainage is generally designed for a maximum depth of 0.3 m.

Drainage curbs and outlets for paved surfaces on erodible slopes will be required if any of the following criteria are met:

- Fill height exceeds 3 m high.
- Longitudinal grade is greater than 4%.
- Superelevation is over 6%.
- Any superelevated pavement is wider than 15 m.

Asphalt curbs are generally used for rural projects. Concrete curbs are used for urban projects and other areas where there is considerable development.

1050.06 GRATES/SPILLWAYS

Grate Inlets

The current practice is to use Bicycle Safe grates on any roadway which cyclists are permitted to travel. Freeway grates shall be used on all other roadways. Wide pavements tend to require depressed grate inlets. Similarly, urban areas use depressed grate inlets.

Due to vane configurations, twin Bicycle Safe and Freeway grate inlets are recommended in areas where gutter flow velocities exceed 1.5 m/s and 2.0 m/s respectively.

Table 1050.A presents grate catchment widths which are recommended for use with the Spreadsheet or Calculator Method grate inlet spacing calculations:

Table 1050.A - Grate Catchment Widths

Inlet Type	w (m)
Undepressed Bicycle Safe	0.305
Depressed Bicycle Safe	0.625
Undepressed Freeway	0.375
Depressed Freeway	0.625

For drawings of catchbasin grates, refer to:
- *MoT Standard Specifications for Highway Construction, Drawing No. 10-SP219.*

Spillways

In rural areas with potential pavement debris problems (e.g. debris from deciduous or coniferous trees, heavy sanding operations, etc.) spillways may be preferred over catchbasins.

Spillway channels lined with riprap are generally recommended. Paved spillway channels are not recommended unless they have very short lengths and adequate soils supporting the sides of the channel. It should also be noted that spillways are more susceptible to damage from snow clearing operations.

Table 1050.B presents the spillway catchment width, which is recommended for use with the Spreadsheet/Calculator Method spillway inlet spacing calculations:

Table 1050.B - Spillway Catchment Width

Inlet Type	w (m)
Paved Spillway	0.600

Grates/Spillways Spacing on a Grade

Research conducted by the Washington State Department of Transportation (WSDOT) has found that the capacity of an inlet on a continuous grade can be estimated by determining the portion of the gutter discharge directly over the width of the inlet. The model assumes a triangular flow cross section and is most accurate for longitudinal slopes of -2% to -3%. The WSDOT model has been modified to account for lateral inflow on mild grades and high velocities on steep grades. Two methods have been developed to provide approximate spacing requirements and also suit calculator and spreadsheet applications.

The inlet spacing calculations should be conducted approximately where the inlet is to be located. At least one iteration will be required to match the assumed inlet location with the calculated inlet location.

For one or two lane roadways, a maximum catchbasin/spillway spacing of 150 m is recommended. The maximum median spacing of 250 m is recommended. The maximum spacing criteria has been established to facilitate maintenance operations and to prevent an excessively long flow path in the event that one becomes blocked. For one and two lane roadways, a minimum catchbasin/spillway spacing of 20 m is recommended. The minimum spacing criteria has been established to prevent over-conservative designs.

Tabular Method

The Tabular Method provides a quick estimate of the inlet spacings, but is limited in terms of crossfall and longitudinal grade combinations. The tables were developed using a runoff coefficient (C) equal to 0.95 and a ponding width of 1.2 m. The tables are useful for normal crossfall and longitudinal grades between 2% and 4%.

Inlet spacing coefficients have been provide in **Table 1050.C**, **Table 1050.D** and **Table 1050.E** for depressed Bicycle Safe grates, depressed Freeway grates and undepressed Bicycle Safe grates. The notation for the spacing tables are as follows:

s_y is the longitudinal grade, m/m
s_x is the crossfall, m/m
i is the rainfall intensity for t_c equal to 5 minutes, 5 year return period, mm/hr
C1, C2 is the spacing coefficients for a single grate
C1, *C2* is the spacing coefficients for twin grates
CB_{one} is the initial inlet spacing, m
CB_{two} is the consecutive inlet spacing, m

The following procedure shall be used to estimate catchbasin spacings:

1. Select appropriate rainfall intensity.
2. Select the longitudinal grade (s_y) and crossfall (s_x) which closely matches the assumed inlet location. It may be necessary to try more than one location.
3. From the appropriate table, select appropriate values for C1, C2 (single) or *C1, C2* (twin).
4. Determine effective/average pavement width (w) from drainage patterns.
5. For single grates, determine CB_{one} and CB_{two} using pavement width (w) in the following formulas:

$$CB_{one} = \frac{C1}{w} \qquad CB_{two} = \frac{C2}{w}$$

else, for twin grates, determine CB_{one} and CB_{two} using pavement width in the following formulas:

$$CB_{one} = \frac{1.2\mathit{C1}}{w} \qquad CB_{two} = \frac{1.2\mathit{C2}}{w}$$

Table 1050.C Inlet Spacing Tables for Depressed BC Bicycle Safe Grate

	Sx=0.02 Sy=0.003		Sx=0.02 Sy=0.005		Sx=0.02 Sy=0.010		Sx=0.02 Sy=0.015		Sx=0.02 Sy=0.02		Sx=0.02 Sy=0.04	
i (mm/h)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)
20	455	436	587	531	834	758	1023	928	1194	1061	1686	1516
30	303	291	392	354	556	505	682	619	796	707	1124	1011
40	227	218	294	265	417	379	512	464	597	531	843	758
50	182	174	235	212	333	303	409	371	477	424	675	606
60	152	145	196	177	278	253	341	309	398	354	562	505
70	130	125	168	152	238	217	292	265	341	303	482	433
80	114	109	147	133	208	189	256	232	298	265	422	379
90	101	97	131	118	185	168	227	206	265	236	375	337
100	91	87	117	106	167	152	205	186	239	212	337	303
110	83	79	107	96	152	138	186	169	217	193	307	276

	Sx=0.04 Sy=0.003		Sx=0.04 Sy=0.005		Sx=0.04 Sy=0.010		Sx=0.04 Sy=0.015		Sx=0.04 Sy=0.02		Sx=0.04 Sy=0.04	
i (mm/h)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)
20	1459	1402	1895	1762	2672	2406	3278	2937	3789	3392	5343	4794
30	973	935	1263	1175	1781	1604	2185	1958	2526	2261	3562	3196
40	729	701	947	881	1336	1203	1639	1468	1895	1696	2672	2397
50	584	561	758	705	1069	963	1311	1175	1516	1357	2137	1917
60	486	467	632	587	891	802	1093	979	1263	1131	1781	1598
70	417	401	541	503	763	688	937	839	1083	969	1527	1370
80	365	351	474	441	668	602	819	734	947	848	1336	1198
90	324	312	421	392	594	535	728	653	842	754	1187	1065
100	292	280	379	352	534	481	656	587	758	678	1069	959
110	265	255	344	320	486	438	596	534	689	617	971	872

Table 1050.D Inlet Spacing Tables for Depressed BC Freeway Grate

	Sx=0.02 Sy=0.003		Sx=0.02 Sy=0.005		Sx=0.02 Sy=0.010		Sx=0.02 Sy=0.015		Sx=0.02 Sy=0.02		Sx=0.02 Sy=0.04	
i (mm/h)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)
20	455	436	587	531	834	758	1023	928	1194	1061	1686	1516
30	303	291	392	354	556	505	682	619	796	707	1124	1011
40	227	218	294	265	417	379	512	464	597	531	843	758
50	182	174	235	212	333	303	409	371	477	424	675	606
60	152	145	196	177	278	253	341	309	398	354	562	505
70	130	125	168	152	238	217	292	265	341	303	482	433
80	114	109	147	133	208	189	256	232	298	265	422	379
90	101	97	131	118	185	168	227	206	265	236	375	337
100	91	87	117	106	167	152	205	186	239	212	337	303
110	83	79	107	96	152	138	186	169	217	193	307	276

	Sx=0.04 Sy=0.003		Sx=0.04 Sy=0.005		Sx=0.04 Sy=0.010		Sx=0.04 Sy=0.015		Sx=0.04 Sy=0.02		Sx=0.04 Sy=0.04	
i (mm/h)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)
20	1459	1402	1895	1762	2672	2406	3278	2937	3789	3392	5343	4794
30	973	935	1263	1175	1781	1604	2185	1958	2526	2261	3562	3196
40	729	701	947	881	1336	1203	1639	1468	1895	1696	2672	2397
50	584	561	758	705	1069	963	1311	1175	1516	1357	2137	1917
60	486	467	632	587	891	802	1093	979	1263	1131	1781	1598
70	417	401	541	503	763	688	937	839	1083	969	1527	1370
80	365	351	474	441	668	602	819	734	947	848	1336	1198
90	324	312	421	392	594	535	728	653	842	754	1187	1065
100	292	280	379	352	534	481	656	587	758	678	1069	959
110	265	255	344	320	486	438	596	534	689	617	971	872

Table 1050.E Inlet Spacing Tables for Undepressed BC Bicycle Safe Grate

	Sx=0.02		Sx=0.02		Sx=0.02		Sx=0.02		Sx=0.02		Sx=0.02	
	Sy=0.003		Sy=0.005		Sy=0.010		Sy=0.015		Sy=0.02		Sy=0.04	
i (mm/h)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)
20	455	284	587	341	834	493	1023	606	1194	644	1686	909
30	303	189	392	227	556	328	682	404	796	429	1124	606
40	227	142	294	171	417	246	512	303	597	322	843	455
50	182	114	235	136	333	197	409	243	477	258	675	364
60	152	95	196	114	278	164	341	202	398	215	562	303
70	130	81	168	97	238	141	292	173	341	184	482	260
80	114	71	147	85	208	123	256	152	298	161	422	227
90	101	63	131	76	185	109	227	135	265	143	375	202
100	91	57	117	68	167	99	205	121	239	129	337	182
110	83	52	107	62	152	90	186	110	217	117	307	165

	Sx=0.04		Sx=0.04		Sx=0.04		Sx=0.04		Sx=0.04		Sx=0.04	
	Sy=0.003		Sy=0.005		Sy=0.010		Sy=0.015		Sy=0.02		Sy=0.04	
i (mm/h)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)	C1 (m^2)	C2 (m^2)
20	1459	966	1895	1175	2672	1554	3278	1914	3789	2046	5343	2899
30	973	644	1263	783	1781	1036	2185	1276	2526	1364	3562	1933
40	729	483	947	587	1336	777	1639	957	1895	1023	2672	1449
50	584	387	758	470	1069	621	1311	765	1516	819	2137	1160
60	486	322	632	392	891	518	1093	638	1263	682	1781	966
70	417	276	541	336	763	444	937	547	1083	585	1527	828
80	365	242	474	294	668	388	819	478	947	512	1336	725
90	324	215	421	261	594	345	728	425	842	455	1187	644
100	292	193	379	235	534	311	656	383	758	409	1069	580
110	265	176	344	214	486	282	596	348	689	372	971	527

Spreadsheet/Calculator Method

The Spreadsheet/Calculator Method provides a detailed estimate of the inlet spacings for different crossfall and longitudinal grade combinations. This method is useful for low grades when using varying design ponding widths and optimizing inlet spacings.

The model requires the following design input:

SW	is the paved shoulder width, m
y_0	is the design depth of flow (for median), m
s_y	is the longitudinal grade, m/m
s_x	is the crossfall, m/m
n	is the Manning's roughness coefficient
i	is the rainfall intensity for t_c equal to 5 minutes, 5 year return period, mm/hr
width	is the effective width of contributing area, m
C_w	is the width weighted runoff coefficient
w	is the inlet catchment width, m

The model will calculate the following values:

PW	is the design ponding width, m
y_0	is the maximum depth of gutter flow (for pavement), m
R_s	is the crossfall-longitudinal grade ratio, m
w_{eff}	is the effective inlet catchment width, m
v	is the gutter flow velocity, m/s
Q_0	is the gutter flow, m^3/s
y_{over}	is the maximum depth of flow outside the catchment width, m
Q_{over}	is the overflow, m^3/s
Q_{int}	is the intercepted flow, m^3/s
Eff	is the inlet efficiency, %
CB_{one}	is the initial inlet spacing, m
CB_{two}	is the consecutive inlet spacing, m

For detailed Spreadsheet/Calculator Method calculations, refer to **Figures 1050.F to H**.

Grates/Spillways in a Sag Vertical Curve

Twin catchbasins or a spillway should be placed in a sag vertical curve to maximize the open area. To prevent excess ponding, the distance to the next inlet should not exceed 100 m.

Quite often in a vertical sag situation on higher fills, two separate drainage inlets are placed in close proximity to each other. The intent of this measure is to provide additional drainage capacity in the event that if one of the inlets becomes plugged, slope failure will not occur.

Grates/Spillways on a Crest Vertical Curve

On vertical curves, the longitudinal grades near the crest are gradually reduced to zero and will result in closely spaced inlets. To increase the drainage capacity of the gutter, it might be possible to increase the crossfall (typically from 2% to 3%) at the crest. The crossfall transition should be long enough and far enough from the crest so as not to adversely affect the longitudinal slope of the gutter.

Cross-Over Flow

Particular attention should be paid to situations where rapid changes in grade and crossfall occur.

Sag vertical curve and spiral combinations may experience channelized gutter flow which can leave one side of the pavement and cross-over to the other side. Careful attention must be paid to inlet spacings within the runout zone to minimize the bypass or cross-over flow. Since the inlet spacing methodologies presented in Section 1050.06 assume a certain degree of bypass flow, it is recommended that the last two inlets upslope of the Tangent to Spiral point should only be half the distance given by the design methodologies.

Crest vertical curve and spiral combinations generally will not experience this type of channelized cross-over flow.

Bridge Approaches

The drainage for bridge decks is usually designed to only accommodate the bridge surface with no allowance for runoff from the approach roads. To avoid flow onto the bridge deck, the spacing of the last two catchbasins upslope of the bridge should only be half the distance given by the design methodologies. The last catchbasin should be as near to the end of the bridge as practicable.

Figure 1050.F Sample Spreadsheet - Spacing for Depressed/Undepressed BC Bicycle Safe Grate

Design Input							
	SW	=	paved shoulder width	=	*1.2*	m	*<input<*
	s_y	=	longitudinal grade	=	*0.03*	m/m	*<input<*
	s_x	=	crossfall	=	*0.02*	m/m	*<input<*
	n	=	Manning's roughness coefficient	=	*0.020*		*<input<*
	i	=	rainfall intensity corresponding to t_c equal to 5 minutes, 5 year return period	=	*30*	mm/hr	*<input<*
	width	=	effective width of contributing area	=	*10*	m	*<input<*
	C_w	=	width weighted runoff coefficient	=	*0.95*		*<input<*
	w	=	inlet catchment width	=	*0.625*	m	*<input<*
	Note:		w=0.305 m for undepressed B.C. Bicycle Safe grate.				
			w=0.625 m for depressed B.C. Bicycle Safe grate.				
Calculate gutter flow and catchbasin spacing							
	PW	=	if(SW<1.85,1.2,SW*0.65)	=	1.2	m	<calc<
	y_0	=	$PW*s_x$	=	0.024	m	<calc<
	R_s	=	s_x/s_y	=	0.67		<calc<
	w_{eff}	=	$if(R_s<5.1,1.1*w,if(R_s<10.1,1.2*w,if(R_s<15.1,1.3*w,if(R_s<20.1,1.4*w,1.5*w))))$	=	0.688	m	<calc<
	v	=	y_0^0.67*s_y^0.5/n	=	0.71	m/s	<calc<
	Q_0	=	0.375*s_y^0.5*y_0^2.67/(n*s_x)	=	0.0077	m^3/s	<calc<
	y_{over}	=	$(PW-w_{eff})*s_x$	=	0.010	m	<calc<
	Q_{over}	=	0.375*s_y^0.5*y_{over}^2.67/(n*s_x)	=	0.0008	m^3/s	<calc<
	Q_{int}	=	$if(v<1.5,Q_0-Q_{over},if(v<2,Q_0-1.1*Q_{over},if(v<2.5,Q_0-1.2*Q_{over},Q_0-1.3*Q_{over})))$	=	0.0069	m^3/s	<calc<
	Eff	=	Q_{int}/Q_0*100	=	89.7	%	<calc<
	CB_{one}	=	$if(V<1.5,Q_0/(C_w*i*width/(360*10000)), 1.2*Q_0/(C_w*i*width/(360*10000)))$	=	97.1	m	<calc<
	CB_{two}	=	$if(V<1.5,Q_{int}/(C_w*i*width/(360*10000)), 1.2*Q_{int}/(C_w*i*width/(360*10000)))$	=	87.1	m	<calc<
Results							
			Gutter velocity is less than 1.5 m/s - single inlet required.				
			Initial catchbasin spacing is approximately 97 m				
			Consecutive catchbasin spacing is approximately 87 m				

Text shown in Column 4 of this section are the actual formulae for those who wish to create a similar spreadsheet.

Results output should incorporate tests for velocity to determine if single or double inlet is required, as well as minimum and maximum length test for initial and consecutive catchbasin spacings.

Figure 1050.G Sample Spreadsheet - Spacing for Depressed/Undepressed BC Freeway Grate

Design Input							
	SW	=	paved shoulder width	=	*1.85*	m	*<input<*
	s_y	=	longitudinal grade	=	*0.003*	m/m	*<input<*
	s_x	=	crossfall	=	*0.02*	m/m	*<input<*
	n	=	Manning's roughness coefficient	=	*0.020*		*<input<*
	i	=	rainfall intensity corresponding to t_c equal to 5 minute, 5 year return period	=	*35*	mm/hr	*<input<*
	width	=	effective width of contributing area	=	*10*	m	*<input<*
	C_w	=	width weighted runoff coefficient	=	*0.95*		*<input<*
	w	=	inlet catchment width	=	*0.625*	m	*<input<*
	Note:		w=0.375 m for undepressed B.C. Freeway grate.				
			w=0.625 m for depressed B.C. Freeway grate.				
Calculate gutter flow and catchbasin spacing							
	PW	=	if(SW<1.85,1.2,SW*0.65)	=	1.2	m	<calc<
	y_0	=	PW*s_x	=	0.024	m	<calc<
	R_s	=	s_x/s_y	=	6.67		<calc<
	w_{eff}	=	if(R_s<5.1,1.1*w,if(R_s<10.1,1.2*w,if(R_s<15.1,1.3*w,if(R_s<20.1,1.4*w,1.5*w))))	=	0.750	m	<calc<
	v	=	y_0^0.67*s_y^0.5/n	=	0.23	m/s	<calc<
	Q_0	=	0.375*s_y^0.5*y_0^2.67/(n*s_x)	=	0.0024	m^3/s	<calc<
	y_{over}	=	(PW-w_{eff})*s_x	=	0.009	m	<calc<
	Q_{over}	=	0.375*s_y^0.5*y_{over}^2.67/(n*s_x)	=	0.0002	m^3/s	<calc<
	Q_{int}	=	if(v<2,Q_0-Q_{over},if(v<2.5,Q_0-1.1*Q_{over},if(v<3,Q_0-1.2*Q_{over},Q_0-1.3*Q_{over})))	=	0.0023	m^3/s	<calc<
	Eff	=	Q_{int}/Q_0*100	=	92.6	%	<calc<
	CB_{one}	=	if(V<2,Q_0/(C_w*i*width/(360*10000)), 1.2*Q_0/(C_w*i*width/(360*10000)))	=	26.5	m	<calc<
	CB_{two}	=	if(V<2,Q_{int}/(C_w*i*width/(360*10000)), 1.2*Q_{int}/(C_w*i*width/(360*10000)))	=	24.5	m	<calc<
Results							
			Gutter velocity is less than 2 m/s - single inlet required.				
			Initial catchbasin spacing is approximately 26 m				
			Consecutive catchbasin spacing is approximately 25 m				

Figure 1050.H Sample Spreadsheet - Inlet Spacing for Spillways

Design Input							
	SW	=	paved shoulder width	=	*1.85*	m	*<input<*
	s_y	=	longitudinal grade	=	*0.005*	m/m	*<input<*
	s_x	=	crossfall	=	*0.02*	m/m	*<input<*
	n	=	Manning's roughness coefficient	=	*0.020*		*<input<*
	i	=	rainfall intensity corresponding to t_c equal to 5 minute, 5 year return period	=	*35*	mm/hr	*<input<*
	width	=	effective width of contributing area	=	*10*	m	*<input<*
	C_w	=	width weighted runoff coeffcient	=	*0.95*		*<input<*
	w	=	grate catchment width	=	*0.600*	m	*<input<*
	Note:		w=0.600 m for paved spillway				
Calculate gutter flow and catchbasin spacing							
	PW	=	if(SW<1.85,1.2,SW*0.65)	=	1.2	m	<calc<
	y_0	=	$PW*s_x$	=	0.024	m	<calc<
	R_s	=	s_x/s_y	=	4.00		<calc<
	w_{eff}	=	$if(R_s<5.1,1.1*w,if(R_s<10.1,1.2*w,if(R_s<15.1,1.3*w,if(R_s<20.1,1.4*w,1.5*w))))$	=	0.660	m	<calc<
	v	=	$y_0\text{^}0.67*s_y\text{^}0.5/n$	=	0.29	m/s	<calc<
	Q_0	=	$0.375*s_y\text{^}0.5*y_0\text{^}2.67/(n*s_x)$	=	0.0032	m^3/s	<calc<
	y_{over}	=	$(PW-w_{eff})*s_x$	=	0.011	m	<calc<
	Q_{over}	=	$0.375*s_y\text{^}0.5*y_{over}\text{^}2.67/(n*s_x)$	=	0.0004	m^3/s	<calc<
	Q_{int}	=	$if(v<2,Q_0-Q_{over},if(v<2.5,Q_0-1.1*Q_{over},if(v<3,Q_0-1.2*Q_{over},Q_0-1.3*Q_{over})))$	=	0.0028	m^3/s	<calc<
	Eff	=	Q_{int}/Q_0*100	=	88.1	%	<calc<
	CB_{one}	=	$if(V<2,Q_0/(C_w*i*width/(360*10000)), 1.2*Q_0/(C_w*i*width/(360*10000)))$	=	34.2	m	<calc<
	CB_{two}	=	$if(V<2,Q_{int}/(C_w*i*width/(360*10000)), 1.2*Q_{int}/(C_w*i*width/(360*10000)))$	=	30.1	m	<calc<
Results							
			Initial spillway spacing is approximately 34 m				
			Consecutive spillway spacing is approximately 30 m				

1050.07 CATCHBASINS

Catchbasin Locations

In general, inlets should be placed at all low points in the gutter grade and at intersections to prevent the gutter flow from crossing traffic lanes of the intersecting road. In urban locations, inlets are normally placed upgrade from the pedestrian crossings to intercept the gutter flow before it reaches the cross walk.

Catchbasin locations should be determined in conjunction with values derived in Section 1050.06.

For information on catchbasin locations, refer to:

- *RTAC Drainage Manual Volume 2 (1987), p. 5.40.*

Concrete and Cast Iron Catchbasin

Cast iron catchbasins are used in conjunction with asphalt drainage curbs to provide shoulder drainage.

Concrete catchbasins are used to provide shoulder drainage as well as act as a junction between pipe sections.

Trapping hoods are required in concrete catchbasins to prevent debris and sediment from entering the pipe system. This is particularly important for small diameter pipes on flat grades where sediment can accumulate along the invert or on pipes with steep grades where invert abrasion can occur.

Catchbasin Lead Pipe

Minimum 200 mm diameter lead pipe is recommended for catchbasin and median drainage to prevent blockage. Lead pipe design should consider catchbasin flow capacities.

Minimum -0.5% slope is recommended for a catchbasin lead installation.

1050.08 STORM SEWERS

General

Storm sewer systems associated with MoT projects are usually designed to pick up flow from catchbasins along a new highway or rehabilitated urban streets. These pipe systems are limited in extent and generally require relatively simple methods of analysis. The Rational Method is recommended for calculating the flow quantities for these systems and simple equations and charts can be used to estimate pipe sizes and flow times in the sewers. A simple design example is provided in Example 5.4. For complicated systems where the sewer network may serve a considerable area, more complicated methods of analysis may be required.

For information on more advanced calculation methods, refer to:

- *RTAC Drainage Manual Volume 2 (1987), p. 5.51.*
- *CSPI Modern Sewer Design (1996), p. 125.*

Design Return Periods

For design storm return periods, refer to Section 1010.02.

The storm sewer system design should be based on the minor/major concept whereby the minor sewer pipe system is designed to carry up to the 10 to 25 year return period storm. Flows in excess of the pipe system capacity are assumed to flow overland to the natural drainage system for the area. With this concept, it is important that in conjunction with designing the pipe system the flow routes for the major floods are also examined and designed where necessary.

In instances where there is no possibility of overland routes for the major flows, some sections of the pipe system may have to be designed for the major flows.

Location

Medians usually offer the most desirable storm sewer locations. In the absence of medians, a location beyond the edge of pavement within the right of way or drainage easement is preferable. It is generally recommended when a storm sewer is placed beyond the edge of pavement that one system, with connecting laterals, be used instead of two systems, with one running down each side. If a storm sewer must be located under the pavement, sufficient vertical clearance must be provided for making the proper inlet to storm sewer connections.

Manholes

Manholes should be located at all changes in direction, grade, pipe size, flow rate and invert elevation to minimize hydraulic and maintenance difficulties. Manholes should also be located such that they do not interfere with the vehicle wheel path.

The following maximum manhole spacings are recommended:

Table 1050.I Manhole Spacings

Pipe Diameter (mm)	Spacing (m)
< 250	Maximum 100
250-400	Maximum 120
500-900	Maximum 200
> 900	Maximum 250

The crown of pipes at manholes must be at the same elevation. During the design procedure, it may be critical to recognize the minor losses at junctions. Possible situations of concern include: changes in pipe diameter and abrupt changes in alignment and slope.

Pipe runs should generally be straight between manholes. The pipes may be laid in curves, either horizontal or vertical, but only one curve is allowable between manholes. The pipe curvature should be as per pipe manufacturer's specification but in no case can the radius be less than 35 m.

Manhole heights may require adjustment to provide positive drainage.

For information on manholes, refer to:

- *RTAC Drainage Manual Volume 2 (1987), p. 5.85.*

For information on manhole sizes, refer to:

- *MoT Standard Specifications for Highway Construction, Drawing 20-SP219.*

Velocities

Velocities should be 0.6 m/s and greater to prevent silting and clogging the pipes. This velocity should be calculated under full flow condition even if the pipe is only flowing partially full with the design storm. With water carrying highly abrasive material over relatively long periods, velocities should be limited to say 5 m/s. In some areas it may be necessary to lay the pipes at flatter gradients than the ground surface in order to meet maximum velocity criteria in which drop manholes may be required.

Pipes on a Grade

In cases where the roadway or ground profile grades increase downstream along a storm sewer, a smaller diameter pipe may sometimes be sufficient to carry the flow at the steeper grade. However, since decreasing the pipe diameter downstream is not recommended, these pipes end up being oversized.

Consideration should be given in such cases to the possibility of running the entire length of pipe at a grade steep enough to minimize the need to use a larger diameter pipe. Although this will necessitate deeper trenches, it is possible for the savings in pipe costs to exceed the increased cost in excavation.

Where storm sewers are laid on steep terrain there may be considerable savings to be made by laying the pipe parallel to the ground surface rather than using drop manholes. The high velocities are not suitable for water with heavy sediment loads, which could abrade the pipe, but may be appropriate where the flows are relatively clean and intermittent. In steep sewers the head losses in the manholes must be minimized otherwise energy dissipation may cause flows out of the manhole covers. Because of the steep terrain, overland flows may cause extensive damage. Care must be taken to ensure clean transitions in the manhole benching and bends should not be greater than 45 degrees.

Foundation Excavation

Figure 1050.J presents volumes for concrete pipe storm sewer. Figure 1050.K presents volumes for corrugated steel pipe storm sewer. Figure 1050.L presents volumes for manholes.

For storm sewer foundation excavations greater than 1.2 m, the use of 1:1 side slopes or a trench box is required. The volumes in Figures 1050.J and K may have to be adjusted accordingly.

Depth of Sewers

The depth of cover varies due to the type of pipe material used, magnitude of vehicular loads, the surrounding material, depth of frost penetration etc. Typically, storm sewers should have at least 1 m of cover between finished grade and the crown of the pipe in untraveled areas and not less than 1.5 m of cover under traveled areas.

Table 1050.M presents maximum cover over concrete pipe.

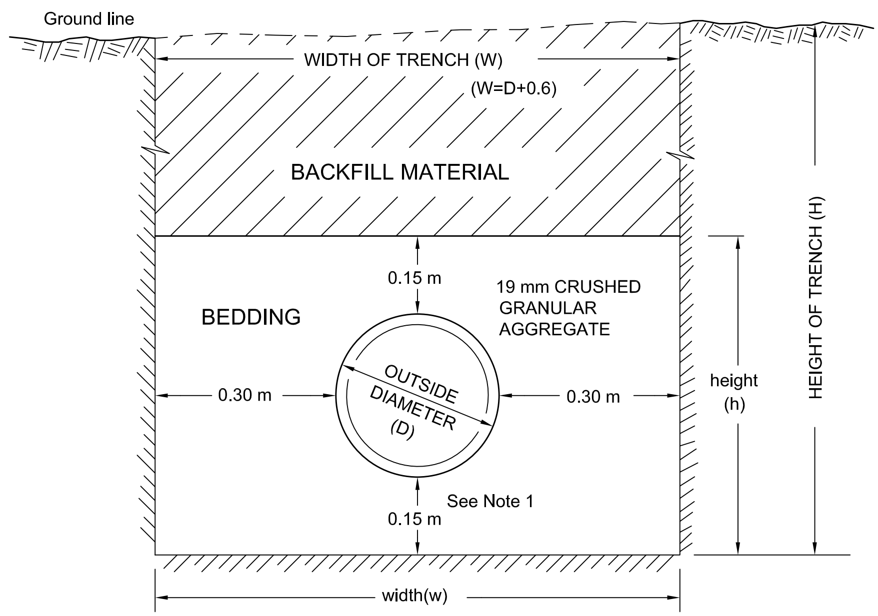
MoT Section	1050		TAC Section	Not Applicable

Figure 1050.J Concrete Pipe Storm Sewer Foundation Excavation

CONCRETE PIPE			BEDDING							TRENCH EXCAVATION
Pipe Size Ø mm	Wall Thickness mm	Outside Diameter mm	Height(h) m	Width(w) m	Area m^2	Pipe Area m^2	Bedding Area m^2	19 mm Agg. Volume m^3	19 mm Agg. Mass t	Volume m^3 per m depth per lin. m
			A	B	C (A x B)	D	E (C - D)	per linear m		F
200	32	264	0.564	0.864	0.487	0.055	0.433	0.433	0.908	0.864
250	37	324	0.624	0.924	0.577	0.082	0.494	0.494	1.038	0.924
300	51	402	0.702	1.002	0.703	0.127	0.576	0.576	1.211	1.002
375	57	489	0.789	1.089	0.859	0.188	0.671	0.671	1.410	1.089
450	64	578	0.878	1.178	1.034	0.262	0.772	0.772	1.621	1.178
525	70	665	0.965	1.265	1.221	0.347	0.873	0.873	1.834	1.265
600	95	790	1.090	1.390	1.515	0.490	1.025	1.025	2.152	1.390
675	102	879	1.179	1.479	1.744	0.607	1.137	1.137	2.388	1.479
750	108	966	1.266	1.566	1.983	0.733	1.250	1.250	2.624	1.566
900	121	1142	1.442	1.742	2.512	1.024	1.488	1.488	3.124	1.742
1050	133	1316	1.616	1.916	3.096	1.360	1.736	1.736	3.646	1.916
1200	146	1492	1.792	2.092	3.749	1.748	2.001	2.001	4.201	2.092

*Multiply Trench Height (H) by Column 'F' to get TRENCH EXCAVATION VOLUME per linear metre

BEDDING AREA
$=(h \times w) - (\frac{\pi}{4} D^2)$
COMP. GRAN. AGGREGATE
Mass per m^3 = 2.1 t



NOTES:

1. In solid rock, use 0.6 m and increase the bedding accordingly.

MoT Section	1050		TAC Section	Not Applicable

Figure 1050.K CSP Storm Sewer Foundation Excavation

CORR. STEEL PIPE			BEDDING							FOUNDATION EXCAVATION
PIPE SIZE Ø mm	WALL THICKNESS mm	OUTSIDE DIAMETER mm	Height(h) m	Width(w) m	Area m^2	Pipe Area m^2	Bedding Area m^2	75mm Agg. Volume m^3	75mm Agg. Mass tonnes	Volume m^3 per m depth per lin. metre
			A	B	C (A x B)	D	E (C - D)	per linear metre		F
200	-	200	0.650	0.800	0.520	0.031	0.489	0.489	1.026	0.800
250	-	250	0.700	0.850	0.595	0.049	0.546	0.546	1.146	0.850
300	-	300	0.750	0.900	0.675	0.071	0.604	0.604	1.269	0.900
400	-	400	0.850	1.000	0.850	0.126	0.724	0.724	1.521	1.000
500	-	500	0.950	1.100	1.045	0.196	0.849	0.849	1.782	1.100
600	-	600	1.050	1.200	1.260	0.283	0.977	0.977	2.052	1.200
700	-	700	1.150	1.300	1.495	0.385	1.110	1.110	2.331	1.300
800	-	800	1.250	1.400	1.750	0.503	1.247	1.247	2.619	1.400
900	-	900	1.350	1.500	2.025	0.636	1.389	1.389	2.917	1.500
1000	-	1000	1.450	1.600	2.320	0.785	1.535	1.535	3.223	1.600
1200	-	1200	1.650	1.800	2.970	1.131	1.839	1.839	3.862	1.800

*Multiply Trench Height (H) by Column 'F' to get TRENCH EXCAVATION VOLUME per linear metre

BEDDING AREA
$=(h \times w) - (\frac{\pi}{4} D^2)$

COMP. GRAN. AGGREGATE
Mass per m^3 = 2.1 tonnes

*In Solid Rock, use 0.3m
- Increase bedding accordingly.

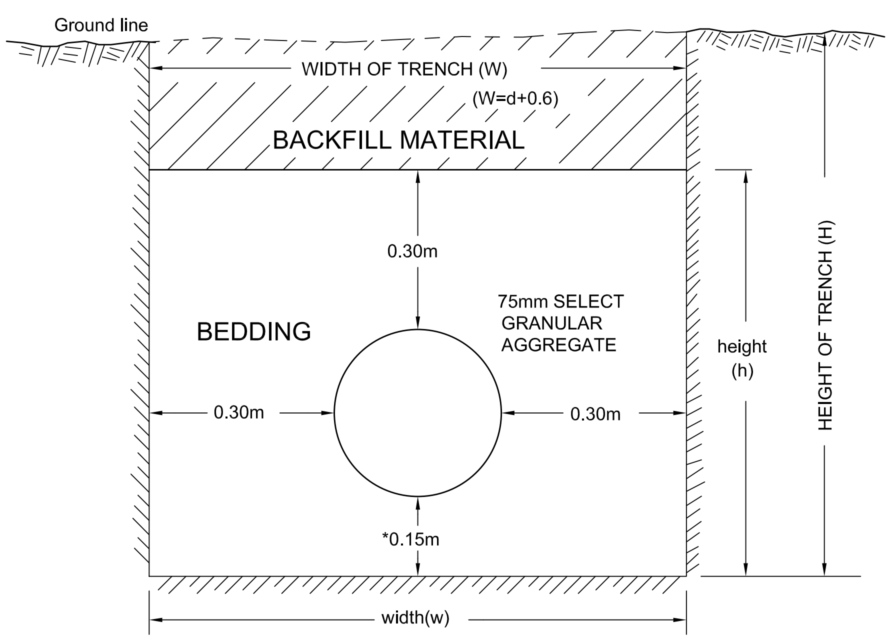
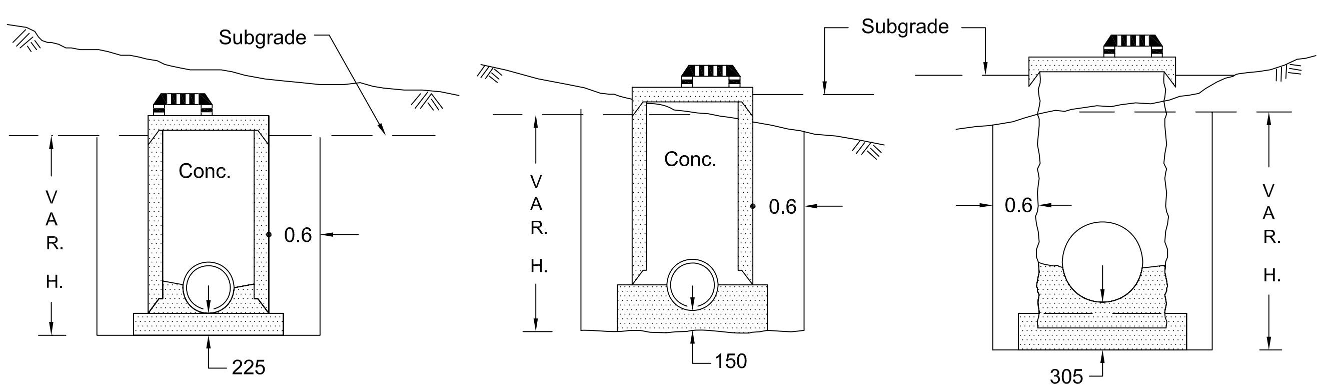


Figure 1050.L Foundation Excavation Volumes per Metre Depth of Manhole

DIAMETER mm	WALL TH. mm	OUTSIDE DIAMETER m	EXCAVATION DIAMETER m	AREA EXCAVATION m^2	VOLUME per m of depth m^3	TYPE OF MATERIALS
900	2.8	0.930	2.130	3.563	3.563	Corr. Steel
	100	1.100	2.300	4.155	4.155	Concrete
1000	2.8	1.030	2.230	3.906	3.906	Corr. Steel
1050	115	1.280	2.480	4.831	4.831	Concrete
1200	2.8	1.230	2.430	4.638	4.638	Corr. Steel
	125	1.450	2.650	5.515	5.515	Concrete
1350	— . —	— . —	— . —	— . —	— . —	— . —
	165	1.680	2.880	6.514	6.514	Concrete
1400	2.8	1.430	2.630	5.433	5.433	Corr. Steel
1500	170	1.840	3.040	7.258	7.258	Concrete
1600	2.8	1.630	2.830	6.290	6.290	Corr. Steel
1650	185	2.020	3.220	8.143	8.143	Concrete
1800	2.8	1.830	3.030	7.211	7.211	Corr. Steel
	195	2.190	3.390	9.026	9.026	Concrete



CONCRETE A BASE — CONCRETE B BASE — CORRUGATED STEEL

SP582-03.01 — SP582-03.07

NOTES:

- TOP LIMIT FOR FOUNDATION EXCAVATION CALCULATION IS SUBGRADE OR GROUND LINE, WHICHEVER IS LOWER.
- NO FOUNDATION EXCAVATION WHEN RISER IS SMALLER THAN SEWER.

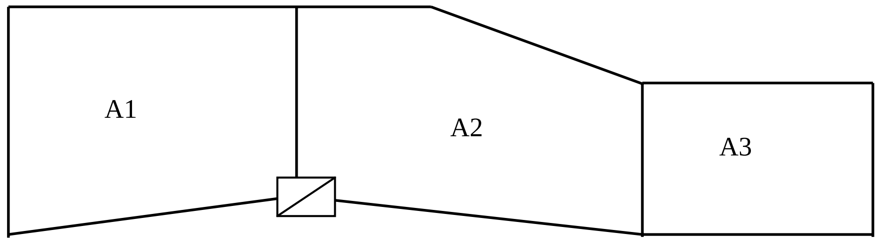
Table 1050.M Concrete Pipe Trench Installation

Design Data:

1. Class “B” bedding.
2. Width of trench at pipe crown = transition width.
3. Backfill = sand and gravel at 1.92 tonnes/m^3
4. Pipe strength - ASTM - C 14 and C 76.
5. Live Load CS-600
6. Safety Factor = 1.5

	COVER IN METRES								
Diameter in	Non-reinf. C 14 - 3		Reinforced C 76 - 111		Reinforced C 76 - IV		Reinforced C 76 - V		Diameter in
mm	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	mm
200	6.4	0.3	-	-	-	-	-	-	200
250	5.2	0.4	-	-	-	-	-	-	250
300	4.2	0.4	-	-	4.8	0.4	6.1	0.3	300
375	3.8	0.4	-	-	5.0	0.4	6.2	0.3	375
450	3.7	0.4	-	-	5.1	0.4	6.3	0.3	450
525	3.7	0.4	3.4	0.5	5.1	0.3	6.3	0.2	525
600	3.8	0.4	3.5	0.5	5.2	0.3	6.4	0.2	600
675	3.6	0.4	3.5	0.5	5.2	0.2	6.5	0.2	675
750	3.4	0.4	3.5	0.4	5.3	0.2	6.6	0.2	750
900	3.0	0.4	3.6	0.3	5.3	0.2	6.6	0.2	900
1050	-	-	3.6	0.2	5.4	0.2	6.7	0.2	1050
1200	-	-	3.6	0.2	5.4	0.2	6.7	0.2	1200
1350	-	-	3.7	0.2	5.4	0.2	6.7	0.2	1350
1500			3.7	0.2	5.5	0.2	6.7	0.2	1500
1650			3.5	0.2	5.5	0.2	6.7	0.2	1650
1800			3.8	0.2	5.5	0.2	6.7	0.2	1800

1050.09 STORM SEWER DESIGN SAMPLE



Step 1 - Determine drainage areas A1, A2, etc. by planimetering area from map. Estimate values of runoff coefficient, C. Determine slopes, S, between catchbasins ←, ↑, etc.

Step 2 - For drainage area, A1, assume the time of concentration, t_c, as 5-20 minutes. Look up rainfall intensity, i, from the IDF curves. Calculate the design flow using the Rational Method.

Step 3 - Find diameter of pipe, d, between ← and ↑ using the design flow and Manning's Equation.

$$v = \frac{R^{0.67} S^{0.5}}{n} \text{ or } Q = \frac{0.31 d^{2.67} S^{0.5}}{n}$$

Assuming a pipe roughness coefficient, n, compute d from the formula and chose the next available size.

Step 4 - Assuming full flow, estimate the travel time, t_t, from ← and ↑ using the following equation:

$$t_t = \frac{\text{pipe length}}{\text{velocity}}$$

Step 5 - Assume t_c for inlet ↑ as t_c for ← + t_t. Look up i. Compute flows at ↑ from $Q_2 = C_2 i(A1+A2)$.

Step 6 - Size pipe between ↑ and → and keep going.

Step 7 - Once the storm sewer system has been designed, the pipe network can be analyzed using a commercially available computer program.

Problem

A storm drain, 150 m long, drains a residential area. The drainage area to the upstream end is 6 hectares and there is an additional 8 hectares before the downstream end. The ground is sloped at 1.0%. What is the design flow at the downstream end of the storm drain? (from both catchment areas).

Solution

Step 1 - A1=6 ha, A2=8 ha, C=0.6, S=0.01 m/m

Step 2 - For drainage area A1 assume t_c=20 min. The 10-year rainfall intensity will be calculated using a formula for the area rather than the IDF curves.

$$i = 77e^{-0.0277 t_c} = 77e^{-0.0277(20\text{min})} = 44\text{mm}/\text{hr}$$

The design flow is:

$$Q_1 = \frac{CiA1}{360} = \frac{(0.6)(44\text{mm}/\text{hr})(6\text{ha})}{360} = 0.44\text{m}^3/\text{s}$$

Step 3 - Assuming a pipe roughness, n=0.013, find diameter of pipe.

$$d = \left(\frac{Qn}{0.31 S^{0.5}}\right)^{0.375} = \left(\frac{(0.44\text{m}^3/\text{s})(0.013)}{(0.31)(0.01\text{m}/\text{m})^{0.5}}\right)^{0.375} = 0.53\text{m}$$

The next larger size is 600 mm diameter.

The full flow velocity of a 600 mm diameter pipe is:

$$v = \frac{R^{0.67} S^{0.5}}{n} = \frac{(0.6m/4)^{0.67}(0.01m/m)^{0.5}}{0.013}$$
$$= 2.2m/s$$

Step 4 - The estimated travel time, t_t, through the pipe is:

$$t_t = \frac{\text{pipe length}}{\text{velocity}} = \frac{150m}{2.2m/s} = 68s = 1.1\text{min}$$

Step 5 - The time of concentration at the next inlet, t_c for A2, is:

t_c for A2 = t_c for A1 + t_t = 20 min +1.1 min = 21.1 min

The rainfall intensity is:

$$i = 77e^{-0.0277t_c} = 77e^{-0.0277(21.1\text{min})} = 43mm/hr$$

The combined design flow for both catchment areas is:

$$C_{1+2} = \frac{C_1A_1 + C_2A_2}{A_1 + A_2} = \frac{(0.6)(6ha) + (0.6)(8ha)}{6ha + 8ha}$$
$$= 0.6$$
$$Q_2 = \frac{C_{1+2}\, i\, (A_1 + A_2)}{360}$$
$$= \frac{(0.6)(43mm/hr)(6ha + 8ha)}{360} = 1.0m^3/s$$

The design flow at the downstream end of the storm drain is 1 m^3/s.

The above design method is best completed in tabular form.

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1060
DITCH INFILLING

1060.01 GENERAL

Land owners adjacent to Provincial Highways often find the roadside ditch is inconvenient when maintaining their property and aesthetically displeasing. The purpose of this policy is to ensure that where infilling of the ditch by the property owner is permitted, it complies with both the Ministry **Standard Specifications for Highway Construction** book and the **BC Supplement to TAC Geometric Design Guide** and ensures proper drainage is maintained. Infilling of roadside ditches by adjacent property owners at their own cost shall generally be permitted.

Exceptions - Infilling of ditches will not be permitted:

- Where the ditch forms an integral part of a flood control system
- Where water storage in the ditch provides a significant reduction in peak flow rates
- Within 3 m of a cross culvert (unless an approved culvert basin with end walls or a manhole is installed)
- Adjacent to any road other than rural minor roads and secondary roads and urban minor and local streets
- In areas used as fish habitat, unless approved by the local environmental agencies
- In areas not approved by the District Manager, Transportation

Access to properties will be limited to designated driveways.

The ditch infilling works, once installed and approved, shall become the property of the Ministry.

The Ministry reserves the right to change, raise, lower or realign the highway in such a way as to render the ditch infilling works ineffective without any recompense to the property owner.

All works on Ministry Right-of-Way will be to appropriate Ministry standards. If the District Manager, Transportation cannot supply adequate direction for design by the property owner, ditch infilling works must be designed and constructed under the supervision of a Professional Engineer at the property owner's expense.

It is the responsibility of the property owner to contact the environmental agencies and, where necessary, obtain their approvals for the works, including Ministry permission for ditch infilling.

Where required by the District Manager, Transportation, the property owner shall submit a design for review and approval or employ a Professional Engineer to design and supervise construction of ditch infilling works. Roadside ditch infilling, when permitted by the Ministry, shall conform to the applicable Ministry of Transportation Standard Specifications for both materials and installation of culverts, including, but not limited to, the following:

1060.02 SIZING

Culverts shall be a minimum of 400 mm in diameter. Driveway culverts which do not meet this standard shall be upgraded.

1060.03 INSTALLATION

Invert elevations shall be a minimum of 700 mm below finished grade of centreline, except where otherwise approved by the Ministry representative. Culvert grade shall generally conform to existing ditch grade with a desirable minimum grade of 0.5%. Bedding shall conform to Ministry of Transportation Standard Specifications, including trench excavation and refilling, to form a gravel bed (see Figure 1060.A).

In locations where the road subgrade is not free draining gravel, a 300 mm thick blanket of drain rock shall be placed on the road side bank of the ditch to a minimum depth of 1 m below highway grade. A 100 mm diameter perforated pipe shall be placed in the toe of the drain rock running parallel to the culvert and shall be drained into the culvert by means of a T or Y junction every 30 m. Clean outs for the perforated pipe shall be installed every 30 m.

1060.04 CROSS CULVERTS

Ditch infilling shall not be allowed within 3 m of cross culverts unless a proper culvert basin with end walls or a manhole is installed.

1060.05 INLET AND OUTLET DITCHES

Existing inlet and outlet ditches to culverts, roadside ditches and cross ditches shall not be blocked by ditch infilling.

1060.06 BACKFILLING

Methods and materials used in backfill shall comply with Ministry of Transportation specifications. Maximum extent of the backfill will be the top of SGSB. The finished ground profile will form a swale parallel to the highway with a minimum cross slope down from the highway shoulder of 5% **and a minimum** 1% longitudinal grade. A typical cross section is shown in Figure 1060.A.

1060.07 CATCH BASINS

Catch basins with removable grates at ground level (for surface drainage and culvert cleanout) shall be installed at 20 m intervals, in the bottom of the swale to drain into the culvert, and immediately upstream of driveways, or as **otherwise required**.

1060.08 PERIMETER AND ROOF DRAINS

Any roof or perimeter drains which enter the ditch must be joined into the culvert, with a saddle branch, above the centreline of the culvert. Cleanouts will be installed at the edge of the R/W.

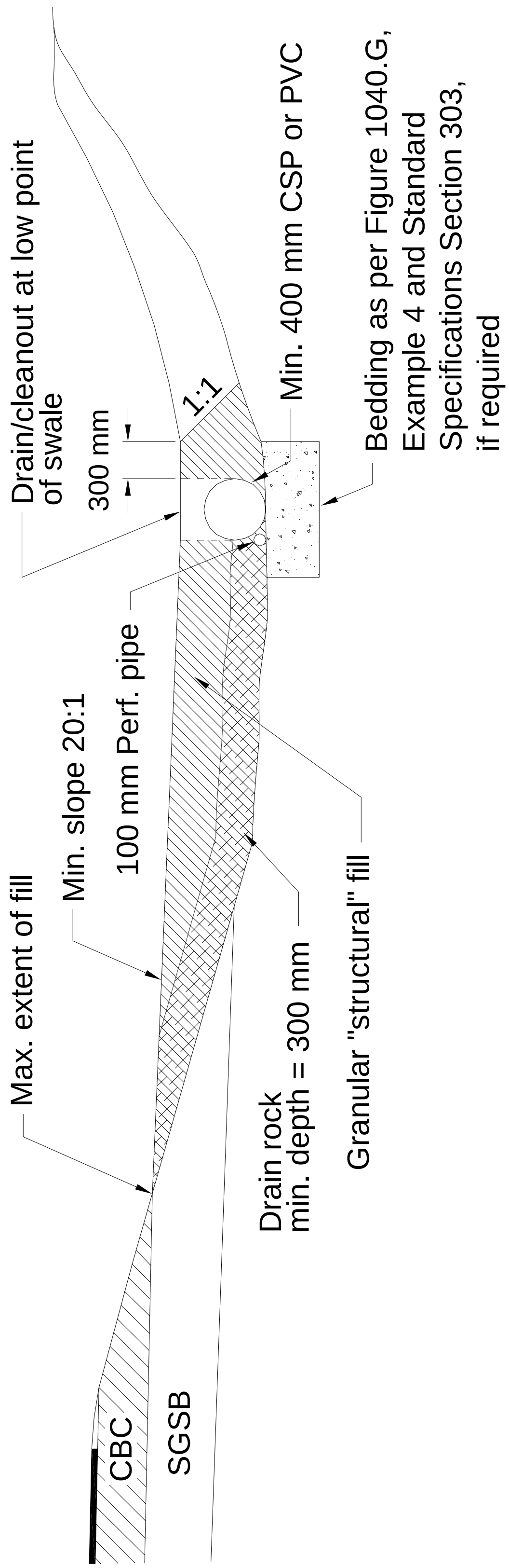
1060.09 PLANTING

Planting of shrubs or trees by property owners or their agents on Highway R/W will not be permitted.

1060.10 TRAFFIC CONTROL

Appropriate traffic control, signage, safety equipment and clothing must be used during construction.

Figure 1060.A Ditch Infilling / Culverting



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1100 RAILWAY CROSSINGS & UTILITIES CHAPTER

1110 RAILWAY CROSSINGS

1120 POLE RELOCATIONS

1100 RAILWAY CROSSINGS & UTILITIES CHAPTER - FIGURES

1110 RAILWAY CROSSINGS

1120 POLE RELOCATIONS

1110
RAILWAY CROSSINGS

1110.01 GENERAL

Any roadworks that revise, reconstruct, or relocate an existing crossing, or create a new crossing, must be approved by the appropriate Federal or Provincial Regulatory bodies. This approval process is co-ordinated through the Rail, Navigable Waters Co-ordinator of Engineering Branch, in Headquarters. The principal contact is:

Mr. Gordon Eisenhuth
Rail, Navigable Waters Co-ordinator
Engineering Branch

Mailing address;
PO Box 9850 Stn Prov Govt
Victoria BC V8W 9T5

Physical address;
4B - 940 Blanshard Street
Victoria BC

Ph: 387-7733 Fax: 387-7735

Drawings:

A special purpose drawing, called an "Application Layout" drawing, must be prepared to accompany an application for new at-grade railway crossings, as well as reconstruction, relocation, or revision of an existing crossing.

Drawing information and crossing requirements shall be in accordance with sample **Figure 1110.A**, at the end of this section. Clear view lines are a function of railway speed and roadway speed. Refer to **Section 1110.12** and **Figure 1110.G** for the roadway and railway approach distances respectively. It is expected that all road design issues will meet the requirements of the BC Ministry of Transportation Supplement to TAC Geometric Design Guide.

Time Frames:

For simple crossing revisions, that require no action or work by the Railway, other than approval, and where all costs are being borne by the Ministry, approvals to proceed can take at least 3 months.

For crossings requiring railway work and/or railway signal work, the process can take at least 5 months.

For any crossings where grants and/or cost sharing are required (to be determined by the Rail, Navigable Waters Co-ordinator Section), the process can take 6 months, at the very least.

Read the rest of this section to familiarize yourself with the background, process and guidelines.

Prologue:

This standard provides guidance in level railway crossing design and also provides information that will help you decide whether it is possible to construct a public crossing at a specific site. It is not the intention of this section to promote the construction of new crossings but to ensure that necessary crossings are designed to the latest standards. Poorly conceived crossings may create safety concerns not only at the crossing, but also to the road network directly adjacent to the crossing.

1110.02 SUMMARY OF RESPONSIBILITY CENTRES FOR RAILWAY CROSSING ISSUES

FUNCTION/RESPONSIBILITY	**TYPE OF CROSSING**		
	LEVEL	**OVERHEAD**	**UNDERPASS**
design standards	-Highway Eng. Branch	-Bridge Eng. Section	-Bridge Eng. Section
construction specifications	-Construction Eng. and Maintenance Services	-Bridge Eng. Section	-Bridge Eng. Section
maintenance contract	-Construction Eng. and Maintenance Services	-Construction Eng. and Maintenance Services	-Construction Eng. and Maintenance Services
maintenance/rehab. issues	-District	-District	-District

Please note that the Rail, Navigable Waters Co-ordinator in Bridge Eng. Section of Engineering Branch provides technical and planning information for the above. See **Section 1110.05"Summary of Responsibilities of Administration of Level Railway Crossings".**

- For utility and culvert crossings the Project Manager is responsible to coordinate with the railway.
- For properties, leases, private railway crossings it is the responsibility of Regional Properties section to coordinate with the railway.

1110.03 OVERVIEW OF LEVEL RAILWAY CROSSINGS

The history of railways in British Columbia predates most of the Province's roads. Many railways were in operation before vehicles were manufactured. As a result, during the initial railway and roadway construction, engineering was not concerned with the intricacies of crossing design. The advent of vehicles, and larger and faster trains, leaves many of the existing crossings poorly located and designed.

INCOMPATIBLE MODES OF TRANSPORTATION

Physical differences between railway operating equipment and roadway operating equipment lead to conflicts because of the manner in which they operate.

Railway equipment, which tends to be very heavy, large, and therefore not very adaptable to directional and speed changes, require rigidly set operating rules and timetables. A train cannot vary direction and is on a two way path which requires coordinated movements. The rules and timetables tend to dictate when and how the equipment is operated. Therefore, the employees are trained in a strict manner to ensure safe operations. Railway equipment is, for the most part, well maintained to a specific operational standard. Since a breakdown can lead to the closure of the trackage, equipment tests are performed regularly.

Roadway equipment, which is comparatively light, manoeuvrable and can vary speed rapidly, have only operational guidelines which limit speed and provide directional rules. The rules and speed limits tend to only emphasize maximum operational limits. Steerage is controlled by the operator. Vehicular operators are given a test which judges adaptability and can therefore, be subjective or change after a license is granted. Since vehicles are privately owned and must be adaptable for the operator's varied usage, the condition and characteristics can vary tremendously from vehicle to vehicle. Road conditions can also vary the operational characteristics of vehicles.

Right of passage for trains at level crossings has been an operational fact since cars where invented. Therefore, operators on roadways must vary operation when a crossing is occupied, or about to be occupied, by rail equipment. From a practical standpoint it is preferable for a train to continue unabated. Crossing occupancy time is reduced in this manner.

Determination of crossing safety must be made by the driver each and every time a crossing is approached. In order to allow this decision to be rendered without distraction the crossing should have clear sightlines to the rail approaches and/or signals. The crossing should have forgiving and smooth, horizontal and vertical alignments, laning and number of tracks clearly marked to avoid confusion. Roadside clutter, lane changing, nearby intersections and congestion can also lead to driver distraction. Wherever possible, a crossing and approaches should be designed to provide the driver with only that information required for safe passage.

STRUCTURAL DIFFERENCES

Railway equipment travels on ribbons of steel attached to ties which are on a "roadbed". The wheel flange rides on the inside or gauge side of the rail which maintains alignment and also maintains the railway equipment's ability to travel on the railway. These rails are approximately six to seven inches high. Due to the sizes and weights of railway equipment, the alignments and grades of the railway are not very flexible.

Roadway equipment travels on a paved or prepared gravel surface. This allows vehicles of various sizes and characteristics to travel a common route.

The **crossing** is a discontinuation of the normal road and rail roadbed structures. The requirement for a flangeway on the inside of the rails disrupts the continuous roadway surface. This "gap" increases the roughness of the roadway. Since the ties, supporting the rail, move up and down with the impacts and weights of the rail traffic, it is difficult to maintain a structurally sound surface in smooth condition.

Maintenance difficulties arise out of the operational and physical differences at level crossings. All work must be scheduled and coordinated so it does not conflict with the operation requirements of either facility. The physical differences generally make repairs inaccessible for either party. For example, the railway cannot run a continuous reballasting program through a level crossing without close coordination with the road authority. Conversely, the road authority cannot continue a paving program through a crossing without close coordination with the rail authority. As an example, both these programs may require raising the elevation of the crossing. This would be reflected in the approach gradients and may be restricted by other facilities (i.e. bridges, underpasses, intersections and drainage patterns) whose elevations may be fixed. Underground utility maintenance necessary for the safety and operation of either road or rail may also be inconvenient.

Drainage problems are caused on the roadway surface by the flangeway or the grade and crossfall of the railway. The flangeway acts like a flue collecting surface runoff and depositing it on the railway track adjacent to the crossing disturbing the integrity of the rail bed. A break in road profile can cause water and debris to collect on the roadway.

Integrity of the road surface and railway are difficult to maintain. A variety of forces all act to varying degrees at every crossing. Impacts of road traffic on the rail and pavement "creep" can break, overturn and move rails so they no longer function at a safe standard. Train impact loading and rail "creep" can pull and crack the road surface, which can cause an unsafe crossing condition for motorists.

LEGAL CONSIDERATIONS

Level crossings, by their very nature, are considered to be amongst the most expensive section of roadway per square meter to construct and maintain. The **liabilities** can also be amongst the most severe, especially when safety considerations of a proposal or maintenance is not given the highest priority. The strength of a liability claim increases through incompetence and negligence. When inspecting a facility or considering routes, a brief rationalization of the alternatives, considerations and effects must be made. If a fault is found, it must be acted on in a response time that is expedient and reasonable. Inspections must be carried out at intervals, which reflect the usage, history and importance of the crossing.

The right of passage, which permitted the installation of the crossing by either party, usually in the form of an Order or Certificate, indicates that a crossing is maintained in accordance with various Railway Acts and the Regulations pursuant thereto. Both railway and roadway authorities have a **legal duty** to ensure crossing safety.

TODAY'S PRACTICES

In order to reflect the developing technology of modern level railway crossings, many of the old crossings should be re-evaluated to determine their future prospects and alternatives (remedial measures) to provide an effective investment.

1110.04 JURISDICTION AND ADMINISTRATIVE LEVELS AND TYPES OF RAILWAY CROSSINGS

Two Charters control various railway crossings by means of Acts, Regulations and/or policies. The following table indicates the appropriate charter.

	FEDERAL CHARTER	**PROVINCIAL CHARTER**
Railway Companies	Burlington Northern Santa Fe Railway Canadian National Railway Canadian Pacific Railway Kelowna Pacific Railway Kettle Falls International Railway Okanagan Valley Railway	British Columbia Railway (Port Subd.) Canadian Forest Products Railway Canfor Englewood Logging Division Southern Railway of BC Grand Forks Railway International Railroad Reload Systems various logging railways industrial/resource spurs
Acts and Regulations	Canadian Transportation Act Railway Safety Act Railway Crossing and Relocation Act Supporting Standards and Regulations	Canadian Transportation Act (specific sections) Railway Safety Act (specific sections) Federal Standards and Regulations (specific sections)

Administrative Levels of Railway Crossings

Three basic administrative levels of railway crossings exist.

1) **Unrestricted** or **Public** railway crossings are generally recognized as public roads or walkways intersecting a railway.

2) **Restricted** or **Private** railway crossings (temporary or permanent) are generally vehicular or pedestrian crossings with controlled access, serving only one facility or property.*

3) **Farm** railway crossings allow farmers continued access to their lands which were severed by the railway.*

Types of Railway Crossings

Three physical types of railway crossings exist.

1) The most common crossing, because of initial cost and level of engineering involved, is at grade and most commonly referred to as the **level crossing**.

2) The second most common crossing is the roadway **overhead** structure (road over rail). Since the highway has more flexible horizontal and vertical alignments, this is the most popular grade separated crossing.

3) The roadway **underpass** structure (road under rail) is preferable when the railway is on a fill or near an escarpment, allowing easy passage of the roadway under the trackage with minimal structure size.

*Restricted (or Private) and Farm crossings are not covered in this section and are not administered by the Rail, Navigable Waters Co-ordinator. Engineering considerations for Restricted (or Private) and Farm crossings can be similar to Minor Public Roads.

1110.05 SUMMARY OF RESPONSIBILITIES OF ADMINISTRATION OF LEVEL RAILWAY CROSSINGS

1. Identify need	a) increase road capacity or convenience	• Area Manager/District/Region
	b) increase safety	• Area Manager/District (Fed/Prov) Agencies responsible for administering the Railway Acts • Railway company • Rail, Navigable Waters Co-ordinator
2. Develop plan and proposal		• Area Manager/District/ Region/Design company
3. Communication for facility/clearance provisions with railway/regulatory agencies		• Rail, Navigable Waters Co-ordinator
4. Allocate funds		• Area Manager/District/Region/Rail, Navigable Waters Co-ordinator
5. Engineering	a) - Level Crossings	• Area Manger/District/ Region/Design company
	b) - Railway signals	• Railway company
6. Application and Negotiation		• Rail, Navigable Waters Co-ordinator
7. Agreement by Rail and Road Authorities		• Rail, Navigable Waters Co-ordinator
8. Approval (Order, Decision etc.)		• (Fed/Prov) Agencies responsible for administering the Railway Acts
9. Maintenance work in accordance with approval; work is carried out by:		• Highway Approaches = road authority • Signals = railway company • Crossing Surface= as arranged

1110.06 TYPES OF WORKS, OPERATIONAL CHANGES, AND STATUS CHANGES AT RAILWAY CROSSINGS

TYPES OF WORKS

Eight basic types of railway works are defined although some activities on existing crossings combine more than one type.

1) **Construction** of a new public crossing.
2) **Alteration** of a crossing including works which vary geometry or dimension of the crossing (within 10 metres of trackage) such as revising the alignment or adding a sidewalk.
3) **Reconstruction** of a level crossing usually indicates that an existing crossing is to be totally renewed without substantial alteration.
4) **Relocation** of a level crossing is usually done to upgrade a section of road or replace an unsafe crossing with one at a more suitable site.
5) **Removal** or **closure** of an existing crossing. Road closure or railway abandonment.
6) **Signalization** of a crossing indicates that some form of an active warning or protective device has been installed at a level crossing.
7) **Interconnection/pre-emption** modification to a railway or traffic signal will require a review of the timing sheets and may require modifications to signal operations to maintain a safe crossing environment. Prior to signal/sign reconfiguration the effect to crossing safety must be evaluated.
8) **Maintenance** work is a repair or partial renewal to an existing crossing or signal to provide safe and unencumbered passage.

OPERATIONAL CHANGES

Operational changes including speed changes (rail or road), lane reconfiguration or changing direction, increasing volumes due to other factors such as development, detours etc. and whistling cessation.

STATUS CHANGES

Status Changes include changes in:

a) road authority
b) jurisdiction
c) maintenance responsibilities.

1110.07 APPROVALS FOR WORKS OR STATUS CHANGES AT RAILWAY CROSSINGS

These are the actions/approvals required before undertaking railway works and status changes.

RAILWAY WORKS/STATUS	REGULATORY ACTIONS REQUIRED
Construction	Public notice/Agreement/Order
Alteration	Public notice/Agreement/Order
Reconstruction	Notify Railway
Relocation	Public notice/Agreement/Order
Removal or closure	Notify Railway*****
Signalization	Public notice/Agreement/Order
Interconnection/pre-emption	Notify Railway
Maintenance	Notify Railway
Operational	Public notice/Agreement/Safety study
Status	Agreement/Order/

NOTE:

Public notices are to be forwarded to landowners immediately abutting the crossing works at least 60 days before the work commences. See **Section 1110.16** for a Public Notice Example.

* May require Order or Certificate if not in connection with a relocation or not included in an Order or Certificate for related work. Federal Grant monies may be available through the Rail, Navigable Waters Co-ordinator.

If an agreement between Road Authority and a Federally-Regulated Railway is not possible due to a dispute over cost, location or design, may require a Decision by the Canadian Transportation Agency (CTA). An Environmental Assessment must be submitted allowing, under the Canadian Environment and Assessment Act, the CTA to issue a Decision or Order. The CTA may be able to help the parties resolve the issues through its mediation process before a Decision is rendered. An Environmental Assessment would not be required if the dispute is resolved through mediation.

1110.08 CONSTRUCTION COSTS AND GRANTS RESPONSIBILITIES AT LEVEL RAILWAY CROSSINGS

The following table describes the basic responsibilities in accordance with activity:

ACTIVITY	FEATURE	COST TO	WORK DONE OR DIRECTED BY	WORK PROTECTION REQUIRED
Construction	Level Crossing Surface	Per Agreement/ Order	Rail & Road	Rail & Road
Construction	Road Approach	Road*	Road	Road & Rail within 5 m of Rail
Construction	Rail Approach	Rail*	Rail	Road & Rail Shoulder to Shoulder
Construction	Road Culvert	Road*	Road	Road & Rail within 5 m of Rail
Construction	Rail Culvert	Rail*	Rail	Road & Rail Shoulder to Shoulder
Installation	RR Whistle Post/Flange Sign	Rail	Rail	None
Installation	RR Crossing Sign "Crossbuck"	Rail	Rail	None
Installation	Stop Sign	Road*	Road	None
Installation	Advance Warning Sign (WC-4, W-10 or W-1011 etc.)	Road	Road	None
Installation	Rail Signals	Per Agreement	Rail	Rail & Road

*** Unless otherwise ordered or agreed.**

Crossing must be public for at least three years and be eligible for Federal Funding, after determination by Transport Canada, for a safety enhancement. Cross-product (trains per day X vehicles per day) should be over 1,000 to have a chance of receiving federal grants for up to 80% of eligible works.

If the road authority is senior in a Municipality, City Town or Village, the road authority shall pay maintenance costs of the crossing surface beyond the original highway right-of-way width.

1110.09 LEVEL RAILWAY CROSSING CONSTRUCTION APPLICATION REQUIREMENTS

Level Railway Crossing Construction Approval Procedures

For the **re/construction of railway crossings,** a drawing, as shown on sample **Drawing 1110.A**, should be completed and forwarded to the Rail, Navigable Waters Co-ordinator. Drawings in PDF format preferred. Some information, which can not normally be included on drawing, is required for the application. Please advise of the proposed date of commencement and the projected time for completion of the works and roadway speed limit and number of vehicles per day and type of traffic (school buses, logging trucks, bicycles etc.).

NOTE: Every reasonable attempt must be made to meet the standards.

Road-Railway Crossing Requirements

Note: If tracks are more than 30.5 metres (100 feet) apart they should be considered as separate crossings unless the tracks are less than the desirable distance in Table A (found in Section 1110.11) apart or vehicle queuing approaches within 5 metres of multiple tracks or a stop condition at or between the tracks causes vehicles to queue within 5 metres of another track.

Overhead luminaries should be installed when an unsignalised crossing has any of the following conditions:

- Train switching movements at the crossing or at any Spur crossing in urban areas;
- Vehicle headlights do not illuminate the crossing due to approach alignments and grades;

Railway crossing signals shall be required if:

- Within three years of opening, the cross-product (trains per day times vehicles per day) is 1000 or over;
- Sight-lines are inadequate (see **Section 1110.12**);
- If the tangential direction of the road alignment at any point within the desirable distance from the crossing (specified in Table A of **Section 1110.12**) exceeds 70 degrees intersection angle with the railway;
- Pedestrian/cyclist crossings of two or more tracks where trains can pass each other;
- Pedestrian/cyclist crossing centre line is more than 3.6 metres (12 feet) from a road crossing signal.

A level railway crossing, road intersection or property access shall not be constructed where:

- There is less than 30 metres between the level railway crossing and road intersection or property access;
- There is more than 30 metres and less than 200 metres between the level railway crossing and a road intersection with a stop sign or traffic signal for traffic departing the crossing unless interconnected to railway signals;
- A study indicates that vehicle queuing will approach within 5 metres of the crossing unless the pre-empted traffic signals can provide an effective clearout phase in accordance with latest standards.

Railway crossing signals with gates shall be required if:

- Within three years of opening, the cross-product exceeds 50,000;
- There are two or more passing tracks or railway equipment is stopped within the required sight distance for the departure time (time it takes to clear all tracks) plus at least 5 seconds before the train arrives;
- There is a signalized roadway intersection within 60 metres of the crossing;
- When train speeds 50 mph or more;
- Crossing Angle exceeds 70 degrees;
- Pedestrian sight distance 8 metres from the nearest rail is less than the departure time (time it takes to clear all tracks) plus at least 5 seconds before the train arrives.

Pedestrian/Cyclist crossing approaches shall have:

- Grades less than 2% within 5 metres of nearest track (less than 1% for crossings with persons depending on mobility assistive devices);
- Grades of less than 10% beyond 5 metres and within 10 meters.

Road grade through crossing and within 10 m of track shall have a maximum grade differential between road grade and railway superelevation (Cross-slope between top of rails):

- 0% for ≥ 60 km/h (road speed)
- 1% for 40-60 km/h (road speed)
- 2% for < 40 km/h (road speed);
- Zero grade differential is preferred.

Road crossfall on tangent approaches shall be transitioned at a maximum rate of 2% per 30 metres to match the track grade at the crossing. Road superelevation on curved approaches shall be transitioned over the appropriate length of spiral and tangent run out (refer to **Section 330** of the BC MoT Supplement to TAC Geometric Design Guide).

Grade separation may be required if Cross-product 200,000 or over within three years or if on divided highway or major arterial.

1110.10 TYPES OF CROSSING SIGNALS AND SIGNAGE

Types of Automatic Signalized Protective Devices for Level Railway Crossings

Three variations of **Automatic Signalized Protective Devices** are generally used. To provide protection from vehicular traffic, the centre of the signal post foundation should be at least 1.4 metres from the face of a curb or 2.6 metres from the edge of the travelled way. If signals are subject to damage from vehicle strikes, and relocation is not practical, protection such as concrete barriers is advisable. The post foundation should also be at least 3 to 5 metres from the nearest rail and positioned to stop road traffic at least 5 metres from the nearest rail. No part of a signal or gate may be less than 3 metres from the nearest rail. These are usually installed and maintained by the rail authority. If stop bars are required for traffic control, they should be placed 2.5 metres in front of the signal or gate, whichever precedes the other and be at right angles to the lane.

1) **Floodlights** are installed at railway crossings in areas of railway switching activities and when the highway approach gradients or alignment do not allow the vehicle headlights to illuminate the crossing. Floodlights are also used in areas with weather caused visibility problems.
2) **Automatic Signals** usually consist of flashing lights and bells on a simple post or mast located to the right of the lane they are intended to control. Generally these devices control only one lane of traffic. **Cantilevered Signals** are used over multiple, when the roadway geometry obscures the signal for approaching traffic or when road speed exceeds 80 km/h, or when signal foundation is more than 7.6 metres from the roadway centreline. Cantilever section should extend from mast at right angles to extend lights over the near edge of any lane it is intended to control.
3) **Gates**, when required, usually are part of the previously mentioned signals. In the lowered horizontal position, the gate should be positioned at right angles to the roadway and extend to within 0.3 meter of the left side of any lane it is intended to control. Gates are used for crossings of multiple tracks, in heavily congested areas, and when the speed and volume of rail and/or road traffic is high. Islands or Median Barriers at the centreline are advisable to ensure driver compliance. Gates will typically begin to descend 3.5 to 8 seconds after railway signals begin to flash.
4) **Interconnection** of automatic signals and highway intersection traffic lights is usually required if the facilities are less than 60 metres apart and beyond 60 metres if studies indicate traffic queuing will reach within 5 metres of the trackage. This circuit is used to provide a pre-emptive clearing of all highway traffic from the railway crossing prior to the train's arrival.
5) **Active Advance Warning Signs** should be employed when a signalized railway crossing is located within a highway speed zone above 60 km/h, or where sight distance to the signal does not allow sufficient stopping distance.
6) **Optically Programmable Signs** (Light Emitting Diode most common) **"NO LEFT/RIGHT TURN TRAIN XING"** signs are used when signalized roadway intersections are within 30 m of a signalized level railway crossing, to ensure that drivers are aware of crossing use by rail equipment before turning toward the crossing. This averts stopped vehicles from blocking lanes or impacting rail equipment. These should not be used in conjunction with or to replace "Protected" turn signals where warranted.

Note: Should any crossing or interconnected traffic signal system fail, the railway should immediately provide qualified flag persons until the signal is again operational. At no time should the interconnection/pre-emption be disconnected or made inoperative without an approved traffic plan.

Types of Level Railway Crossing Advisory Signage

Three types of advisory signs are used.

1) **Railway Advance Warning Sign** (WC-4, W-10 or W-1011 etc.) This is required at all public level railway crossings and should be placed between 30 & 150 metres from the track in low speed zones and between 105 & 230 metres from the track in highway speed zones, where most practical, on right hand side of road and facing the approaching traffic. This is installed and maintained by the road authority.

2) **Reflectorized Crossing Signboard** is required at all public level railway crossings and should be installed, where practical, at least 3 metres from the nearest trackage, on right hand side of road and facing the approaching traffic. When the crossing has automatic signals, this sign is usually attached to the signal post. Small advisory signs are attached to the post below the sign at crossings with multiple tracks to indicate the number of tracks to be traversed.

   These are usually installed and maintained by the rail authority; also known as "crossbucks". On federally regulated railways it is common to find the railway mileage noted on the back of the signboard.

3) **Stop Signs** (R1) and **Stop Bars** should be at least 5 metres from the nearest track and, where possible, they should not pre-empt good sight-lines or the introduction of automatic signalization, if either is warranted. These are usually installed and maintained by the road authority. Stop signs should not be removed unless an engineering study indicates otherwise. Stop signs are also required for unsignalised level railway crossings within 60 metres of a major road intersection.

Stop bars should be at right angles to the road. Stop Signs should be attached to the Reflectorized Crossing Signboard post.

Other signs used at railway crossings are "No Stopping On Tracks" or "No Stopping Foul Of Tracks". These are usually used when railway crossings and roadway intersections are less than 60 metres apart or where vehicles frequently stop in the trackage area. At intersections near railways, it may be necessary to install "No Right Turn On Red" signs to ensure motorists do not cross the railway when rail equipment is present.

The railway provides Whistle Posts on the railway approaches to a road crossing. These are removed in areas where an Anti-Whistling By-Law has been approved by the railway and Municipality if the Ministry agrees. Studies must be conducted in accordance with Federal Whistling Cessation Regulations before it can be considered. Anti-Whistling is coordinated by the Rail, Navigable Waters Coordinator. “NO TRAIN HORN” signs may be used at crossings where trains are not required to whistle.

Level Cyclist Railway Crossings

Advance warning signs are installed at all railway crossings to warn the cyclist of the crossing. All bike paths and bike lanes have pavement stencils to warn cyclists of railway crossings.

Pedestrian Crossings

Pedestrian crossing should have clear view of any adjacent road crossing signals or signs. When pedestrian crossings centre line is not within 3.6 metres (12 feet) of road crossings, separate warning signs are required. Signals dedicated to pedestrian crossing use may be required when the pedestrian crossing centre line is more than 3.6 metres (12 feet) from a public road crossing with signals. Maze barriers may also be warranted if approach grades exceed 10% or if crossing does not have signals with gates. Maze barriers may also be warranted if other vehicles can access the crossing.

1110.11 CLEAR VIEW TRIANGLE

Clear view is defined as a sight line without obstruction from 1.1 metres above the road surface to 1.2 metres above track level in a quadrant. **Table A** is used for all crossings to calculate the distance along the road approach from the railway crossing the driver must be able to see the train. **Table B** is the distance from the crossing, along the track, that the driver must be able to see the train for crossings that do not have stop signs or signals. Use **Table C** at all crossings without gates and at crossings with road design speeds less than 10 km/h.

Table A	**Distance Along Road Approach to the Nearest Track, in metres**			
Road Grade >>	0%	-3%	-5%	-8%
Road Design Speed km/h				
Stop sign/Signal	10	10	10	10
10	35	35	35	35
20	50	50	51	51
30	60	60	61	62
40	70	71	73	74
50	110	113	115	118
60	130	134	138	144
70	180	187	193	203
80	210	219	227	341
90	265	278	288	307
100	360	377	391	416

Table B Distance Along The Track From Crossing (No Signals or Stop Signs)

Track speed mph	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
Sight Distance (m)	90	113	135	158	180	203	225	248	270	293	315	338	360	383	405

Table C Distance Along The Track From Crossing With Stop Sign or Signal (No Gates)

Track speed mph	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
Sight Distance (m)	156	194	233	272	311	350	389	428	467	506	544	583	622	661	700

Correction value for multiple tracks in Table B and C

Distance between outside track centrelines (m) as measured along centreline of each lane ~ 'round up'	5m	10m	15m	20m	25m	30m	35m	40m
Multiply **Table B** Sight Distance (m) by this factor for required sight distance	1.25	1.33	1.42	1.50	1.60	1.70	1.80	1.90
Multiply **Table C** Sight Distance (m) by this factor for required sight distance	1.10	1.20	1.30	1.39	1.48	1.57	1.67	1.77

Note: Gates are considered to be a compulsory stop condition used to mitigate the effects of very poor sightlines, nearby intersections and high road and/or rail speeds. Signals without gates are a mandatory stop condition but allow drivers to proceed when they determine it is safe to do so. Therefore crossings with gates do not normally have a sightline requirement.

Note: Correction to the above values should be made for slow moving equipment, very large/long loads and where road geometry may cause road vehicles to occupy the trackage area for longer than 17 seconds. Corrections for cyclists over multiple tracks may also be required.

Note: Pedestrian sightlines are based on the ability of a pedestrian to see the train a sufficient distance from a point 8 metres from the track to allow the pedestrian to clear all tracks (departure time) plus at least 5 seconds before the train arrives. Pedestrian departure times are based on a travel speed of 1.22 m/s.

1110.12 LEVEL RAILWAY CROSSING SURFACE SELECTION

When constructing a new crossing, or when upgrading, widening and/or relocating a level crossing, determination of the crossing surface type should be made. On upgrading (some widening projects) or relocation projects, where the railway is the junior party, they should be given the opportunity to upgrade the surface to a more suitable type given the traffic and environment. Some cost sharing may be applicable for crossings where rideability and liabilities are paramount.

Roadway speed is a very important consideration in the selection process. Drivers in urban environments, with slow moving traffic, do not consider a rough crossing surface as anything more than a nuisance. On rural routes and highways where speeds exceed 50 km/h, a well designed and maintained crossing will be more likely viewed as a safety issue.

Rail speed increases the requirement for the trackage to be stable and exactly positioned. Most railway mainlines have portions of trackage with speed exceeding 50 mph. Since the track flexes under each wheel, speed can cause the wheel flange to climb the track and cause a derailment if the railway gauge is not exact or due to lateral forces in a curve.

The characteristics of a crossing have a direct bearing on the rideability, safety, and level of maintenance required. Rideability and safety are enhanced if road and railway approaches are level, at a right angle crossing, and in good condition. The crossing life, maintenance costs and rideability suffer a great deal if the crossing is skewed, has super-elevated curves, or poor approach grades, in any combination (common in B.C. due to geography).

Crossing surfaces should incorporate flangeways with dimensions not greater than 4.75 inches (12.06 cm) or less than 2.5 inches (6.35 cm).

In urban areas and on crossings with regular pedestrian/cyclist use or in areas with persons depending on mobility (assistive) devices, the flangeway should be 64 to 70 mm (2.5 to 2.75 inches) wide and 50 mm (2 inches) deep. This minimum flangeway width is preferred for accommodating the above noted users; therefore, skewed crossings should be avoided. The crossing surface shall be at least 2.8 metres wide measured at right angles to the trail or path.

Deviation for the crossing surface elevation to the top of rail elevation should not exceed 1 inch (25 mm). For crossings with regular pedestrian or cyclist use, or in areas with persons depending on mobility (assistive) devices or where road speed exceeds 60 km/h, this deviation should not be greater than 0.4 inches (10 mm).

Outside “mud rails” are no longer permitted. There may be some rail equipment wear outside of the rail head on the crossing surface but this should not exceed 0.4 inches (10 mm) in depth.

Crossing surfaces are required to extend 0.5 metres beyond the width of the travelled surface (top of shoulder to top of shoulder) measured at right angles to the road.

The environment of a crossing can affect safety and maintenance costs/rideability of a crossing. The environment can be defined as the weather patterns of the crossing area and its effect on the surface and subgrade. If there is poor subgrade/subsoil and harsh weather patterns that act on a crossing, more frequent inspection and maintenance is required. Good drainage, as with any weight bearing material, is paramount.

If weather patterns affect surface traction for vehicles, then safety is an increased concern. A crossing with good traction, especially on curves, becomes one of the highest priorities.

1110.13 TYPES OF LEVEL RAILROAD CROSSINGS

See "TYPICAL CROSSING SECTIONS" FIGURE 1110.B through 1110.D

BITUMINOUS

The **asphalt paved** crossing surface is popular because of the availability of the bituminous material and the construction techniques are universal to all road authorities. They are often paved from the tie level, full depth, to the top of rail or an appropriate lift of gravel is placed to allow paving. In areas of heavy rail or roadway traffic, the pavement often cracks or buckles allowing the creation of potholes in the surface. Cracks and potholes allow the introduction of water into the railway ballast leading to track pumping which, in turn, compounds the problem. Where pavement potholes and cracking are obvious, often the pressure of vehicles is enough to break or overturn a rail which, if not immediately remedied, would certainly cause a train derailment.

CONCRETE PANEL

Concrete panel or concrete planked crossings have been in use for the last 30 years at crossings with heavy road traffic. Generally there are panels between the rails one on each outer side of the rail. As with all crossings preparation of the railway structure including ballast has been renewed and the area is not prone to settlement problems, this type of crossing can provide good service. Rubber flangeway "rail seal" products are often attached to the panels but separate (unattached) flangeway materials are satisfactory.

RUBBER

The **rubber** crossing surface is usually made up of full depth panels, pre-formed to abut directly to the rail, forming a seal against water. Some types of rubber crossings are not full depth and require shims to ensure the proper road surface elevation. Full depth rubber crossings provide a flexible member between the pumping of the trackage and rutting of the pavement. Due to the nature of rubber in wet weather discretion should be used when considering its use near or at curves and intersections/cross-walks.

TIMBER

Timber is the most common type of crossing surface and is especially prevalent on rural roads or crossings with low vehicular speeds and/or volumes. Generally there are five or six planks between the rails with two on each outer side. The timbers are usually attached to the ties by a spike, although screws are occasionally used. Shims are sometimes placed between the wooden plank and the ties to obtain the proper elevation. The timber planks should not rest on the tie plate and spikes as this may cause a tilting of the plank resulting in a rough crossing surface. Since traction may be poor on wet timber surfaces use of this type of crossing in curves or near intersections is not recommended.

TREATED TIMBER

Treated hardwood timber planks are usually installed at locations where road traffic is heavy. Generally, six to eight planks are used between the rails with two on each outer side. Since they are made of hardwood, and are engineered for each placement, high speed highway use is acceptable. Timber sections are screwed into hardwood rail ties. Some manufacturers may provide crossing panels that are made up of several planks fastened with structural rods and post tensioned.

Note: All crossings should be used in conjunction with flangeway designs meeting the requirements noted in the previous section, “Level Railway Crossing Surface Section”.

1110.14 PUBLIC NOTICE EXAMPLE

Example of a Notice for distribution to the Railway Safety Directorate, Railway Company and Municipality for federal railway crossing works, (for new crossings it must also be forwarded to land owners immediately abutting the project:)

NOTICE

date:_______

Please be advised that the Ministry of Transportation is proposing to ______"A"_______ _____"B"____road/highway to ______"C"_____ at the railway crossing of _______"D"_________ Railway at Mile ______"E"______ Subdivision.

The location of the proposed work will be from lot_____________ to lot_______________ in the Land Registry District of _________________-or- all within the railway right-of-way.

Attached is a copy of Drawing No. ______ dated ____ which indicates the location and design of the proposed works.

The crossing will be ________lanes wide and provide ________"F"________. The road will cross the track at an angle of degrees.

This railway crossing has been designed in accordance with design standards passed in support of the Railway Act with the exception of the __"G"___ which is required due to the geography on the _____"H"______.

This project will provide ____"J"_____ to more safely accommodate traffic.

This project is scheduled to start _date______and be completed by__date______.

For further information contact ____"I"__________.

Please provide written objections based on safety of persons or property to ______"I"_________within 60 days of the Notice date; copies of written objections should be forwarded to:

Director General
Railway Safety Directorate
Transport Canada
427 Laurier Avenue West - Suite 1410
Ottawa Ontario K1A 0N5
Canada

A - construct, relocate etc..
B - name of road crossing
C - enhance safety, increase capacity etc..
D - name of railway company
E - mileage (including Subdivision name) on railway
F - sidewalks, lighting etc..
G - _% grades, crossing angles, sightlines etc..
H - indicate approach, quadrant etc..
I - project manager name and address.
J - more lanes, better alignment, better sightlines etc.

MoT Section	1110		TAC Section	Not Applicable

Figure 1110.A - Sample Level Crossing Application Layout

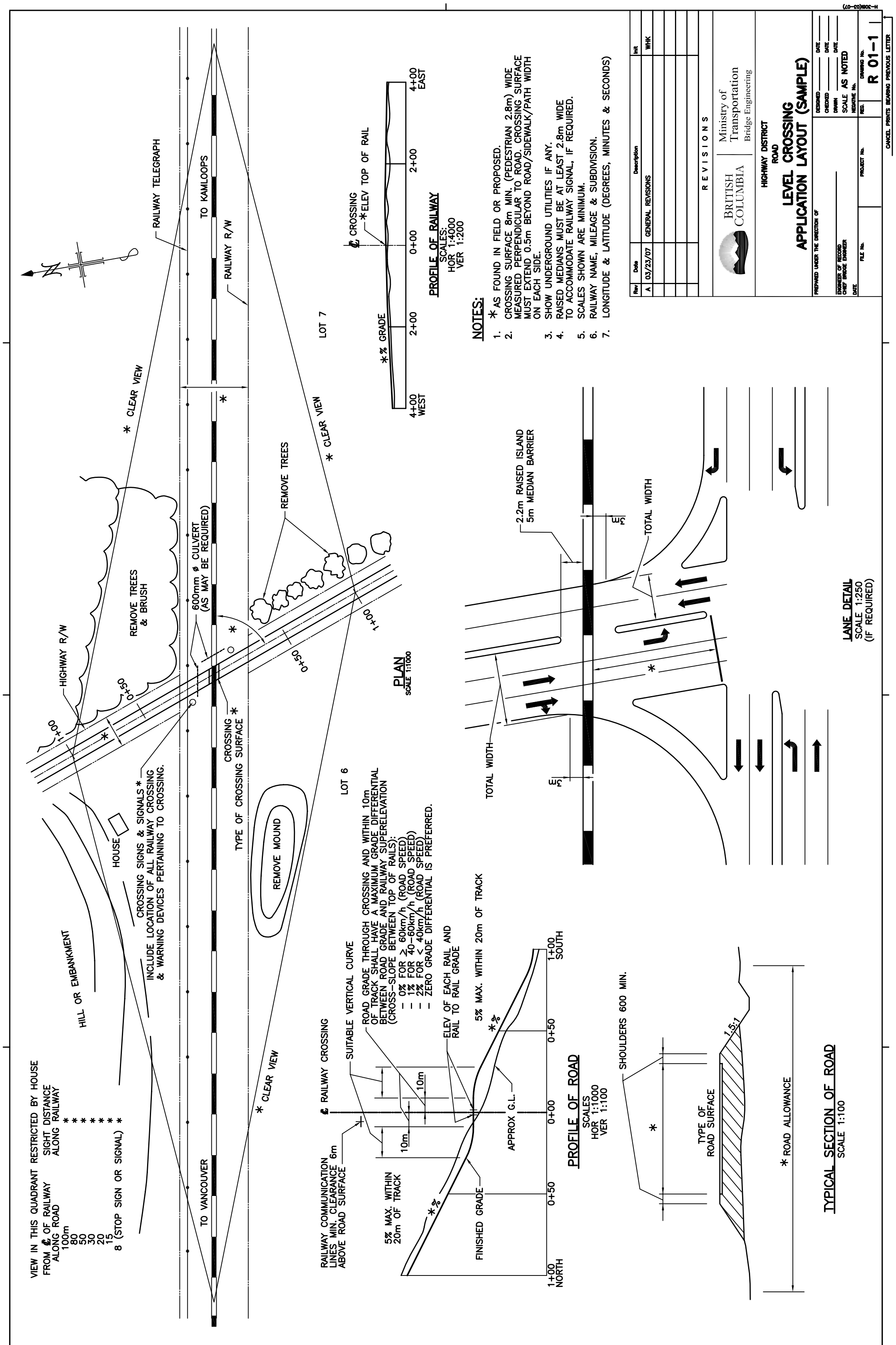
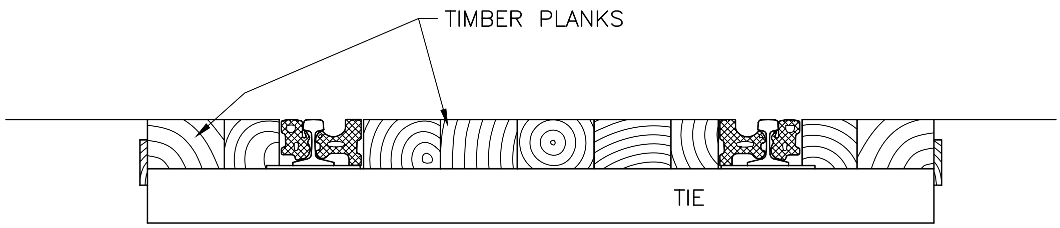
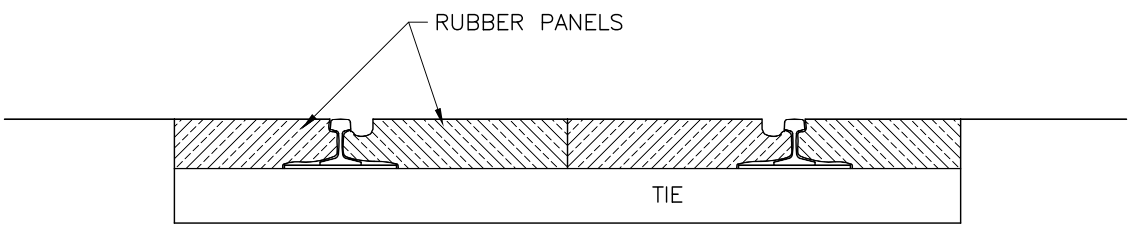


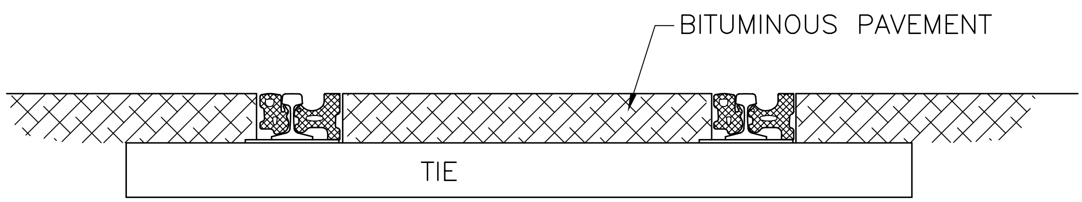
Figure 1110.B - Typical Cross Sections



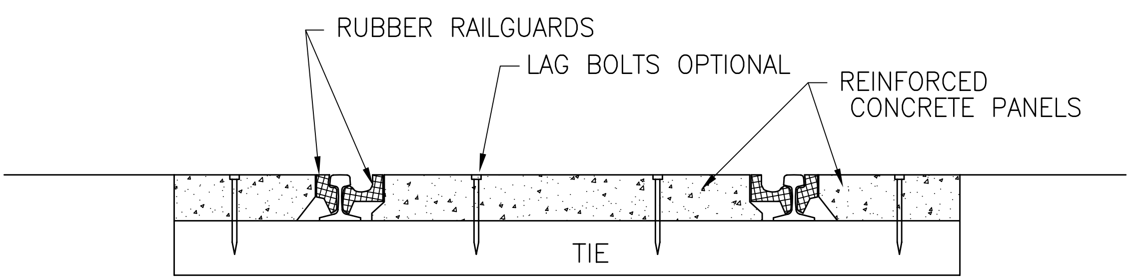
TIMBER CROSSING



RUBBER (ELASTOMERIC) PANEL CROSSING



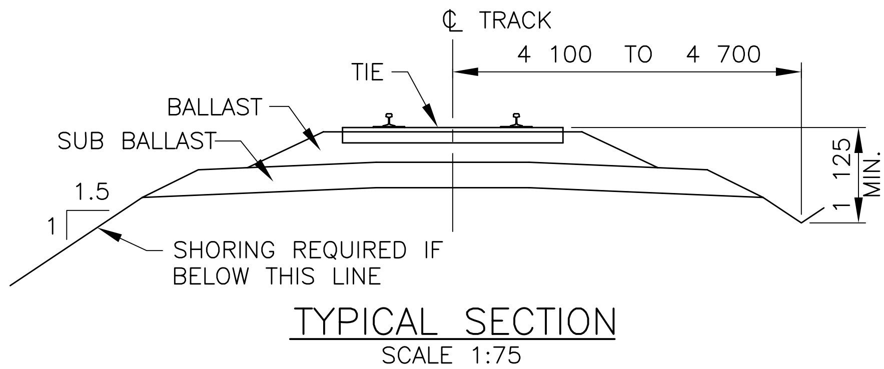
BITUMINOUS CROSSING / RUBBER SEALS

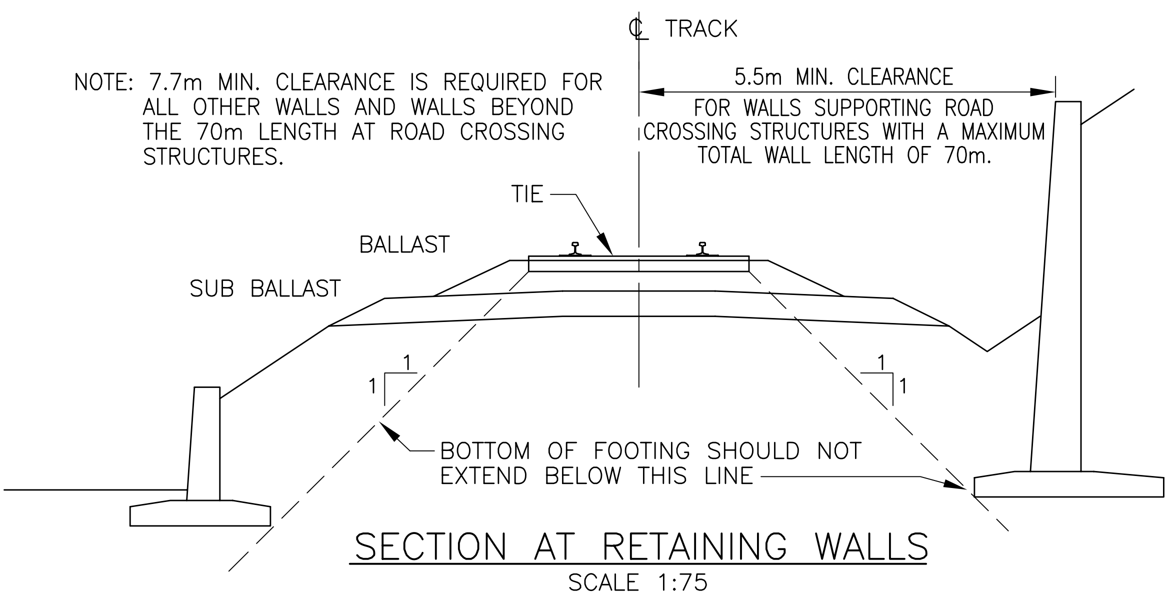


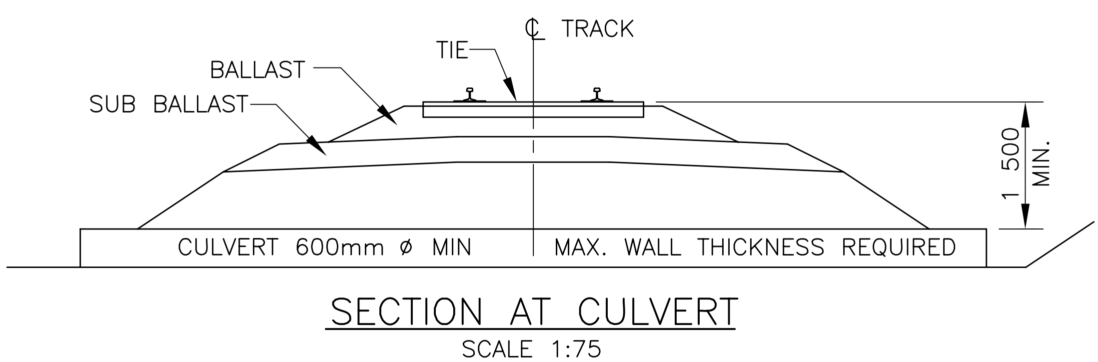
CONCRETE CROSSING / RUBBER SEALS

NOTE: – RUBBER FLANGEWAYS TO BE USED.
– RAIL FLANGE WAYS DO NOT CONFORM TO CURRENT STANDARDS.

Figure 1110.C - Typical Cross Sections

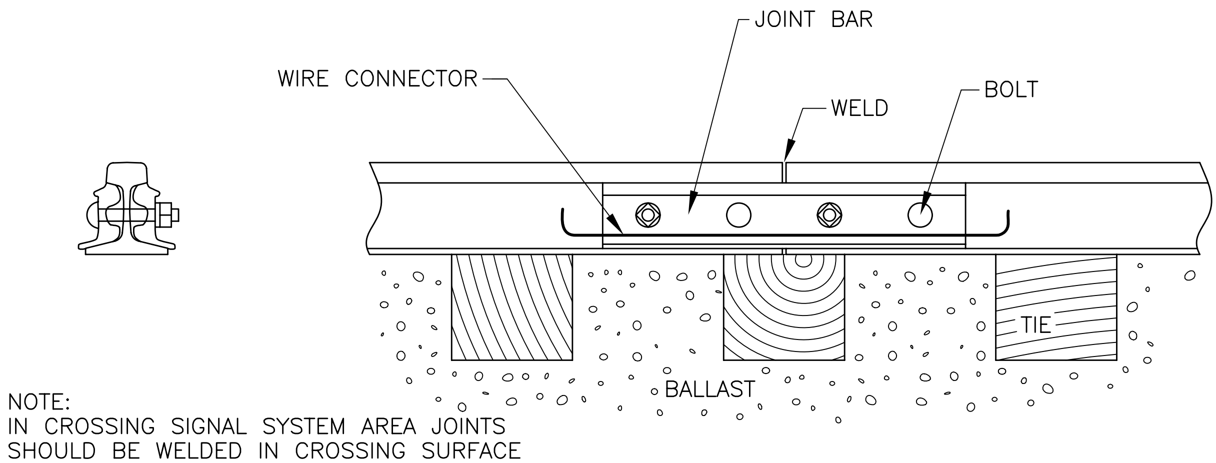




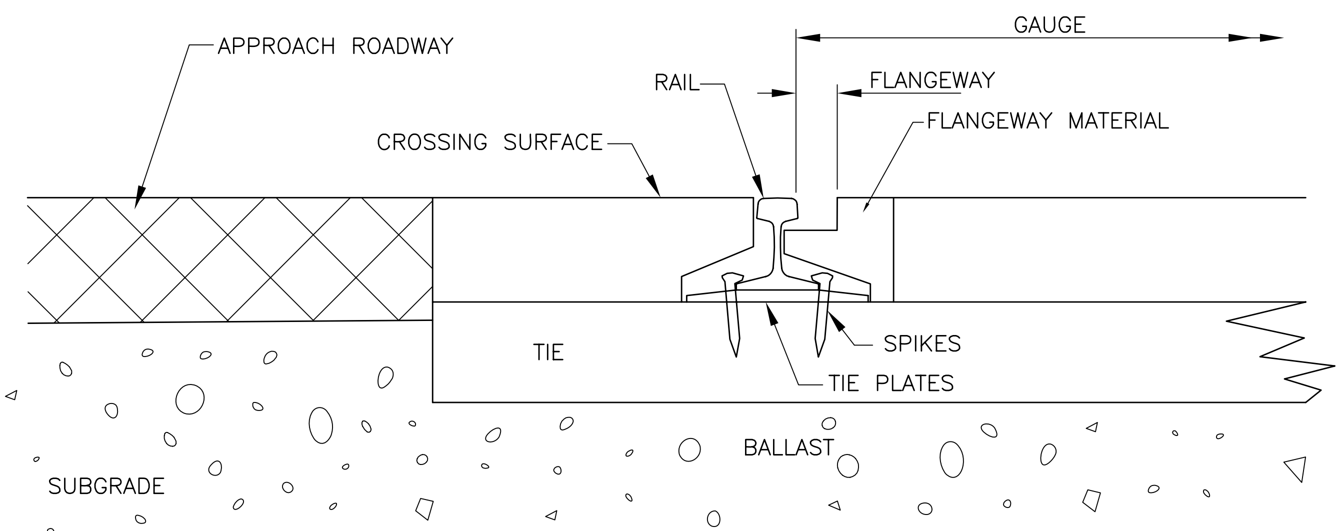


MoT Section	1110		TAC Section	Not Applicable

Figure 1110.D - Typical Cross Sections



DETAIL AT RAIL JOINTS
SCALE 1:10

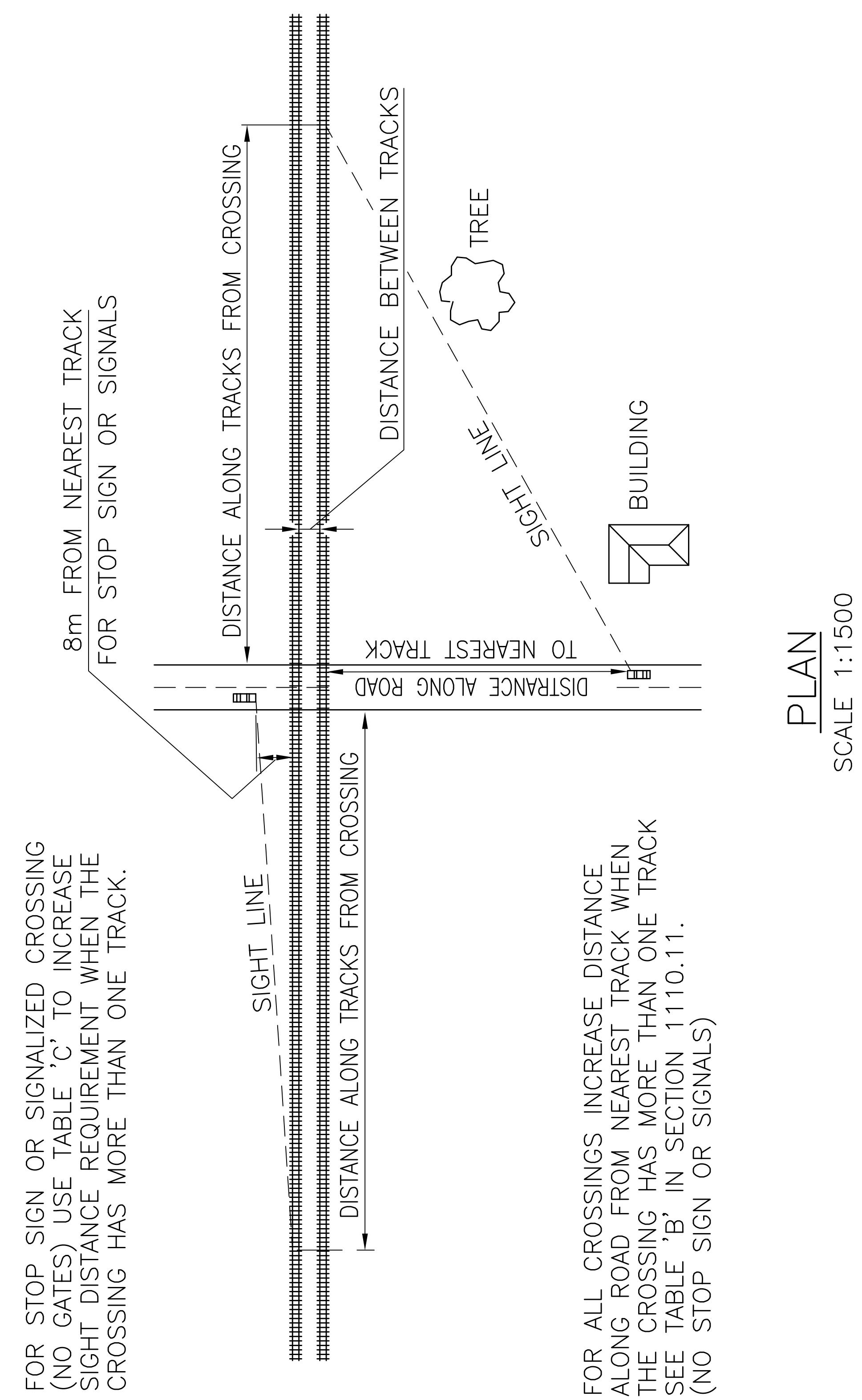


NOTE: FLANGEWAY –WIDTH 4.75" TO 2.5" (2.75" PREFERRED IN URBAN AREAS)
–DEPTH <3"

TYPICAL SECTION
SCALE 1:10

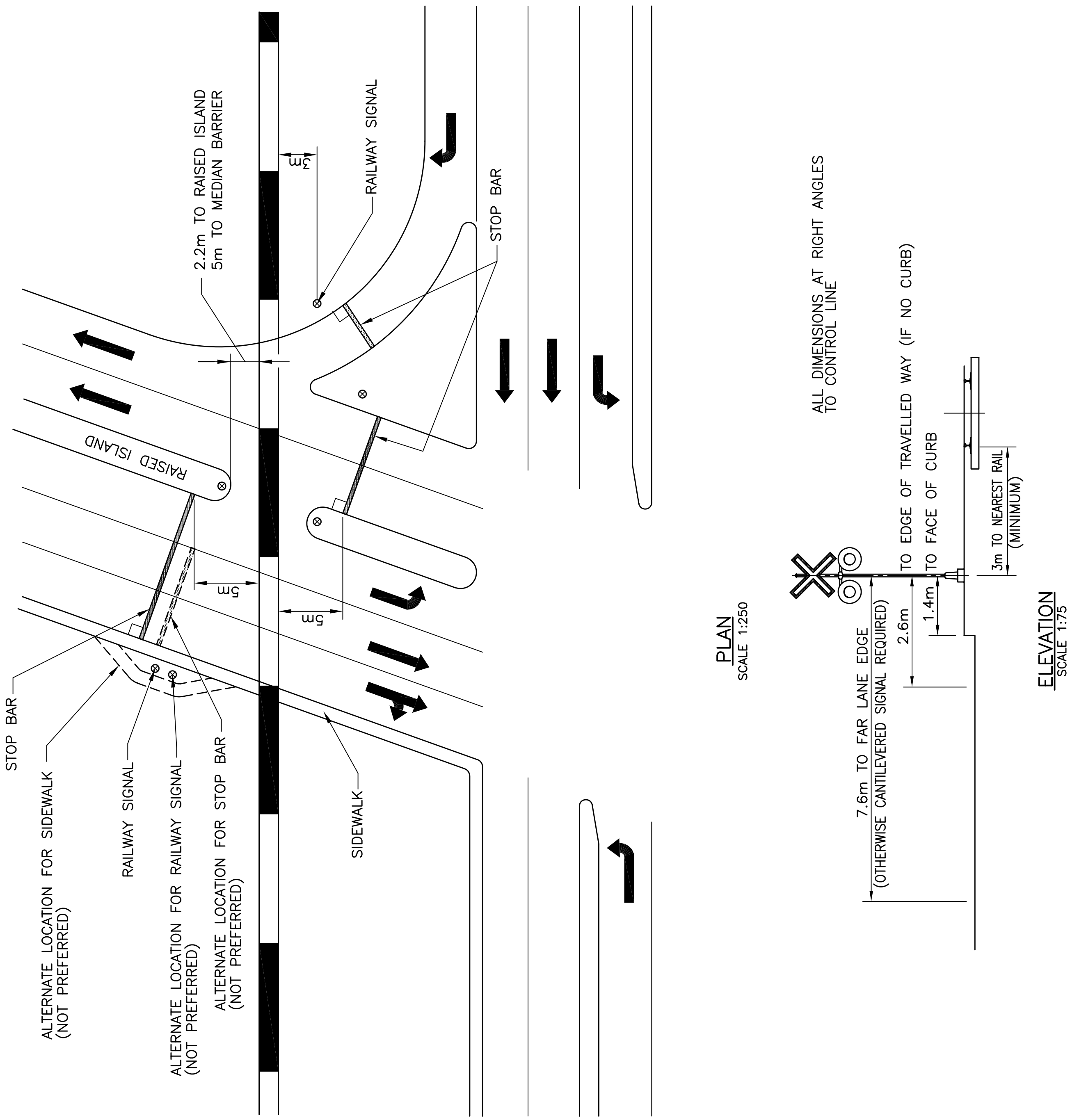
MoT Section	1110		TAC Section	Not Applicable

Figure 1110.E - Clear View Triangle Requirements



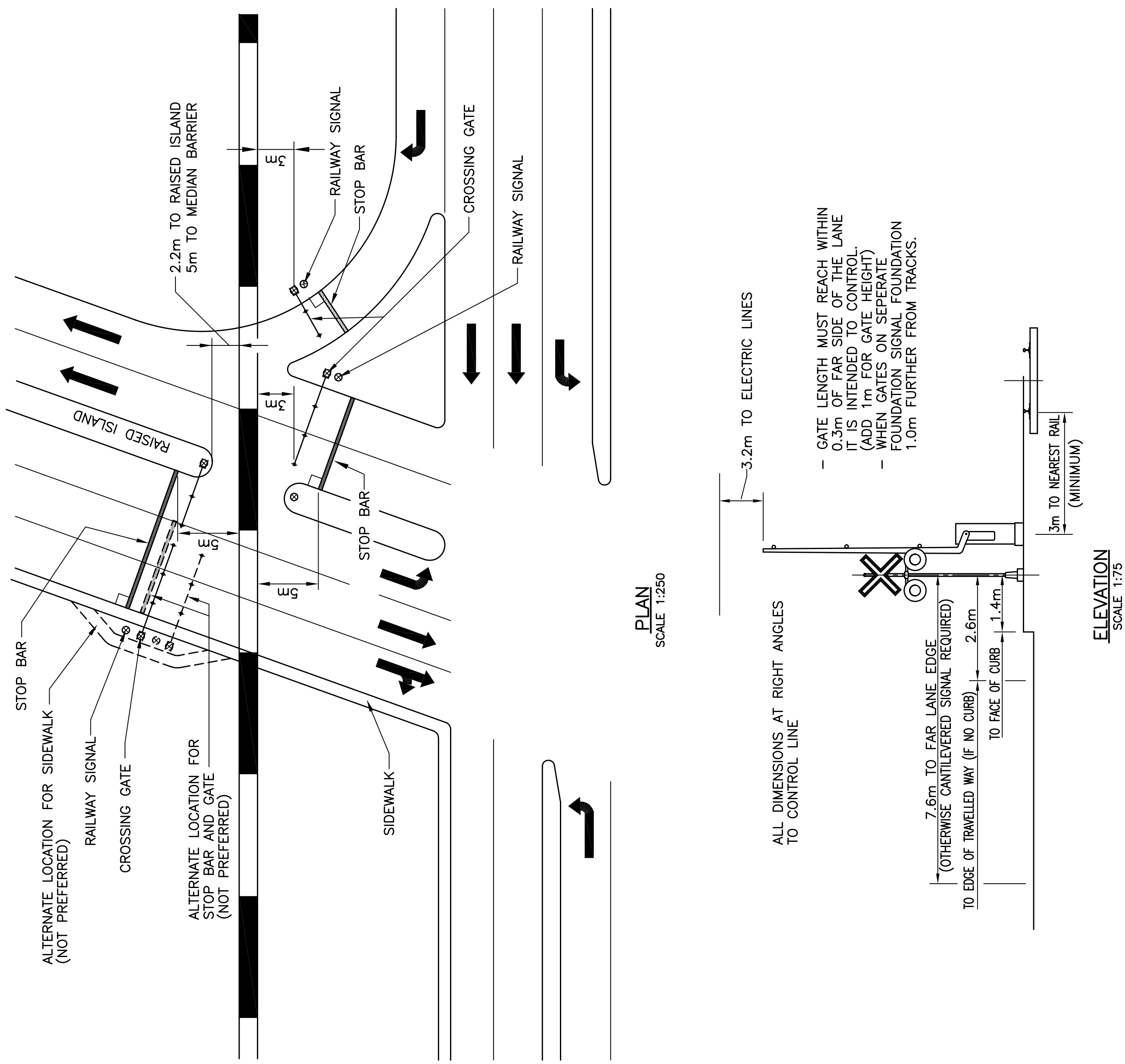
MoT Section	1110		TAC Section	Not Applicable

Figure 1110.F - Typical Detail for Crossing Signals



MoT Section	1110		TAC Section	Not Applicable

Figure 1110.G - Typical Detail for Crossing with Gates



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intentionally left blank

1120
POLE RELOCATIONS

1120.01 GENERAL

Read this section of the BC Supplement in conjunction with the **Utility Policy Manual**. Where any discrepancy occurs, the Utility Policy Manual shall govern, unless otherwise stipulated.

1120.02 RECOMMENDED GUIDELINES FOR POLE LOCATIONS

Minimum Offset for Utility Poles are as follows:

1. For Curb and Gutter Projects with Posted Speed of 60 km/h or less, at least 0.3 m behind the sidewalk (if there is one) or a minimum of 2.0 m from the outside face of the curb, whichever is greater.
2. For Curb and Gutter Projects with Posted Speed greater than 60 km/h, outside the Clear Zone as per Section 620, or protected by approved guardrail.
3. For Open Shoulder Projects, outside the Clear Zone, as per Section 620, where applicable (preferably within 2.0 m of edge of R/W), or protected by approved guardrail.

Every effort shall be made to avoid poles within traffic islands.

Street lighting is a possibility on all highways through urban areas. Therefore, minimum clearances from Overhead Power Lines shall be established in accordance with the **Utility Policy Manual**.

Minimum vertical clearances above the ground surface or from the pavement crown shall be in accordance with the **Utility Policy Manual**.

1120.03 EXCEPTIONS TO HORIZONTAL OR VERTICAL CLEARANCES

Exceptions to offset requirements are discussed in the **Utility Policy Manual**.

In addition, the *Corridor Ambient Geometric Design Elements Guidelines Policy* (Tab 13 of the Design Manual) may be applied to utility setbacks to ensure uniformity within the specific corridor under review. See the Project Design Criteria.

1120.04 RELOCATION OF UTILITY POLES

For Active Projects:

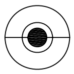
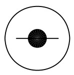
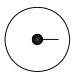
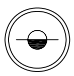
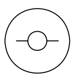
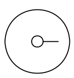
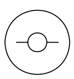
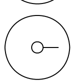
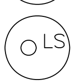
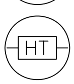
1) It is desirable to contact each Utility Owner during the design stage, advising that highway improvements are proposed, and to discuss the affects of the design on the utility in question.
2) As soon as plans showing location of proposed streets, limits of cuts and fills, and proposed R/W limits are available, supply a set of prints to each Utility Owner, indicating the poles to be relocated
3) A legend similar to **Figure 1120.A** shall be affixed to the first sheet (key plan) of each set of prints showing the poles to be relocated.
4) Correspondence to the Utility Owner should:
   a) Give a general project description;
   b) Query the accuracy of the utility locations as shown and ask to be advised of any errors or omissions;
   c) Indicate minimum acceptable distance from face of curb to face of pole on curb and gutter projects;
   d) For telephone pole relocation, request an estimate of the number of spliced sheath metres involved;
   e) State Construction Scheduling, if known.
5) If the project is to be a contract, send a copy of each Utility Owner's accompanying letter, with a copy of the Pole Relocation List (H-96) to the Contract Documents Officer.

1120.05 RELOCATION COSTS OF UTILITY POLES

Where the Ministry requests relocation of pole lines, the Ministry's contribution shall be in accordance with the appropriate Protocol Agreement.

MoT Section	1120		TAC Section	Not Applicable

Figure 1120.A Utility Pole Legend Sample

	Blue Circle	Transformer Pole
	Blue Circle	Power Pole
	Blue Circle	Power Guy Pole
	Red Circle & Blue Circle	Combination Power and Telephone Pole
	Red Circle	Telephone Pole
	Red Circle	Telephone Guy Pole
	Black Circle	Telegraph or telecommunication pole
	Black Circle	Telegraph or telecommunication guy pole
	Green Circle	Lamp standard
	Blue Circle	High tension power tower

1200 CONTRACTS AND DRAWINGS CHAPTER

1200 CONTRACTS AND DRAWINGS CHAPTER TABLES

1200 CONTRACT AND DRAWINGS CHAPTER FIGURES

1210.01 INTRODUCTION

The computer drafting program used to produce Contract Drawings for the Ministry of Transportation is **"AUTOCAD"**, by Autodesk Inc. AutoCAD is the preferred drafting program to be utilized by all contractors to the Ministry. A minimum of one hard copy of the contract drawings will be supplied along with a compact disk(s) containing a digital copy of all drawings. The only acceptable file formats are **.dxf** and **.dwg** formats. Manually drafted drawings will no longer be produced for contracts. The AutoCAD software is used by all Ministry Branches, Regions and Districts to facilitate:

a. The development and maintenance of standards to ensure consistent drawing quality and integrity.

b. The transfer of technical information within the Ministry of Transportation in a manner that simplifies and standardizes the manipulation of technical information by each Branch.

c. The development and maintenance of a record system to ensure accessibility and continuity.

d. Interaction with other electronic geo-based systems such as Highway Information, Electronic Mapping, CAiCE, etc.

1210.02 GENERAL

Manual drawings had been conceptualized, designed and drawn at a specific scale. AutoCAD gives the ability to draw in real world coordinates using real units of measure. Because of the linear nature of Highway Design, units must be carefully considered. It is most rational to select metres as the drawing unit for design drawings.

The general concept is to draw and design the entire project, if possible, as one drawing – call it the design drawing. This drawing will contain all the necessary information as required for each plan plate. Refer to 1220.04. Working frames are then superimposed, overlapped and orientated to indicate the individual plan plates. At this point a great part of the drawing can be saved, with the appropriate name, as the key plan. By using an all encompassing design drawing, redefinition of symbols and conversions of linetypes will be consistently applied to the project.

Each working frame becomes a viewport for the paper space layout for individual drawings. These layouts are used for final plotting of contract drawings. This should be done without destroying the larger design drawing.

1210.03 DATA STORAGE

Production Stage:

During the production of the contract drawings, keep all pertinent drawings in a sub-directory of the hard drive named to reflect the project. It will be easier to backup the drawings. Recommended file names use the region number and drawing sequence assigned by the Ministry plus the drawing type (e.g. R1-185-100 for plans).

Backup and/or Archive Stage:

A system for backing up data on a daily basis should be in place.

When the contract drawings are finalized and plotted for signature, the plot versions of the drawings shall be archived onto two complete sets of CDs. Both sets of archived CDs make up part of the contract and are property of the Ministry of Transportation. Project CDs are labeled as follows:

Drawing Series Number (See Section below)

Project Name:	Start Rd to End Creek
Consultant Co.	ABC Engineering
or	
Ministry Designer	W. Bobroske
Disk No.	1 of X
Date	YYYY-MM-DD

1210.04 NUMBERING OF DRAWINGS

Refer to Technical Circular T-5/93.

When a contract is issued for design, the drawings are assigned a designation number by the Regional Manager, Engineering, or their designate, made up the Region number or name and a drawing series number. The complete format is as follows:

RR-NNN-nnn where
RR is the Region encompassing all or most of the Project;
NNN is the Drawing Series within that Region;
nnn is the sheet number within that Series

For example: R1-127-001

'R1-127'	indicates Region 1, Drawing Series 127 and is unique to this project.
'001'	indicates that this is drawing number one in this series. This is usually the key plan.

Currently there are three Regional designations – R1, R2, and NR. The NR designation stands for Northern Region and is used for Region 3. Due to the R3 designation being used in another area of the province prior to 2002, the NR designation will be used to avoid duplicating previously used contract drawing numbers.

Drawings are numbered (nnn) sequentially or in sequential groups through the project without gaps and are arranged in the general order as shown on the Index. Depending on the type and complexity of the contract, some of these items may be combined or omitted entirely.

In the traditional method, drawing numbers are sequential with no gaps and without leading 0's.

RR-NNN-1	Key Plan
RR-NNN-2 through 14	Plans
RR-NNN-15 through 25	Profiles

and so on…

Alternately, the drawing numbers may be grouped by drawing type. Using this method, you may add or delete drawings without completely re-sequencing the drawing numbers and /or changing all the cross-referencing. The following drawing numbering system is suggested:

Title Page is unnumbered

RR-NNN-001	Key Plan
RR-NNN-101 through 199	Plans
RR-NNN-201 through 299	Profiles
RR-NNN-301 through 399	Typical Sections
RR-NNN-401 through 499	Geometrics and Laning

and so on…

1210.05 SIGNING OF DRAWINGS

Technical Circular T-2/93 has been replaced by the procedure below

Procedure:

Title Blocks

Title blocks are limited to working drawings and will show only one signature block for the Senior Designer. This will be a consultant's representative or the Regional Manager of Design whether for Major Projects, Regional, or District contracts. Contract drawings prepared by Ministry staff or by consultants selected from the professional category of RISP shall be signed and stamped by a Professional Engineer. Additional drawing types requiring a Professional Engineer as the Senior Designer will be determined as needed. Professional Engineers must sign and stamp in the signature block provided. Refer to Figure 1210.C.

All but very small contracts (≤ 3 km) will have a front page and a key plan page. The front page will have no title block; it will show the provincial logo, the ministry name, the project name, the project number and the name and title (no signature) of the Regional Director or Chief Engineer.

The key plan page will show the ministry name, a key plan, the drawing index, the symbol legend where appropriate, the contract details including contract type, number, location, length, etc. as well as the dated signatures of the Regional Director and Regional Manager, Engineering. There may be infrequent occasions when the key plan will be signed by a HQ Branch Director and the Chief Engineer. For Major Projects, the Major Project Director will sign along with the Project Manager. The key plan page signatures will be on either the full size or reduced title block as shown on Fig. 1210.A or 1210.B. For very small contracts (≤3 km), the front page is not mandatory. The signatures on the key plan signify acceptance for construction. The Senior Designer signs and stamps the working drawings, assuring accuracy and content. These signatures are required for all projects regardless of length or size.

Propert Acquisition Plan (PAP)

Property Acquisition Plans shall be signed by the Senior Designer which indicates the only meaningful review to ensure the accuracy of the proposed right-of-way.

Exception: PAP drawings for small trespasses and drainage easements on unnumbered routes and Section 42 acquisitions may be signed by the District Manager, Transportation.

Quality Control

The Design Manager for the project will, at the start of each major design phase, identify the person who will provide quality control of the technical content by reviewing and approving each stage.

Issuing of Drawings for Tender

Refer also to Technical Circular T-11/06

One complete set of full size drawings signed and stamped by the Senior Designer (Consultant Engineer or Ministry Engineer) with the appropriate Ministry officials signatures on the Key Plan can be sent to the Queen's Printer. These drawings will be scanned to produce the electronic PDF files for posting on the BC Bid website. Queen's Printer will print the full-size and half-size drawings for distribution to courtesy plan holders and for Tender document sales. Local printers can also be used to produce the electronic PDF files and Contract Administration offices would then post them on the BC Bid website and make them available to Queen's Printer for printing.

As per the policy in the Contract Administration Manual, the signed and stamped tender drawings will be used for the contract award. Therefore, these drawings shall **not** be annotated as "Issued for Tender" or "Issued for Construction".

For scanning and copying purposes, ink stamps must be used. Embossed seals are not acceptable.

Engineering drawings issued for tender that have not been signed and sealed must be authorized for use by the Regional Director or Branch Director and the drawings must be labeled "Preliminary Not for Construction" prior to posting on BC Bid.

1210.06 AMENDED DRAWINGS

1. Once a project drawing has been approved by either the Regional Director or the Chief Engineer, any further alterations or amendments must be recorded in the revision space provided. Revised drawings must be signed and stamped by the Senior Designer.

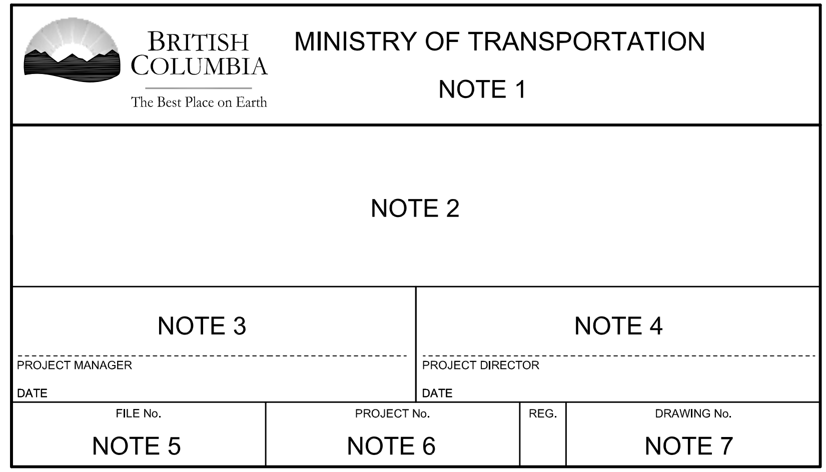
2. A major revision which completely alters the intent of the original approved drawing must be re-approved. (e.g. signatures of the Senior Designer, Regional Manager Engineering, and Regional Director).

3. If an approved project plan is amended, either the original or seven prints are to be submitted to the Regional Property Agent.

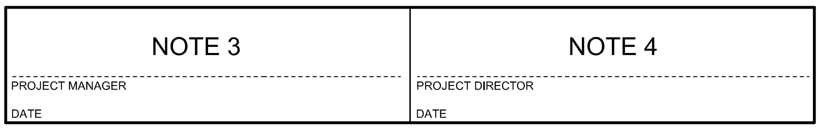
4. When a project plan drawing is amended to show R/W as purchased, do not remove the original boundary or area. Show the amended R/W boundary with a heavier line and note the increase or decrease in area.

MoT Section	1210		TAC Section	Not Applicable

Figure 1210.A Title Block for Major Projects Key Plan



FULL SIZE TITLE BLOCK



REDUCED VERSION OF TITLE BLOCK (ALTERNATE)

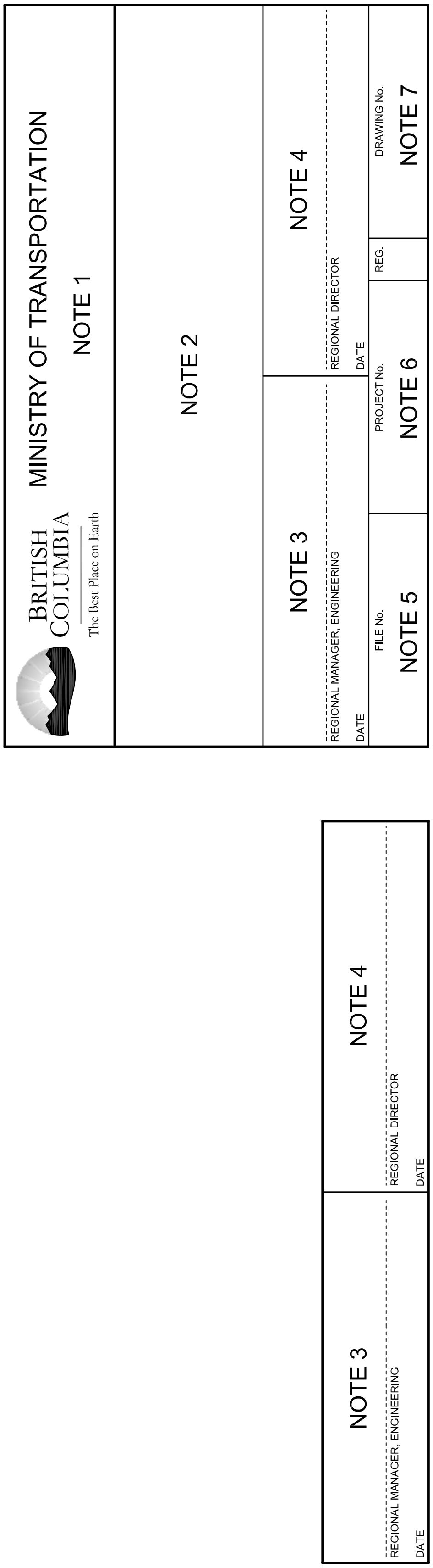
NOTES:

1. MAJOR PROJECT NAME IS ENTERED HERE.
2. SUB-PROJECT/DESCRIPTIVE NAME (to be on all drawings and part of all correspondence) AND SPECIFIC DRAWING INFORMATION IS ENTERED HERE.
3. PROJECT MANAGER SIGNS HERE, ABOVE THE APPROPRIATE TITLE. THE PROJECT MANAGER SIGNS FOR ACCEPTANCE OF THE DESIGN WORK ON BEHALF OF THE MINISTRY.
4. PROJECT DIRECTOR SIGNS HERE, ABOVE THE APPROPRIATE TITLE. THE PROJECT DIRECTOR SIGNS TO AUTHORIZE THE USE OF THE DESIGN WORK FOR THE MAJOR PROJECT.
5. THIS IS THE CORRESPONDENCE FILE NUMBER. IF USED, THE FIELD HEADING SHOULD BE CHANGED TO IDENTIFY WHOSE FILE NUMBER IS LISTED (e.g. "MINISTRY FILE No." OR "CONSULTANT FILE No.").
6. PROJECT NUMBER.
7. PROJECT DRAWING NUMBERS. USED FOR DRAWING CONTROL AND TRACKING.

THE FULL SIZE TITLE BLOCK IS NORMALLY USED. THE REDUCED VERSION IS AN ALTERNATIVE. SEE SAMPLE DRAWINGS.

MoT Section	1210		TAC Section	Not Applicable

Figure 1210.B Title Block for Region/District Key Plan



FULL SIZE TITLE BLOCK

REDUCED VERSION OF TITLE BLOCK (ALTERNATE)

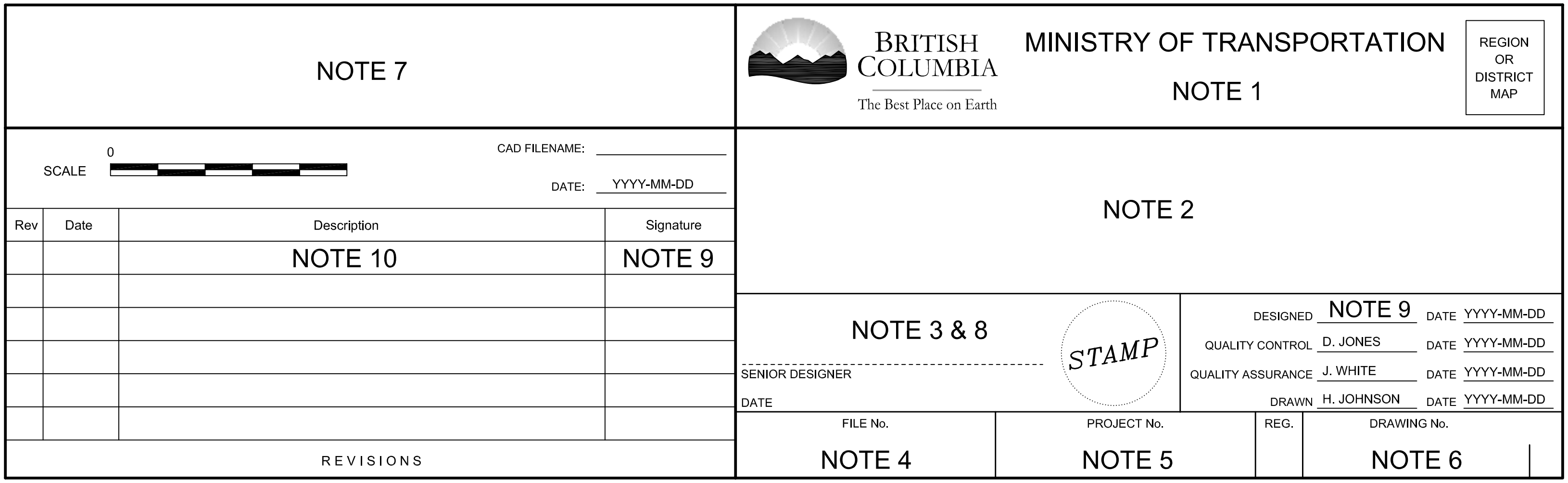
NOTES:

1. REGION OR DISTRICT NAME IS ENTERED HERE.
2. PROJECT NAME (to be on all drawings and part of all correspondence) AND SPECIFIC DRAWING INFORMATION IS ENTERED HERE.
3. REGIONAL MANAGER OF ENGINEERING'S SIGNATURE GOES HERE, ABOVE THE APPROPRIATE TITLE.
4. REGIONAL DIRECTOR'S SIGNATURE GOES HERE, ABOVE THE APPROPRIATE TITLE.
5. THIS IS THE REGION, DISTRICT OR CONSULTANT'S CORRESPONDENCE FILE NUMBER. IF USED, THE FIELD HEADING SHOULD BE CHANGED TO IDENTIFY WHOSE FILE NUMBER IS LISTED (e.g. "DISTRICT FILE No." OR "CONSULTANT FILE No.").
6. PROJECT NUMBER.
7. PROJECT DRAWING NUMBERS. USED FOR DRAWING CONTROL AND TRACKING.

THE FULL SIZE TITLE BLOCK IS NORMALLY USED. THE REDUCED VERSION IS AN ALTERNATIVE. SEE SAMPLE DRAWINGS.

MoT Section	1210		TAC Section	Not Applicable

Figure 1210.C Title Block for Drawings



NOTES:

1. REGION, DISTRICT, BRANCH OR MAJOR PROJECT NAME IS ENTERED HERE.
2. PROJECT NAME (to be on all drawings and part of all correspondence) AND SPECIFIC DRAWING INFORMATION IS ENTERED HERE.
3. SENIOR DESIGNER'S SIGNATURE AND STAMP GOES HERE. (Senior designer could be a consultant, the Regional Manager of Design, or the HQ equivalent.) "Senior designer" annotation may be replaced with the title of the signer.
4. THIS IS THE HEADQUARTERS, REGION, DISTRICT OR CONSULTANT'S CORRESPONDENCE FILE NUMBER . IF USED, THE FIELD HEADING SHOULD BE CHANGED TO IDENTIFY WHOSE FILE NUMBER IS LISTED (e.g. "DISTRICT FILE No." OR "CONSULTANT FILE No.").
5. PROJECT NUMBER.
6. PROJECT DRAWING NUMBERS. THESE ARE USED FOR DRAWING CONTROL AND TRACKING.
7. CONSULTANT'S LOGO MAY BE ENTERED HERE.
8. REVISIONS MUST BE SIGNED AND STAMPED BY THE SENIOR DESIGNER.
9. THE FIRST INITIAL AND COMPLETE LAST NAME OF THE PERSON GOES HERE. TYPEWRITTEN NAMES ARE PERMITTED.
10. "ISSUED FOR TENDER" OR "ISSUED FOR CONSTRUCTION" SHALL NOT BE ANNOTATED ON ANY TENDER DRAWINGS.

1220.01 FRONT PAGE

Sample Figure 1220.A

This page will have the Provincial logo, the Ministry name, the project number, the project name and will indicate the name and title of the Chief Engineer or the Regional Director (not signatures).

Large projects (discretionary ≥ 3 km) will have a separate front page; the front page is unnumbered and will have the name and title (not signatures) of the Chief Engineer or the Regional Director. For smaller projects (discretionary) there is no requirement for a front page.

1220.02 KEY PLAN

Sample Figure 1220.B

The designer has the option of not using the conventional title block as shown in Sample Figure 1220.B. The main title block can be removed except for the Drawing No. field and the signature lines can be placed at the bottom center of the sheet. This reduced version of the title block is shown on Figures 1210.A and 1210.B. It is the designer's choice which title block to use.

The key plan page shall have the following information appropriate to the scope and scale of the drawing.

A large scale key plan and location map showing:

- Highway route and city, town name.
- "Project site" located on this map.
- North arrow (preferably oriented upwards).

A Schematic Drawing showing:

- North arrow oriented to the key map.
- Scale.
- Sufficient cadastral mapping to orient the user.
- Land districts, ranges, section lines, street names and city or town boundaries shown for reference.
- Borders depicting mapping sheet coverage and layout.
- The proposed design location line for the main line with the beginning and end stations labelled as LIMIT OF CONSTRUCTION.
- The proposed design location lines for any frontage or service roads with their appropriate LIMIT OF CONSTRUCTION stations (if applicable).

A Symbol Legend (if it is a small enough project) showing those standard symbols and line styles that represent components shown on the drawings. See Figure 1250.A through Figure 1260.B for the detailed definitions. All symbols and linetypes shall be displayed in the legend at scale 1:1.

Survey information may be shown (as specified in the MoT General Survey Guide Section 600.02) such as:

- Survey control points table.
- Survey control origin.
- Data sources and quality.

Title Showing:

PROVINCE OF BRITISH COLUMIBA
MINISTRY OF TRANSPORTATION
PROJECT No.
HIGHWAY NAME & No. – GENERAL LOCATION
PROJECT NAME
CONTRACT TYPE (PAVING, GRADING, ETC.)
PROJECT LIMITS (DEFINED BY ROAD NAMES, CHAINAGE, ETC.)
STA. X+XX.XXX – STA. X+XX.XXX
LKI: SEG. XXXX
km XXXX TO km XXXX

Index showing the following (as applicable):

RN-nnn-000	Front Page
RN-nnn-001	Key Plan
RN-nnn-002	Legend
RN-nnn-101 to 1xx	Plans
RN-nnn-201 to 2xx	Profiles
RN-nnn-301 to 3xx	Typical Sections
RN-nnn-401 to 4xx	Geometrics and Laning
RN-nnn-501 to 5xx	Spot Elevations
RN-nnn-601 to 6xx	Signing and Pavement Markings
RN-nnn-701 to 7xx	Drainage
RN-nnn-801 to 8xx	Volume Overhaul Diagram

RN-nnn-901 to 9xx	Gravel Quantity and Haul Chart
	All other drawings specific to contract, i.e. Bridge or Geotechnical Electrical and Lighting Standard Drawings

The key plan is signed by the Regional Manager of Engineering and Regional Director or by a HQ Branch Director and Chief Engineer. These signatures indicate acceptance for construction. (*Refer to Section 1210.05)*

1220.03 LEGEND

Sample Figure 1220.C

Large projects may have one page exclusively for the legend. All symbols, linetypes and any other unique features may be listed on this page.

This page will have the standard title block as per Figure 1220.C.

1220.04 PLAN PLATES

Samples Figure 1220.D

Project chainage is to run left to right with the North Arrow up, if possible. The North Arrow orientation can be altered if a compromise is required. The plan drawing series shall be cross referenced to the geometrics and laning, drainage, utility, spot elevation and profile series drawings as required. All cross-reference boxes shall be in a clear area of the drawing and shall conform to the layout shown on the sample drawing.

Plan Plates shall have the following information:

Base Information: (Screened or Masked)

AutoCAD methods for screening/masking are discussed in Section 1230.03

- Mapping at a scale appropriate to the type of work (1:250, 1:500 and 1:1000 are the standards). See Figure 1260.C for contour interval standards.
- Accurate representation of all existing buildings, utilities (aerial and underground), accesses, drainage structures and courses, fences, road surfaces and shoulders.
- Current legal descriptions and lot lines of all plans, easements, etc. within the project, city/town boundaries, land district, ranges, sections and district lots, Indian Reserves, parks, railways, etc.

All are to be shown with their standard linetypes and symbols as shown in Figures 1250.A through 1260.C. All field information that represents BCLS data should be shown in accordance with symbols and abbreviations which have been approved by the Surveyor General and as presented on Figure 1250.A.

Title Blocks: Surveyed by:

Survey Date:

Office processed by:

(As specified in the MoT General Survey Guide Section 600.04)

All relevant P-line Information:

- Identification: i.e., “P-Line 100”, P.I.’s, P.O.T.’s and stations.
- Bearings between P.I.’s or P.O.T.’s.
- Ties between P-Line P.I.’s or P.O.T.’s and cadastral survey points (i.e., iron pins or monuments) showing bearings and distances.

Design L-Line Information:

- The “Glossary of Terms” in the “Major Works Construction Agreement”, defines the “LIMIT OF CONSTRUCTION” as the geographic limits of the project. The beginning and end of project plus the extent of all sides shall be called “LIMIT OF CONSTRUCTION.”
- Limit of Construction on the primary L-Line with stations.
- Secondary L-Line Limits of Construction with stations.
- Numerical identification placed close to all L-Lines, eg. ‘500 Line’.
- Labelling of all horizontal control stations such as:

L-P.I.	Point of Intersection
P.O.T.	Point on Tangent
P.O.C.	Point on Curve
P.O.S.	Point on Spiral
B.C.	Beginning of Curve

E.C.	End of Curve
T.S.	Tangent to Spiral
S.C.	Spiral to Curve
P.C.C.	Point of Compound Curvature
C.S.	Curve to Spiral
S.T.	Spiral to Tangent
S.T.S.	Spiral Tangent Spiral
S.C.S.	Spiral Curve Spiral

- Identification of any intersecting L-Lines thus:

  P.O.T. 124+12.571 =
  P.O.T. 505+00.000
- Label L-line revisions LR2-P.I., LR3-P.I., etc.
- Label stations that define structures, i.e., bridge abutment stations.
- Station ticks at 20 m intervals with annotation at 100 m (station) intervals.
- Azimuth indicated on tangents only on "P" lines and "L" lines shown thus: 00°00'00"

The horizontal curve information shall be shown opposite the P.I. and internal to the curve, where possible thus:

Simple Curves:

Rc	Radius of Curve
Δ	Intersection Angle
Tc	Tangent distance from P.I. to curve points
Arc	Arc Length of curve
Ec	External distance from P.I. to the circular curve

Spiralled Curves:

Rc	Radius of Curve
Δ	Intersection angle of the entire curve
Δc	Central angle of the circular curve
A.D.	Tangent distance from P.I. to T.S. or S.T.
Arc	Arc length of circular curve S.C. to C.S.
Es	External distance from P.I. to the circular curve.

The spiral information shall be shown internal to the spiral between the (T.S. and S.C.) and (C.S. and S.T.) thus:

Ls	Length of Spiral
θs	Spiral Angle

Compound curve data location is at the discretion of the designer as long as the information is complete.

In a complicated design with numerous alignments and curves, include the P.I. station with the curve data.

To fully indicate the impact of the design, the following elements shall be shown on the plan drawings:

- Geotechnical test holes shall be shown if available.
- The proposed edge of pavement drawn with a 0.50 pen and clearly labelled.
- Top of Cut (T.O.C.) and Base of Fill (B.O.F.) drawn with the standard line patterns; their transition point shall be labelled thus: C/F or F/C.
- Removals of existing infrastructure shall be clearly labelled. This includes all utilities such as hydro, gas, water, telephone and sewer, as well as curbs, barrier, pavement, sidewalks, drainage structures, and services such as underground storage tanks. When an existing fence is affected, clearly label the start and end of the affected section(s) as well as the type of fence.

R/W requirements for the project shall be laid out on separate set of Property Acquisition Plans. These drawings shall have the same number as their "plan" counterpart but with an "RW" extension. The only exception to this will be on very small projects (one or two plan sheets) and only with approval from the Regional Properties Branch (See Section 1220.11).

Clearing and grubbing requirements shall be to four decimal places and indicated on the plan sheets only and summarized as "CL. and GR. total this sheet x.xxxx ha".

Clearing and grubbing limits, if not coincidental with the R/W, shall be shown with the standard line pattern and annotated as "Clearing and Grubbing Limit" or "Cl & Gr" if space is limited. These boundaries shall be established following the same criteria as the R/W boundary (see Section 1220.11).

Signing and pavement markings shall be indicated on a separate set of drawings.

A schematic layout of the plan sheets shall be shown on each drawing with the specific sheet highlighted to show its orientation in the overall project.

1220.05 PROFILES

Sample Figure 1220.E

Profiles shall be developed for all L-line traverses in a manner that portrays the vertical as well as horizontal alignments.

All L-line profiles shall be at Horiz. 1:2000 / Vert. l:200. An appropriate scale for a secondary or frontage road could be Horiz. l:1000 / Vert. l:100. More than one profile can be drawn on a sheet as long as they remain individual entities. **Urban Design** profile scale is Horiz. 1:250 / Vert. l:50.

The “K” value shall be entered on all profiles for each curve. Asymmetrical vertical curves shall indicate the “K” value for each half plus the applicable Length of Vertical Curve (LVC).

Design speed of the proposed road shall be shown on the profile in a boxed note. If there are multiple profiles on a sheet, they each shall have design speed notation.

Also shown are existing utility crossings, new culvert crossings, benchmarks, drainage, construction notes and quantities, etc.

Project quantities shall be shown across the top of the profile.

Items shown are project specific. Some examples are: excavation, embankment, stripping, SGSB depth, hog fuel depth, side slopes, etc.

Profiles that run parallel to, or cross the main L-line, shall be referenced to the main line in order to easily locate their position on the plan sheets.

Horizontal alignment shall be shown symbolically and TO SCALE on the bottom of the profile. Azimuths will be shown for all tangents sections. Curves will be shown as offset straight lines. Spirals are sloped lines between tangent and curve. Station of transition points (B.C. and E.C. or T.S., S.C., C.S. and S.T.) shall be shown, as well as radius, with direction (Lt. or Rt.) and design superelevation.

1220.06 TYPICAL SECTIONS

Sample Figures 1220.F and 1220.G

The typical section drawing(s) shall show all aspects of the template criteria relating to all the road classifications within the project. Most of this information is currently defined within Section 430, 440 and 450. However, as a result of site specific anomalies, approved variations to the standard are occasionally warranted.

The sections shall be developed at a scale that allows the viewer to assimilate the data without question. If a section is too long to be shown in its entirety, it should be broken rather than drawn ‘not to scale’. If there are variable scales involved on a sheet, then bar scales shall be shown near each section and the note ‘as shown’ shall be written in the scale box.

The designer should not place template section information on other drawings. It is more effective to cross reference to a drawing specifically designated for the purpose.

Every effort should be made to maintain continuity of information. For example, enlarged detail sections should be shown relative to their main section.

1220.07 GEOMETRICS AND LANING

Sample Figure 1220.H and 1220.I

Geometrics and Laning drawings shall have the following:

- North arrow and grid points, correctly aligned, with sufficient latitudes and departures (Northing and Easting) annotation for orientation.

Design L-line information required:

- Secondary L-lines Limits of Construction with stations.
- Numerical identification near all L-lines, i.e., ‘500 Line’.
- Street names.
- Labelling of all horizontal control stations such as:

L-P.I.	Point of Intersection
P.O.T.	Point on Tangent
P.O.C.	Point on Curve

P.O.S.	Point on Spiral
B.C.	Beginning of Curve
E.C.	End of Curve
T.S.	Tangent to Spiral
S.C.	Spiral to Curve
P.C.C.	Point of Compound Curvature
C.S.	Curve to Spiral
S.T.	Spiral to Tangent
S.T.S.	Spiral Tangent Spiral
S.C.S.	Spiral Curve Spiral

- Identification of any intersecting L-lines thus:

  P.O.T. 124+12.571 =
  P.O.T. 505+00.000
- Label L-line revisions LR2-P.I., LR1-P.I, etc.
- Label stations that define structures, i.e. bridge abutments stations.
- Station ticks at 20 m intervals with annotation at 100 m (station) intervals.
- Coordinates for: Limits of Construction, P.I.'s and L-line intersections.

The horizontal curve information shall be shown opposite the P.I. and internal to the curve in the following format.

Simple Curve Nomenclature:

Rc	Radius of curve, in metres
Δ	Intersection angle between the tangents
Tc	Tangent distance from P.I. to curve points
Arc	Arc length
Ec	External distance from P.I. to the circular curve

Spiral Curve Nomenclature:

Rc	Radius of curve, in metres
Δ	Intersection angle of the entire curve
Δc	Central angle of the circular curve
AD	Tangent distance from P.I. to the T.S. or S.T.
Arc	Length of circular curve from S.C. to C.S.
Es	External distance from P.I. to the circular curve

The horizontal curve information for frontage bulbs and intersections shall be boxed similar to sample Figure 1220.I.

The spiral information shall be shown internal to the spiral between the (T.S. and S.C.) and (C.S. and S.T.) in the following format:

Ls	Length of Spiral
θs	Spiral angle

Compound curve data location is at the discretion of the designer as long as the information is complete.

Laning:

Configuration of all applicable lane lines, DRAWN TO SCALE, and as depicted on the laning sample drawing including: shoulder edges, pavement edges, lane edges, paint lines, gores, crosswalks and stop lines.

Other design details including:

- Median and lane tapers, additional lanes, barrier flares, bus bays and drainage curbs annotated with their applicable beginning and ending stations.
- Sufficient annotation of lane and offset dimensions to clearly define the layout.
- Design speed, design vehicle.
- Standard symbols and line types to define concrete curb and gutter, extruded curb, median and roadside barrier, barrier terminus treatments and structural walls.
- Join or match lines, where applicable, with notation of adjoining sheet.
- Geometric and Laning series drawings shall be cross-referenced to their Drainage and Spot Elevation series counterparts.
- All arrows indicating direction of travel shall be **hollow arrows**. The **only** time solid arrows shall be used is on signing and pavement marking drawings, and this indicates where and what to paint.

1220.08 SPOT ELEVATIONS

Sample Figure 1220.J

Spot elevations are required at all L-line intersections with minor and major roads and all interchanges; accesses are excluded unless the tie to existing ground is more than 5 m from the normal highway pavement edge. Straightforward and simple spot elevations may be shown on laning and geometric drawings. If the spot elevation requirements are too extensive, they should be on a separate set of drawings.

Spot elevations shall be shown in any area where the finished grade and shoulders are not defined by the normal roadway template, super-elevation or crossfall rates. Such areas are acceleration and deceleration ramps, tapers, intersection radii and where the new design has to match an existing facility.

On curb and gutter projects, the elevations are carried where the asphalt and concrete curb meet.

The increment spacing for spot elevations is left to the designer's discretion. However, a 20 m interval is a maximum with the desirable being 10 m maximum at intersections and all locations where drainage may prove complicated. Spot elevations shall be to three decimal places, and the actual elevation point can be defined with a leader line or the decimal point.

A profile of a travelled edge, as experienced by a driver, is a useful tool for establishing accurate spot elevations.

Spot elevation series drawings shall be cross-referenced to their geometrics and laning, drainage and utility series counterparts.

1220.09 SIGNING AND PAVEMENT MARKINGS

Sample Figure 1220.K

Signing and pavement marking drawings will now be consolidated on one separate set of drawings**. This is intended to be a set of drawings for the use of pavement marking and signing crews**. The only signs and luminaires indicated on any of the other drawings will be that of existing detail on the plan sheets.

Reference manuals for signs and pavement markings are:

- Manual of Standard Traffic Signs and Pavement Markings
- Pedestrian Crossing Control Manual for British Columbia

The location of both existing and proposed signs shall be shown with the appropriate symbol as shown in Figure 1250.F.

These symbols shall represent both existing and proposed appliances. Cross-reference to specialty drawings where special traffic appliances may be required.

All arrows indicating direction of travel shall be solid arrows and shall be shown at the actual locations where the arrows are to be painted.

Pavement marking drawings must be drawn to scale l:500 or 1:250 only.

Proposed luminaire pole positions must be shown on this drawing.

Refer to layer conventions in Chapter 1230 for the text height to accompany signs.

1220.10 DRAINAGE AND/OR UTILITIES

Sample Figure 1220.L

Drainage and/or utilities drawings shall have the following information:

North arrow correctly oriented.

This set of drawings shall be developed by making a screened duplicate set of geometric and laning drawings prior to their being annotated with their design information. This will allow the designer to clearly portray the drainage/utility design, as it will appear highlighted against the faded background.

Existing drainage/utility information shall be added to these screened duplicates, depicted with standard line styles, and annotated. Refer to Figures 1260.A through 1260.B.

Aside from the laning, the only geometric information required on these drawings is the reference grid, line designations, station ticks with annotation every 100 m and L-line control points depicted with a circle symbol.

If the drainage and utility designs are extensive, the designer should consider separating the elements onto individual drawings.

The open and closed drainage system (or utility) designs shall be depicted with the appropriate symbols as shown in Figures 1250.A through 1250.H. Such symbols and general layout procedures shall generally conform to the Ministry sample drawing. A benchmark for determining if the drawings will be accepted is for the designer to critique the drawings from a construction contractor's perspective for completeness of information.

If there is any design detail that could possibly impact on the drainage/utility systems, said detail should also be shown on these drawings in order to alleviate any conflicts. Such details could be special ground treatments (densification), structures (luminaires and sign footings, walls, bridge piers etc), or utilities (drainage).

Drainage series drawings shall be cross-referenced to their geometrics and laning, utility and spot elevation series counterparts.

Utility series drawings shall be cross-referenced to their geometrics and laning, drainage and spot elevation series counterparts.

1220.11 PROPERTY ACQUISITION PLANS

Samples Figure 1220.M and 1220.N

As a result of the current legislation governing the acquisition of property for highway construction, it is commonly necessary to initiate negotiations well in advance of project tendering. In order to allow the property acquisition group to proceed with their mandate, they require a set of drawings depicting R/W requirements for the project. The Property Acquisition Plan will become the basis for (1) the appraiser to estimate the loss in value for the land required, and (2) for the Ministry's representative and the property owner to understand the disturbances and impacts to the property from the taking, including any reduction in value to the remainder of the property. This set of drawings is produced by making duplicates or AutoCAD plots of the project plan plates after the L-line has been established and shown on the drawings. In urban areas especially, it is desirable to turn off or remove the contours, clearing and grubbing and proposed edge of new pavement lines allowing the R/W drawings to become more legible. Due to the complexity of property negotiations, good liaison with the Property Services Branch is required throughout the design process. All drawings are labelled "Property Acquisition Plan" as a separate note or in the title block, as applicable.

The acquisition plans are a stand alone set. Once they are signed, no revisions are necessary as the design evolves unless it has a direct impact on the R/W requirements. See Section 1210.06 and farther on in Section 1220.11 for further instructions.

Definitions:

The Ministry and its representatives, while in the process of designing facilities for highway purposes, shall define a requirement to procure titled lands. This procurement may be either temporary or permanent in nature, and may be from either private or publicly held lands. In addition, the designer shall define any requirement to procure municipal road areas.

Temporary would constitute a "license" of some type (LTC – License to Construct), and permanent could constitute Statutory Rights-of-Way (SRW) or an acquisition of property in "fee simple" (i.e. ownership).

Statutory Rights-of-Way (SRW):

An SRW grants an interest in the land, but no title. It is for a specific use of the land and is registrable. Registrable SRW's are documents filed as charges against the title of the land in the Land Title Office. It is worded to ensure permanent, continuous entry, egress, passage, installation and maintenance on exactly defined portions of privately owned lands for Ministry purposes (e.g., drainage, landscaping).

Leases:

A lease is an arrangement where the titleholder grants an interest to another person or party. It is for a definite term and it is registrable.

Licenses:

Licenses give the Ministry the right to work on private lands for the duration of the project only, e.g. the installation of a retaining wall on the R/W boundary where excavation behind the wall during construction may be necessary. However, there is no need for a continued right on the license area extending after construction is complete. Licenses are not registrable in the Land Title Office and is purely a matter of contract and it is revocable. If the form of tenure to the land is an SRW or License as opposed to R/W, then it should be noted on the plan accordingly. Moreover, LTC's must be defined sufficiently (e.g. dimensions) to allow legal survey of the license area in case of expropriation.

Due to the nature of licenses, they should not be used to gain early entry to private lands that eventually will be R/W due to the risk of revocation or trespass.

An example of a license to construct would be as follows:

A roadway is in the final stages of construction. A driveway has been provided to a property, and the Ministry did not have to enter the property to join to the existing driveway. The new access is assumed to have an 8% grade. If the Ministry was to reduce the grade of the driveway, it would require entering and constructing on the property, but the Ministry does not want to pay any settlements for access to property etc. It would be beneficial to the property owner to give an LTC to the Ministry, waving all rights and claims, to allow the Ministry to build a driveway having a lesser grade, and perhaps, more to the owners preference.

Please note: Everything that is required for the road and its supporting structures should be purchased and not left on SRW's or LTC's.

Acquisition of Property (Partial or total acquisition in fee simple):

When the property requirement is of a permanent nature, and the land must be purchased, there are two avenues of direction.

1. The property owner is willing to sell the land and agrees to compensation payable. This is a straightforward transfer of land in fee simple and can be accommodated with a reference plan.
2. Expropriation Act, RSBC 1996, C.125.

   In order to protect the rights of the property owner and to establish a procedure to acquire land for highway purposes, the Expropriation Act was legislated in 1987.

   Where a property owner signs an agreement to sell the land but disagrees with the compensation payable, Section 3 of the Act ensures that the compensation payable will be settled by the Supreme Court of BC.

   Where an owner disagrees with the Ministry regarding the sale of the property, and the compensation payable, Section 6 of the Act can be used to obtain the land required. Section 6 of the Act defines the entitlements and the procedures to determine compensation and obtain the land.

Right-of-Way (R/W) development:

The proposed R/W boundary shall be shown with a heavy line symbol as per the standard shown on Figure 1260.B. Referencing shall be with one of the following methods which are listed in the preferred order:

1. An annotated distance along a property line from an existing survey reference point, i.e., an iron pin, as it allows for minor revisions of the L-line without affecting the boundary. Offsets and/or distances shall be set to the nearest 0.1 m.
2. Station and offset from the control line. The station where the offset occurs and the distance to the R/W must be clearly labelled. Refer to sample drawing Figure 1220.M.

The expected accuracy for area calculations is high and steps must be taken to provide a conclusive result. Inaccuracies may result in a second or third acquisition from an owner, or overpayment, with risks to project budget, schedule, and the possibility of expropriation.

Where possible, R/W should be established using the same method as will be used by B.C.L.S. to establish final R/W.

Area calculations shall be done to the highest possible precision by one of the following methods which are listed in the preferred order:

1. AutoCAD using applicable geometry.
2. On an original mylar or vellum, using applicable geometry.
3. Electronic methods such as digitizing tables.
4. Planimeter using the average of four readings.

Drawing Content:

Clearing and grubbing areas shall not be shown on Property Acquisition Plans.

Each parcel of land, enclosed within the R/W and including existing R/W, will have the area shown to the precision shown in "General Survey Instructions to British Columbia Land Surveyors", published by the Surveyor General and reprinted below.

Up to 0.1 ha	quote to 0.0001 ha
From 0.1 ha up to 1 ha	quote to 0.001 ha
From 1 ha up to 10 ha	quote to 0.01 ha
From 10 ha up to 100 ha	quote to 0.1 ha
From 100 ha and over	quote to 1 ha

Individual areas shall be outlined by a box in order to make them easily distinguishable from other plan information.

Remaining portions of a parcel that have been severed by the proposed highway R/W shall also have areas calculated and labelled as previously defined.

Other than in subdivisions, a table of the areas involved with applicable comments may be located on the drawing containing the largest "take" for that lot. The comments should cross reference the adjacent drawing noting the smaller "take" for that lot.

If one table is all that is required, it is preferable to locate it on the first drawing of the set of acquisition drawings.

If there are many individual areas or several tables, one alternative is to list all tables on one drawing sheet, preferably located at the rear of all acquisition drawings.

Another alternative is to provide an index of tables with applicable drawing numbers to be located on the first Property Acquisition Plan.

Another alternative for larger projects is to provide a table of areas (for each property impacted) per drawing sheet. The table should be located in unobtrusive areas of the plan, and split if necessary, so as to not hide information.

When there is more than one area "take" from a parcel, the drawing numbers will be listed beside the areas. Areas shall be subtotaled per parcel. Refer to the sample table below

Legal Description	New R/W Req.	R/W Inside	R/W Outside	License to Construct	Comments
Lot 1, Plan 6976, D.L. 47965	0.0737 ha Dwg-09RW				
Plan 1799-RW			0.0499 ha Dwg-09RW		Encroachment (Northern Railway)
Plan H-275		0.154 ha Dwg-09-RW 1.54 ha Dwg-09RW 0.287 ha Dwg-09RW 2.17 ha Dwg-09RW Total 4.15 ha	3.00 ha Dwg-09RW 1.47 ha Dwg-09RW 0.399 ha Dwg-09RW 0.541 ha Dwg-09RW 0.0202 ha Dwg-09RW Total 5.43 ha		Outside Area is Surplus

For Urban Street Design Projects, all R/W areas to be shown to the nearest 0.1 m^2. Areas to be calculated using appropriate geometry. Do NOT use planimeter.

Package of Plans for Delivery of the Right-of-way:

- One set (full size and half size) of all project contract drawings (unsigned is acceptable) including plans, laning, cross-sections and profiles.
- One copy of area summaries from the Design Folders, form H749.
- The Property Acquisition Plan AutoCAD file on compact disc for the B.C.L.S.

The following is a short check list for Property Acquisition Plans:

- North arrow.
- Title block.
- Scale and scale bar (metric).
- Table of areas involved and comments.
- R/W and dimensions for each parcel.
- A sufficient amount of the legal description should be shown on the plan to correctly identify the property. Some legal descriptions are too long to enter in full. In the alternative, use the Land Title Office property identifier (PID) numbers to legally define the property.
- Project number.
- All utility poles, buildings, fences, existing land improvements (including underground improvements such as storage tanks) and accesses within 10 m of the proposed R/W and all improvements beyond the 10 m that are impacted by the R/W, accesses and construction but never less than 30 m from centre line.
- Existing accesses should be marked to indicate whether the access remains open, to be closed or relocated.
- Proposed toes with cut/fill points annotated at transition points.
- Obtain all pertinent signatures.
- Section 42, and Section 64 gazetted road (all old road) plotted inside/outside the new R/W.
- Easement/utility R/W.
- Co-ordinate listing (if available).
- All “I.P.’s” and monuments that are found are symbolized. All I.P.’s and monuments that cannot be found, are not to be indicated on the plans.
- A “For Property Acquisition Only” stamp, if applicable. (Required on small contract not using separate Property Acquisition Plans).
- Note any and all surveys or plan numbers on the drawing; it is all useful information.
- If the area appears to be convoluted, outline the area to be acquired in red pencil on a separate print. If your computer system is appropriate, this may be done automatically.
- Clear and grub line and areas are **not** to be shown.

Old Road Areas:

There has been some confusion regarding the method of handling old road areas on our plans where the old road does not have a surveyed R/W, or its boundary has not been established by adjacent subdivision.

Section 42 roads are such a case. The following procedure shall apply:

1. All old roads are to be checked with the Regional Office for possible “Gazette Notice”. If there is a Gazette notice, the Gazetted width shall be indicated on the plans with a line type similar to that used for “Clearing and Grubbing” and labelled as “R/W established by B.C. Gazette dated _______________”.
2. If a Gazette Notice is not in existence, then the area of existing road shall be that of the “travelled way”. The travelled way is defined as the width between the outer edges of the road shoulders. It is necessary, therefore, to show on the plans the plotted position of the edge of shoulders obtained by occasional measurement. The area shall be calculated by estimating the average width within each lot.

1220.12 VOLUME OVERHAUL DIAGRAM

Sample Figures 1220.O, 1220.P and 1220.Q

A volume overhaul diagram provides a convenient method for studying haul and overhaul and for estimating payments. It is a continuous curve showing the accumulated algebraic sum of volumes [cuts (+) and fills (-)] from the beginning station through the entire project for each individual alignment. The X-axis (abscissa) is the stationing. The Y-axis (ordinate) represents the tabulated cumulative volume of cut and fill between successive cross sections. For small projects, cross section areas are calculated, cut and fill volumes are tabulated to give algebraic sum of volumes at each station and the cumulative total. This cumulative total is the ordinate for the volume overhaul diagram. Cut volumes are adjusted for swell or shrinkage before solving ordinates. Typical adjustment values are shown in the table below.

Material*	Factor	Comment
Type A	20% Swell	Solid rock and rock stratum
Type B	1% Shrinkage 10% Shrinkage	Clean broken rock Granular materials
Type C	Unadjusted	
Type D	15% Shrinkage 20% Shrinkage	Granular materials Fine-grained silts or clays

**See Standard Specifications 201.11 for exact definitions of Material Types.*

Payment for excavation is made at a bid price per cubic metre. This unit price includes payment for excavating and loading material, transporting it any distance less than the freehaul limit and placing it in the fill. The Ministry freehaul limit is typically 300 m. The freehaul volumes are determined by offsetting the ordinate line horizontally and replotting the ordinates until an intersecting line is reached.

Above the balance line, the freehaul is measured from the bottom of the cut slopes and/or at balance points to the right. Below the balance line, the freehaul is measured from the top of the cut slopes and/or balance points to the left. The resultant freehaul is the shaded area on the volume Overhaul Diagram. If material is brought in from a pit, the deadhaul distance from the pit to the road is subtracted from 300 m to solve the remaining freehaul.

It is often necessary to move excavated material beyond the stipulated freehaul distance. The operation is called overhaul. The unit in which overhaul is computed is the “station m”. One station m is 1 m^3 of excavated material moved one 100 m station. Overhaul areas are the unshaded portions of the volume overhaul diagram. Overhaul volumes are determined as individual areas multiplied by the percentage of each material type times their appropriate swell or inverse shrinkage factor.

Characteristics of a Volume Overhaul Diagram:

1. A rising line indicates that the excavation quantity is larger than the embankment quantity at that point on the roadway; a falling line indicates the reverse.
2. Steep slopes indicate large differences between cuts and fills at the section; flat slopes indicate small differences.
3. Points of zero slope (top and bottom of curve) indicate changing from an excess of cut to an excess of fill or vice versa.

See Figure 1220.O for sample Overhaul calculations.

Note:

When haul is included in the bid price, the volume overhaul drawings are for information only and a note must be placed on each drawing to indicate accordingly.

1220.13 GRAVEL QUANTITY AND HAUL CHARTS

Sample Figure 1220.R

The following materials are to have their own quantity and haul charts:

1. High Fines 25 mm Surfacing Aggregate
2. Crushed Base Course Aggregates:
   - Nominal sizes can be 25, 50 or 75 mm
   - Specify as Well, Intermediate or Open-graded
3. Select Granular Sub-Base
4. Gravel Facing
5. Gravel Blankets
6. Gravel Filter Layers
7. Bridge End Fills
8. Structural Backfill for Bin Walls and Structural Steel Plate Culverts

Haul charts are not required for materials that are to be supplied in place, as bid price includes haul. However, haul charts for such items would assist in bid preparation.

Description of Sample Gravel Quantities and Haul Chart Figure 1220.R:

Items numbered on chart as follows:

Quantity Charts:

1. Project kilometres columns labelled every km. Distances are to scale.
2. Material type headings.
3. Quantity required in the kilometre interval. Enter NIL for columns where quantity is “0”. All quantities are in unit tonnes.
4. Calculated quantity for fraction of km at end of project.
5. Total project quantities for each material type.
6. Sum of total project quantities.

Haul Charts:

7. Heading of haul chart. Consists of material type and origin of material.
8. Haul km. Km distance from supply location (Pit, stockpile, etc.).
9. Identification of material source, its distance from the project, and an arrow indicating where the hauled material enters the project.
10. Total hauled material for first km minus freehaul distance for each direction of haul. Haul quantities are in unit tonnes. Distances are to scale.
11. Haul for each subsequent km. Distances are to scale.
12. Total km haul.
13. Sum of total km haul.

Haul Summary:

14. Total haul of all materials for each km.
15. Sum of total km haul of all materials.

Notes:

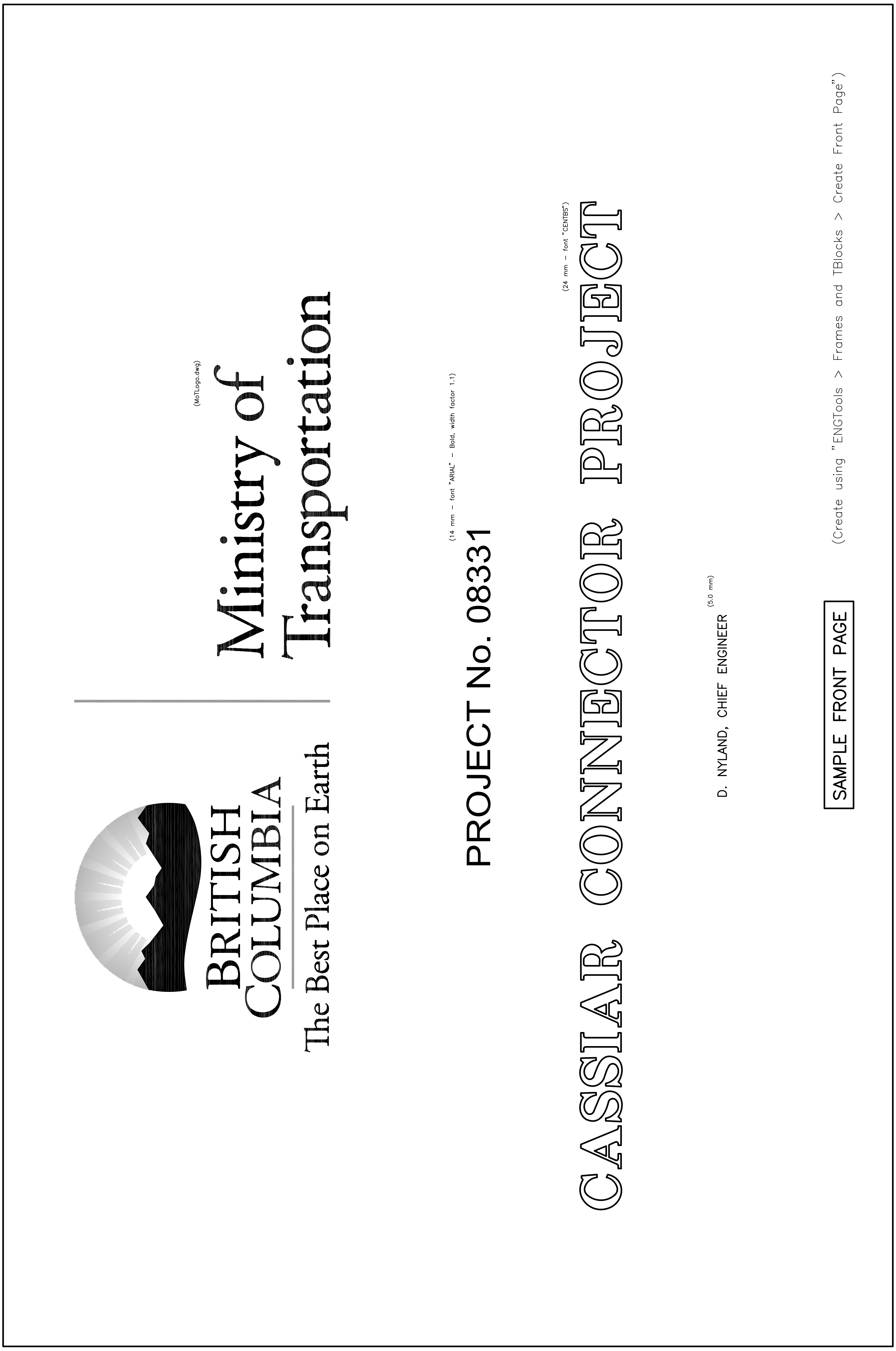
Payment for asphalt concrete pavement and asphalt concrete levelling course will be at the unit price bid per tonne, supplied in place. As such, these items are not usually included in the haul chart. Their inclusion is useful in bid preparation.
Haul on material which is stockpiled prior to installation in a course on the highway will be measured from the original point of production via the stockpile to the delivery point minus 1 kilometre freehaul.

Haul on material which is placed directly on the highway will be measured from the point of production to the delivery point minus 1 kilometre freehaul.

Haul on material produced for stockpiling only will be measured from a point one kilometre freehaul distance from the point of production to the delivery point.

Figure 1220.A Sample Front Page

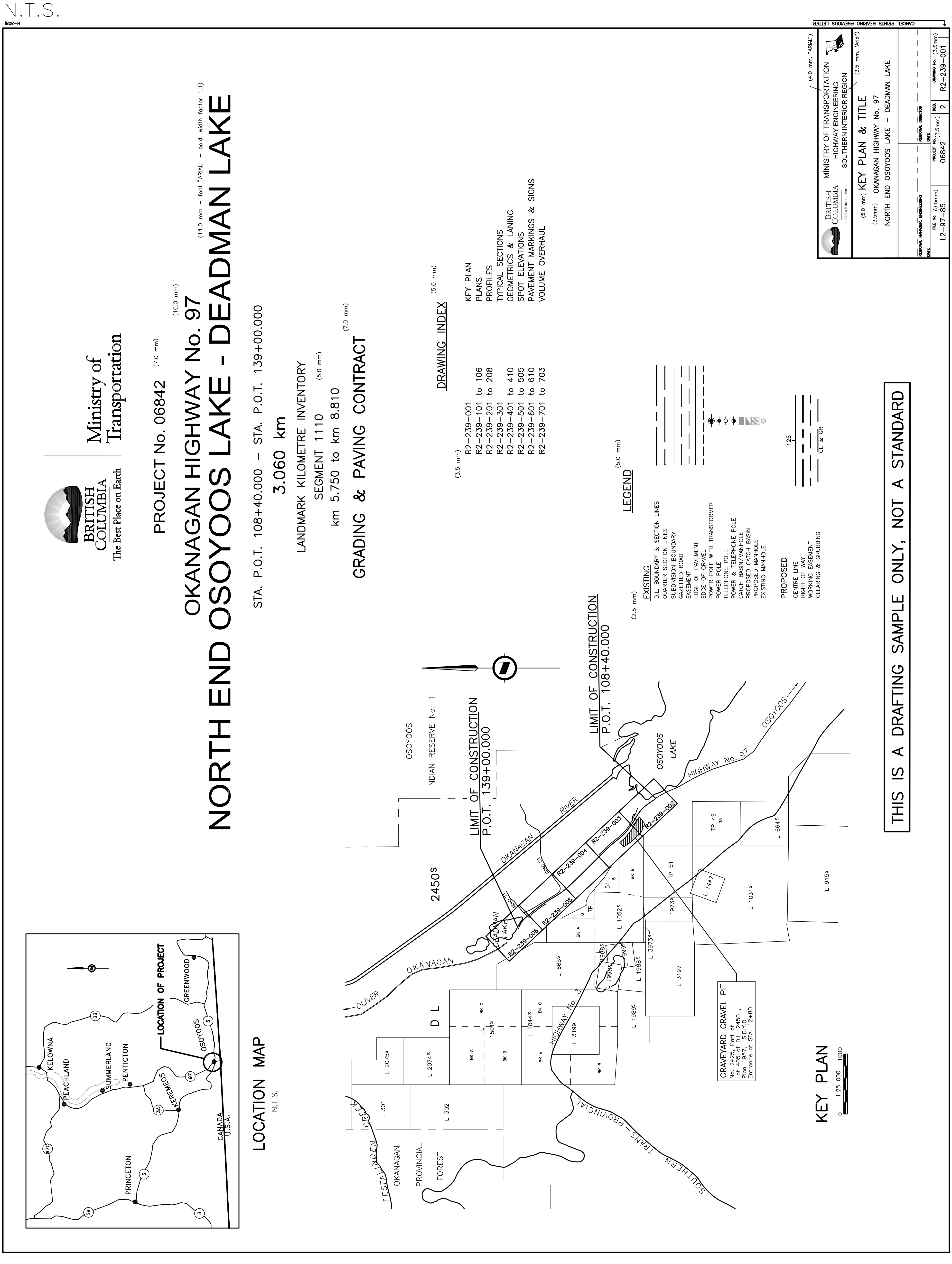
N.T.S.



MoT Section	1220		TAC Section	Not Applicable

Figure 1220.B Sample Key Plan

N.T.S.



MoT Section	1220		TAC Section	Not Applicable

Figure 1220.C Sample Legend

N.T.S.

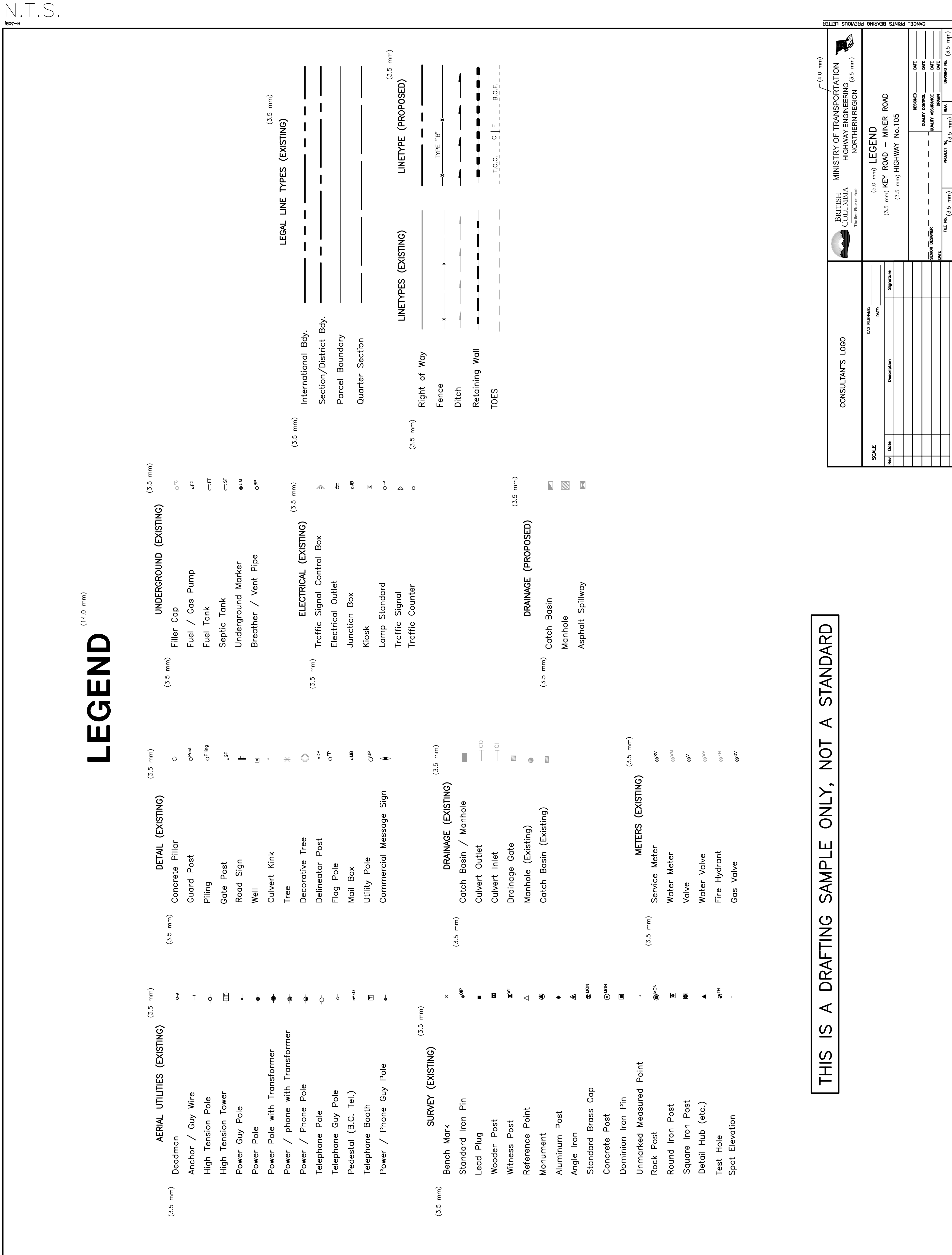
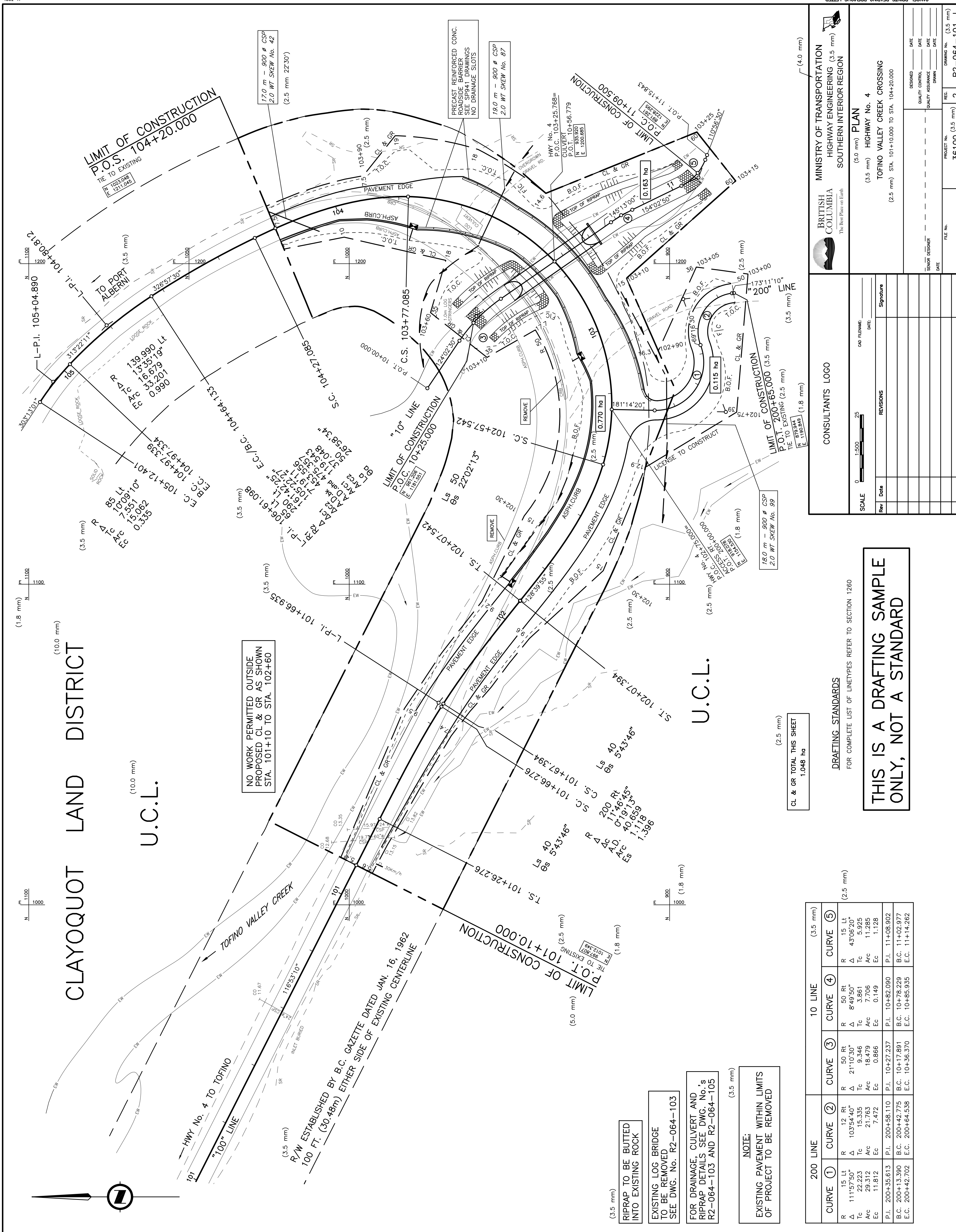


Figure 1220.D Sample Plan

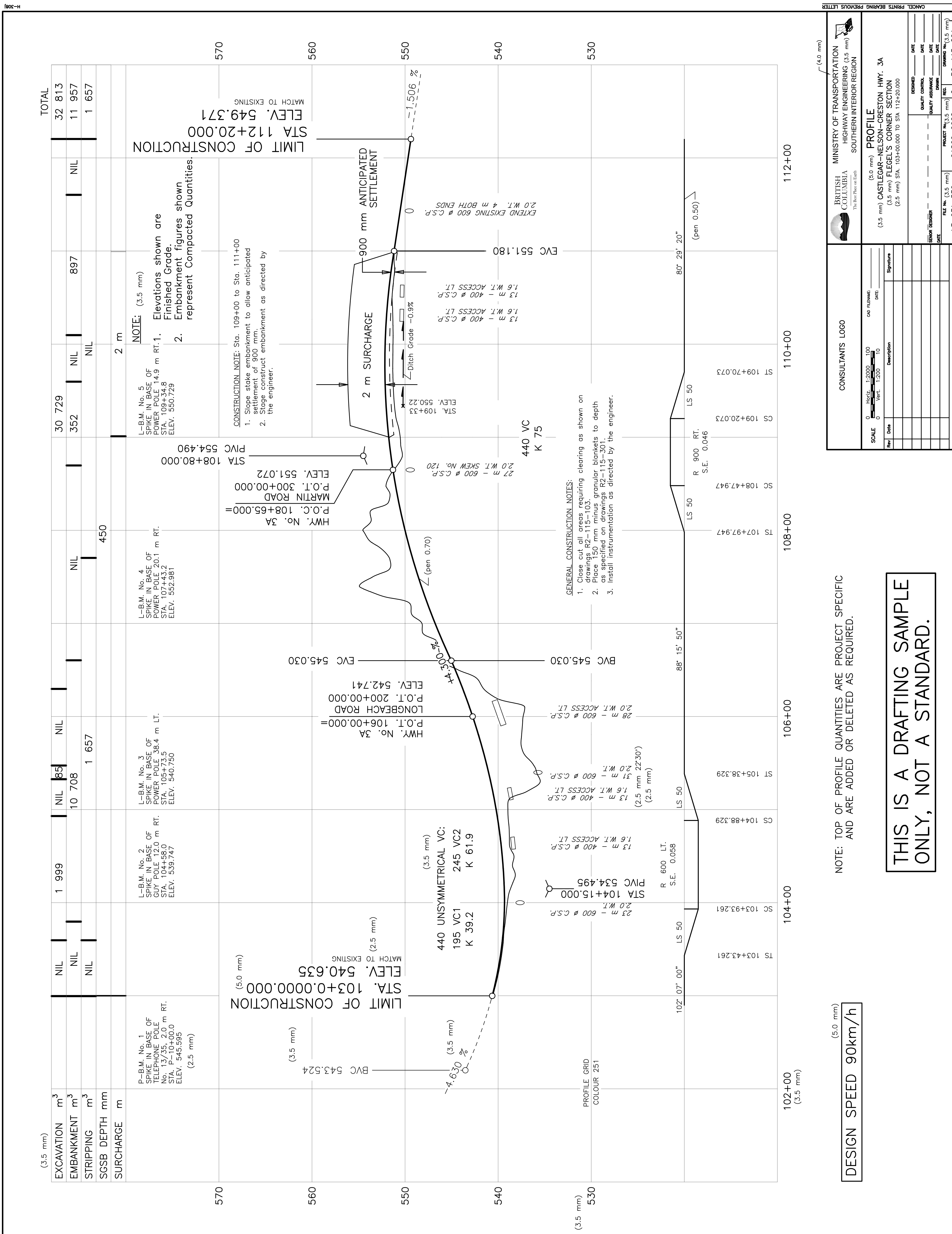
N.T.S.



MoT Section	1220		TAC Section	Not Applicable

Figure 1220.E Sample Profile

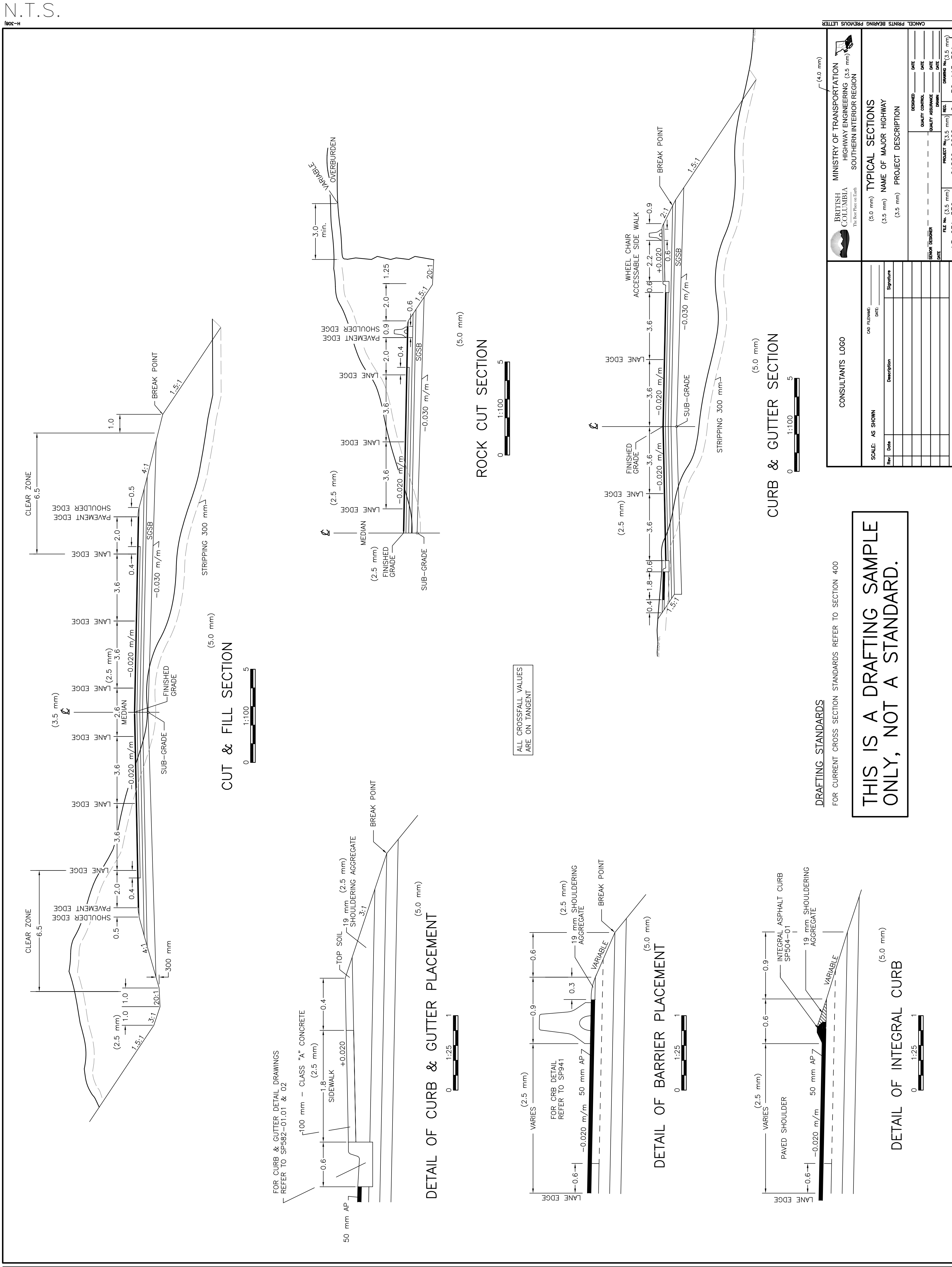
N.T.S.



MoT Section	1220		TAC Section	Not Applicable

Figure 1220.F Sample Typical Sections

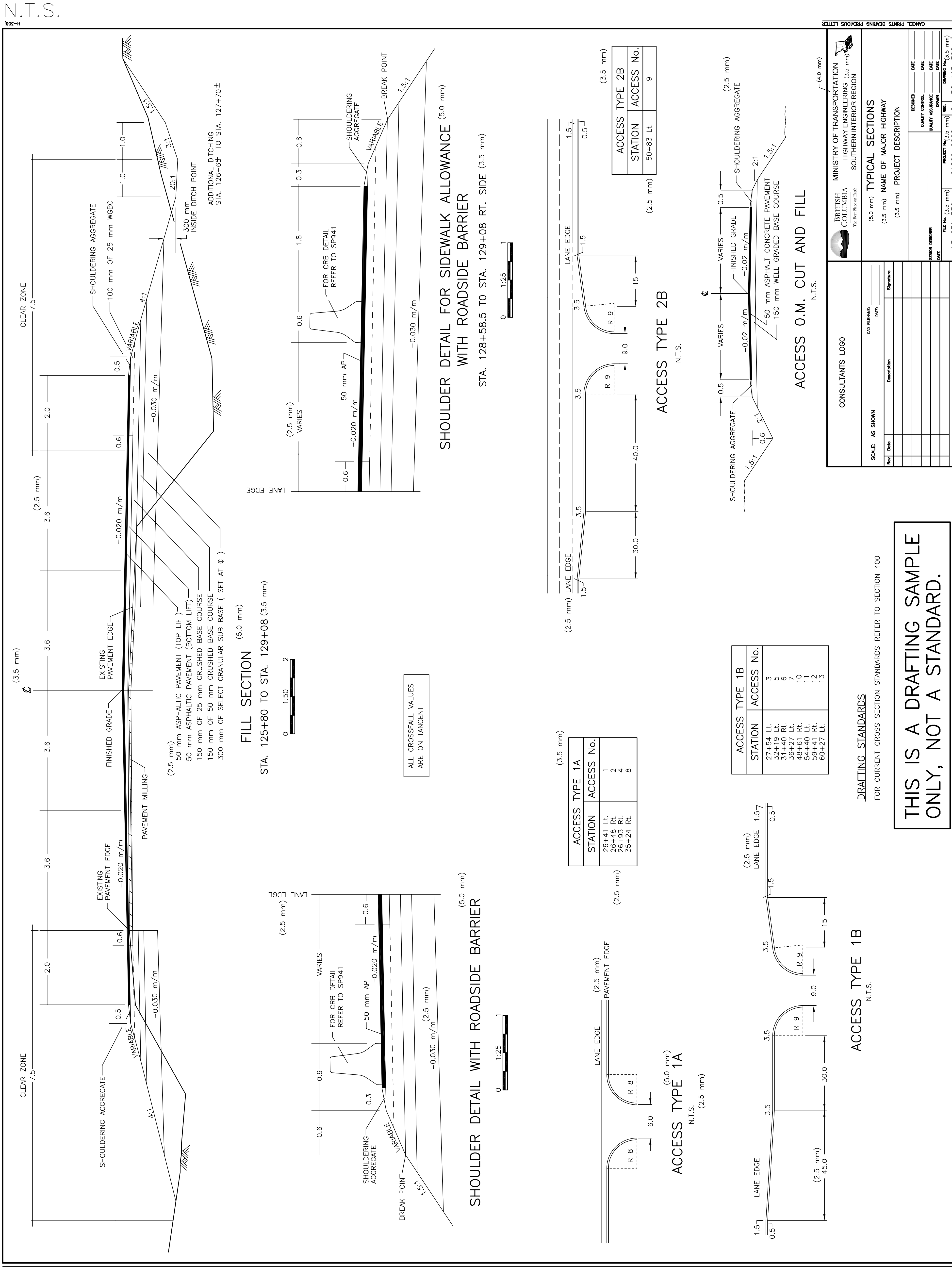
N.T.S.



MoT Section	1220		TAC Section	Not Applicable

Figure 1220.G Sample Typical Sections

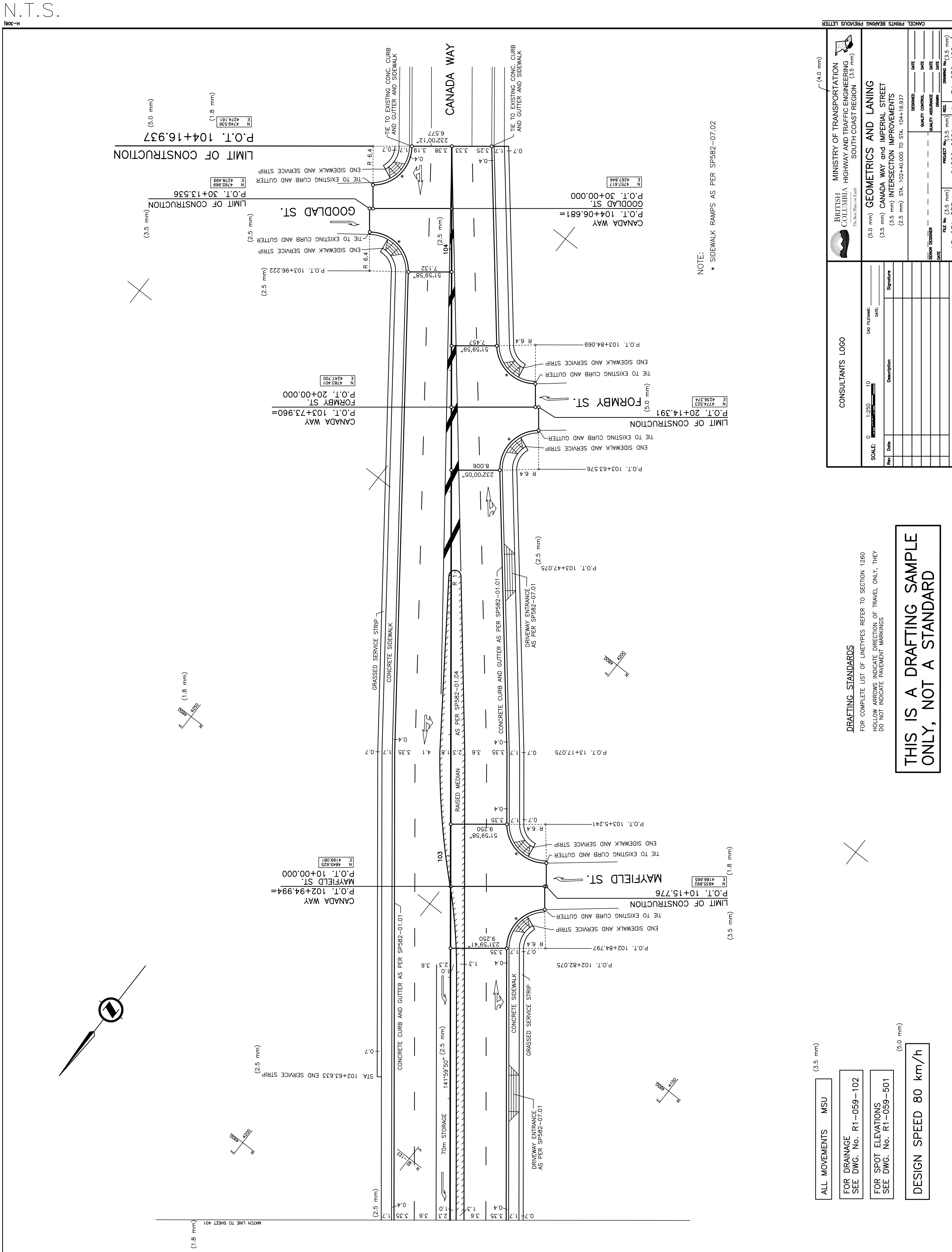
N.T.S.



MoT Section	1220		TAC Section	Not Applicable

Figure 1220.H Sample Geometrics and Laning

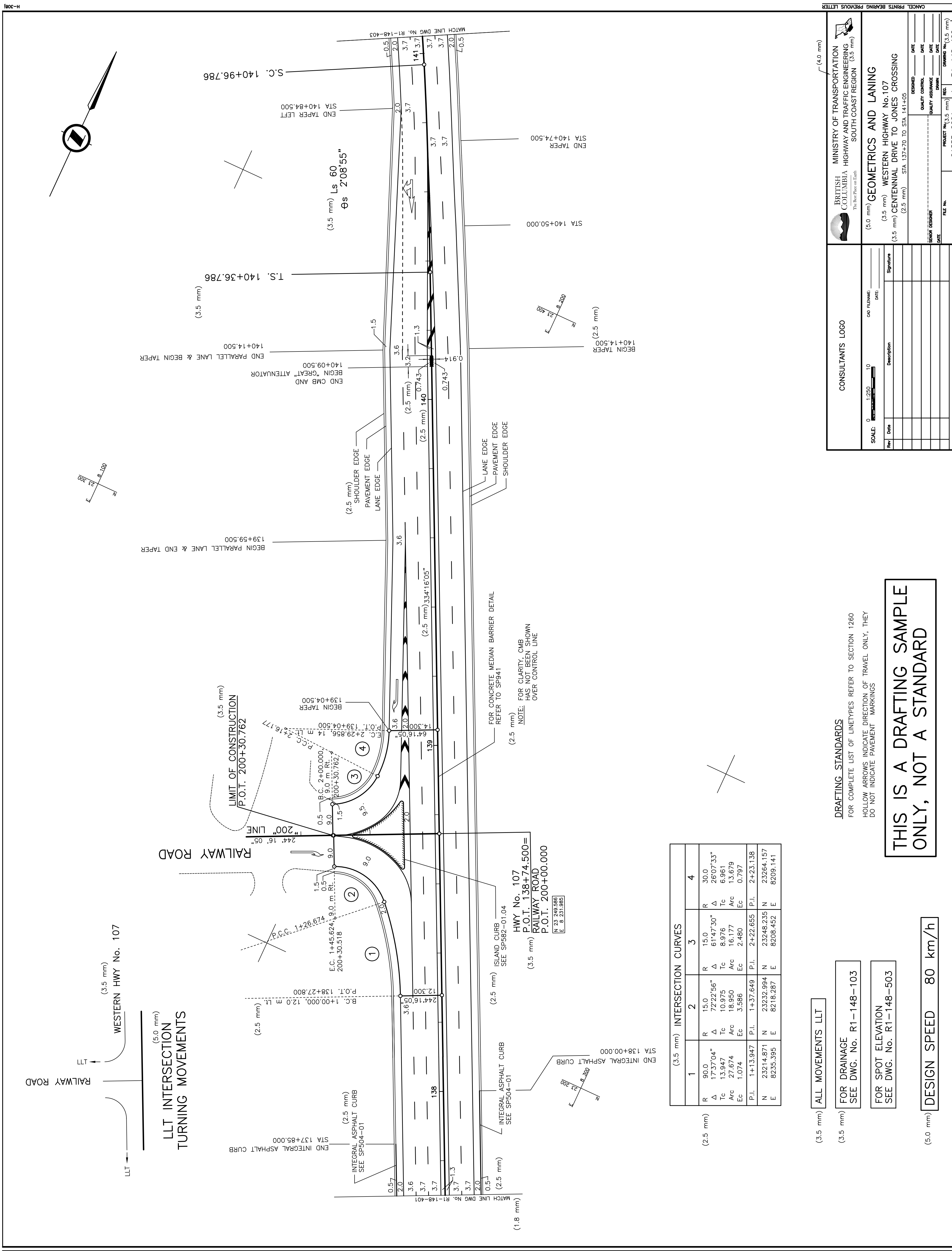
N.T.S.



MoT Section	1220		TAC Section	Not Applicable

Figure 1220.I Sample Geometrics and Laning

N.T.S.



MoT Section	1220		TAC Section	Not Applicable

Figure 1220.J Sample Spot Elevations

N.T.S.

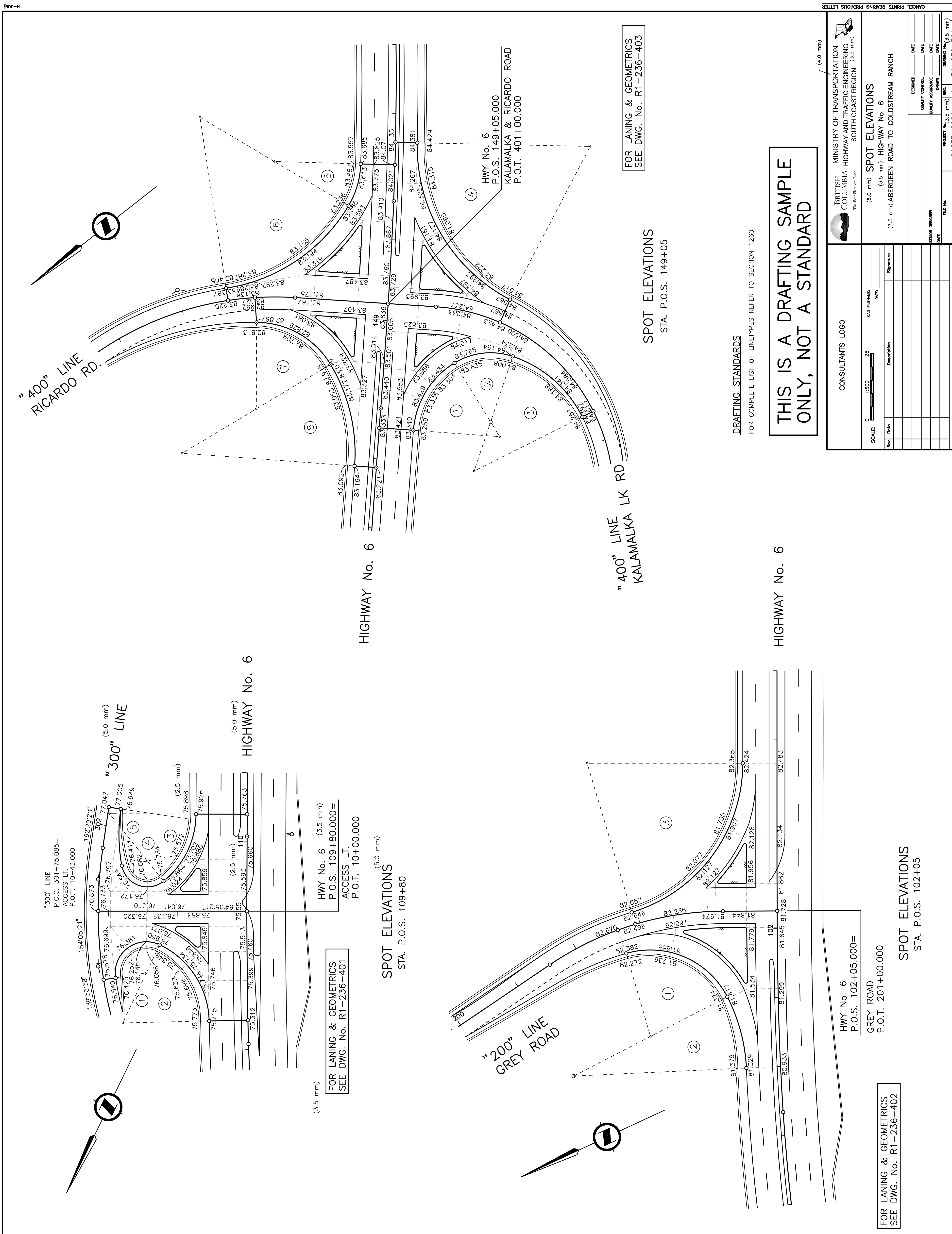
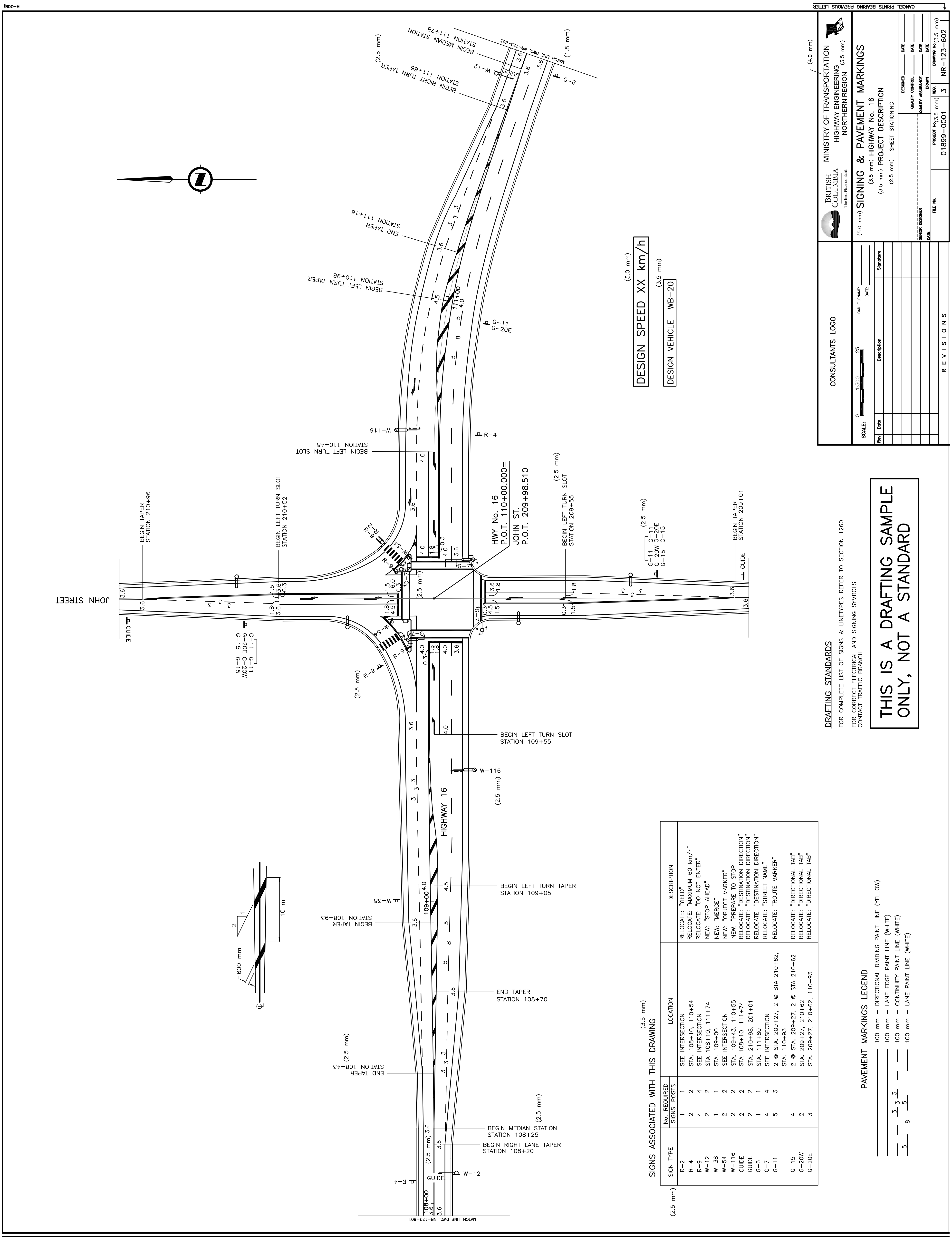


Figure 1220.K Sample Signing and Pavement Markings

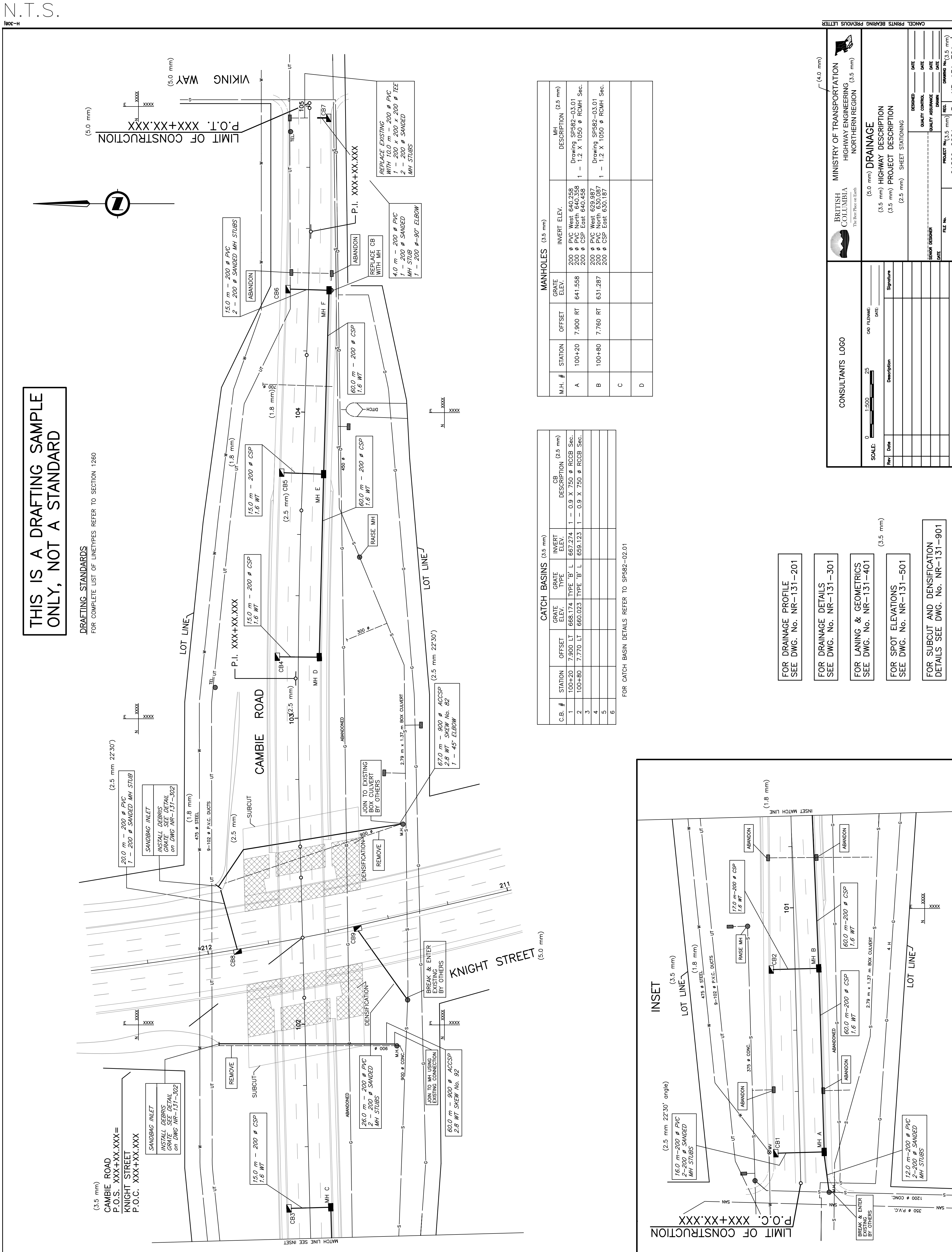
N.T.S.



MoT Section	1220		TAC Section	Not Applicable

Figure 1220.L Sample Drainage

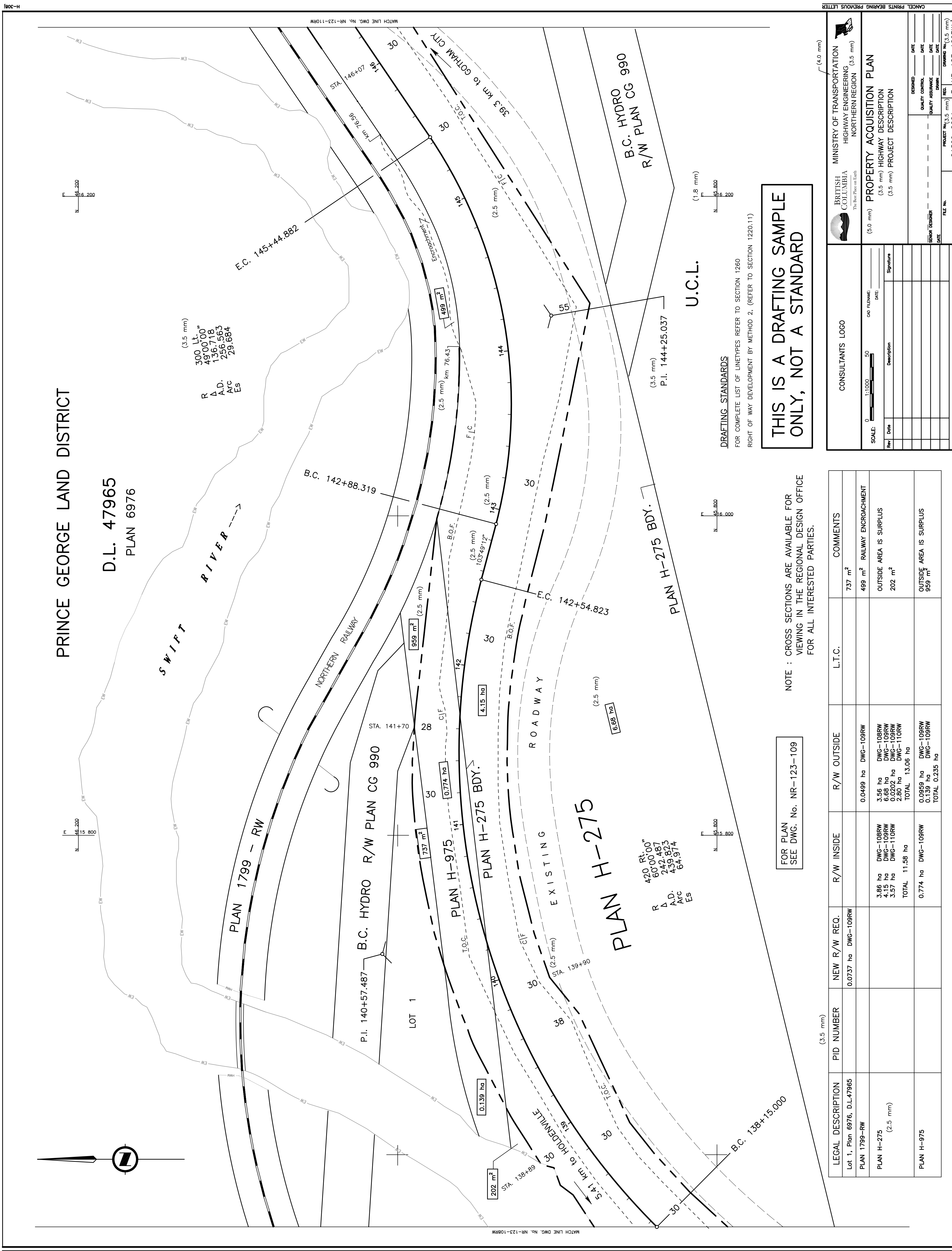
N.T.S.



MoT Section	1220		TAC Section	Not Applicable

Figure 1220.M Sample Property Acquisition Plan (Rural)

N.T.S.



MoT Section	1220		TAC Section	Not Applicable

Figure 1220.N Sample Property Acquisition Plan (Urban)

N.T.S.

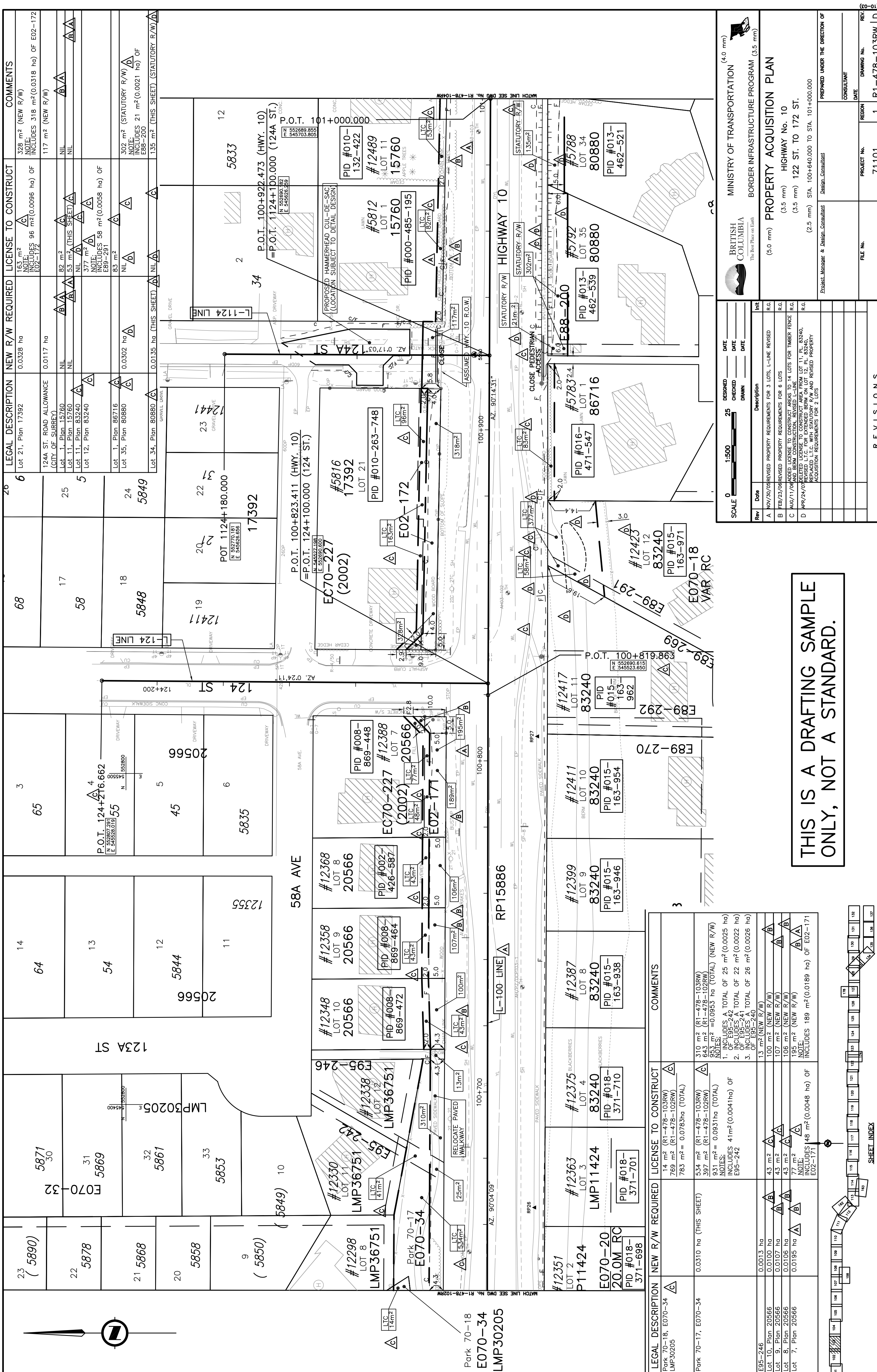


Figure 1220.O Sample Overhaul Tabulation Chart

MINISTRY OF TRANSPORTATION
ENGINEERING BRANCH

OVERHAUL

PROJECT NAME OREGON JACK–CACHE CREEK   MADE BY J.H.C.   SHEET 1 OF 1
HIGHWAY TRANS CANADA HWY No. 1   CHECKED BY G.H.   DATE APRIL 2006

A				B	C	D	E	F
STATIONS		STATIONS		AREA cm²	SCALE FACTOR	MATERIAL TYPE	FACTOR	OVERHAUL (B x C x D x E) Sta. m
3+00	3+60	4+05		0.60	1 000	100% D	1.20	720
7+55	11+35	24+06	24+55	105.50	1 000	100% D	1.20	126 600
11+35	12+35	18+40	19+25	20.10	1 000	100% A	0.833	16 743
22+37	23+65	24+06		7.90	1 000	60% A	0.833	3 948
22+37	23+65	24+06		7.90	1 000	40% D	1.20	3 792
								151 083
24+55	24+65	27+10	27+45	4.50	1 000	100% A	0.833	3 749
33+20	34+70	34+70		2.40	1 000	100% A	0.833	1 999
							TOTAL	157 551

NOTE: Scales for this example
Horiz.: 1 cm = 0.5 Sta.
Vert. : 1 cm = 2000 m³
∴ Scale Factor = 0.5 x 2000
= 1000

NOTE: To be used in conjunction with Sample Volume Overhaul Diagram
On SCHEDULE 7 we show overhaul quantities in 1000 Sta. m; therefore, divide above Sta. m by 1000 and show: 157.6

Form H 759

Figure 1220.P Sample Volume Overhaul

N.T.S.

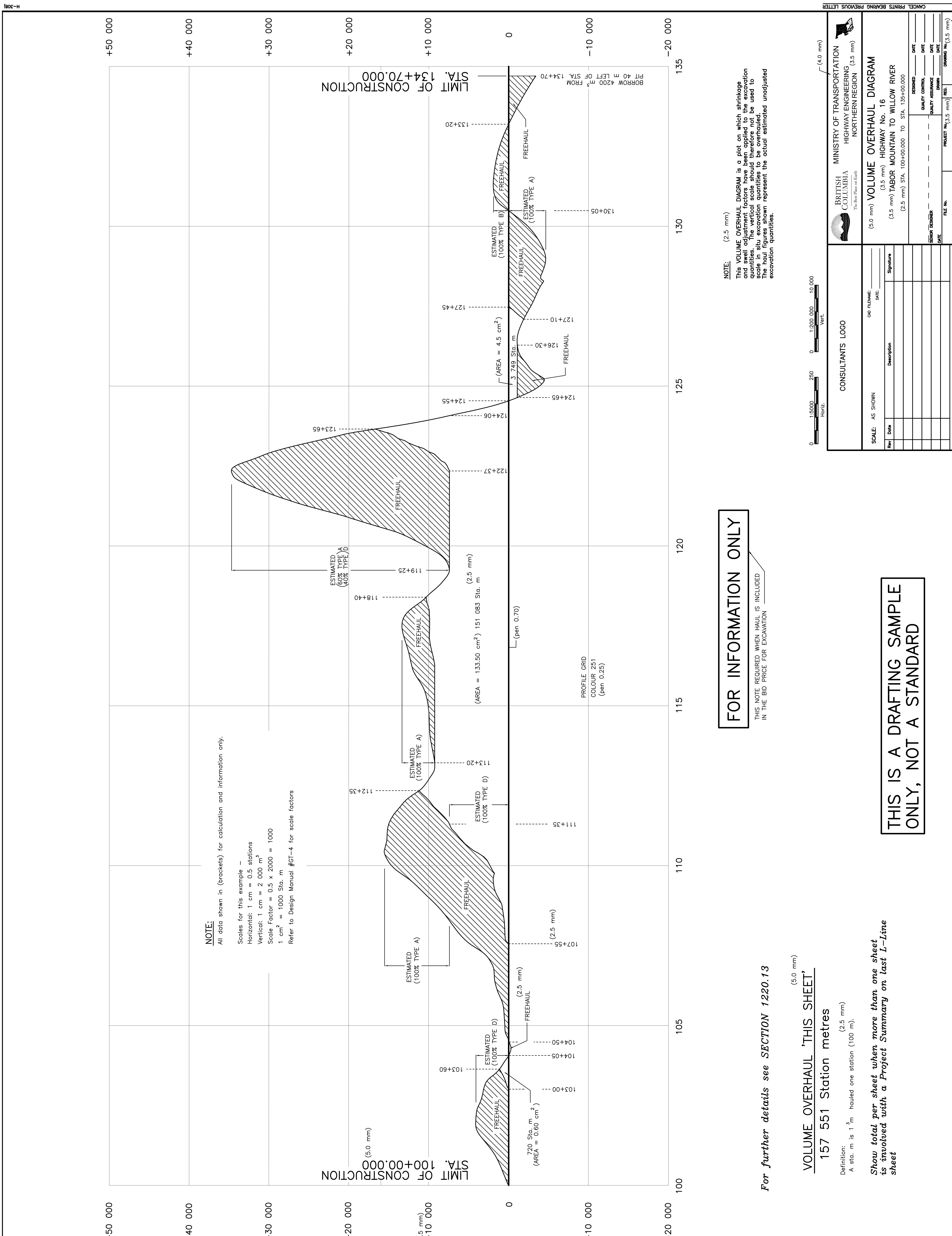
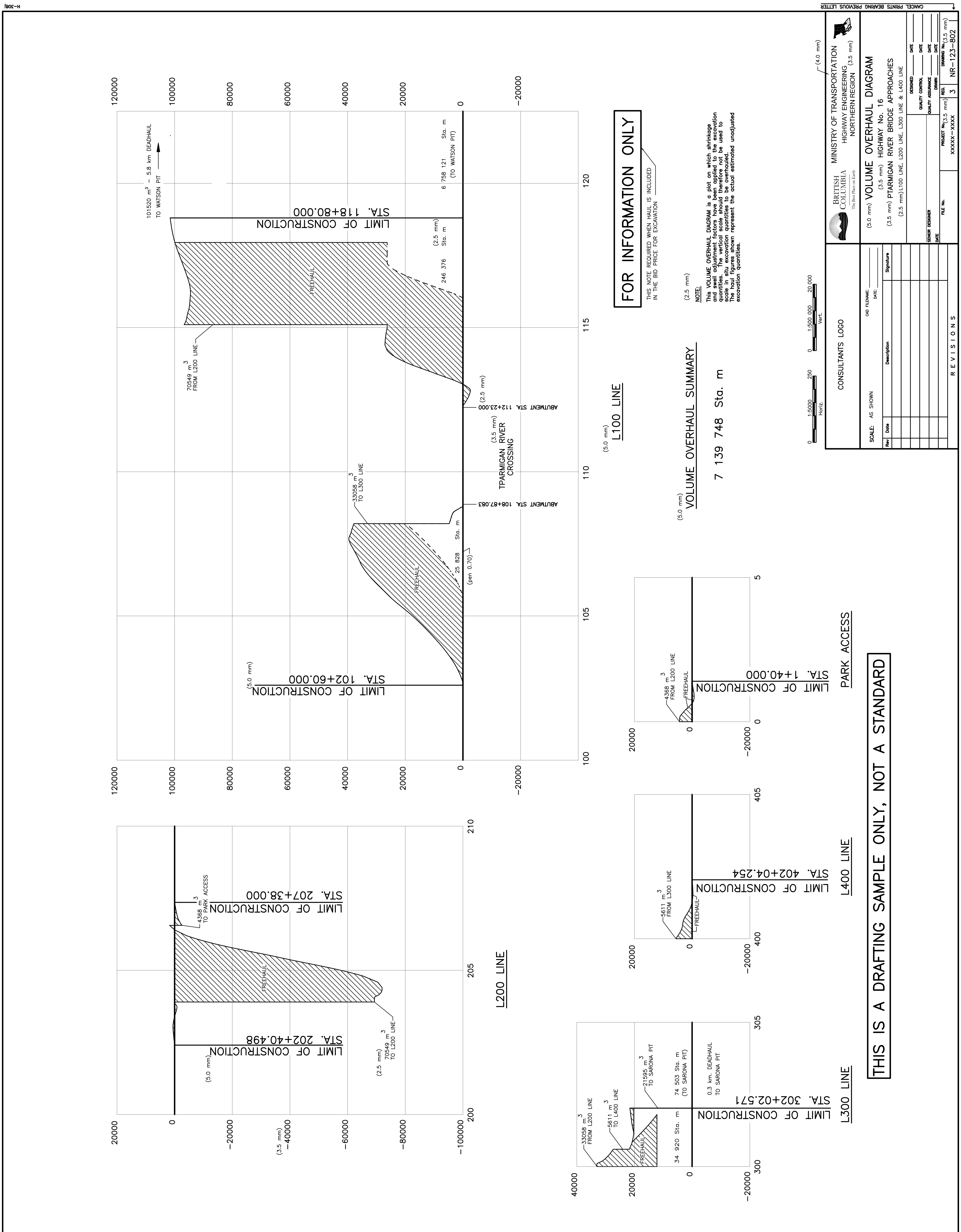


Figure 1220.Q Sample Volume Overhaul

N.T.S.



MoT Section	1220		TAC Section	Not Applicable

Figure 1220.R Sample Gravel Quantities and Haul

N.T.S.

H-308j

(10.0 mm)
GRAVEL QUANTITIES AND HAUL

(3.5 mm) PROJECT KILOMETRES

(3.5 mm)	0–1	1–2	2–3 (3 ①)	3–4	4–4.064	TOTALS
25 mm OF CRUSHED BASE COURSE	2 843	2 843	4 370	11 804	←83	21 943
50 mm OF CRUSHED BASE COURSE ②	3 146 ③	3 146	4 455	12 396	←88 ④	23 231 ⑤
SELECT GRANULAR SUB–BASE	15 611	15 611	22 682	60 012	←400	114 316
HIGH FINES GRANULAR SURFACING AGGREGATE	NIL	NIL	NIL	281	←NIL	281
STRUCTURE BACKFILL	NIL	NIL	NIL	520	←NIL	520
				TOTAL		170 541 ⑥

⑦ (5.0 mm)
25 mm WELL GRADED CRUSHED BASE COURSE

JONES GRAVEL PIT LOCATED 1.2 km FROM INTERSECTION OF SOUTH SERVICE ROAD AND UNDERPASS ROADWAY ⑨

FIRST KILOMETRE ⑧				7 781 ⑩	5 385	13 166
SECOND KILOMETRE			3 816 ⑪			3 816 ⑫
THIRD KILOMETRE		2 843				2 843
FOURTH KILOMETRE	2 118					2 118
				TOTAL		21 943 ⑬

50 mm WELL GRADED CRUSHED BASE COURSE

FIRST KILOMETRE				8 141	5 754	13 895
SECOND KILOMETRE			3 846			3 846
THIRD KILOMETRE		3 146				3 146
FOURTH KILOMETRE	2 344					2 344
				TOTAL		23 231

SELECT GRANULAR SUB-BASE

FIRST KILOMETRE				40 403	27 361	67 764
SECOND KILOMETRE			19 311			19 311
THIRD KILOMETRE		15 611				15 611
FOURTH KILOMETRE	11 630					11 630
				TOTAL		114 316

HIGH FINES GRANULAR SURFACING AGGREGATE

FIRST KILOMETRE					281	281
				TOTAL		281

STRUCTURE BACKFILL

FIRST KILOMETRE				260	260	520
				TOTAL		520

(5.0 mm) **HAUL SUMMARY**

(3.5 mm)	
FIRST KILOMETRE	102 189 ⑭
SECOND KILOMETRE	28 606
THIRD KILOMETRE	22 778
FOURTH KILOMETRE	16 968
TOTAL	170 541 ⑮

NOTE:

ALL GRAVEL UNITS ARE IN TONNES

THIS IS A DRAFTING SAMPLE ONLY, NOT A STANDARD.

CONSULTANTS LOGO

SCALE: AS SHOWN CAD FILENAME: DATE:

Rev	Date	Description	Signature

R E V I S I O N S

BRITISH COLUMBIA The Best Place on Earth

(4.0 mm) MINISTRY OF TRANSPORTATION
HIGHWAY ENGINEERING
NORTHERN REGION (3.5 mm)

(5.0 mm) GRAVEL QUANTITIES AND HAUL
(3.5 mm) HIGHWAY No. 16
WILLOW RIVER INTERCHANGE

DESIGNED DATE
QUALITY CONTROL DATE
SENIOR DESIGNER QUALITY ASSURANCE DATE
DATE DRAWN DATE

FILE No. PROJECT No. (3.5 mm) XXXXX–XXXX REG. 3 DRAWING No. (3.5 mm) NR–123–803

CANCEL PRINTS BEARING PREVIOUS LETTER

1230.01 GENERAL LAYER NAMING CONVENTION

Layer names have been adopted to identify the Branch or Section producing the work and to group common elements logically. The typical layer name consists of three parts; the prefix, the base layer name and the suffix.

The **prefix** denotes the source of the data on the layer in question. This is a single letter and refers to the Branch or Section. There have been 16 prefixes authorized so far. They are listed in Table 1230.A.

The **base layer** name describes the contents of the layer. The standard names of these layers are shown in Table 1230.B. A sub-prefix is used to distinguish between existing and design information. To allow for a separation of these items, the base layer names shown in Table 1230.B is expanded with the addition of a secondary prefix, either "DET-" or "DES-" to indicate existing DETail or proposed DESign, respectively.

The **suffix** is used to provide a more detailed description of entities on the base layer.

Examples:

- FDES-LANE contains proposed or design laning from the Field Survey Office.
- FLEGAL contains existing legal information as picked up by the Field Survey.
- FDET-DRAIN contains existing drainage information as picked up by the Field Survey.

Tables 1230.C through 1230.F show the application of this naming convention (prefix, sub-prefix, and base layer name) as it might typically be used for plans, typical sections, profiles and cross section drawings.

Table 1230.A Prefix/Branch Identifiers

Prefix	Branch	Prefix	Branch
A	Major Projects	M	District/Maintenance
B	Bridge	P	Highway Planning
C	Construction	R	Geotech – Resistivity
D	Design	S	Planning Services
E	Traffic – Electrical	T	Traffic – Civil
F	Survey	U	Building Services
G	Geotech	V	Paving
H	Highway Safety	X	Consultants

Any request for additions to this list should be made, in writing, to the Standards Section of Highway Engineering Branch to avoid conflicts.

Table 1230.B – Base Layer Names

Layer Name	Contents	Layer Name	Contents
ARCH	Architectural: proposed buildings, plumbing, HVAC, etc.	STRUCT	Highway related structural information: retaining walls, bridge information, etc.
CON	Major/Minor Contours with elevation text.	TEMPLATE	Cross section data: sub-grade line, gravels etc.
CONTROL	Traverse information: Reference Hubs, Benchmarks, etc.	TBLOCK	Drawing frame, Titles, Bar Scale, Match lines, etc.
DRAIN	Open/closed drainage systems.	TOES	Slope stakes, cut and fill lines with annotation.
GEN	Existing detail: houses, walls, fences, etc.	TOPOG	Major natural features: rivers, lakes, cliffs, etc.
GEO	Geotech: test holes, pits, instrumentation	UTIL	Underground and surface utilities
GRID	Grid marks, coords, North Arrow.	VEG	Trees, hedges, treelines, gardens, etc.
INSETS	Detail blowups: Manholes, etc.	VERT	Vertical alignment, text Limit of Construction
JUNK	Personal reminders, drafting notes, etc.		
LANE	Paint lines, islands, edge of pavement, curbs, sidewalks, barrier, directional arrows, etc.	**The following layers would be used if too much information would otherwise be on the normal layer shown below.**	
LEGAL	Existing legal pins, ties, monuments and boundaries	GAS/OIL	Gas or oil lines, valves and meters. Normally on UTIL layer.
LLINE	Designed control line information: centrelines, station curve geometry, etc.	HYDRO	Underground hydro facilities. Normally on UTIL layer.
LTEX	Lline notation text: “Begin Taper”, lane width value, etc.	SAN	Sewer lines, manholes, etc. Normally on UTIL layer
NOTES	Relevant notes: Design Speed, Benchmarks, etc.	STORM	Closed drainage utility. Normally on DRAIN layer.
SIGNS	Signing symbols and information	TEL	Underground telephone lines, manholes etc. Normally on UTIL layer
SPOT	Spot elevations	WATER	Water valves, lines, etc. Normally on UTIL layer.

See Tables 1230.C through 1230.F for further details of layer contents.

Table 1230.C – Layer Convention for Plans

PLANS		ACAD		LAYER DESCRIPTIONS	
LAYER	DESCRIPTION OF ENTITY	COLOUR		LINETYPE	REMARKS
CONTROL – GRID – LEGAL – NOTES – T BLOCK - TOPOG					
_CONTROL	All other than listed blow	1	BL		All traverse control point and benchmarks
	Reference Hubs	1	BB	Symbol	
	Benchmarks	1	BB	Symbol	
_GRID	All other than listed below	1	BL		
	Grid Cross	1	BE		LISP
	Grid Text	1	BE		LISP Text Ht. 1.8
	North Arrow	2	BB	Symbol	
_LEGAL	All other Existing Legal	2	BL		
	Lot Boundaries	2	BL		
	Lot Description	2	BL	Text	Text Ht. 3.5
	Plan No.	3	BE	Text	Text Ht. 5.0
	District Lot Line	4	BE		
	District Lot Description	4	BE	Text	Text Ht. 7.0 or 10.0
	¼ Section Lines	3	BE		
	¼ Section Description	3#	BE	Text	Text Ht. 7.0
	Municipal Boundaries	3	BE		
	Municipal Description	3	BE	Text	Text Ht. 5.0
	Range Lines	3	BE		
	Range Description	3	BE	Text	Text Ht. 5.0
	Township Lines	2	BL		
	Township Description	2	BL	Text	Text Ht. 3.5
	Pins	1	BB	Symbol	
	Monuments	1	BB	Symbol	
	Easement	2	BE		
_NOTES	All other than listed below		BE	Text	Text Ht. varies

BB = BY BLOCK, BL = BY LAYER, BE = BY ENTITY, #EXCEPTION TO TEXT RULES.

Table 1230.C – Layer Convention for Plans cont'd.

PLANS		ACAD	LAYER DESCRIPTIONS	
LAYER	DESCRIPTION OF ENTITY	COLOUR	LINETYPE	REMARKS
_TBLOCK	All other than listed below	2 BL		
	Drawing Shell	BB		To Block 1023/1044
	Title Information			
	- Name of Plan	3 BE	Text	Text Ht. 5.0
	- Description	2 BL	Text	Text Ht. 3.5
	- Stationing	1 BE	Text	Text Ht. 2.5
	- Logo	BB		Symbol
	- Legends	BE/BB	Symbol/Text	Text Ht. varies
	- Scale Bar	BB		Symbol
_TOPOG	All other Existing	165 BL	Continuous	Major Natural Features
	River, Creek, Lake, Streams	5 BE	Continuous	
	Scarps, Top/Bottom Bank	36, 165 BE		
DET = DETAIL (EXISTING)				
_DET-ARCH	Architectural Details	BE		If few, put under Det-Gen.
_DET-CON		251 BL		
	Contours - Minor	251 BL	Continuous	
	Contours – Major	253 BE	Continuous	
	Contour Labels	251# BE	Text	Text Ht. 2.5
_DET-DRAIN	All other Existing	5 BL		
	Ditches	5 BE		
	Culverts	5 BB	Symbol	
	Flumes	5 BL	Continuous	
_DET-GAS/OIL	All other Existing	202 BL		If few, put under Det-Util.
	Gas Valves and Meters	202 BB	Symbol	
	Gas Lines	202 BE		
_DET-GEN	All other Existing	BE	Cont.	Houses, Fences, etc.
_DET-GEO	All other Existing	2 BL		Geotechnical Information
	Instrumentation	2# BL	Text	Text Ht. 2.5
	Test Pits, Test Holes	1,2 BB	Symbol	
_DET-HYDRO	All other Existing	202 BL		If few, put under Det-Util.
	Manholes	5 BB	Symbol	
	Underground Elec. Lines	202 BE		

BB = BY BLOCK, BL = BY LAYER, BE = BY ENTITY. # EXCEPTION TO TEXT RULES.

Table 1230.C – Layer Convention for Plans cont'd.

PLANS		ACAD	LAYER DESCRIPTIONS	
LAYER	DESCRIPTION OF ENTITY	COLOUR	LINETYPE	REMARKS
_DET-LANE	All other Existing	165 BL		
	Centerline	165 BE		
	Laning Shoulder	165 BL	Dash	
	Paint Lines	165 BE	Dash	
_DET-ROADS	All other Existing	165 BL		
	All Existing Road Features	165 BL/BE	Cont.	
	Railroad	1 BE		
	Edge of Pavement	36 BE	Continuous	
	Shoulder, Dirt Road, etc.	165 BL/BE	Dash	
_DET-SAN	All other Existing	202 BL		If few, put under Det-Util.
	Manholes	5 BB	Symbol	
	Sewer Lines	202 BE		
_DET-SIGNS	All other Existing	165 BL		
	Signs	165 BB	Symbol	
	Sign Information	BE	Text	Text Ht. varies
_DET-SPOT	All other Existing	165 BL		
	Spot Elevations	165 BB/BL	Symbol/Text	Text Ht. 1.8
_DET-STORM	All other Existing	5 BL		If few, put under Det-Drain
	Catch Basins	5 BB	Symbol	
	Manholes	5 BB	Symbol	
	Storm Sewer	5 BE		
_DET-STRUCT	All other Existing	1 BL		If few, put under Det-Gen.
	Retaining Walls	1 BE		
	Bridges	2 BE	Continuous	
_DET-TEL	All other Existing	202 BL		If few, put under Det-Util.
	Manholes	5 BB		Symbol
	Underground Tel. Lines	202 BE	-Line*	
_DET-UTIL	All other Existing	202 BL		Put all utilities under Det-Util if the drawing is not too busy
	All Aerial Utilities & Poles	202 BB	Symbol	
	Tel Ped., BC Hydro Kiosks	202 BB	Symbol	
	Wire Hts., Traffic Lights	202 BE		
	Traffic Signal/Control Box	165 BB	Symbol	

BB = BY BLOCK, BL = BY LAYER, BE = BY ENTITY. # EXCEPTION TO TEXT RULES.

Table 1230.C – Layer Convention for Plans cont'd.

PLANS		ACAD	LAYER DESCRIPTIONS	
LAYER	DESCRIPTION OF ENTITY	COLOUR	LINETYPE	REMARKS
_DET-VEG	All other Existing	116 BL		
	Decorative Trees	116 BB	Symbol	
	Treeline, Vegetation, Hedges	116 BE		
_DET-WATER	All Other Existing	5/202 BL		If few, put under Det-Util.
	Water Valves	5/202 BB	Symbol	
	Water Lines	5/202 BE		
DES = DESIGN (PROPOSED)				
_DES-DRAIN	All other Proposed	2 BL		
	Ditching (Ditch)	3 BE		
	Proposed Culverts	4 BE	Continuous	
	Pipes, Concrete/Plastic etc.	3 BE	Continuous	
	Culvert Note	1 BE	Text	Obliqued 22º30' Text Ht. 2.5
	+Box	1 BE		
	Catch Basins	1 BB	Symbol	
	C.B. Information Notes	1 BE	Text	Text Ht. 2.5
	Storm	3 BE		
	Sanitary	3 BE		
	Rip Rap	1 BE		
	All Drainage Notes	1 BE	Text	Text Ht. 2.5
_DES-GEO	All other Proposed Geo	6 BL		Geotechnical Information
	Pavement Eval. & Rehab.	6 BL		
	Instrumentation (PIE2,SI)	6 BB	Symbol	
	Test Pits	2 BB	Symbol	
	Test Holes	2 BB	Symbol	
	Gravel Pit Dev./Stock Pit	6 BB	Continuous	Geotech. Symbols-Pit Dev.
	Remedial Work (Slides)	8 BE	Continuous	Subexcavation/berm/ reconstruction area
	Horizontal Drains	1 BE	Dash	

BB = BY BLOCK, BL = BY LAYER, BE = BY ENTITY. # EXCEPTION TO TEXT RULES.

Table 1230.C – Layer Convention for Plans cont'd.

PLANS		ACAD	LAYER DESCRIPTIONS	
LAYER	DESCRIPTION OF ENTITY	COLOUR	LINETYPE	REMARKS
_DES-INSETS	All other Proposed	BE		Note: Linetype and symbols to be done as close to standards when drawn.
	Detail Drawings	BE		
	Eg. - Chain Link Fence	BE		
	- Special Section	BE		
	- Sign Post Design	BE		
	Landscaping Drawing	BE		
	General Detail Drawings	BE		
	Titles	BE		Text Ht. varies
	General Text Size	BE	Text	Text Ht. varies
_DES-LANE	All other Proposed	2 BL		
	Raised Is. & Median Is.	3 BE	Continuous	
	Raised Turn Slots	3 BE	Continuous	
	Painted Turn Slots	2 BL	Continuous	
	Painted Lines – Lane Edge	2 BL	Continuous	
	Painted Lines – Yellow Line	51 BE	Continuous	
	Edge of Pavement	3 BE	Continuous	
	Shoulders	1 BE	Continuous	
	Curbs	3 BE	Continuous	
	Sidewalks	2 BL	Continuous	
	No-Post Barrier(CRB, CNB)	6 BE		
	W Beam	3 BE		
	Traffic Direction Arrows	1 BB	Symbol	
_DES-L-LINE	All other Proposed	2 BL		Proposed Control line for main road, secondary roads, access, detours, quadrants, etc.
	Radius lines	1 BE	Dash	
	Centreline	4,3 BE	Continuous	Main Centerline color 4 Secondary Centerline Color 3
	Curve Geometry/Curve Points	1 BE	Text	Secondary roads, access, quadrants, Text ht. 2.5
	Dist. & Az. on Tang.	1 BE	Text	Text Ht. 2.5
	Stationing (100 m)	2# BL	Text	Text Ht. 2.5
	P.O.T.'s, P.O.S.T.'s, etc.	6 BE	Text	Text Ht. 2.5
	Curve Sta. Leader Line	2 BL	Continuous	

BB = BY BLOCK, BL = BY LAYER, BE = BY ENTITY. # EXCEPTION TO TEXT RULES.

Table 1230.C – Layer Convention for Plans cont'd.

PLANS		ACAD		LAYER DESCRIPTIONS	
LAYER	DESCRIPTION OF ENTITY	COLOUR		LINETYPE	REMARKS
_DES-L-LINE	Circles	2	BL		Radius- main line 1.0 rad.
		1	BE		
	Arc Centre 0.5 rad.				
	Curve Stations	2	BL	Text	PI/BC/EC/TS/SC/CS/ST, Text Ht. 3.5
	Co-ordinates	1	BE	Text	Text Ht. 1.8 Boxed
	Curve Data	2	BL	Text	Text Ht. 3.5
	Limits of Construction	3	BE	Text	Text Ht. 5.0 Main Line
		2	BL	Text	Text Ht. 3.5 Secondary Line
	+Leader Lines	3,2	BE	Continuous	
	Abut. Stations	2#	BL	Text	Text Ht. 2.5
	+Leader Lines	1	BE	Continuous	
	20 m TIC Mark	1	BE	Continuous	
	100 m TIC Mark	2	BL	Continuous	
_DES-LTEXT	All other Proposed	6	BL		Text Ht. 2.5
	Lane Width	6	BL	Text	Text Ht. Varies
	Notation Paint Lines	6	BL	Text	Text Ht. 2.5
	Notation Pavement Edge	6	BL	Text	Text Ht. 2.5
	Notation Shoulder	6	BL	Text	Text Ht. 2.5
	Notation Begin & End Taper	6	BL	Text	Text Ht. 2.5
	Notation Begin & End Barrier	6	BL	Text	Text Ht. 2.5
_Des-NOTES	All other Proposed	1	BL		Remove, Abandon, etc.
	- Note Box		BE	Continuous	Text Ht. varies
	- Note Text		BE	Text	Text Ht. varies
	All other Notes		BE		Text Ht. varies
	Design Speed Text	3	BE	Text	Text Ht. 5.0
	Design Speed Box	3	BE	Continuous	
	Construction Notes	1,2	BL /BE	Text	Text Ht. 2.5 & 3.5 (Raise, Close, etc.)
	Match Lines	1	BL	Text	Text Ht. 1.8
	Construction Notes Title		BE	Text	Text Ht. varies

BB = BY BLOCK, BL = BY LAYER, BE = BY ENTITY. # EXCEPTION TO TEXT RULES.

Table 1230.C – Layer Convention for Plans cont'd.

PLANS		ACAD		LAYER DESCRIPTIONS	
LAYER	DESCRIPTION OF ENTITY	COLOUR		LINETYPE	REMARKS
_DES-RW	All other Proposed	2	BL		Design R/W/CL&GR
	R/W Boundaries	4	BE		
	O/S to Proposed R/W	2	BL	Text	Text Ht. 3.5
	R/W Areas	2#	BE	Text	Text Ht. 2.5 & Boxed
	Approv. Officer Stamp	2	BB	Symbol	
	R/W Sheet Summary	2#	BE	Text	R/W Req'd. etc. Text Ht. 2.5
	O/S CL & GR	1	BE	Text	Text Ht. 2.5
	CL & GR Boundary Lines	3	BE		
	CL & GR Areas	2#	BL	Text	Text Ht. 2.5 & Boxed
	Limits (CL & GR Notes)	1	BE	Text	Text Ht. 2.5
	Waste Disposal	6	BE		
	Disposal Area O/S	1	BE	Text	Text Ht. 2.5
	CL & GR Summary	2#	BL	Text	Text Ht. 2.5
	CL & GR Box	2	BL	Continuous	
_DES-SIGNS	All other Proposed	2	BL		
	Sign Symbol & Text	1	BB	Symbol	Symbols must add Text Ht. 2.5
	Sign Box Title (Summary)	2	BL	Text	Text Ht. 3.5
	Sign Box Text (Summary)	1	BE	Text	Text Ht. 2.5
_DES-SPOT	All other Proposed	6	BL		Intersection Elevations
	Spot Elevation	6	BB	Symbol	
	Spot Elevation Text	6	BL	Text	Text Ht. 1.8 or 2.5
_DES-STRUCT	All other Proposed	1	BL		
	Retaining Wall	3	BE		Block color 11
	Bridge Information	1	BL	Continuous	
	Bridge Text	1	BL	Text	Text Ht. 2.5
	Fencing	3	BE		
_DES-TOES	All other Proposed	6	BL		
	Toes	6	BE		Indicate "C" for cut, "F" for fill
	C & F Notation	6	BL		Text Ht. 2.5

BB = BY BLOCK, BL = BY LAYER, BE = BY ENTITY. # EXCEPTION TO TEXT RULES.

Table 1230.C – Layer Convention for Plans cont'd.

PLANS		ACAD		LAYER DESCRIPTIONS	
LAYER	DESCRIPTION OF ENTITY	COLOUR		LINETYPE	REMARKS
_DES-UTIL	All other Proposed	3	BL		Design underground & surface utilities
	Telephone	3	BE		
	Hydro	3	BE		
	Water	3	BE		
	Electrical	3	BE		
	Railways	1	BE		
	Oil	3	BE		
	Gas	3	BE		
_JUNK		7			Personal Notes (to be frozen)

BB = BY BLOCK, BL = BY LAYER, BE = BY ENTITY. # EXCEPTION TO TEXT RULES.

Table 1230.D – Layer Convention for Typical Cross Sections

PLANS		ACAD	LAYER DESCRIPTIONS	
LAYER	DESCRIPTION OF ENTITY	COLOUR	LINETYPE	REMARKS
_TBLOCK				See Plan TBlock (Pg. 1230-4)
_TOPOG		36 BL		
	Original ground line	36 BL	Continuous	
	Earth Hatch Pattern	165 BB	Symbol	
_DET-GEO				See Cross Sections Det-Geo Sheet (pg. 1230-14)
_Des-INSETS		BL		See Plan Des-Insets (Pg. 1230-7)
_DES-LTEXT		6 BL		
	Section Title	3 BE	Text	Text Ht. 5.0
	Subtitle	2 BE	Text	Text Ht. 3.5
	Dimensions	6 BL	Text	Text Ht. 2.5
	Dimension Lines & Leader	6 BL	Text	
	Descriptive Test	6 BL	Text	Text Ht. 2.5
_DES-NOTES		BE	Text	Text Ht. varies
_DES-TEMPLATE		1 BL		
	Pavement	1 BL	Continuous	Solid to Actual Asphalt Thickness
	Gravel Lines	1 BL	Continuous	
	Slope Lines	1 BL	Continuous	
_DES-RW	Stripping	165 BE		

BB = BY BLOCK, BL = BY LAYER, BE = BY ENTITY. # EXCEPTION TO TEXT RULES.

Table 1230.E – Layer Convention for Profiles

PLANS		ACAD		LAYER DESCRIPTIONS	
LAYER	DESCRIPTION OF ENTITY	COLOUR		LINETYPE	REMARKS
_CONTROL		2	BL		
_GRID	L.B.M. Description Text	2#	BL	Text	Text Ht. 2.5
		2	BL		
	Grid Lines	1	BE	Continuous	
	Elev. & Sta. Text	2	BL	Text	Text Ht. 3.5
	Quantities	2	BL	Text	Text Ht. 3.5
	Top Sheet Files	2	BL	Text	Excavation/Embankment/Etc. Text Ht. 3.5
_TBLOCK					See Plan TBlock (pg. 1230-4)
_TOPOG		2	BL		
	Original Ground Line	2	BL	Continuous	Existing ground line
	Earth Hatch Pattern	1	BB	Symbol	
_DETGEO	All other Existing	2	BL		Geotechnical Information
	Soils survey TH logs and Data	2	BL		
	Strata Interfaces	2	BL	Divide	Soil boundaries
	Water Table	5	BE	Dash	
_DET-UTIL	All other Existing	202	BL		
	Gas Lines	202	BL	Circle	
	Oil Lines	202	BL	Circle	
	B.C. Tel	202	BL	Circle	
	B.C. Hydro	202	BL	Circle	
	All Text	202	BL	Text	Text Ht. 2.5
_DES-DRAIN		6	BL		
	Culverts	6	BL		
	Culvert Text	6	BL	Text	Text Ht. 2.5 obliqued 22º30’
	Ditching	1	BE		
	Ditching Text	6	BL	Text	Text Ht. 2.5
_Des-INSETS					See Plan Des-Insets(pg. 1230-7)
	Access or Detour Profile		BE		
	Insets		BE		

BB = BY BLOCK, BL = BY LAYER, BE = BY ENTITY. # EXCEPTION TO TEXT RULES.

Table 1230.E – Layer Convention for Profiles cont'd.

PLANS		ACAD	LAYER DESCRIPTIONS	
LAYER	DESCRIPTION OF ENTITY	COLOUR	LINETYPE	REMARKS
_DES-L-LINE		1 BL		
_DES-NOTES	Horizontal Alignment	3 BE	Continuous	
	Horizontal Alignment Text	1 BL	Text	Text Ht. 2.5
		3 BL		Text Ht. varies
	Construction Notes	6 BE	Text	Text Ht. 2.5
	Design Speed Text Box	3 BL	Continuous	
	Design Speed Text	3 BL	Text	Text Ht. 5.0
	NOTE:	3# BB	Symbol	Text Ht. 3.5
_DES-VERT		1 BE	Continuous	Text Ht. varies
	Vertical Alignment	4 BE	Continuous	
	Vertical Alignment Text	2 BE	Text	Text Ht. 3.5
	Limit of Construction	3 BE	Text	Text Ht. 5.0

BB = BY BLOCK, BL = BY LAYER, BE = BY ENTITY. # EXCEPTION TO TEXT RULES.

Table 1230.F – Layer Convention for Cross Sections

PLANS		ACAD	LAYER DESCRIPTIONS	
LAYER	DESCRIPTION OF ENTITY	COLOUR	LINETYPE	REMARKS
_GRID		1 BL		
	Grid Lines	1 BL		
	Text	1 BL		Text Ht. 2.5
	Construction Lines/text	7 BE		To be frozen
_TOPOG		165 BL		
	Original ground line	165 BL	Continuous	
	Earth Hatch Pattern	165 BB	Symbol	
_DET-GGEO		2 BL		
	THlogs & Data	2 BL		
	Strata Interfaces	2 BL	Divide	Soil Boundaries
	Water Table	5 BE	Dash	
	Failure Plane	3 BB	Phantom	Inferred failure plane (slides)
_DES-DRAIN		3 BL		
	Culverts	3 BL	Circle	
	Ditching	1 BE	Continuous	
_DES-GEO		202		
	Remedial Work	202 BL		Subexcavation, berms, cuts/fill areas, etc.
	Horizontal Drains	5 BE	Dash	
_DES-NOTES		1 BL		
	Stationing	4 BE	Text	Text Ht. 7.0
	Elevations	3 BE	Text	Text Ht. 5.0
	Notation Text	1 BL	Text	Text Ht. 2.5
	Eg. Top of Bank, etc.	1 BL		
	Grade Line	30 BE	Continuous	
	Proposed Cross sections areas & volumes	1 BL		
_DES-TEMPLATE		1 BL		Design template as derived from typical sections
	Pavement	1 BL	Continuous	Solid to Actual Asphalt Thickness
	Gravel Lines	1 BL	Continuous	
	Slope Lines	1 BL	Continuous	

BB = BY BLOCK, BL = BY LAYER, BE = BY ENTITY. # EXCEPTION TO TEXT RULES.

1230.02 COLOUR ASSIGNMENTS AND FONTS

Many elements of Contract Drawings are to be plotted with 0.25 pen. To avoid having a screen full of red – the Ministry standard for 0.25 – other colours can be mapped to Pen 1. See Table 1230.I.

Each layer will have a default BYLAYER colour.

Table 1230.G Highways SHX Codes

Code	Output
%%150	Δ(Delta symbol)
%%151	Δc
%%152	θ(Theta symbol)
%%153	Ministry of Transportation & Highways
%%154	Province of British Columbia
%%155	turns on subscript
%%156	turns off subscript
%%157	turns on superscript
%%158	turns off superscript
%%159	Centreline symbol

When producing contract drawings with AutoCAD, the designer shall use consistent lettering height and font style. The recommended font to be related to the “Standard” AutoCAD style is either ARIAL or ROMANS.shx. The ROMANS font is the closest to Leroy™ template lettering style previously used. We have provided a variation on the ROMANS.shx font called HIGHWAYS.shx with additional codes, which are summarized in Table 1230.G.

There are five normal text heights to be used on contract drawings. These heights are associated with specific AutoCAD colours and Ministry pen weight assignments.

Table 1230.H Text Criteria

Text Height	AutoCAD Colour	Pen Weight
1.8 mm	Red	0.18 or 0.25 mm*
2.5 mm	Red	0.25 mm
3.5 mm	Yellow	0.375 mm
5.0 mm	Green	0.50 mm
7.0 mm	Cyan	0.75 mm

*Most pen plotters are not consistently capable of plotting with a 0.18 mm pen because of ink drying speeds, etc. For those offices and consultants that are using this technology, use 0.25 mm pens for this text, although the height will remain at 1.8 mm. Those offices and consultants with newer technology, such as electrostatic, laser or Inkjet plotters capable of finer line notation, should use the 0.18 mm pen weight.

Table 1230.I Pen Assignments

MINISTRY STANDARD AUTOCAD PEN COLOURS				
0.25 PEN	**0.375 PEN**	**0.50 PEN**	**0.75 PEN**	**SPECIALTY COLOURS**
Red (1) Blue (5) All other colours	Yellow (2)	Green (3)	Cyan (4)	(7) – Used for User’s Working Layer – construction lines etc.

1230.03 SCREENING/MASKING

Most existing detail is to be drawn using colours that do not conflict with the proposed detail colours. This will allow the pen plotting palette to be set up to plot the existing detail with a shade of grey. This screening effect will ensure that the proposed detail is the most prominent while still having legible existing detail.

1250
SYMBOLS

1250.01 INTRODUCTION

Highway Engineering Branch has developed standard symbols to represent existing features as picked up in a field survey, as well as design features that must be represented on contract drawings and the usual assortment of notes, bar scales, arrows, etc.

Where appropriate, the survey symbols have been selected from standards set by the B.C. Surveyor General's Office.

All symbols have been created using AutoCAD and are available on all HEIS Systems in the Ministry. These symbols are also available to all consultants by downloading the BC MoT AutoCAD Standards from the following website:

http://www.th.gov.bc.ca/AutoCAD/

As shown on the following pages, the symbols have been grouped by category.

These are:

Survey Symbols	1250.A
Utility Symbols	1250.B
Detail Symbols	1250.C
Drainage Symbols	1250.D
Meter and Valve Symbols	1250.E
Road Sign Symbols	1250.F
Bar Scales and Arrows	1250.G
Standard Notes	1250.H

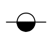
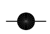
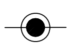
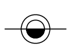
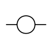
The symbols have been drawn with explicit linetype and colour. See Section 1230.01 for the correct layer for each symbol.

Figure 1250.A Standard Survey Symbols

SYMBOLS	TSS	DESCRIPTION	DWG NAME	LAYER
	AP	Aluminum Post	alm-post	_LEGAL
	AI	Angle Iron	angl-irn	_LEGAL
	BM	Benchmark	benchmrk	_CONTROL
MON	MN	Concrete Post - brass cap on 75 cm high concrete cylinder	con-post	_LEGAL
	LM	Control Monument - GEODETIC B.M., integrated survey monument	monument	_LEGAL
	IE	Indefinite Elevation	indefelv	_DET-SPOT
	LP	Lead Plug	led-plug	_LEGAL
	RIP	Non Standard Round Iron Post	round-ip	_LEGAL
	SIP	Non Standard Square Iron Post	squar-ip	_LEGAL
	DIP	Old Pattern Dominion Iron Post	domin-ip	_LEGAL
	RP	Reference Point	refpoint	_CONTROL
MON	RPM	Rock Post - brass cap mounted in concrete or rock	rok-post	_LEGAL
	SE	Spot Elevation	spot-elv	_DET-SPOT
MON	BCM	Standard Brass Cap	bras-cap	_LEGAL
OIP	IP	Standard Iron Pin	iron-pin	_LEGAL
TH	TH	Test Hole	testhole	_DET-GEO
	TT	Test Pit	testpit	_DET-GEO
	DH	Traverse Hub, Detail Hub etc.	detalhub	_CONTROL
	PM	Unmarked Measured Point	msrd-pnt	_LEGAL
WT	WP	Witness Post - with distance to true corner	wit-post	_LEGAL
	WN	Wooden Post	woodpost	_LEGAL

Figure 1250.B Standard Utility Symbols

(AERIAL UTILITY)

SYMBOLS	TSS	DESCRIPTION	DWG NAME	LAYER
	AN/GW	Anchor/Guy Wire	guy-line	_DET-UTIL
	PD	B.C. Tel Pedestal	tel-pedl	_DET-UTIL (_det-tel)
	DM	Deadman	deadman	_DET-UTIL
	HV	High Tension Pole	ht-pole	_DET-UTIL (_det-hydro)
	HT	High Tension Tower	ht-tower	_DET-UTIL (_det-hydro)
	PT	Power and Telephone Pole	pt-pole	_DET-UTIL
	GE	Power Guy Pole	powr-guy	_DET-UTIL (_det-hydro)
	PP	Power Pole	pwr-pole	_DET-UTIL (_det-hydro)
	PS	Power Pole with Transformer	trns-pwr	_DET-UTIL (_det-hydro)
	GY	Power/Telephone Guy Pole	pt-guy	_DET-UTIL
	PH	Power/Telephone Pole with Transformer	trns-pt	_DET-UTIL
	PB	Telephone Booth	t-booth	_DET-UTIL (_det-tel)
	GT	Telephone Guy Pole	tel-guy	_DET-UTIL (_det-tel)
	TP	Telephone Pole	tel-pole	_DET-UTIL (_det_tel)

(ELECTRICAL UTILITY)

SYMBOLS	TSS	DESCRIPTION	DWG NAME	LAYER
	K	B.C. Tel Kiosk	kiosk	_DET-UTIL (_det-tel)
	EO	Electrical Outlet	ele-outl	_DET-UTIL
	JB	Junction Box	junc-box	_DET-UTIL
	LA	Lamp Standard	lampstnd	_DET-UTIL
	TA	Traffic Counter	trafcntr	_DET-UTIL
	SN	Traffic Signal	traf-sig	_DET-UTIL
	TX	Traffic Signal Control Box	cont-box	_DET-UTIL
	UP	Utility Pole	util-pol	_DET-UTIL

MoT Section	1250		TAC Section	Not Applicable

Figure 1250.C Standard Detail Symbols

SYMBOLS	TSS	(STANDARD DETAIL) DESCRIPTION	DWG NAME	LAYER
	CSN	Commercial Sign	com-sign	_DET-SIGNS
	CN	Concrete Pillar	con-pilr	_DET-GEN
	DT	Decorative Tree	dec-tree	_DET-VEG
DP	DO	Delineator Post	delinpst	_DET-SIGNS
FP	PF	Flag Pole	flagpole	_DET-GEN
GP	GA	Gate Post	gatepost	_DET-GEN
MB	MB	Mailbox	mail-box	_DET-GEN
Piling	PG	Piling	piling	_DET-GEN (_det-struct)
Post	PO	Post	gardpost	_DET-GEN
	TE	Tree	tree	_DET-VEG
	W	Well	well	_DET-UTIL (_det-water)

SYMBOLS	TSS	(UNDERGROUND DETAIL) DESCRIPTION	DWG NAME	LAYER
BP	VP	Breather/Vent Pipe	vent	_DET-UTIL (_det-gas/oil)
FC	FC	Filler Cap	fill-cap	_DET-UTIL (_det-gas/oil)
FP	FU	Fuel/Gas Pump	gas-pump	_DET-UTIL (_det-gas/oil)
FT	FT	Fuel Tank	fuel-tnk	_DET-UTIL (_det-gas/oil)
ST	ST	Septic Tank	sept-tnk	_DET-UTIL (_det-san)
UM	UM	Underground Marker	ug-mrker	_DET-UTIL

Figure 1250.D Standard Drainage Symbols

SYMBOLS	TSS	DESCRIPTION	DWG NAME	LAYER
—⊣ CI	CI	Culvert Inlet	culvtin	_DET-UTIL (_det-drain)
•	KK	Culvert Kink	cul-kink	_DET-UTIL (_det-drain)
—⊣ CO	CO	Culvert Outlet	culvtout	_DET-UTIL (_det-drain)
	DG	Drainage Grate	drngrate	_DET-UTIL (_det-storm)
	CB	Existing Catch Basin	xist-cb	_DET-UTIL (_det-storm)
	MH	Existing Manhole	xistmhol	_DET-UTIL (_det-storm)
	AS	Proposed Asphalt Spillway	asp-splw	_DES-DRAIN
	CH	Proposed Catch Basin	prop-cb	_DES-DRAIN
	CM	Proposed Catch Basin/Manhole	cb-mh	_DES-DRAIN
	MD	Proposed Manhole	propmhol	_DES-DRAIN

Figure 1250.E Standard Meter and Valve Symbols

SYMBOLS	TSS	DESCRIPTION	DWG NAME	LAYER
⊗FH	FH	Fire Hydrant	fir-hyd	_DET-UTIL (_det-water)
⊗GV	GV	Gas Valve	gas-valv	_DET-UTIL (_det-gas/oil)
⊗SV	SV	Service Meter	serv-mtr	_DET-UTIL
⊗V	V	Valve	valve	_DET-UTIL
⊗WM	WM	Water Meter	watr-mtr	_DET-UTIL (_det-water)
⊗WV	WV	Water Valve	watrvalv	_DET-UTIL (_det-water)

Figure 1250.F Standard Road Sign Symbols

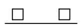
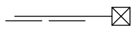
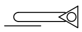
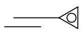
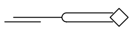
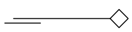
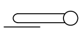
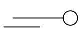
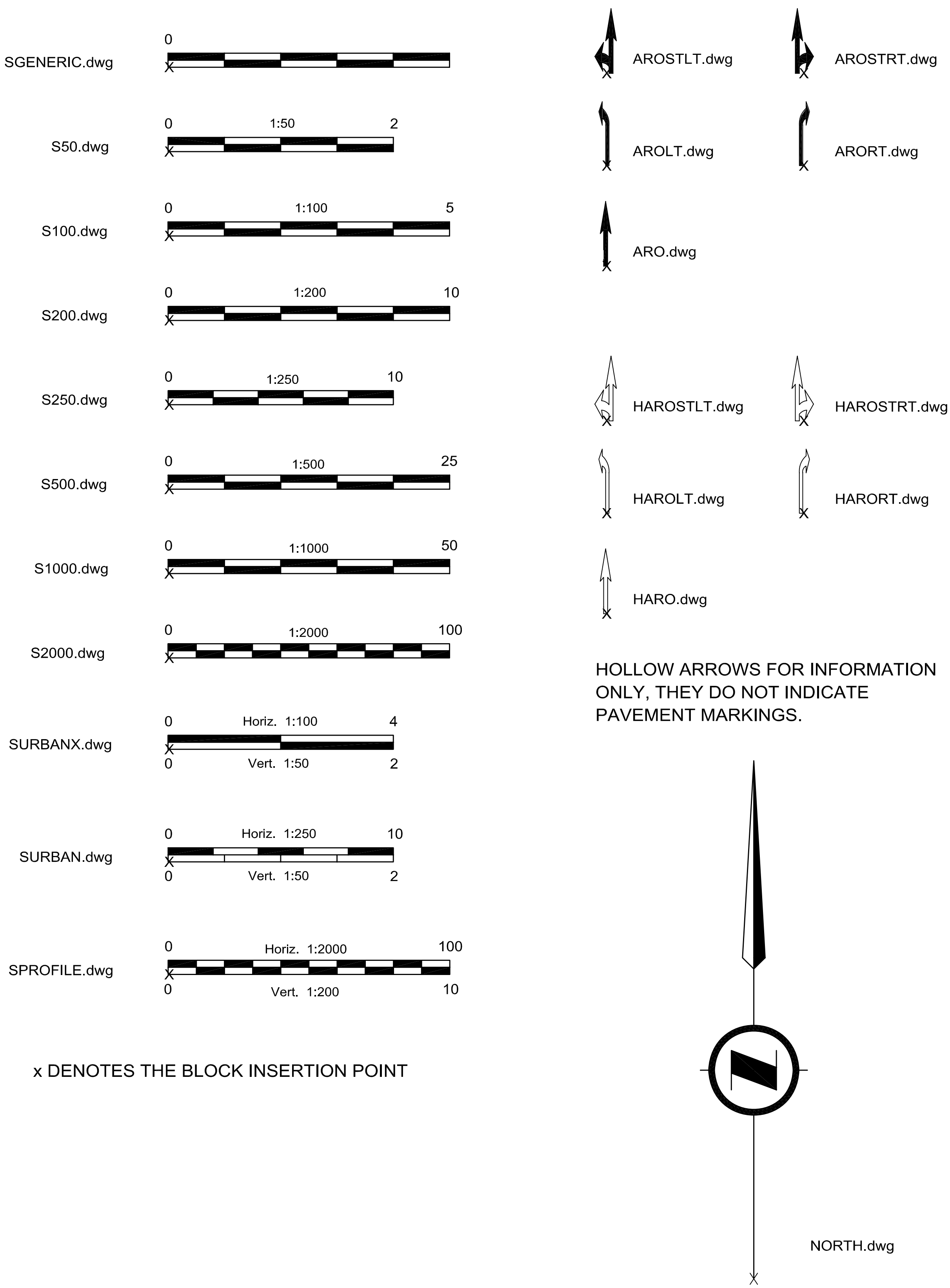
(N.T.S.) SYMBOLS	TSS	DESCRIPTION	DWG NAME	LAYER
		Breakaway (steel)	brkaway	_DET-SIGNS
		Cantilever Structure	cantilvr	_DET-SIGNS
		H.D. Combination Pole (type 7)	type-7	_DET-SIGNS
		H.D. Davit Pole (type 6)	type-6	_DET-SIGNS
		Heavy Combination Pole (type H)	comb-h	_DET-SIGNS
		Heavy Pole (type H)	type-h	_DET-SIGNS
	SI	Road Sign - One Post (wood or telspar)	one-post	_DET-SIGNS
		Sign Bridge Structure	bridge	_DET-SIGNS
		Std Combination Pole (type 1)	type-1	_DET-SIGNS
		Std Davit Pole (type 3)	type-3	_DET-SIGNS
		Two Post (wood or telspar)	two-post	_DET-SIGNS

Figure 1250.G Standard Bar Scales and Arrows



MoT Section	1250		TAC Section	Not Applicable

Figure 1250.H Standard Notes

FOR R/ W ACQUISITION ONLY

SENIOR DESIGNER

x DATE

DES- RW.DWG

APPROVED FOR R/ W ACQUISITION

REGIONAL MANAGER, ENGINEERING

REGIONAL DIRECTOR

x DATE

DATE

REG- RW.DWG

SANDBAG INLET SANDBAG.DWG	END FENCE END- FENC.DWG	ADJUST ADJUST.DWG
FENCE TYPE 'B' FENC- TYP.DWG	REMOVE REMOVE.DWG	SWALE SWALE.DWG
BEGIN FENCE BEG- FENC.DWG	ABANDON ABANDON.DWG	BREAK & ENTER EXISTING BRK- ENTR.DWG

NOTE:

1. Elevations shown are Finished Grade.
2. Embankment figures shown represent Compacted Quantities.

NOTE-1.DWG

R/W AREA NOTE

Areas shown are within join lines unless followed by (total).

In this case the area from the adjoining sheet is included.

AREA.DWG

x Denotes the Block Insertion Point

1260.01 INTRODUCTION

The Ministry has developed standards for representing existing features and proposed design features that are to be shown on contract drawings.

The complex linetypes have been created within AutoCAD itself.

Figures 1260.A and 1260.B indicate the standard dimensions and line weight for most linetypes.
(Note: These figures are from the 2001 edition of the BC Supplement to TAC and have not been revised to reflect recent changes; therefore, some of the colours listed for the linetypes are incorrect and the reference to the old CLINE is no longer applicable.)

The linetype definition file, along with standard drawing frames, and symbols library are installed on all HEIS Systems.

For consultants, these Drafting Standards can be downloaded from the Ministry Web page at:

http://www.th.gov.bc.ca/AutoCAD/

Contour standards are shown in Figure 1260.C, which shows the normal line weight for minor and major contours and the normal text height for contour information. Also shown are the contour intervals for various scales.

MoTH Section	1260		TAC Section	Not Applicable

Figure 1260.A "Existing" Linetypes

(CONSTRUCTION DETAIL)

DESCRIPTION NAME ~ TSS CODE ~ LINE WEIGHT, COLOR (#)	CLINE NAME	LAYER
Berm in Cut or Fill ~ BE, BF ~ 0.25, Color (1)	berm	_TOPOG
Hog Fuel ~ HF ~ 0.25, Color (1)	hog-fuel	_DET-GEN
Riprap ~ RI ~ 0.25, Color (1)	riprap	_DET-DRAIN

(NATURAL DETAILS)

DESCRIPTION NAME ~ TSS CODE ~ LINE WEIGHT, COLOR (#)	CLINE NAME	LAYER
Ground Crack ~ None ~ 0.25, Color (8)	grdcrack	_TOPOG
Marsh/Swamp ~ MS ~ 0.25, Color (5)	swamp	_TOPOG
Sand ~ SA ~ 0.25, Color (8)	sand	_TOPOG
Solid Rock ~ SR, TR ~ 0.25, Color (8)	sld-rock	_TOPOG
Talus ~ T, BN, BR, LR ~ 0.25, Color (8)	talus	_TOPOG
Trail ~ TI ~ 0.25, Color (6)	trail	_TOPOG
Type A Horizon ~ A ~ 0.35, Color (2)	ahorizon	_TOPOG

Figure 1260.A "Existing" Linetypes cont'd

(MAN-MADE FEATURES)

DESCRIPTION NAME ~ TSS CODE ~ LINE WEIGHT, COLOR (#)	CLINE NAME	LAYER
Concrete Barrier (CRB, CMB, etc) ~ RB ~ 0.25, Color (6) 10 mm Blocks	no-post	_DET-ROADS
Dirt Road & Dirt Driveway ~ DR ~ 0.25, Color (6) 4 2	dirt-rd	_DET-ROADS
Fence ~ FE ~ 0.25, Color (1) 15 2 15	efence	_DET-GEN
Garden, Lawns, Vegetation ~ GN, L ~ 0.25, Color (9) 0.5 2.5	veg	_DET-VEG
Gravel Road, Driveway, Lane, etc. ~ GR, RD, GL, EG ~ 0.25, Color (6) 6 2	gravel	_DET-ROADS
Hedge, Bush LIne & Tree Line ~ HG, BH, TL, ~ 0.25, Color (9) 1 mm radius arcs	hedge	_DET-VEG
Railway Ballast ~ BA ~ 0.25, Color (1) 15 5	ballast	_DET-ROADS
Railway Lines ~ RR ~ 0.25, Color (1) 10 mm Blocks	railway	_DET-ROADS
Rest Area ~ None ~ 0.25, Color (1) 5 4	rst-area	_DET-GEN
Retaining Wall (State Type) ~ BI, HD, RE, WW ~ 0.25, Color (1) 4 4 8 4	ewall	_DET-GEN (_det-struct)
Toes ~ LT, RT, TO ~ 0.25, Color (6) 6 4	etoes	_DET-ROADS
W-Beam or Thri-Beam Guardrail ~ GS ~ 0.25, Color (6) Symbol @ 15	e-wbeam	_DET-ROADS

MoTH Section	1260		TAC Section	Not Applicable

Figure 1260.A "Existing" Linetypes con't

(ALIGNMENT DETAIL)

DESCRIPTION NAME ~ TSS CODE ~ LINE WEIGHT, COLOR (#)	CLINE NAME	LAYER
Bottom of Slope ~ BS, CZ ~ 0.25, Color (8) 1 1	b-of-slp	_TOPOG
Centerline of Existing Pavement ~ DL, YL, CL ~ 0.25, Color (6) 2 6 2 30	cntrline	_DET-LANE
Deceleration Lane ~ None ~ 0.35, Color (2) 3 3	decel	_DET-LANE
Rural White Paintline ~ BL ~ 0.35, Color (2) 5 8	rpaint	_DET-LANE
Shoulder Edge, Left or Right ~ SH, LS, RS ~ 0.25, Color (6) 3 2	shldr	_DET-LANE
Urban Paintline ~ None ~ 0.35, Color (2) 3 6	upaint	_DET-LANE

(LOT BOUNDARIES)

DESCRIPTION NAME ~ TSS CODE ~ LINE WEIGHT, COLOR (#)	CLINE NAME	LAYER
Easement ~ EA ~ 0.35, Color (2) 10 5	easement	_LEGAL
Gazette Boundary ~ None ~ 0.35, Color (2) 15 5	gazette	_LEGAL
International Boundary ~ None ~ 0.7, Color (4) 30 5 5 5 5 5 5 5	int-bnd	_LEGAL
Parcel Boundary, Old Road R/W ~ None ~ 0.35, Color (2) Continuous	parcel boundary	_LEGAL
Quarter Section Line ~ None ~ 0.5, Color (3) 30 5	qsec-lin	_LEGAL
Section Line & District Lot Boundary ~ None ~ 0.7, Color (4) 30 5 5 5	sec-dist	_LEGAL

Figure 1260.A "Existing" Linetypes con't

(UNDERGROUND)

DESCRIPTION NAME ~ TSS CODE ~ LINE WEIGHT, COLOR (#)	LINE SAMPLE	CLINE NAME	LAYER
Corrugated Steel, Cast Iron & PIpelines ~ CS, CT, PN ~ 0.25, Color (5)	5 1	pipe	_DET-UTIL (_det-drain)
Gas Main ~ GM ~ 0.25, Color (14)	G 30 2 30 G	egm	_DET-UTIL (_det-gas/oil)
Oil Line ~ OL ~ 0.25, Color (14)	OIL 30 2 30 OIL	eol	_DET-UTIL (_det-gas/oil)
Plastic Pipe ~ PC ~ 0.25, Color (5)	4 1	pipe-pls	_DET-UTIL (_det-drain)
Sanitary Sewer Line ~ SU ~ 0.25, Color (14)	SAN 30 2 30 SAN	esewr	_DET-UTIL (_det-san)
Storm/Sewer Drain ~ DS ~ 0.25, Color (5)	S 30 2 30 S	ess	_DET-UTIL (_det-storm)
Underground Electrical ~ UE ~ 0.25, Color (14)	UE 30 2 30 UE	eue	_DET-UTIL (_det-hydro)
Underground Miscellaneous ~ UG ~ 0.25, Color (14)	UG 30 2 30 UG	eum	_DET-UTIL
Underground Telephone ~ UT ~ 0.25, Color (14)	UT 30 2 30 UT	eut	_DET-UTIL (_det-tel)
Water Main ~ WR ~ 0.25, Color (14)	W 30 2 30 W	ewm	_DET-UTIL (_det-water)

MoTH Section	1260		TAC Section	Not Applicable

Figure 1260.A "Existing" Linetypes con't

(HYDRAULIC)

DESCRIPTION NAME ~ TSS CODE ~ LINE WEIGHT, COLOR (#)	CLINE NAME	LAYER
Creek Center, Ditch Center, Stream Center ~ CK, DC, SM ~ 0.25, Color (5)	editch	_DET-UTIL (_det-drain)
Ditch Edge ~ DE ~ 0.25, Color (5)	eg-ditch	_DET-UTIL (_det-drain)
Edge of Water ~ EW ~ 0.25, Color (5)	edgewatr	_TOPOG
Extreme High Water Mark ~ EH ~ 0.25, Color (5)	extr-hwm	_TOPOG
High Water Mark ~ HW ~ 0.25, Color (5)	hwm	_TOPOG
Seepage ~ SG ~ 0.25, Color (5)	seepage	_TOPOG

(GEOTECH)

DESCRIPTION NAME ~ TSS CODE ~ LINE WEIGHT, COLOR (#)	CLINE NAME	LAYER
Estimated Water Table Elevation ~ None ~ 0.25, Color (5)	e-water	_DET-GEO
Measured Water Table Elevation ~ None ~ 0.25, Color (5)	m-water	_DET-GEO
Slide, Scarp, Sluff Line ~ SF ~ 0.35, Color (2)	scarp	_TOPOG
Top of Slope (Embankment) ~ TB ~ 0.25, Color (8)	embank	_TOPOG

Figure 1260.B "Proposed" Linetypes

(CONSTRUCTION DETAIL)

DESCRIPTION NAME ~ TSS CODE ~ LINE WEIGHT, COLOR (#)	Pattern dimensions	CLINE NAME	LAYER
Berm in Cut or Fill ~ BE, BF ~ 0.25, Color (1)	7 3	berm	_TOPOG
Clearing and Grubbing Line ~ GC ~ 0.50, Color (3)	5 15	clr-grb	_DES-RW
Hog Fuel ~ HF ~ 0.25, Color (1)	6 6	hog-fuel	_DES-RW
RipRap ~ RI ~ 0.25, Color (1)	3 4	riprap	_DES-DRAIN
Stripping ~ S ~ 0.25, Color (8)	7 2	striping	_DES-RW
Waste ~ WE ~ 0.25, Color (8)	5 5	waste	_DES-RW

(SURFACE DETAIL)

DESCRIPTION NAME ~ TSS CODE ~ LINE WEIGHT, COLOR (#)	Pattern dimensions	CLINE NAME	LAYER
Proposed Ditch ~ None ~ 0.50, Color (3)	5 15	pditch	_DES-DRAIN
Proposed Fence ~ None ~ 0.50, Color (3), Text Color (1)	32 (X)	pfence	_DES-STRUCT
Proposed Highway R/W ~ None ~ 0.7, Color (4)	5 5 5 5 30	p-row	_DES-RW
Proposed Retaining Wall (State Type) ~ None ~ 0.50, Color (3), Blk. Color (11)	4 4	pwall	_DES-STRUCT
Proposed Toes ~ None ~ 0.25, Color (6)	2 2	ptoes	_DES-TOES
Proposed W-Beam or Thri-Beam Guardrail ~ None ~ 0.50, Color (3)	Symbol @ 15	p-wbeam	_DES-LANE

MoTH Section	1260		TAC Section	Not Applicable

Figure 1260.B "Proposed" Linetypes con't

(UNDERGROUND)

DESCRIPTION NAME ~ TSS CODE ~ LINE WEIGHT, COLOR (#)	Sample	CLINE NAME	LAYER
Proposed Gas Main ~ None ~ 0.50, Color (3), Text Color (1)	G 62 G	pgm	_DES-UTIL
Proposed Oil Line ~ None ~ 0.50, Color (3), Text Color (1)	OIL 62 OIL	pol	_DES-UTIL
Proposed Sanitary Sewer Line ~ None ~ 0.50, Color (3), Text Color (1)	SAN 62 SAN	psewr	_DES-DRAIN
Proposed Storm/Sewer Drain ~ None ~ 0.50, Color (3), Text Color (1)	S 62 S	pss	_DES-DRAIN
Proposed Underground Electrical ~ None ~ 0,50, Color (3), Text Color (1)	UE 62 UE	pue	_DES-UTIL
Proposed Underground Miscellaneous ~ None ~ 0.50, Color (3), Text Color (1)	UG 62 UG	pum	_DES-UTIL
Proposed Underground Telephone ~ None ~ 0.50, Color (3), Text Color (1)	UT 62 UT	put	_DES-UTIL
Proposed Water Main ~ None ~ 0.50, Color (3), Text Color (1)	W 62 W	pwm	_DES-UTIL

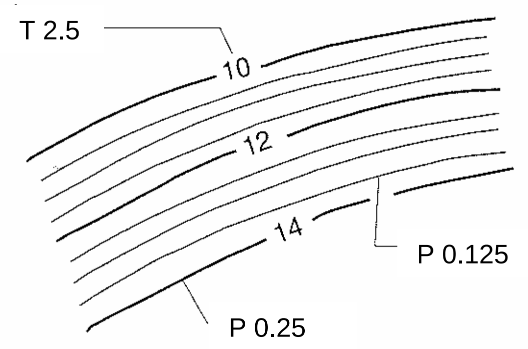
(LOT BOUNDARIES)

DESCRIPTION NAME ~ TSS CODE ~ LINE WEIGHT, COLOR (#)	Sample	CLINE NAME	LAYER
Proposed Easement ~ EA ~ 0.35, Color (2)	10 5	easement	_LEGAL

Figure 1260.C – Contour Intervals

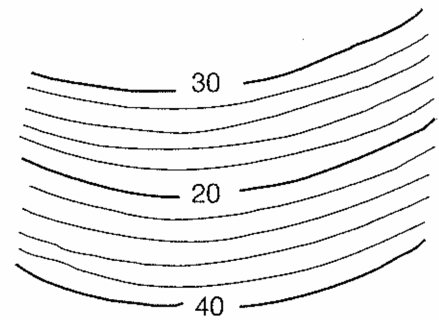
SITE PLAN 1 : 250

Use 0.5 m contour intervals



PLAN 1 : 500

Use 2 m contour intervals, accentuate 10 m contours

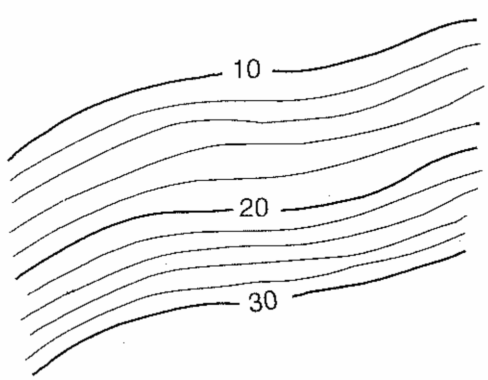


T = Text height in mm
P = Pen width in mm

Depending on the type of plotter, users may have to adjust pen colours to produce a legible screened contour plot that does not obscure the other drawing entities.

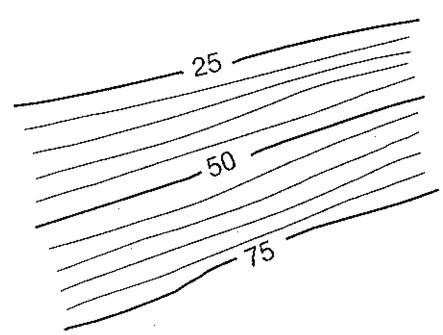
PLAN 1:1000

Use 2 m contour intervals, accentuate 10 m contours.

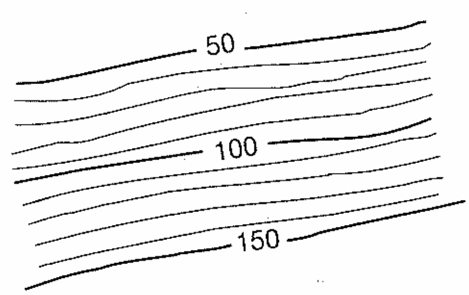


MAPPING RECCE TYPE 1 : 5000

For 5 m contour intervals, accentuate 25 m contours.



For 10 m contour intervals, accentuate 50 m contours.



KEY PLANS: Variable Scales

Use 2 m, 5 m, or 10 m contours.

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1270 CAiCE Design Project Data Format Terms of Reference

1270.1 General

The Ministry policy that all design contracts are to be completed in CAiCE Design Project Data Format was officially applied October 1, 2003. All design contracts from that date forward must reference this section of the B.C. Supplement to TAC Geometric Design Guide.

The Ministry is implementing the CAiCE Design Project Data Format Policy for the following reasons:

1. The policy provides the Ministry with a standard format for all engineering data, regardless of whether Ministry staff or consultants complete the work.

2. The policy provides the opportunity for the Ministry to maintain a repository of engineering data that can be easily utilized in the future.

3. The common format will improve the flow of engineering data, eliminating the significant problems that have been experienced by Ministry construction supervision offices trying to utilize completed designs.

The CAiCE Design Project Data Format Terms of Reference has been developed through consultation with Ministry Field Services construction supervision staff, Ministry regional designers and Ministry/CEBC selected consultant designers.

Highway Project Lifecycle Definitions and CAiCE Deliverable Requirements

- *Needs Study* (No CAiCE deliverable requirement)
  The identification of requirements for new or improved highways within the provincial highway network and/or municipal streets networks.

- *Reconnaissance Study* (No CAiCE deliverable requirement)
  A qualitative, high-level approach to identify all possible corridors between two specified nodes and to review the feasibility of each corridor. A single valley would be considered a corridor.

- *Corridor Study* (No CAiCE deliverable requirement)
  A quantitative and qualitative evaluation to select a preferred corridor from a number of possible alternatives, or to identify the requirements for further study of selected corridors.

- *Route Study* (No CAiCE deliverable requirement)
  The graphical development of accurate plans for all feasible locations of roads and/or configurations of interchanges/intersections, and their technical review.

- *Preliminary Design*
  (CAiCE deliverable requirement if standalone design assignment)
  To determine the ability of selected locations and configurations to meet the needs and requirements established in the previous stages, and recommend one for successive design stages.

- *Functional Design*
  (CAiCE deliverable requirement if standalone design assignment)
  The horizontal and vertical geometric design for the phase preceding the development of the final detailed design drawings.

- *Detailed Design* (CAiCE deliverable requirement)
  The development of construction (contract) drawings and technical specifications for construction, including the completed geometric and geotechnical design, special site considerations and construction details.

- *Construction* (CAiCE deliverable requirement)
  To standardize construction supervision practices and complete the detailed design based on construction original ground and the actual sub-surfaces un-earthed.

- *Post Construction* (CAiCE deliverable requirement)
  To develop an As Built CAiCE DTM and As Built AutoCAD drawings for evidence in court, recording changes to a design during construction, background information when evaluating costs of further improvements.

The designer, depending on the project lifecycle phase, must submit a PRELIMINARY DESIGN , FUNCTIONAL DESIGN, DETAILED DESIGN and/or CONSTRUCTION archive(s) as detailed in Section 1270.10 Design Project Data Archive Preparation.

The PRELIMINARY, FUNCTIONAL and DETAILED DESIGN archives are required by the Ministry to retain an electronic record of design options/alternatives included in the contract design report. These options/alternatives will include anything shown to the public, municipal councils, and prepared as part of the environmental review process.

The CONSTRUCTION archive containing only the final design is required by the Ministry as a detailed record of the final design and to provide the necessary information for Ministry construction supervision purposes.

1270.2 CAiCE Design Project Data Format Policy Exceptions

It is recognized that there are certain project situations where the CAiCE Design Project Data Format Policy will not apply. These specifically relate to design build projects and projects that meet specific exception criteria.

The policy exception criteria are presented below as a series of questions. If any one question is answered as **YES**, then the project must adhere to the CAiCE Design Project Data Format Policy. These questions should be answered through consultation with Ministry Field Services. Ministry Representative refers to Ministry Field Services or Ministry Field Services Consultant.

- Will the Ministry Representative have to provide survey layout?
- Will the Ministry Representative have to do earthwork quantity surveys or quality control surveys on survey layout?
- Will there be a requirement for the Ministry Representative to calculate any earthwork or gravel quantities from x-sections or DTM surface comparisons?
- Is the project an extension of, or in any way connected to an existing CAiCE project?

- Is data from other sources such as AutoCAD, design summaries etc. insufficient to provide the Ministry Representative with the detail necessary to administer the project?

The requirement for a DETAILED DESIGN archive will be determined by the Ministry design contract manager. This decision will be based on whether the completed design project will be immediately tendered for construction. If the completed design is expected to sit for a period of time for re-activation at some time in the future, then the DETAILED DESIGN archive will be a design contract requirement.

From past experience, when design projects have been completed but were not immediately tendered for construction, they were shelved for future use. Problems were often encountered when these design projects were re-activated and revisions were required prior to construction. Often the designer who originally completed the project was no-longer with the consulting firm and the original project knowledge was lost. The lack of a consistent standard for electronic design deliverables makes the re-activation of shelved designs more costly and time consuming.

Ministry design contracts will specify which of the four CAiCE Design Project Data Archives are required.

All Ministry of Transportation highway construction projects require the completion of an As Built CAiCE DTM and As Built AutoCAD drawings.

With the exception of design build projects, the As Built CAiCE DTM is completed by whoever is the Ministry Representative, be that Field Services or consultant doing the construction supervision. As Built AutoCAD drawings are prepared by the Engineer of Record responsible for the design.

A non design build project As Built CAiCE DTM is to be generated from the CAiCE design, incorporating any construction related design changes picked up by ground survey.

The As Built deliverable requirement also applies to all design build projects. For design build projects, the construction contractor completes the As Built deliverables and then has them certified by the Engineer of Record responsible for the design.

A design build project As Built CAiCE DTM can be generated from the CAiCE design or from a design completed in software other that CAiCE. The As Built CAiCE DTM is to incorporate any construction related design changes picked up by ground survey.

The reasoning behind the requirement for As Built deliverables are as follows:

- Used in court to establish that the highway was built in accordance with design criteria and that any changes that have occurred were a result of natural settlement, etc.
- Record changes to a design during construction accompanied by letters or reports indicating why the changes were implemented.
- Enable the Ministry to quickly evaluate costs on further improvements required to a recently constructed project.

1270.3 Missing or Problem Design Project Data Archive Content

The PRELIMINARY DESIGN, FUNCTIONAL DESIGN, DETAILED DESIGN and CONSTRUCTION CAiCE Design Project Data Archive files must contain the information specified in this section of the B.C. Supplement to TAC Geometric Design Guide as referenced by the Highway Design Contract Terms of Reference.

If a designer has failed to provide the complete error free CAICE Design Project Data Archive files, it is the full responsibility of the designer to resolve all omissions, deficiencies and errors in a timely manner. In the case of the CONSTRUCTION archive, it is imperative that there is no negative impact on the construction project schedule.

The Ministry will not be responsible financially for any extra work incurred by a consultant to resolve the identified omissions, deficiencies or errors when these Terms of Reference have not been followed.

1270.4 Ministry Standard Libraries, Tables, Macros, Fragments

To assist consultants with the completion of CAiCE design work to Ministry standards, the Ministry provides all consultants with a complete set of standard libraries, tables, macros and fragments. These files are available for download from the Ministry's Public Website at the address shown below:

http://www.th.gov.bc.ca/publications/eng_publications/geomet/CAiCE/CAiCE.htm

The website is regularly updated as changes are made and Ministry installations are upgraded.

The Ministry provides technical support in the use of this material through the contact below, any other CAiCE software technical support should be directed to CAiCE at Autodesk as provided for, by a consultants annual subscription agreement.

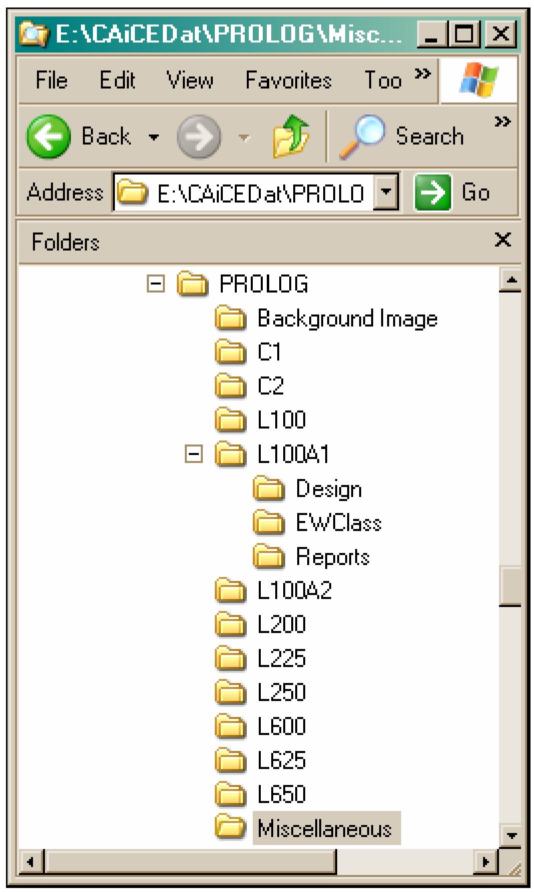
Dale Francis
Senior Business Analyst
Highway Engineering and Geomatics
Information Systems Branch
Ministry of Transportation
Email: Dale.Francis@.gov.bc.ca

Ministry technical support for standard libraries, tables, macros and fragments should be requested by email as required.

1270.5 Design Project Folders and Organization

A CAiCE project folder can become very difficult to work with as a project grows and the number of project files increase. To improve the general organization of a CAiCE project deliverable, designers are required to implement the following folder structure:

- Project Folder
  - Background Image Folder
  - Alignment Folders
    - Design (Optional)
    - EWClass (Optional)
    - Reports (Optional)
  - Miscellaneous Folder
  - All Other Files



Background Image Folder

Archive Requirement

- Preliminary Design – Yes
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

A Background Image folder will contain only the AutoCAD DWG and Microstation DGN (Trim Mapping) background image files optionally created for use with the design.

Alignment Folders

Archive Requirement

- Preliminary Design – Yes
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

Individual Alignment folders are to contain files that directly relate to the alignment named in the Alignment folder name. Separate folders must be created for the mainline, minor, sideline and access/intersection curve horizontal alignments. Optional Alignment folder sub-folders "Design", "EWClass" and "Reports" can be added by the designer to assist with the organization of project files if so desired. Alignment folder names should not be defined using special characters. Typical files that should be placed under the Alignment folder are as follows:

Required:

CDG	CAiCE Drawing Graphics Files
EAR	Base Cross Section and Design Cross Section Files
ERP	End Area Report Files
LIS	List Files
PF$	Terrain Profiles
PXS	Draw X-Section Macro Parameter File
PPF	Draw Profile Sheets Macro Parameter File
RPT	Report Files
RTF	Rich Text Format Documents
TBL	Alignment Specific Tables (e.g.: Earthwork Classification Table)
VRB	Design VRS Backup Files
VRS	Design Files

Required if created:

X#%	Edit Area Attributes Manual Material Envelope Definition
XCP	Advanced End Areas / Volumes Exception Station Details
XLS	Excel Spreadsheet Files
DOC	Word Documents
ER2	Advanced End Areas / Volumes Exception Station Data Report
INI	Alignment Specific Parameter Files
LOG	Log Files
TXT	Text Files

If optional Alignment folder sub-folders are to be used, then typical files that should be placed under the main alignment folder and its sub-folders are as follows:

Main Alignment Folder

Required:

CDG	CAiCE Drawing Graphics Files
EAR	Base Cross Section Files
PF$	Terrain Profiles
PXS	Draw X-Section Macro Parameter File
PPF	Draw Profile Sheets Macro Parameter File
TBL	Alignment Specific Tables

Required if created:

INI	Alignment Specific Parameter Files
TXT	Text Files

Design Sub-folder

Required:

EAR	Design Cross Section Files
VRB	Design VRS Backup Files
VRS	Design Files

Required if created:

X#%	Edit Area Attributes Manual Material Envelope Definition
XCP	Advanced End Areas / Volumes Exception Station Details

EWClass Sub-folder

TBL	Alignment Specific Earthwork Classification Tables

Reports Sub-folder

Required:

ERP	End Area Report Files
LIS	List Files
RPT	Report Files
RTF	Rich Text Format Documents

Required if created:

DOC	Word Documents
ER2	Advanced End Areas / Volumes Exception Station Data Report
LOG	Log Files
XLS	Excel Spreadsheet Files

Miscellaneous Folder

Archive Requirement

- Preliminary Design – Yes
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

A Miscellaneous Folder will contain designer created files that do not relate to a specific horizontal alignment. Typical files that could be placed in this folder are shown below and potentially files shown above, if they are common to multiple alignments:

Required:

CCL	Project Specific Cell File
CDG	CAiCE Drawing Graphics Files
FTB	Project Specific Feature Table
LIS	List Files
RPT	Report Files
RTF	Rich Text Format Documents
TBL	Tables (e.g.: Non-Alignment Specific Earthwork Classification Table)

Required if created:

DOC	Word Documents
INI	Parameter Files
LOG	CAiCE Design Project Log Files
TXT	Text Files
XLS	Excel Spreadsheet Files
PXS	Draw X-Section Macro Parameter File
PPF	Draw Profile Sheets Macro Parameter File

1270.6 Design Project Data Archive Project Log Files

Archive Requirement

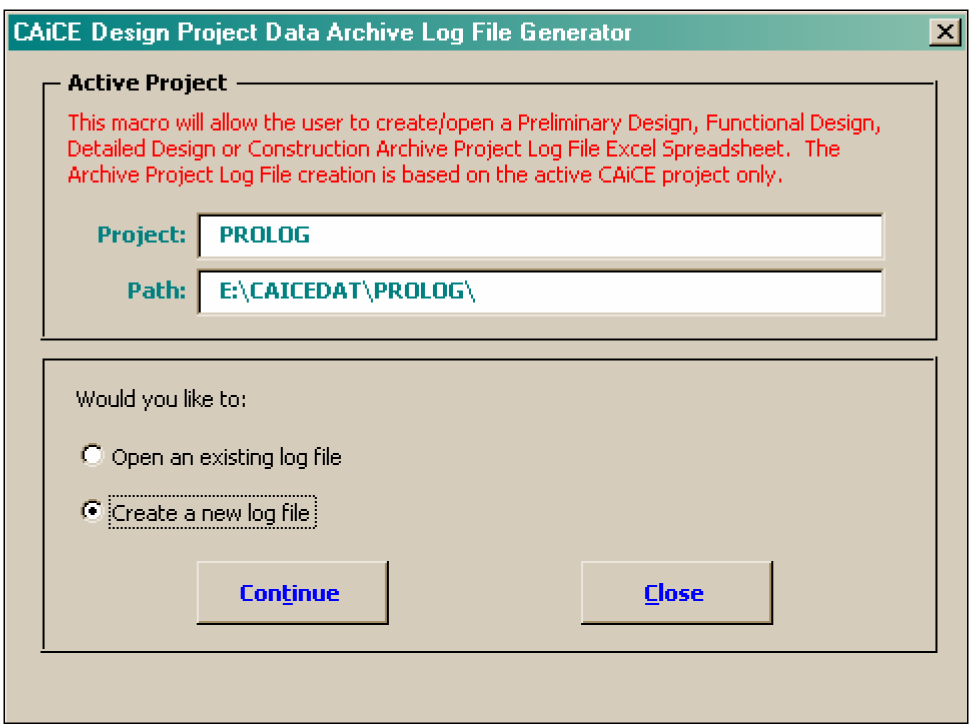
- o Preliminary Design – Yes
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

The designer must create and maintain a Design Project Data Archive Project Log File for each of the design assignment phases, Preliminary Design, Functional Design, Detailed Design and Construction Supervision, depending on the phase that is being completed under contract.

To establish a standard for the creation of all Design Project Data Archive Project Log Files, the Ministry has developed the CAiCE Design Project Data Archive Log File Generator Macro that will generate a basic log file Excel spreadsheet.

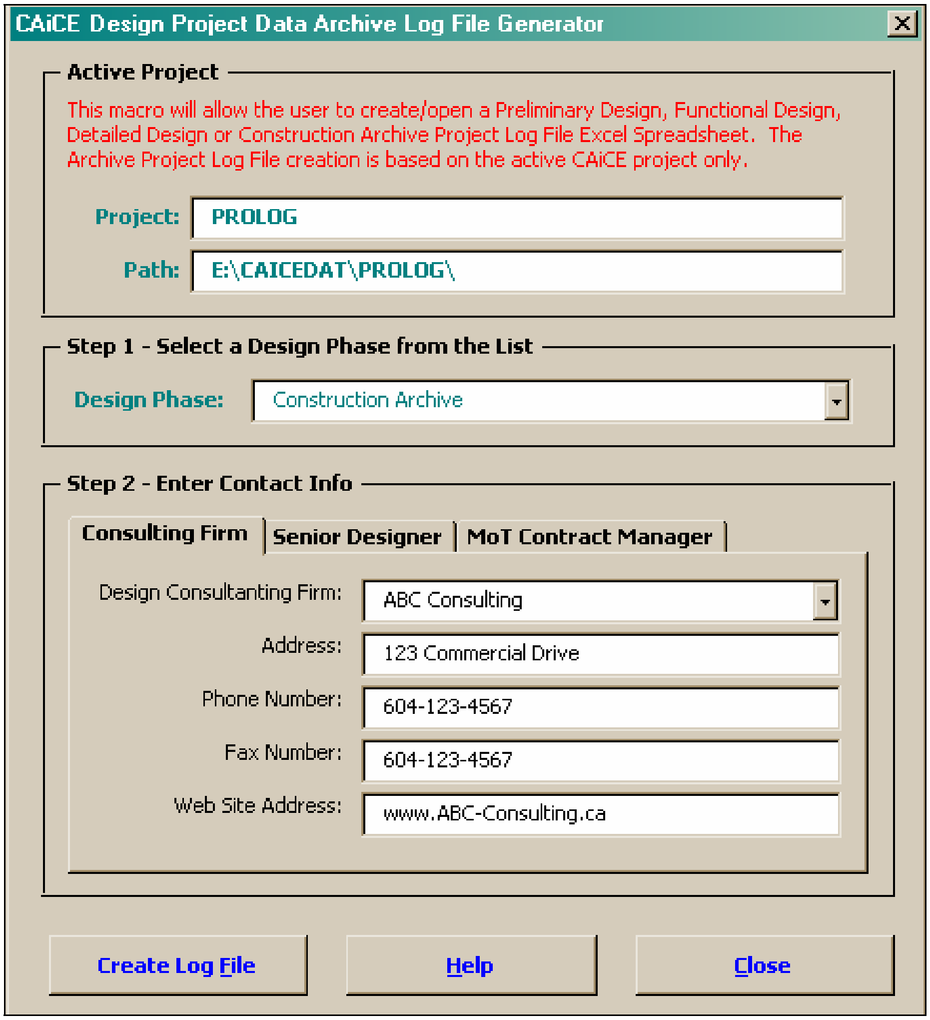
It should be noted that the successful use of the CAiCE Design Project Data Archive Log File Generator Macro depends on strict adherence to the project data archive naming conventions detailed in sections 1270.5 Design Project Folders and Organization, 1270.7 Design Project Data Archive CDG Files and 1270.8 Design Project Data Archive Content and Naming Conventions.

Macro Dialogue Box #1



Macro dialogue box #1 displays the current CAiCE project and drive/folder path. The designer selects to open an existing log file spreadsheet or create a new one.

Macro Dialogue Box #2



Macro dialogue box #2 displays the current CAiCE project and drive/folder path. The designer selects the Preliminary Design, Functional Design, Detailed Design or Construction Archive as a basis for the creation of the project log file spreadsheet. The designer enters consulting firm, senior designer and MoT contract manager contact information to be added to the spreadsheet and saved by the macro for future use.

The macro, using this basic input from the designer will populate the log file spreadsheet with project data identification and descriptions found in the CAiCE project. The designer must then add information to the basic log file spreadsheet as required, appropriately describing the contents of the CAiCE Design Project Data Archive.

The log file spreadsheet defines how all CAiCE project files and database elements relate to one another with their relevant descriptions. The macro populates the spreadsheet as intelligently as possible, but it is up to the designer to finalize it, to meet the specific requirements of the CAiCE Design Project Data Archive Log File.

If the macro is unable to positively identify and assign a specific CAiCE project file or database element with a horizontal alignment or profile, then the spreadsheet entry is assigned an identifier ***LFEVR*** (log file entry verification required). In this situation, it is up to the designer to review this specific file or database element and decide whether it should be left in its current location in the spreadsheet, moved or removed.

If the macro is unable to find a description associated with a CAiCE database element, or it is dealing with a file, then the spreadsheet entry is assigned an identifier ***UDDR*** (user defined description required). In this situation, it is up to the designer to add an appropriate description or remove the CAiCE database element or file.

The macro provides the ability to append data to an existing log file spreadsheet so that any descriptions and or comments that are added or revised during a previous log file spreadsheet generation will be maintained. Additions and/or revisions to the spreadsheet should be limited to spreadsheet column E otherwise the ability to append to a previously generated spreadsheet may result in difficulties. The append capability does not apply to rows removed from a previously generated log file spreadsheet or moved to a different location in the spreadsheet. For these situations, these same rows would have to be moved and/or removed the next time the spreadsheet is generated.

The spreadsheet and it's user defined descriptions, in combination with the contract Preliminary, Functional or Detailed Design Report, must provide sufficient detail to allow anyone reviewing the project to understand why a project phase has evolved the way it has. This is to include a record of what has been provided to the public and municipal councils, prepared as part of the environmental review process and what follow-up actions have taken place.

Specifically related to the Construction project log file, the designer must include details on issues that may warrant special attention during construction. The log file must be used to record details of the final design sufficient to allow construction supervision staff to understand methods and how the final design is pulled together. Entries in the log file must be as descriptive as possible to limit the amount of contact needed between construction supervision staff and the designer as the final design data is utilized. Basically, if the designer is making some sort of addition or revision that directly relates to the use of the final design data, then it should be documented in the project log file. Below are a few examples of what log file descriptions should include, but do not necessarily cover all potential additions:

- Base cross section file descriptions including a description of the DTM surfaces used and stratum surfaces present in the file.
- Cross section station text file descriptions indicating any geometry chains used to limit x-section scanline widths.

The Design Project Data Archive Log File Generator Macro creates the log file spreadsheet in the project Miscellaneous folder using the following naming convention prefixed by the project name:

@@@@@@@-PRELIMINARY DESIGN PROJECT LOG FILE.XLS
@@@@@@@-FUNCTIONAL DESIGN PROJECT LOG FILE.XLS
@@@@@@@-DETAILED DESIGN PROJECT LOG FILE.XLS
@@@@@@@-CONSTRUCTION PROJECT LOG FILE.XLS

1270.7 Design Project Data Archive CDG Files

Design project data archive CDG files provide construction supervision staff and anyone else wishing to review the project data, a very easy method of producing views of all design elements that directly relate to the major, minor, sideline and access/intersection curve horizontal alignments.

Separate CDG files must be created for the major, minor, sideline and access/intersection curve horizontal alignments with associated detail. For example the CDG files generated for the major L100A1 horizontal alignment would include the following detail:

L100A1 PLAN CDG File

Archive Requirement

- o Preliminary Design – No
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

- All related survey points (with cells) and survey chains (with patterning)
- All related AutoCAD DWG background image files
- All related Trim Mapping DGN background image files

L100A1 GEOMETRY CDG File

Archive Requirement

- o Preliminary Design – No
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

- Major horizontal alignment L100A1
- All related ditch horizontal alignments D10, D11, D12, etc.
- All related structure horizontal alignments S20, S21, S22, etc.
- All related design fragment application geometry chains 100PSHR65, 100PLEL79, etc.
- All 3D driveway chains (CAiCE survey chains) 100PDWR117, 100PDWL57, etc.
- All related right of way geometry chains PRW43, PRW57, etc.
- All related temporary license for construction access geometry chains PTLCA32, PTLCA46, etc.
- All related clearing and grubbing geometry chains PCLGR18, PCLGR23, etc.
- All related cut/fill toe geometry chains 100PTCL23, 100PTFR43, 100PTOL76, etc.
- All related vertical cutoff geometry chains 100PVCL12, 100PVCR27, etc.
- All gutter geometry chains 100PGUR87, 100PGUL99, etc.
- All back of sidewalk (outermost) geometry chains 100PSWR14, 100PSWL53, etc.
- All barrier (not controlled by edge of pavement) geometry chains 100PNEB34, 100PNEB147, etc.

- All island curb (curb and pavement intersect) geometry chains 100PIC47, 100PIC253, etc.
- All asphalt curb (curb and pavement intersect) geometry chains 100PAC47, 100PAC253, etc.
- All raised median curb (curb and pavement intersect) geometry chains 100PRMC48, 100PRMC254, etc.
- All concrete median centre divider (curb and pavement intersect) geometry chains 100PMC26, 100PMC365, etc.
- All related geometry chains not identified above

L100A1 PROFILES CDG File

Archive Requirement

- o Preliminary Design – No
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

- All related profiles L100A1P1 etc.
- All related design fragment application profiles 100PDCR75, 100PBEL88, etc.

L100A1 UNDERGROUND CDG File

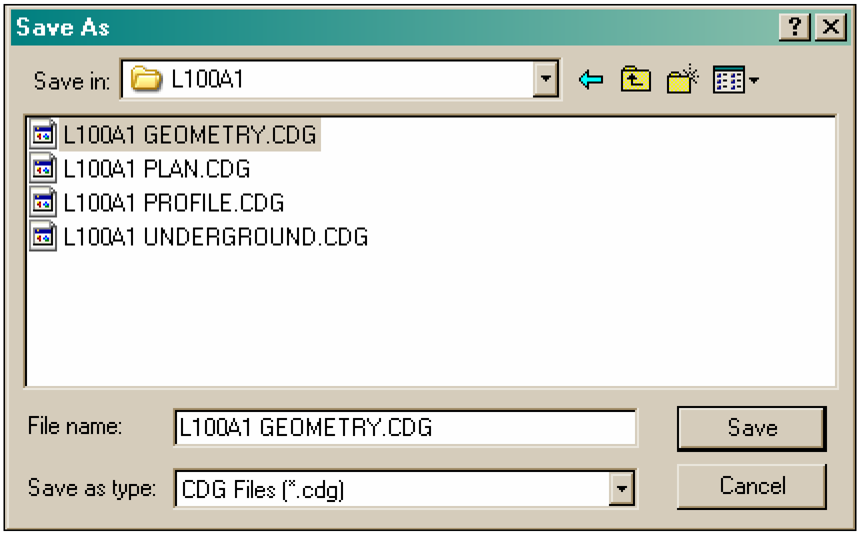
Archive Requirement

- o Preliminary Design – No
- o Functional Design – No
- o Detailed Design – Yes
- o Construction – Yes

- All related storm drain / storm sewer line pipe geometry chains PDS25, PDS342, etc.
- All related sanitary sewer line pipe geometry chains PSU13, PSU134, etc.
- All related water line pipe geometry chains PWR17, PWR589, etc.

The basic design project data archive CDG file naming convention that must be used is to prefix the name with the horizontal alignment followed by one of four descriptive names (PLAN, GEOMETRY, PROFILES or UNDERGROUND) that describe the graphics snapshot of that specific aspect of the project.

L100A1 PLAN.CDG
L100A1 GEOMETRY.CDG
L100A1 PROFILES.CDG
L100A1 UNDERGROUND.CDG



1270.8 Design Project Data Archive Content and Naming Conventions

Many CAiCE database elements and files are required to complete the design project. These requirements are detailed throughout this section. As the CAiCE design project progresses, without the implementation of the strict naming conventions detailed in this section, it would be very difficult for anyone apart from the designer to review and work with the completed project.

To improve the general use of completed CAiCE design projects, designers must provide the following design project data archive content and follow the required CAiCE database element and file naming conventions.

CAiCE Project Name

Archive Requirement

- Preliminary Design – Yes
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

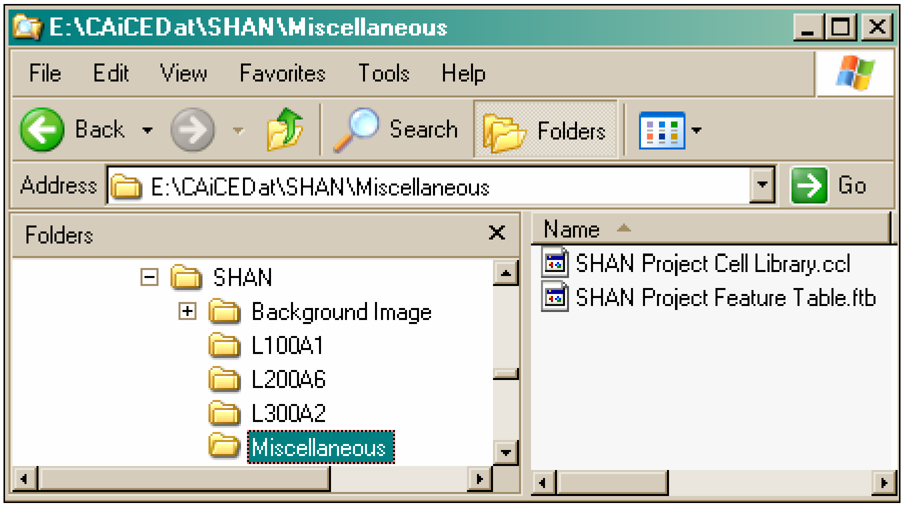
CAiCE project names can be created to a maximum of 7 characters. The CAiCE project name chosen must reflect the name of the design project as much as possible within the 7 character limit. The Ministry may choose to assign the CAiCE project name and if so, it will appear in the design contract terms of reference.

Design Project Specific Feature Table and Cell Library File

Archive Requirement

- Preliminary Design – Yes
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

The Ministry Standard BCGlobal Feature Table file and BCGlobal Cell Library file must be copied to the project Miscellaneous folder for use with the project. If the designer has the requirement to make modifications, the feature table file and/or cell library file must be renamed so that it reflects the project as shown in the example below:



Project Cadastral

Archive Requirement

- Preliminary Design – Yes
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

The designer must provide AutoCAD DWG background image files generated as part of the completed survey project that can be used to display the project cadastral while working within CAiCE. These are to be saved in the CAiCE project Background Image folder.

The basic CAiCE project cadastral file naming convention that must be used is to prefix the file name(s) with "CADASTRAL".

CADASTRAL @@@@@@@.DWG

Plan Detail

Archive Requirement

- Preliminary Design – No
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

The designer must provide AutoCAD DWG and Microstation DGN (Trim Mapping) background image files optionally created for use with the design. These files may have been generated as part of the completed survey project or as a supplement to the survey during the design process.

The basic CAiCE Project Plan Detail file naming convention that must be used is to prefix the file name(s) with “PLAN DETAIL”.

PLAN DETAIL @@@@@@@.DWG
PLAN DETAIL @@@@@@@.DGN

CAiCE Database Element and File Naming Descriptions

Archive Requirement

- o Preliminary Design – Yes
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

Generally most of the CAiCE database elements provide an input field for description. The designer should make full use of these input fields, if there is additional information needed to describe an element beyond what is required by the element naming conventions described in this section. The designer should make full use of long file naming when creating files within a CAiCE project. Descriptions and file names can contain such things as alignment references, DTM names, stations, dates, links to other files, etc.

Horizontal Alignment Geometry Chains

The purpose of implementing naming conventions for horizontal alignments is to ensure that all alignments have **unique names and stationing**, therefore reducing any chance of confusion.

Contract drawings that represent horizontal alignments must have the horizontal alignment names match the names used within the CAiCE design project. This will ensure consistency between CAiCE designs and the resulting contract drawings.

A CAiCE horizontal alignment geometry chain has a 10 character limit. Working within this limit, designers must now implement the following database element naming conventions:

L100 – Major Alignment

Archive Requirement

- o Preliminary Design – Yes
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

This is the basic naming convention for horizontal alignments where there are no design alternatives being considered. The start station of the L100 alignment would be 100+00 or 100+000 for very long alignments.

L100A1, L100A2, L100A3 etc. – Major Alignment Alternatives

Archive Requirement

- o Preliminary Design – Yes
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

This is the basic naming convention for a horizontal alignment where different design alternatives are being considered.

L200, L225, L250, L275, L300 etc. – Minor or Sideline Horizontal Alignments

Archive Requirement

- o Preliminary Design – Yes
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

This is the basic naming convention for a horizontal alignment defining minor alignments or sidelines. The start station of these alignments would be the same as the convention used for a major alignment. The start station of the L200 alignment would be 200+00 or if the station format has been changed on the major alignment to accommodate an extra long alignment then 200+000. The start station of the L225 alignment would be 225+00 or if the station format has been changed on the major alignment to accommodate an extra long alignment then 225+000. The designer must ensure that stationing being used on a minor or sideline horizontal alignment is unique to that alignment. If there is any chance of a stationing overlap, for example with stationing on alignment L200 overlapping stationing on alignment L225, then the alignment L225 should not be used and the higher alignment name used such as L300.

C1, C2, C3 etc. – Access/Intersection Curve Horizontal Alignments (Curb Return)

Archive Requirement

- o Preliminary Design – No
- o Functional Design – No
- o Detailed Design – Yes
- o Construction – Yes

There will be no requirement for access/intersection curve horizontal alignments in situations where the curve radius is less than 10 metres and/or the length of horizontal alignment would be less than 20 metres. Beyond these criteria, access/intersection curve horizontal alignments and associated details are required unless otherwise specified through consultation with Ministry Field Services.

This is the basic naming convention for a access/intersection curve horizontal alignment. The start station of these access/intersection curve horizontal alignments would be the same as the convention used for a minor alignment or sideline. The designer must ensure that the stationing being used on the access/intersection curve horizontal alignment is unique to that access/intersection curve for the same reasons described above for minor and sideline horizontal alignments.

<u>*D10, D11, D12 etc.* – Ditch Horizontal Alignments</u>

Archive Requirement

- o Preliminary Design – No
- o Functional Design – No
- o Detailed Design – Yes
- o Construction – Yes

This is the basic naming convention for a ditch horizontal alignment. The start station of these ditches would be the same as the convention used for a minor or sideline horizontal alignment. The designer must ensure that the stationing being used on the ditch horizontal alignment is unique to that ditch for the same reasons described above for minor and sideline horizontal alignments.

<u>*S20, S21, S22, etc.* – Structure Horizontal Alignments</u>

Archive Requirement

- o Preliminary Design – No
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

This is the basic naming convention for a structure horizontal alignment. The start station of these structures would be the same as the convention used for a minor or sideline horizontal alignment. The designer must ensure that the stationing being used on the structure horizontal alignment is unique to that structure for the same reasons described above for minor and sideline horizontal alignments.

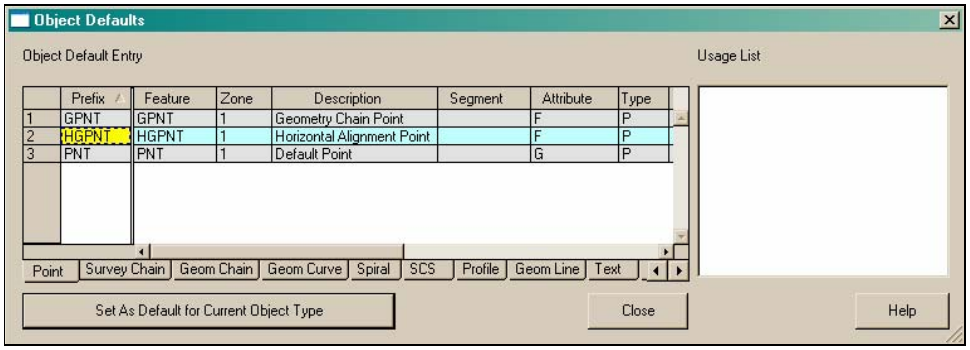
Horizontal Alignment Elements – Points, Curves, Spirals, Spiral Curve Spirals

Archive Requirement

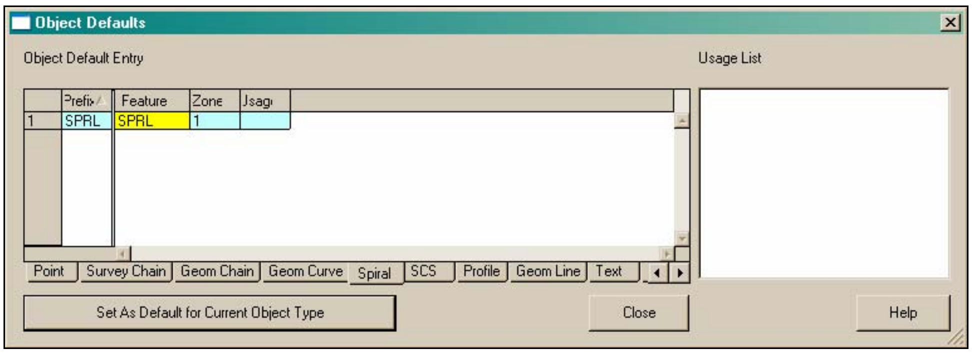
- o Preliminary Design – Yes
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

The basic horizontal alignment element naming conventions that must be used are what have been defined by the Ministry standard CAiCE object defaults. The object defaults are found in CAiCE using the Settings➔Object Defaults command.

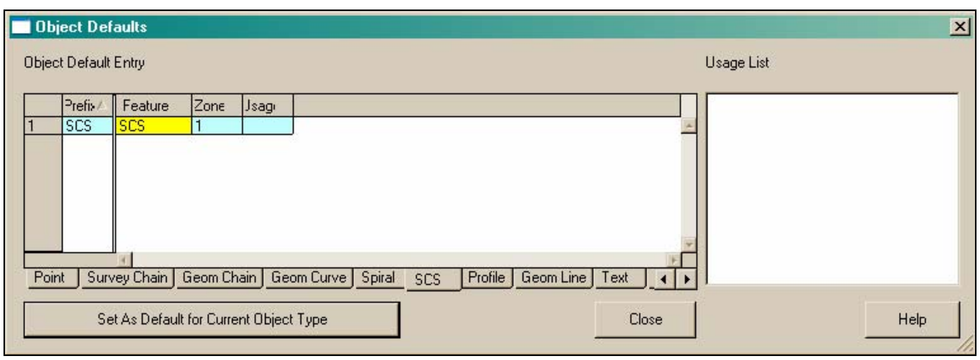
Points - *HGPNT*



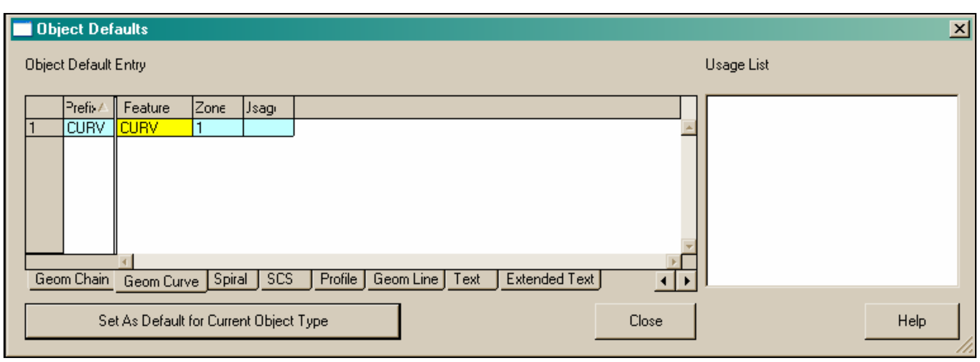
Spirals – *SPRL*



Spiral Curve Spiral – *SCS*



Curves – *CURV*



Design Element Feature Codes

Archive Requirement

- o Preliminary Design – Yes
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

If it has not been specified elsewhere in this document, design element feature codes must be applied as set out in the project object defaults for such elements as profiles, horizontal alignments etc.

Superelevation Lines

Archive Requirement

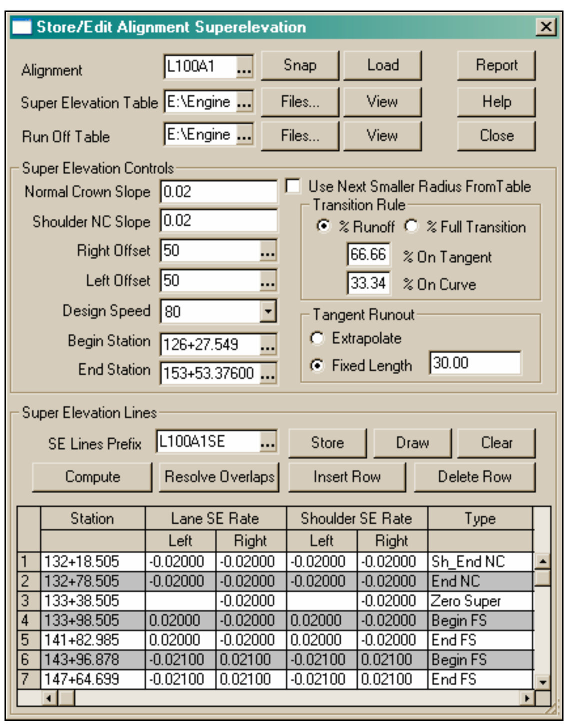
- o Preliminary Design – No
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

The basic superelevation line element naming convention that must be used is to make the SE lines prefix the same as the Horizontal Alignment Name as shown below:

L100A1SE

If there is a requirement for more that 99 superelevation lines on a specific horizontal alignment, then the designer can drop the prefix "L" as shown below:

100A1SE



Cross Section Stations Text Files

Archive Requirement

- o Preliminary Design – No
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

The designer must create and maintain cross section stations text files that may be required to generate cross section scanlines. The files must include station intervals and individual stations such as those shown below:

<u>Functional Design</u>

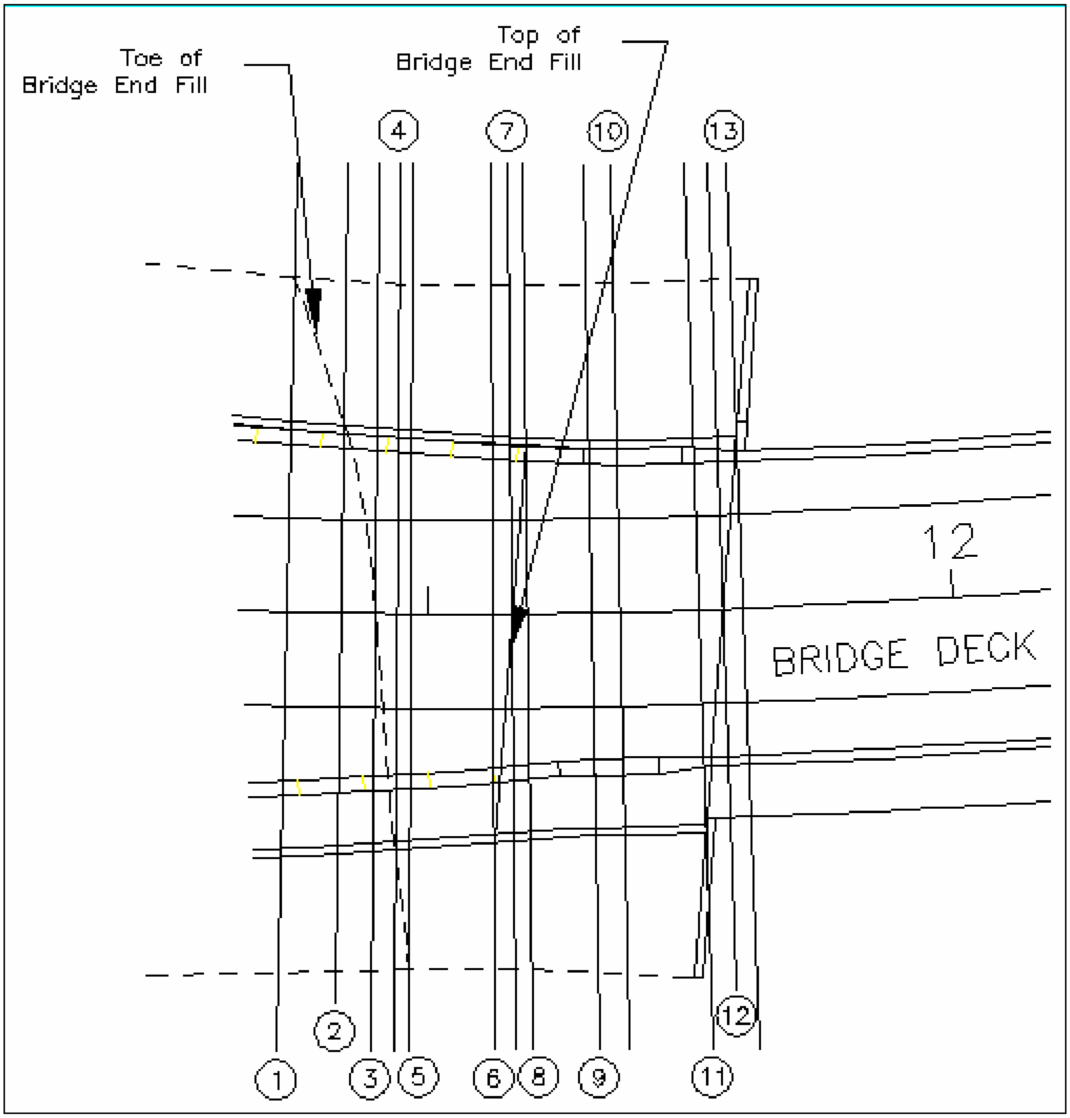
- Station interval maximum of 20m
- Any other miscellaneous odd stations generated and used by the designer

<u>Detailed Design</u>

- All roadway width change stations
- All crossfall/superelevation change stations
- All roadway template change stations – gravel, ditch widths, slopes, etc.
- All vertical alignment high and low point break stations
- Station Intervals that reflect material types, 5m, 10m, 20m, etc. A maximum 10 metre interval is to be used unless otherwise specified through consultation with Ministry Field Services.
- Any other miscellaneous odd stations generated and used by the designer in the calculation of final design volumes.
- All horizontal alignment curve and spiral transition stations
- All contract drawing spot elevation locations
- All structure stations – bridge abutments, retaining walls, etc. A maximum 5 metre interval is to be used unless otherwise required by the structure design. Bridge and wall drawings on the following pages provide an indication of the cross section stations that are required for structure situations.

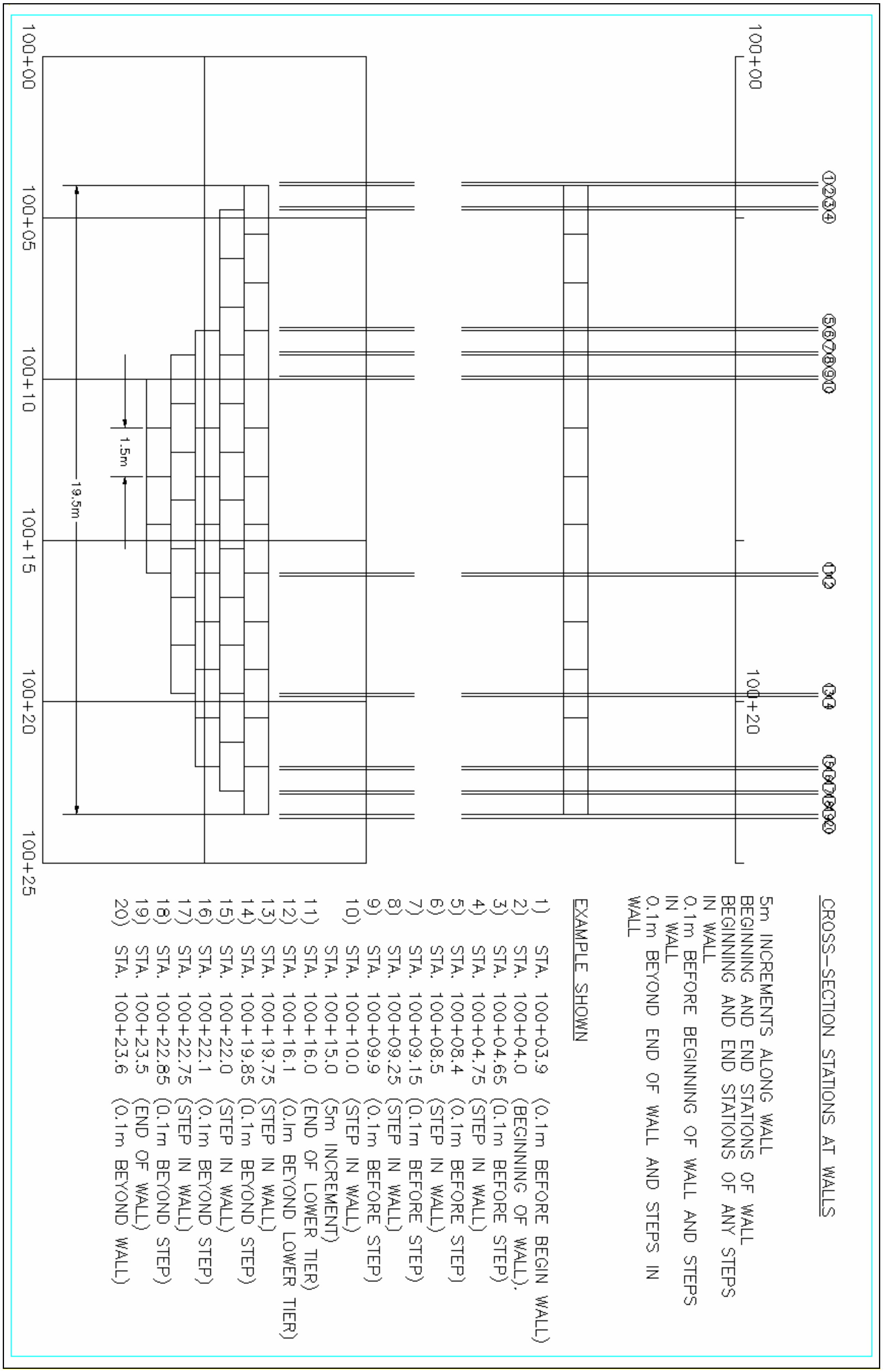
  Structure stations are not required if structure construction is to be paid for by facial area or by an all inclusive cost. In these situations, cross section stations are still required at 5 metre intervals for approximate wall structure excavation and backfill quantity calculations used for project tender reference purposes.

Plan View of Cross Section Locations at Skewed Bridge Abutments



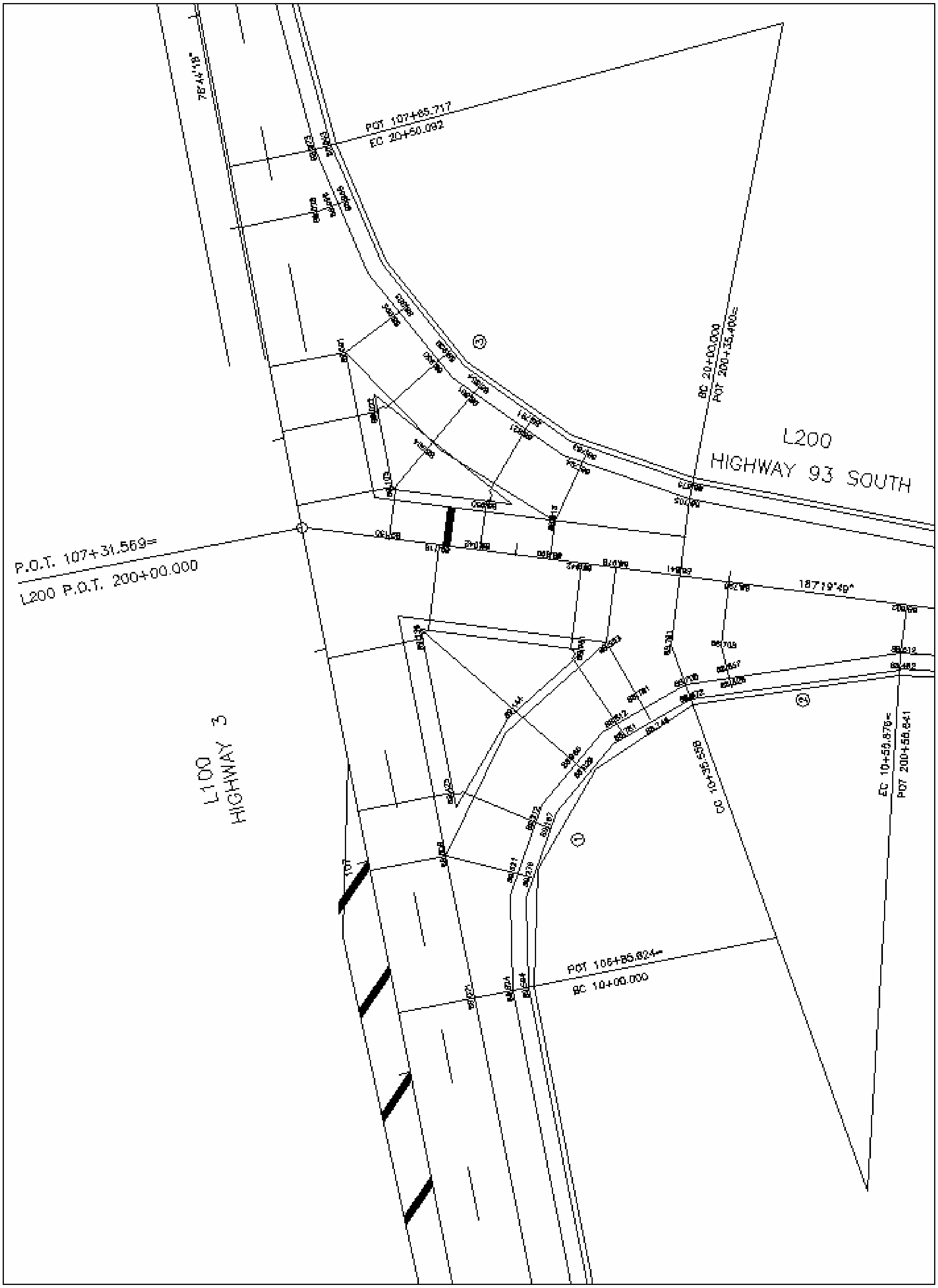
1. Intersection of left toe with chain from site design (toe of endfill)
2. Intersection of left gravel shoulder with chain from site design (toe of endfill)
3. Intersection of centerline with chain from site design(toe of endfill)
4. Intersection of right gravel shoulder with chain from site design (toe of endfill)
5. Intersection of right toe with chain from site design (toe of endfill)
6. Intersection of offset from back of abutment (top of endfill) with right gravel shoulder.
7. Intersection of offset from back of abutment (top of endfill) with centerline.
8. Intersection of offset from back of abutment (top of endfill) with left gravel shoulder.
9. End of CRB flare taper right.
10. End of CRB flare taper left.
11. Intersection of gravel shoulder with back of bridge abutment right.
12. Intersection of centerline with back of bridge abutment.
13. Intersection of gravel shoulder with back of bridge abutment left.

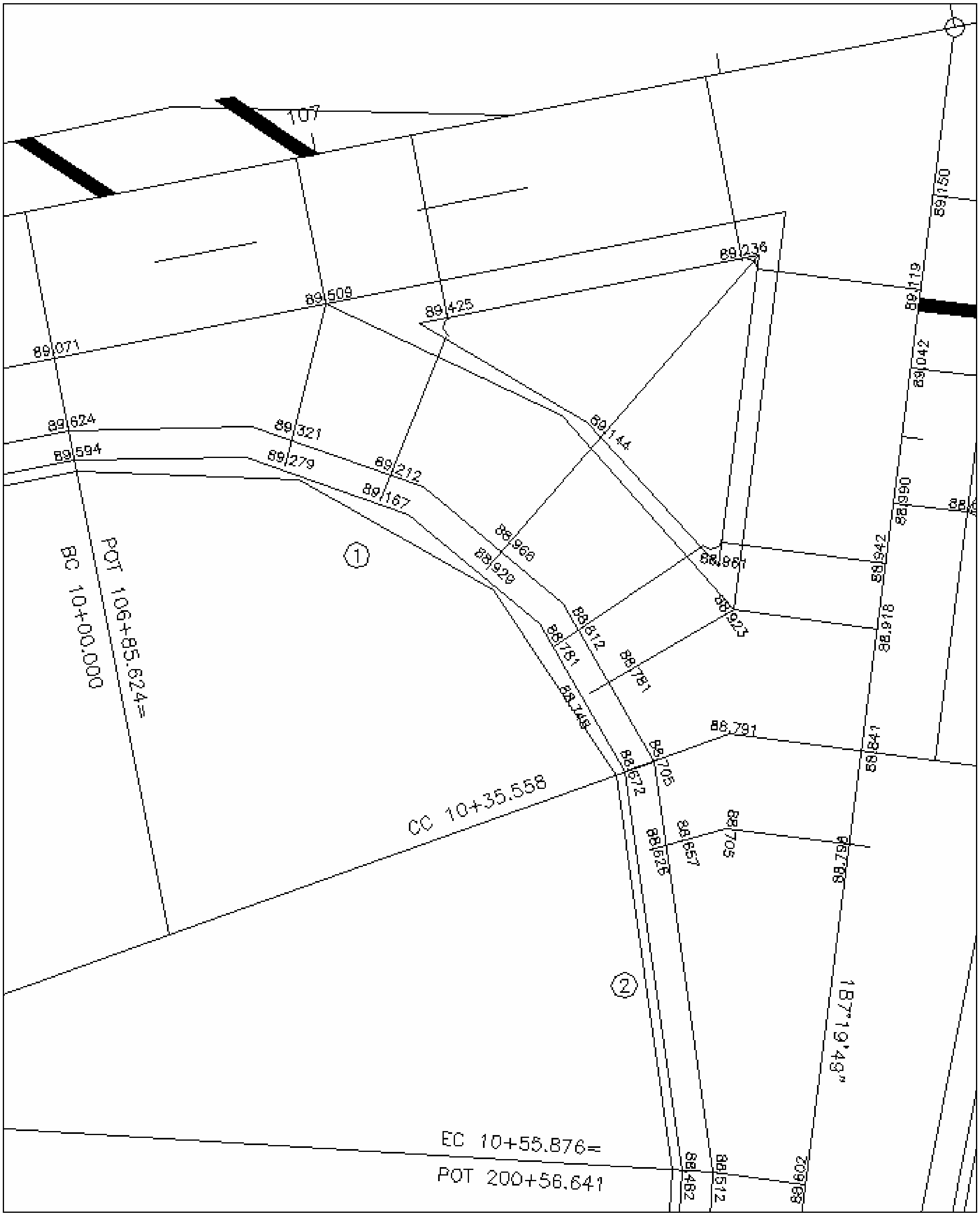
Additional cross sections should be extracted at the ends of wing walls, bends in wing walls etc.

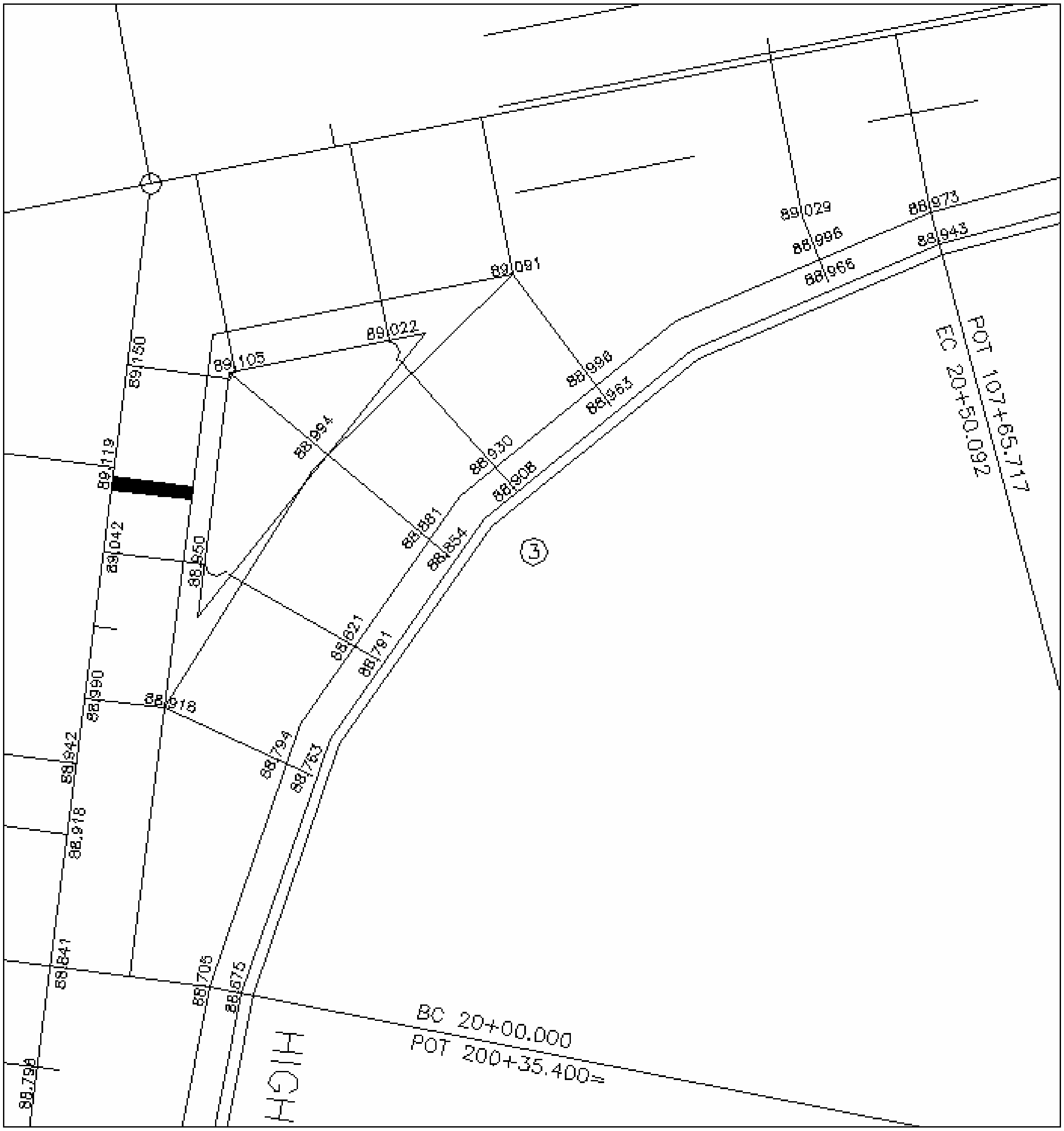

100+00
100+05
100+10
100+15
100+20
100+25
1.5m
19.5m
CROSS-SECTION STATIONS AT WALLS
5m INCREMENTS ALONG WALL
BEGINNING AND END STATIONS OF WALL
BEGINNING AND END STATIONS OF ANY STEPS IN WALL
0.1m BEFORE BEGINNING OF WALL AND STEPS IN WALL
0.1m BEYOND END OF WALL AND STEPS IN WALL
EXAMPLE SHOWN
1) STA. 100+03.9 (0.1m BEFORE BEGIN WALL)
2) STA. 100+04.0 (BEGINNING OF WALL).
3) STA. 100+04.65 (0.1m BEFORE STEP)
4) STA. 100+04.75 (STEP IN WALL)
5) STA. 100+08.4 (0.1m BEFORE STEP)
6) STA. 100+08.5 (STEP IN WALL)
7) STA. 100+09.15 (0.1m BEFORE STEP)
8) STA. 100+09.25 (STEP IN WALL)
9) STA. 100+09.9 (0.1m BEFORE STEP)
10) STA. 100+10.0 (STEP IN WALL)
STA. 100+15.0 (5m INCREMENT)
11) STA. 100+16.0 (END OF LOWER TIER)
12) STA. 100+16.1 (0.1m BEYOND LOWER TIER)
13) STA. 100+19.75 (STEP IN WALL)
14) STA. 100+19.85 (0.1m BEYOND STEP)
15) STA. 100+22.0 (STEP IN WALL)
16) STA. 100+22.1 (0.1m BEYOND STEP)
17) STA. 100+22.75 (STEP IN WALL)
18) STA. 100+22.85 (0.1m BEYOND STEP)
19) STA. 100+23.5 (END OF WALL)
20) STA. 100+23.6 (0.1m BEYOND WALL)

- All intersection stations – access/intersection curves, etc.

  The designer must supply vertical cutoff stations through an intersection, where major, minor, sideline and access/intersection curve horizontal alignment stations are coincident. These stations will include all key locations necessary for layout and to provide an accurate representation of earthwork quantities through an intersection. Key stations will include beginning and end of access/intersection curves, paint line convergences and island corners. The following drawings show the typical requirements for spot elevations and design cross section stations required for construction supervision layout and earthwork calculations through an intersection. Cross section stations are to be supplied at the beginning and end of an intersection (Sta. 106+85.624 & 107+85.717) with full roadway width and a station 1cm outside of each of these stations at the vertical cutoff offset.


78°44'18"
POT 107+65.717
EC 20+50.092
BC 20+00.000
POT 200+35.400=
L200
HIGHWAY 93 SOUTH
P.O.T. 107+31.569=
L200 P.O.T. 200+00.000
187°19'49"
L100
HIGHWAY 3
CC 10+35.558
EC 10+58.879=
POT 200+58.841
POT 106+86.624=
BC 10+00.000

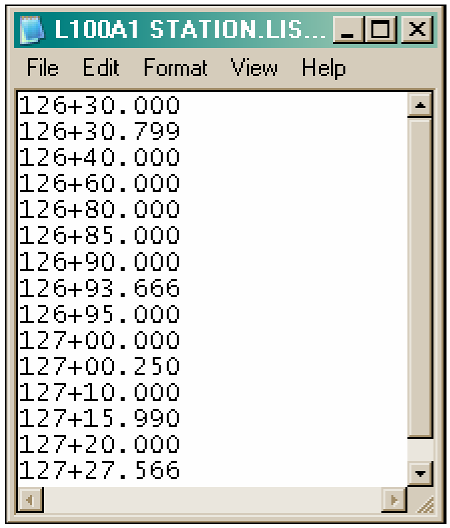

107
89.150
89.236
89.119
89.509
89.425
89.071
89.042
89.624
89.321
89.144
89.594
89.279
89.212
89.167
88.990
88.966
88.929
88.961
88.942
POT 106+85.624=
BC 10+00.000
88.812
88.923
88.781
88.918
88.781
88.748
88.791
88.705
88.672
88.841
CC 10+35.558
88.626
88.657
88.705
88.798
187°19'49"
EC 10+55.876=
POT 200+56.641
88.482
88.512
88.602


89.029
88.973
88.996
88.943
88.966
89.091
89.022
89.105
89.150
88.996
88.963
88.994
88.930
88.908
89.119
88.881
88.854
89.042
88.950
88.821
88.791
88.990
88.918
88.942
88.794
88.763
88.918
88.841
88.705
88.675
POT 107+65.717
EC 20+50.092
3
BC 20+00.000
POT 200+35.400=
HIGH

- All abrupt stations for cutoffs. Examples of abrupt stationing for cutoffs are reflected on the previous drawings detailing access/intersection curve requirements. Earthwork quantities will start and end abruptly at each end of the access/intersection curve as they are vertically tied to the 2 main alignments. There is no running in or out of the quantities (CAiCE exceptions) as this is only a construction supervision remeasure concern.

The file naming convention that must be used for the designer created text files containing cross section station lists, is to prefix the file name with the name of the associated horizontal alignment and “STATIONS”. For example the filename to be used for the L100A1 horizontal alignment stations list would be as follows:

L100A1 STATIONS.LIS


L100A1 STATION.LIS...
File Edit Format View Help
126+30.000
126+30.799
126+40.000
126+60.000
126+80.000
126+85.000
126+90.000
126+93.666
126+95.000
127+00.000
127+00.250
127+10.000
127+15.990
127+20.000
127+27.566

DTM Naming

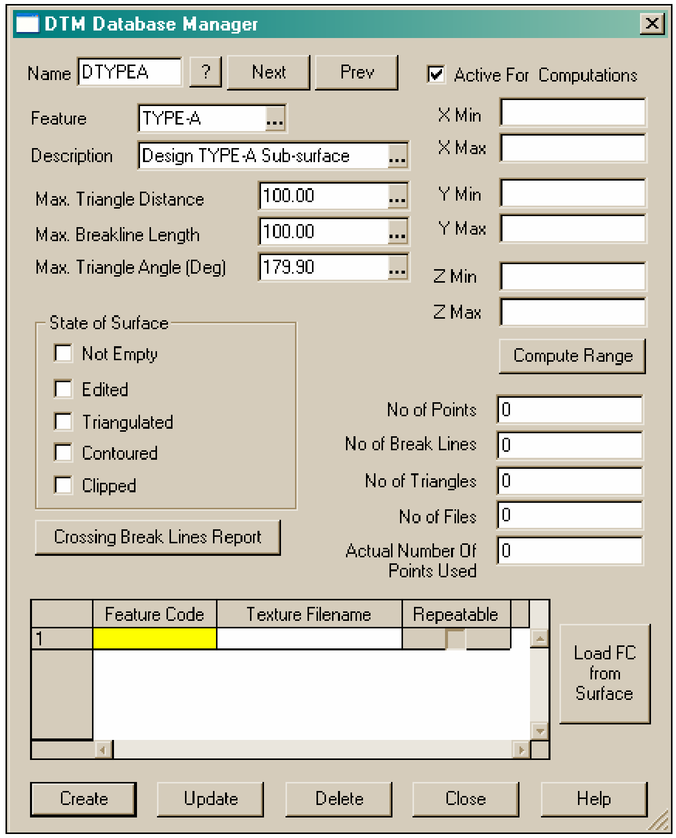
Archive Requirement

- Preliminary Design – Yes
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

The basic design DTM surface naming conventions that must be used are to prefix all location survey and design created DTMs with an “S” for survey and a “D” for design. The remaining part of the DTM name must be limited to a maximum of 6 Characters.

Guidelines for naming DTMs and assigning corresponding feature codes are shown in the examples below:

Name “*SOG*”	Feature “*OG*”	Survey Original Ground
Name “*DTYPEA*”	Feature “*TYPE-A*”	Design TYPE-A Sub-surface
Name “*DTYPEA1*”	Feature “*TYPE-A1*”	Design TYPE-A1 Sub-surface
Name “*DTYPEB*”	Feature “*TYPE-B*”	Design TYPE-B Sub-surface
Name “*DTYPEC3*”	Feature “*TYPE-C3*”	Design TYPE-C3 Sub-surface



Data Source and Extent Boundary Definition

Archive Requirement

- o Preliminary Design – Yes
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

Survey points and chains data source, extent boundary survey chains, are only to be generated by the designer if additional data is being added to the base original ground for design purposes. These survey chains must be generated in CAiCE using points from the survey database vs. digitized points.

These survey chains will provide anyone reviewing the project, a clear indication of what aspects of the base original ground have been collected from each data source, such as ground surveys, digital mapping, 3D laser scanning, LiDAR, etc. The basic naming convention that must be used is to prefix the survey chain name with “SURVEY”, “MAPPING”, “3DLASER, LiDAR” etc. The designer must assign the survey chain a feature code of BD. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

This type of survey chain may already exist in the CAiCE survey data base, generated during the original location survey phase of the project.

SURVEY23, MAPPING19, 3DLASER303, LIDAR72

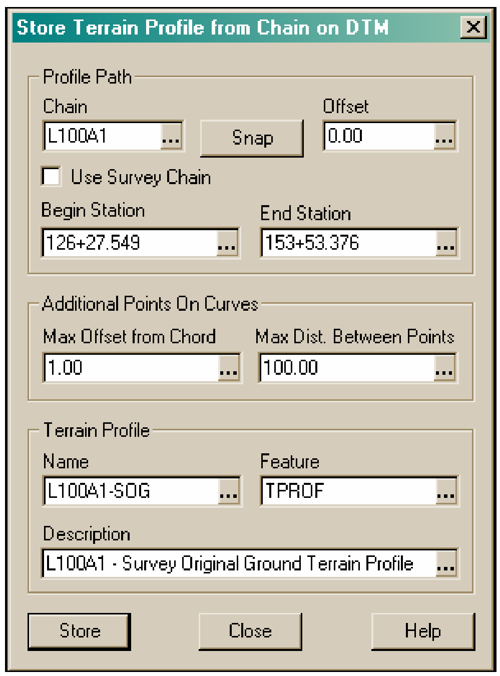
Terrain Profile PF$ Files

Archive Requirement

- o Preliminary Design – Yes
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

The basic CAiCE terrain profile file naming convention that must be used is to make the file name the same as the horizontal alignment name with an indication of what DTM was used. For example, the terrain profile file name to be used for a profile generated using the L100A1 horizontal alignment and the SOG DTM would be as follows:

L100A1-SOG



Base Cross Section EAR Files

Archive Requirement

- o Preliminary Design – No
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

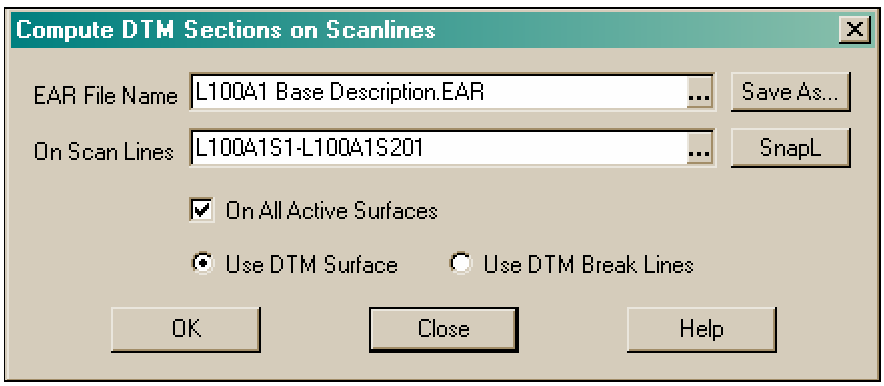
Base cross section EAR files must include all relevant geotechnical sub-surfaces used to complete the final design. In areas where there are clearly overhangs, the designer must make sure the necessary work is completed to introduce the overhangs into the base cross section files for design and construction supervision purposes. An example of overhang definition is shown in the

Ministry General Survey Guide Section 900 CAiCE Survey Project Data Format Terms of Reference.

Design base cross section EAR files must contain cross sections for design and construction supervision purposes as detailed earlier in this section for the creation of cross section stations text files.

Below is the basic naming convention that must be used when creating a base cross section EAR file. The EAR file name is to be prefixed with the horizontal alignment name and then followed by the word "Base" and an optional description if there is additional information needed to describe a file's contents. Example base EAR file names and descriptions are shown below:

L100A1 Base Stripping and Stripping Limits.EAR
L100A1 Base Milling.EAR



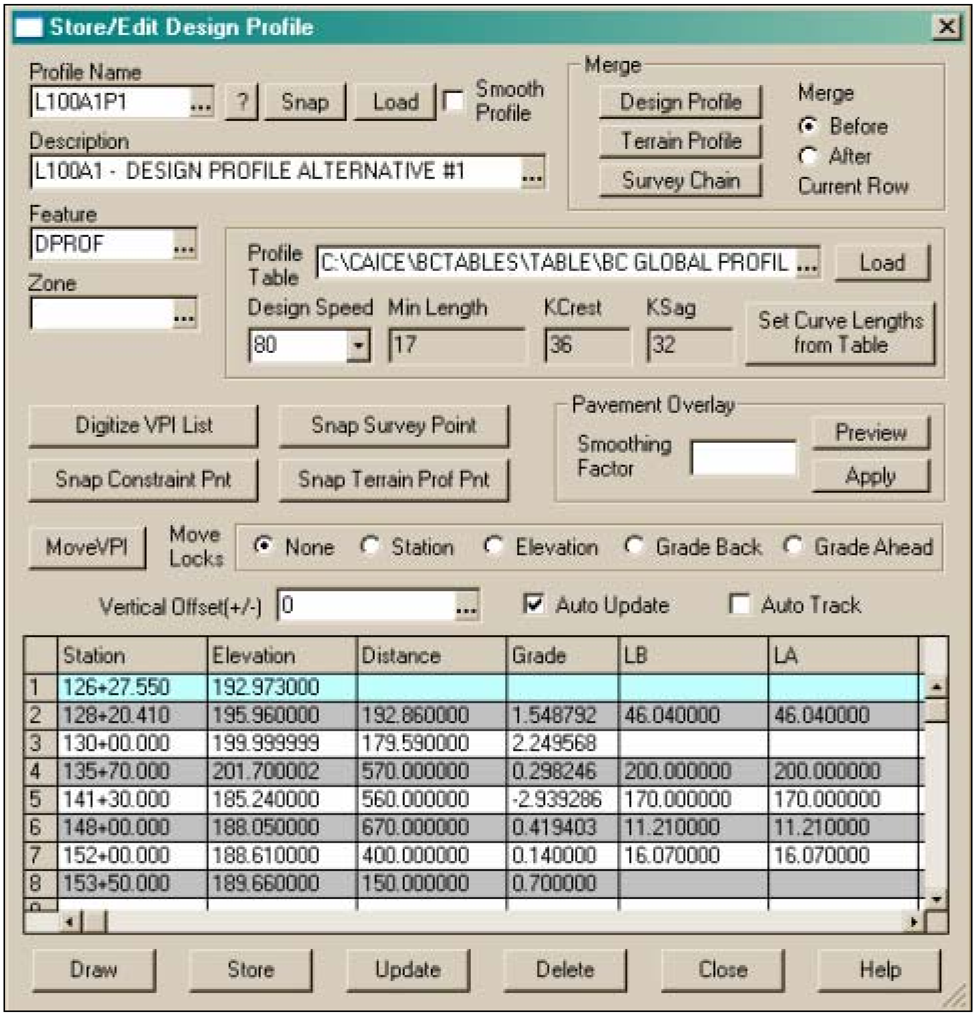
Design Profiles

Archive Requirement

- o Preliminary Design – Yes
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

The basic CAiCE design profile element naming convention that must be used is to prefix the name with the horizontal alignment name as described earlier in this section and append the prefix with the design profile alternative indicator as shown below:

L100A1P1, L200A1P4, L300A1P5 etc.



Design Cross Section EAR Files

Archive Requirement

- Preliminary Design – No
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

Final design cross section EAR files must contain cross sections at all stations required for construction supervision as detailed earlier in this section for the creation of cross section stations text files. Final design cross section EAR files must include those stations that are hard copied for project tender reference documents.

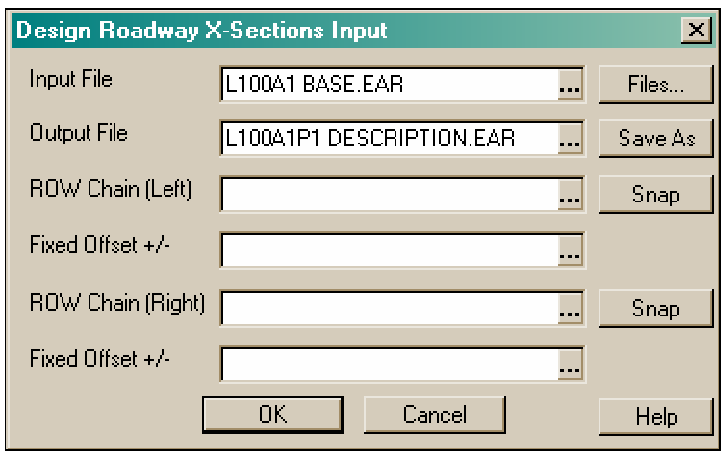
The designer must provide the complete detail for structures such as bridge abutments and walls etc. using the Ministry generic link fragments or specialized Ministry structure fragments when available, if structure construction is to be paid for by cubic metre. The included structures must be provided in sufficient detail that will allow construction supervision staff to calculate the different material volumes associated with the different structure configurations. The first set of wall structure drawings that follow, provide an indication of the structure related cross section surfaces to be created by the designer, their associated design surface names, and associated materials.

If structure construction is to be paid for by facial area or by an all inclusive cost, then only limited wall design detail is required to approximate wall structure excavation and backfill quantity calculations used for project tender reference purposes. The second set of wall structure drawings that follow, provide an indication of the structure excavation and backfill related cross section surfaces to be created by the designer, their associated design surface names, and associated materials.

If specific project typical section requirements cannot be accommodated by the Ministry standard fragments sets, then the Ministry generic link fragments must be used to complete the design. **No manual cross section editing is permitted in the completion of a CAiCE design cross section EAR file.**

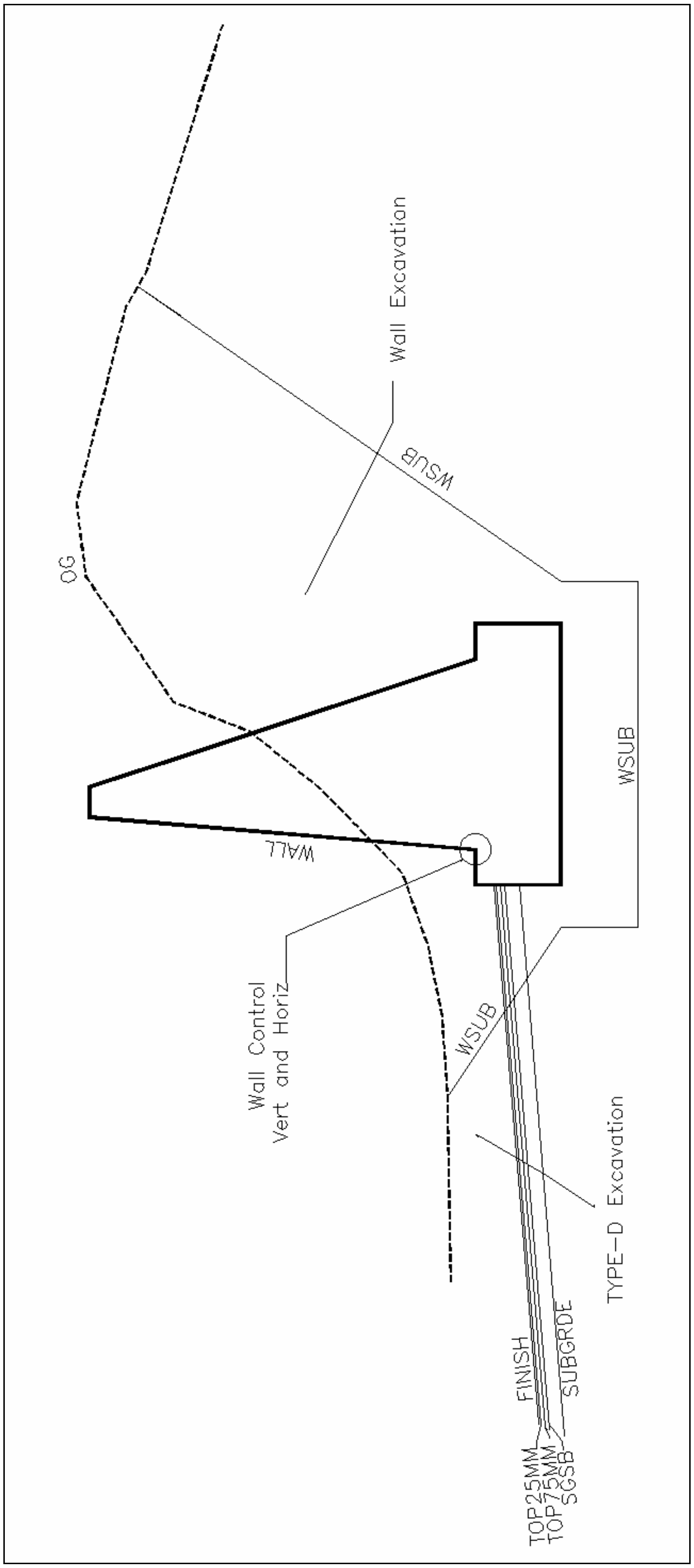
Below is the basic naming convention that must be used when creating a design cross section EAR file. The EAR file name is to be prefixed with the combined horizontal alignment and profile name and then followed by an optional description if there is additional information needed to describe the file's contents.

L100A1P1 Description.EAR – Design Cross Section EAR File

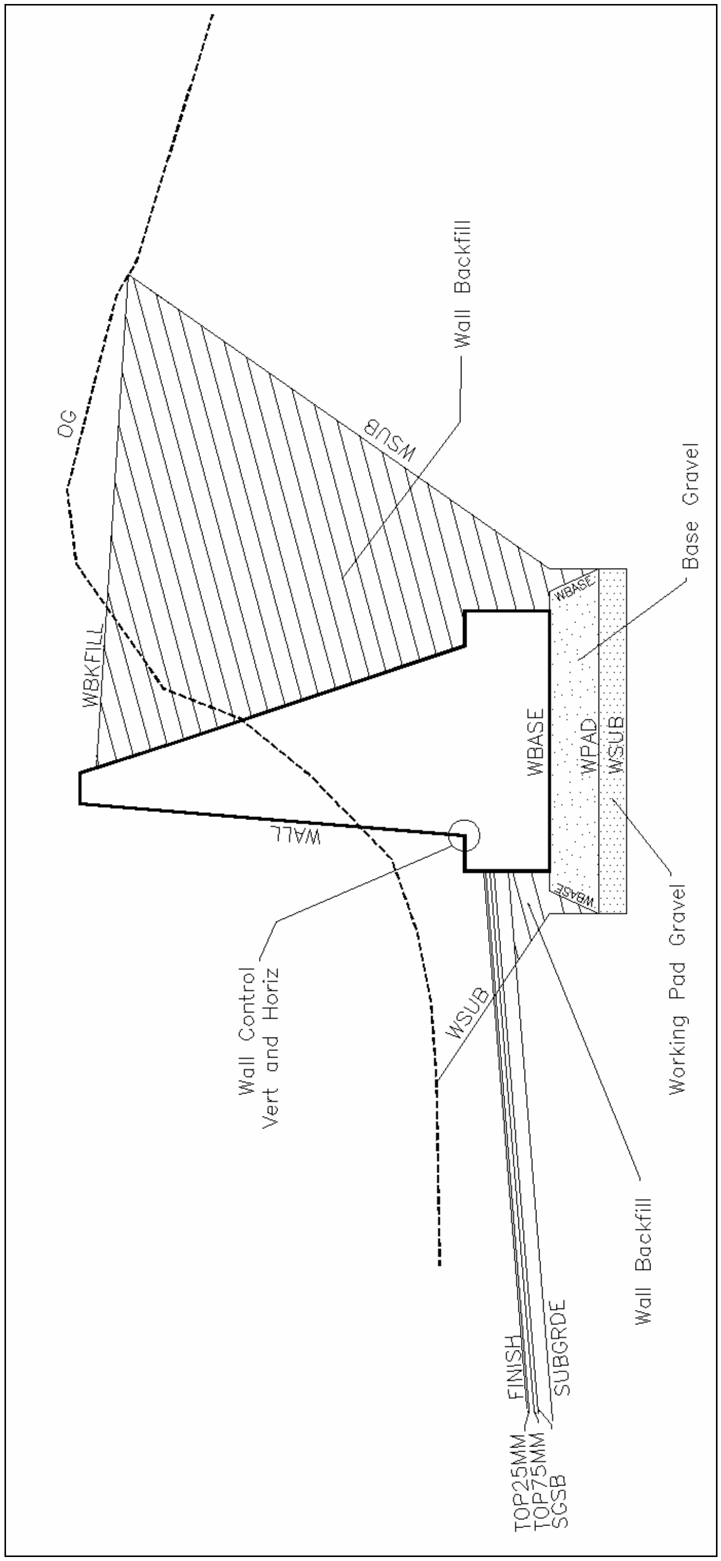


Input Name: *L100A1 BASE Description.EAR*
Output Name: *L100A1P1 Description.EAR*

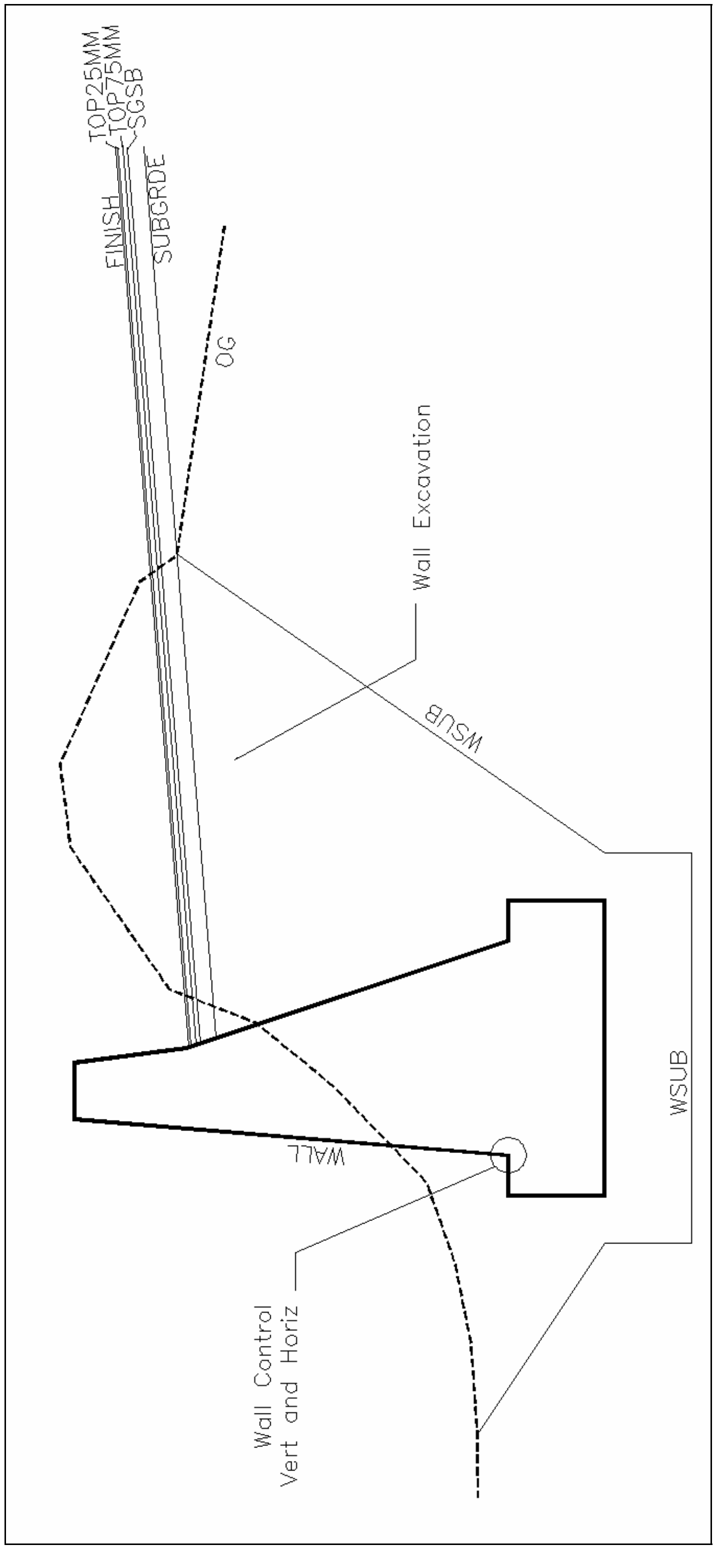
Breast Wall
Excavation Surfaces and Materials



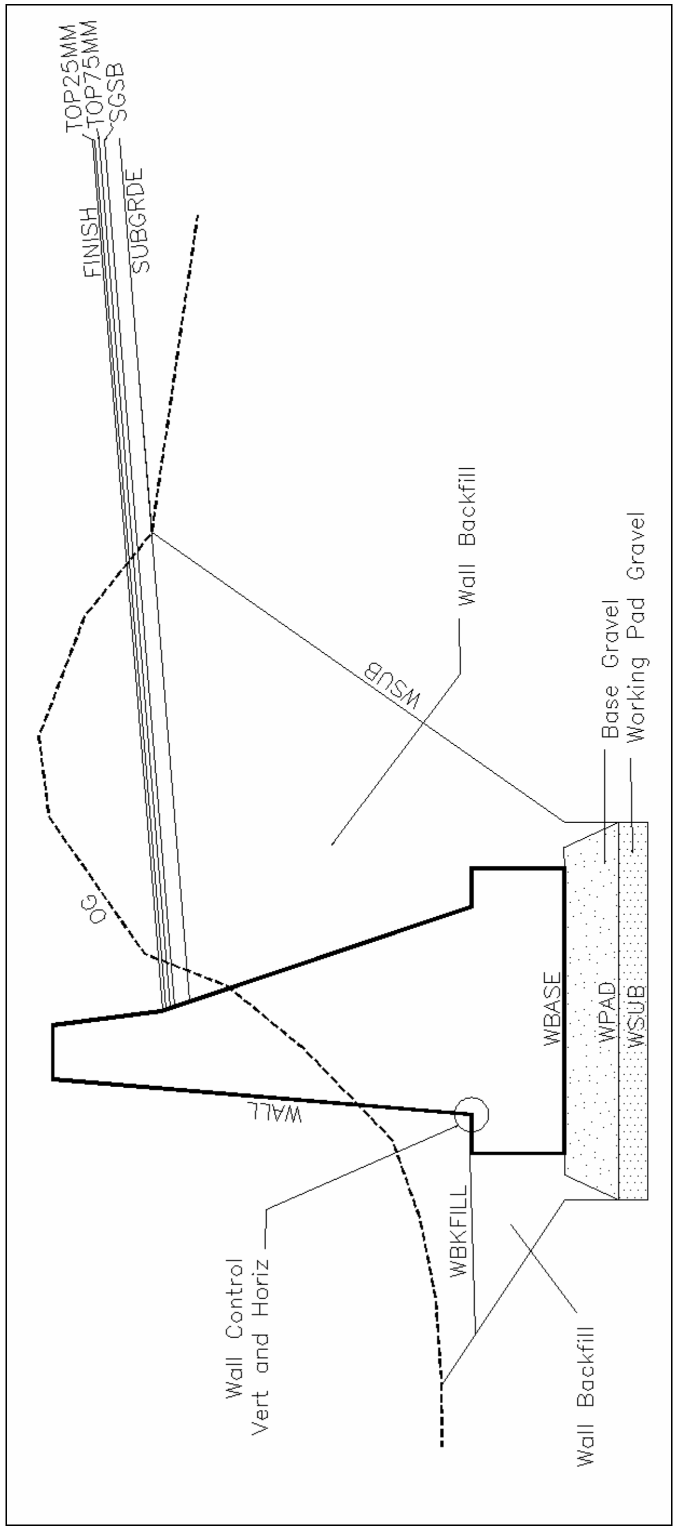
Breast Wall
Fill Surfaces and Materials



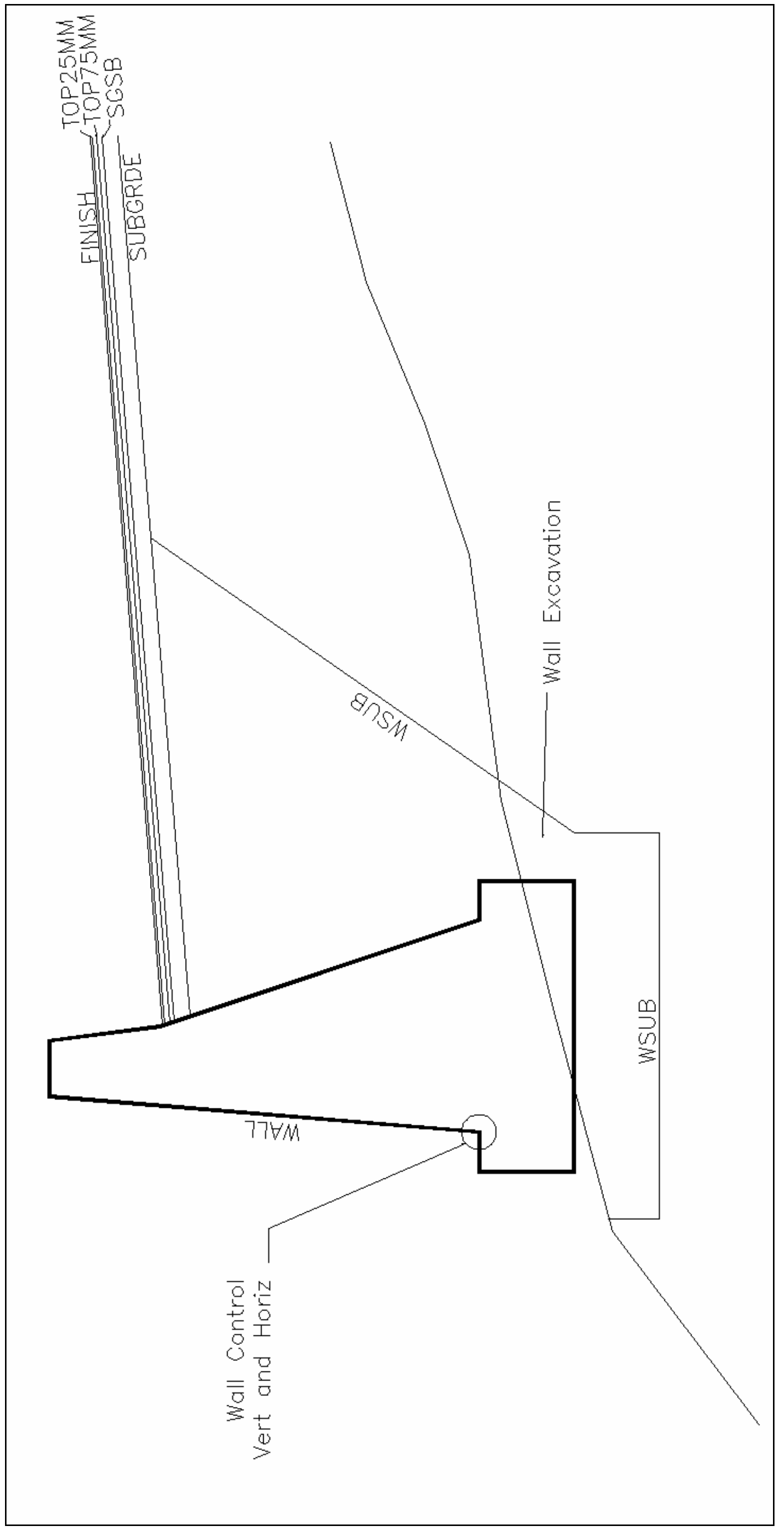
Gravity Wall (Cut Scenario)
Excavation Surfaces and Materials



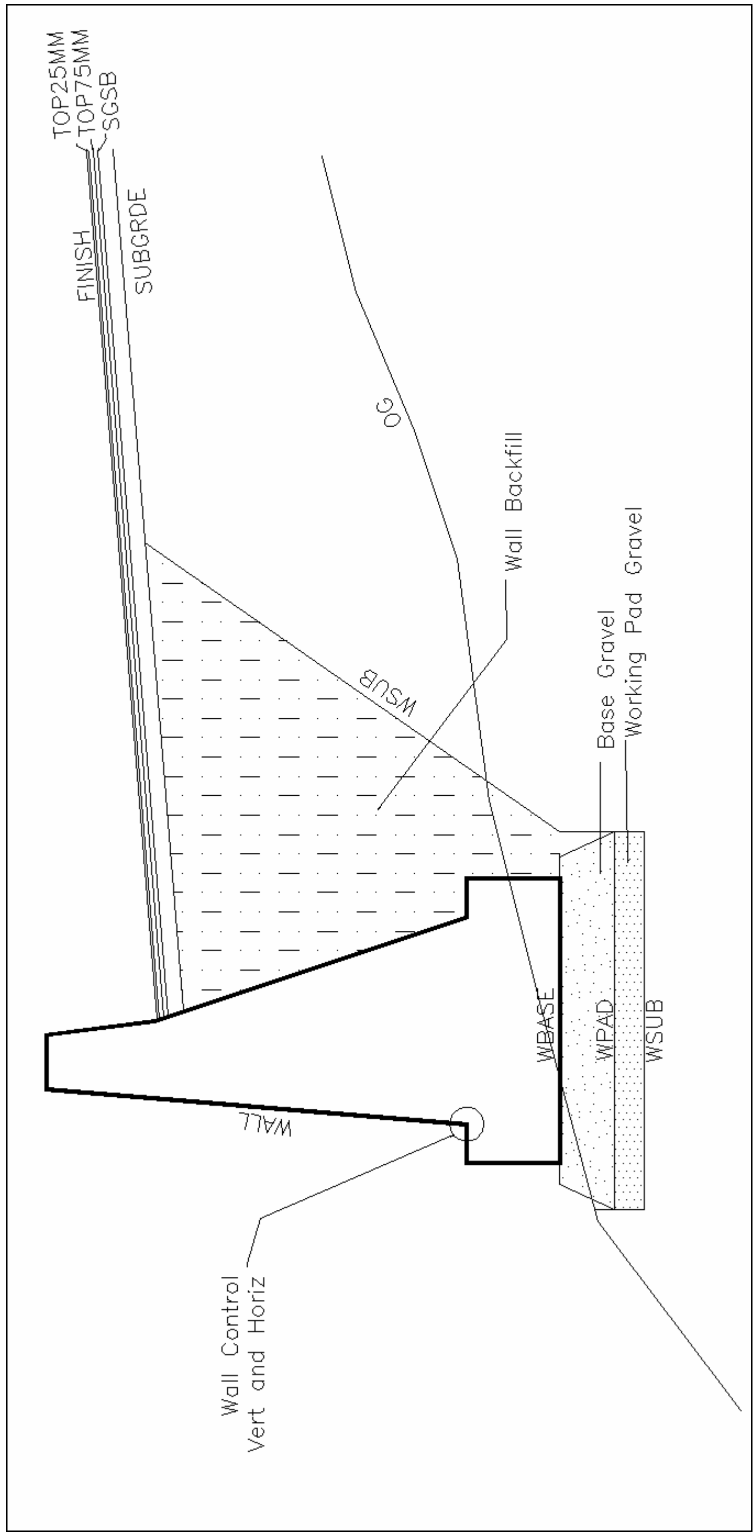
Gravity Wall (Cut Scenario)
Fill Surfaces and Materials



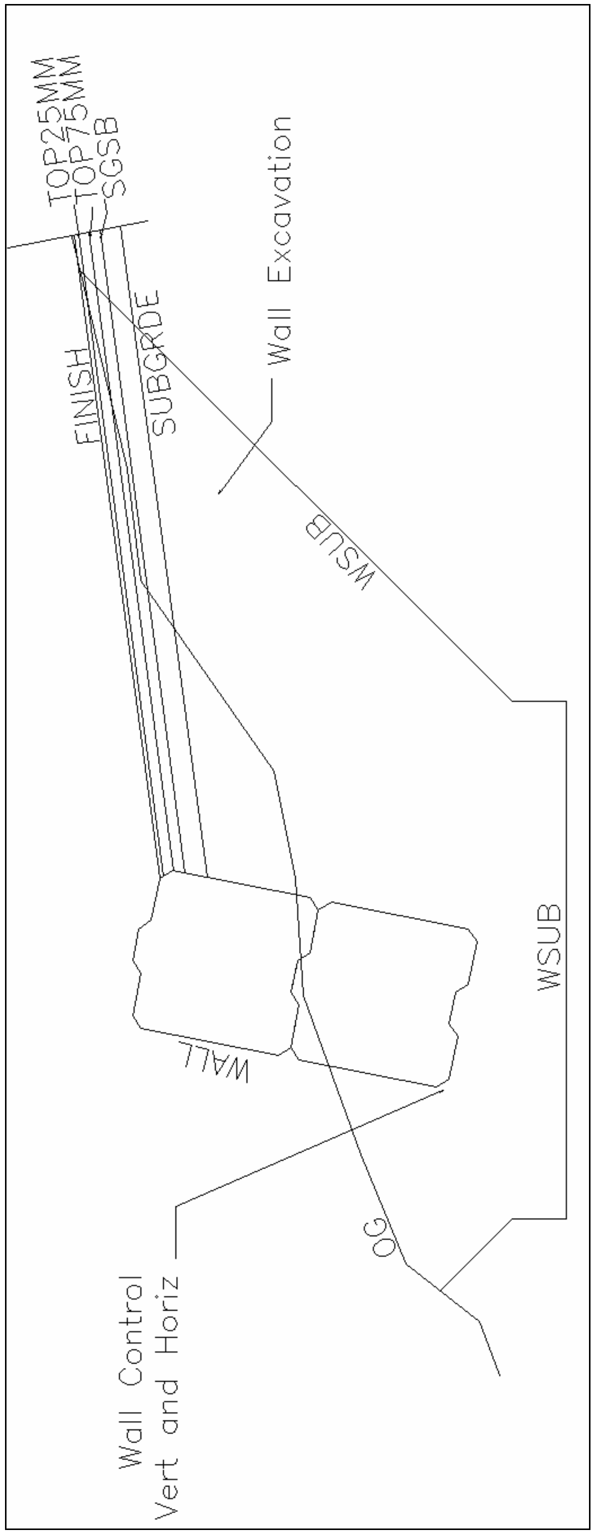
Gravity Wall (Fill Scenario)
Excavation Surfaces and Materials



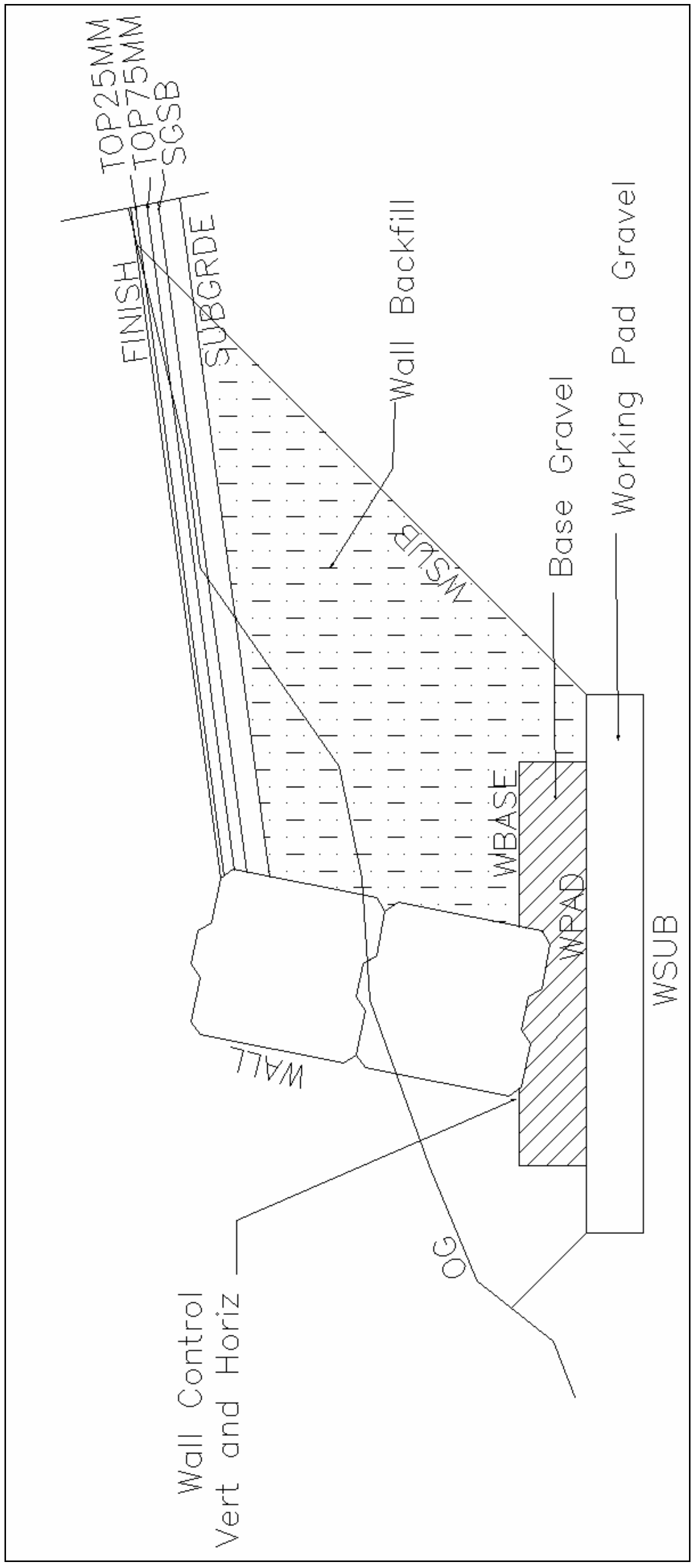
Gravity Wall (Fill Scenario)
Fill Surfaces and Materials



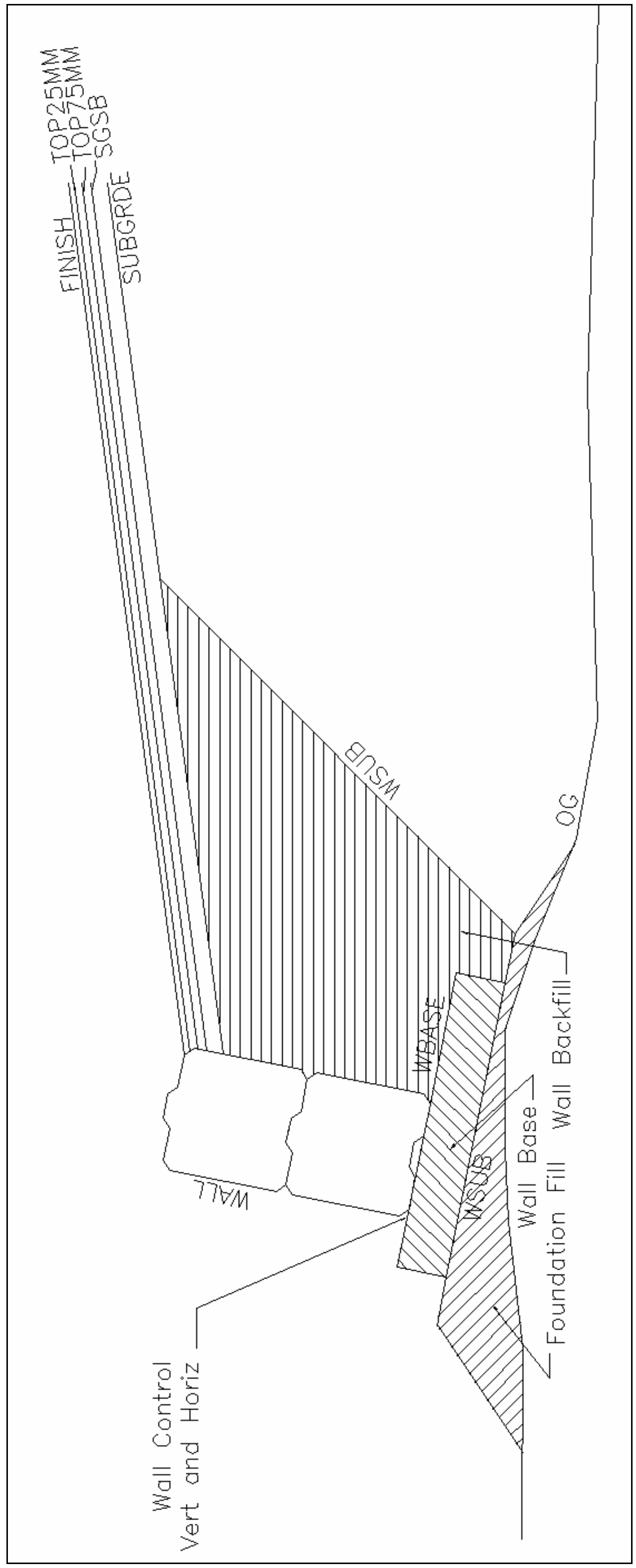
Modular Concrete Wall (Flat Pad)
Excavation Surfaces and Materials



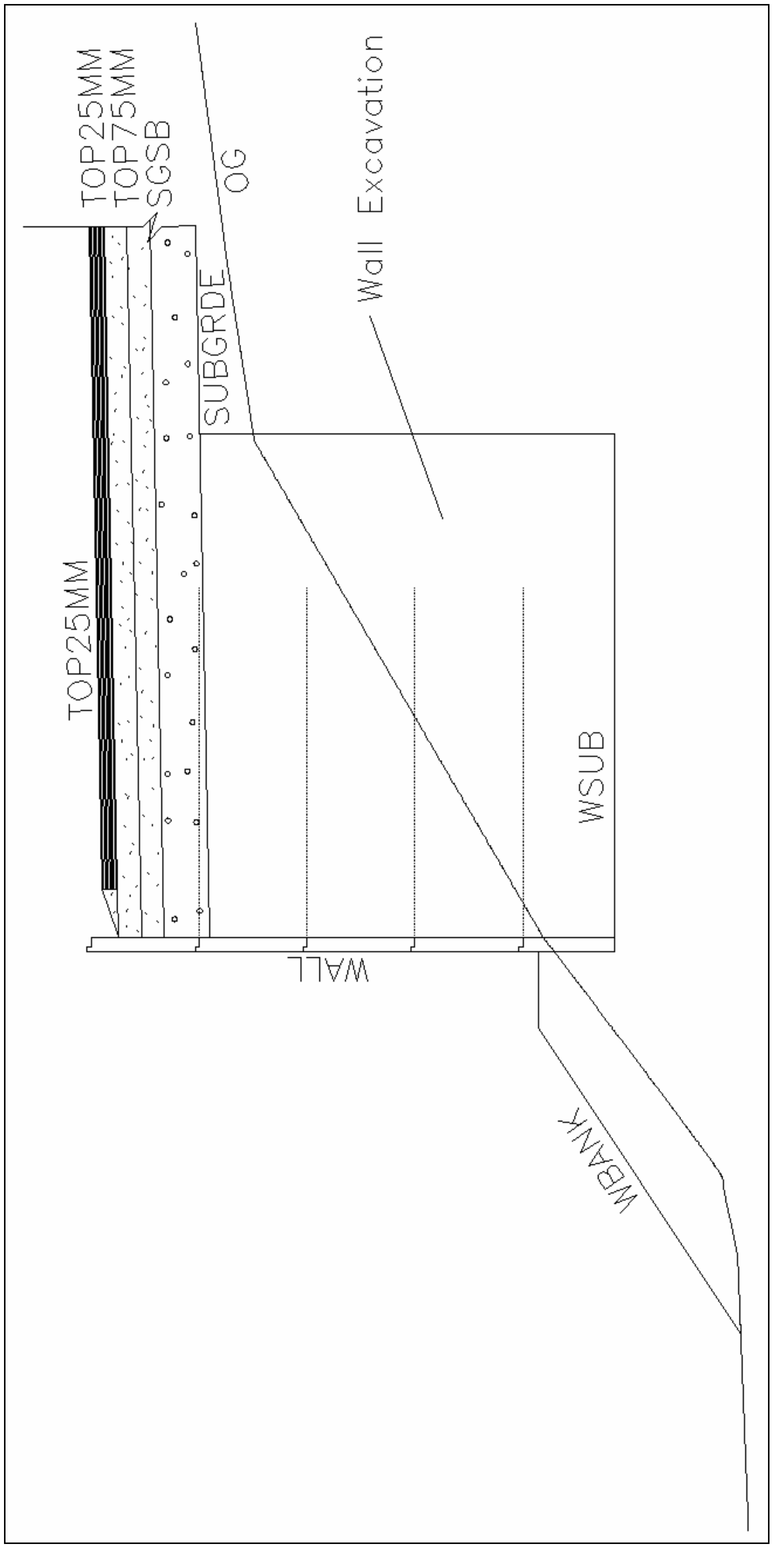
Modular Concrete Wall (Flat Pad)
Fill Surfaces and Materials



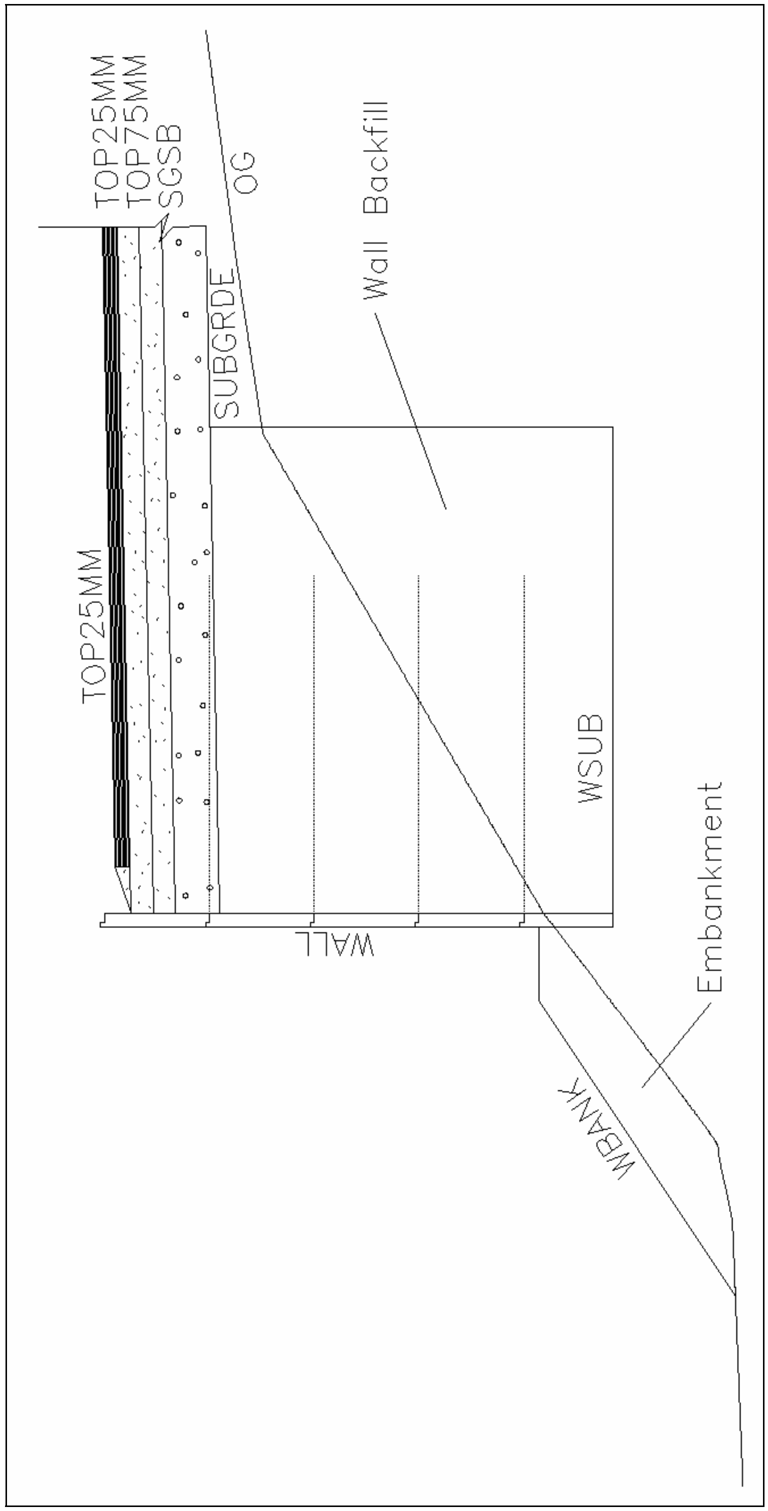
Modular Concrete Wall (Sloped Pad)
Fill Surfaces and Materials



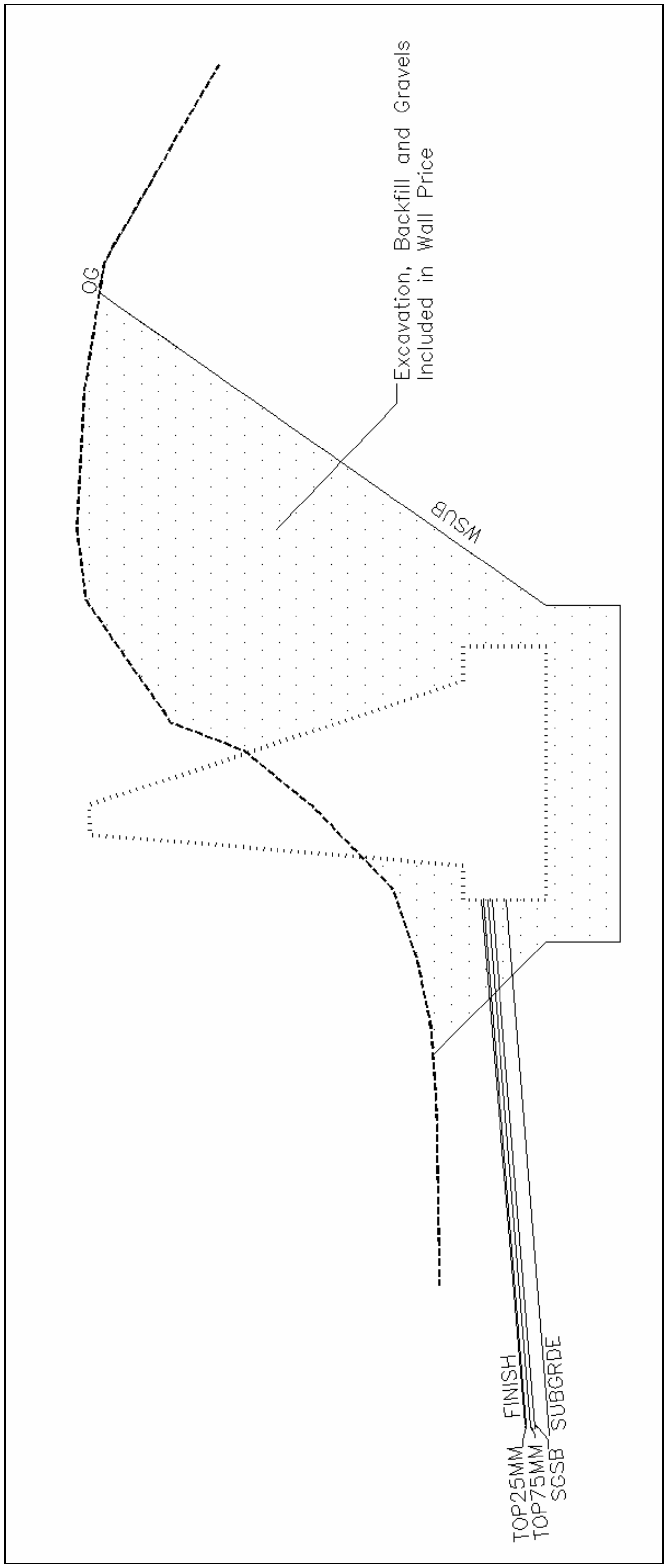
Re-inforced Earth Wall
Excavation Surfaces and Materials



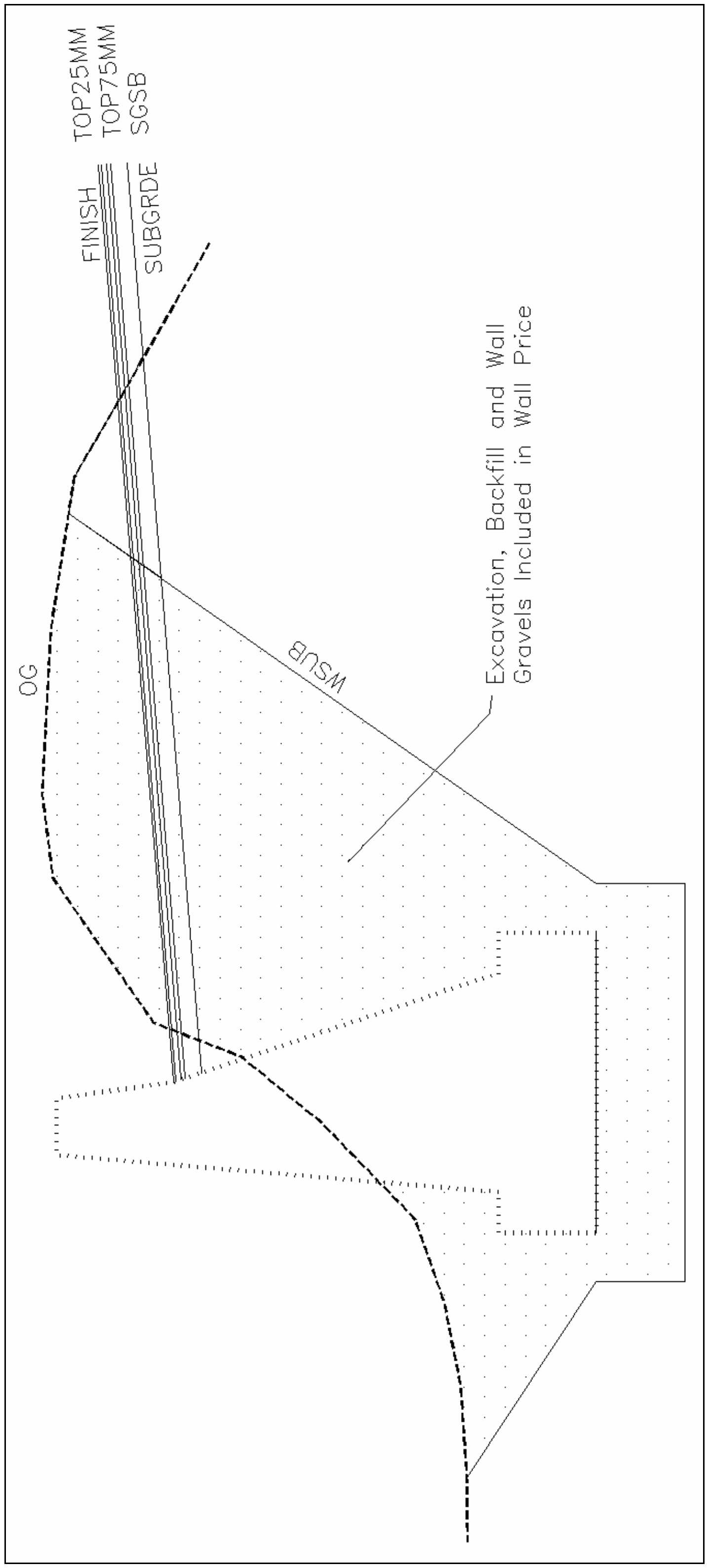
Re-enforced Earth Wall
Fill Surfaces and Materials



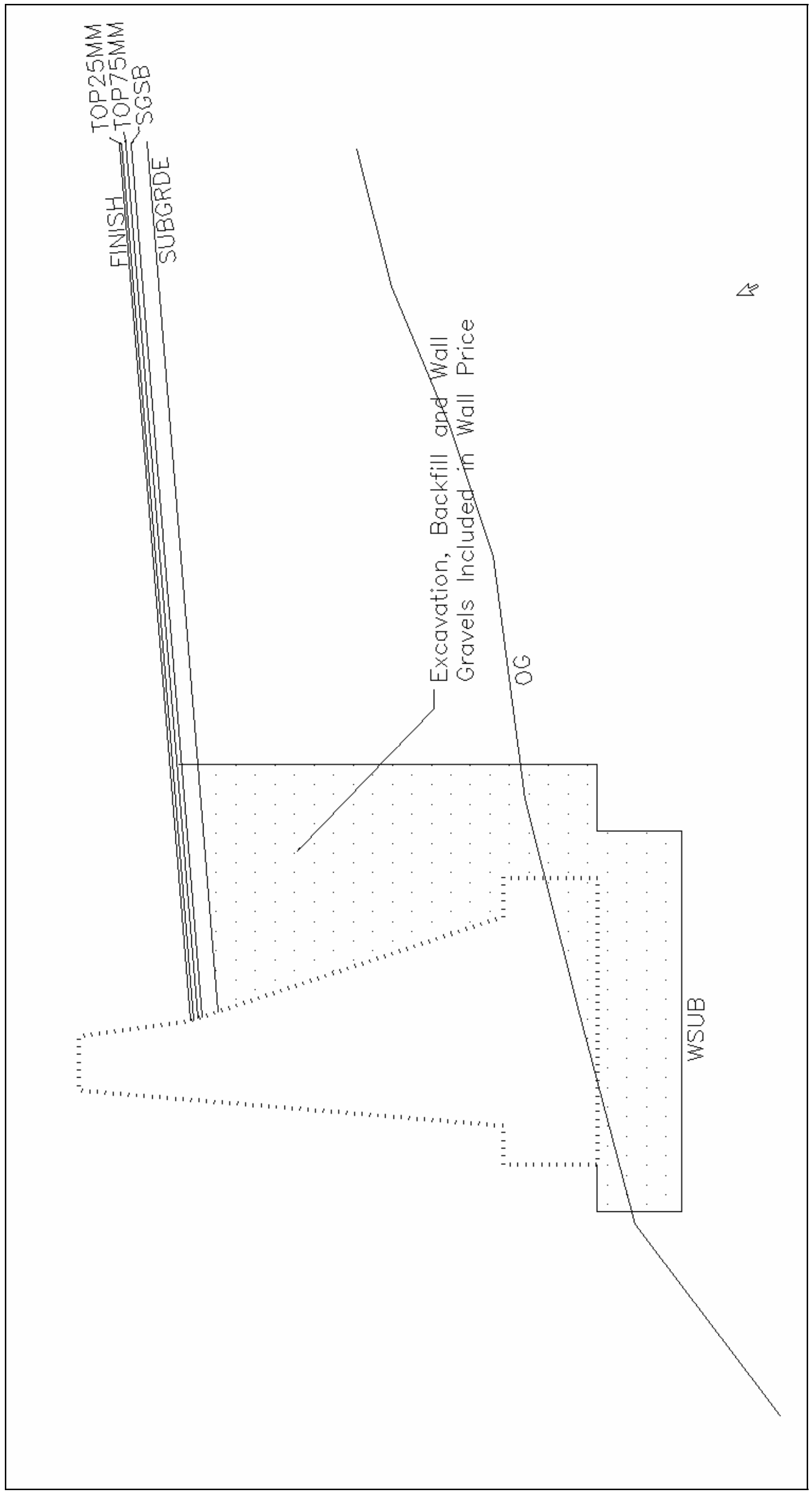
Breast Wall
Excavation, Backfill and Gravels Included in Wall Price



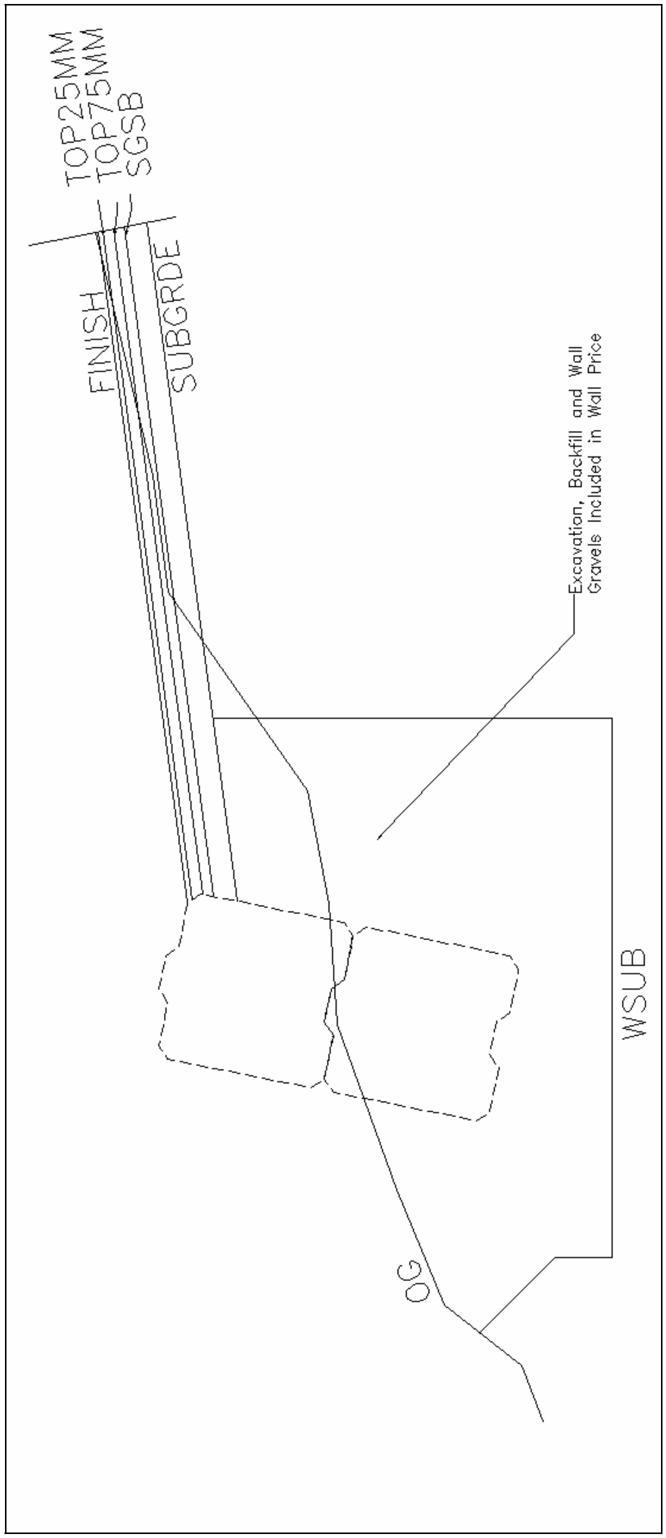
Gravity Wall (Cut Scenario)
Excavation, Backfill and Gravels Included in Wall Price



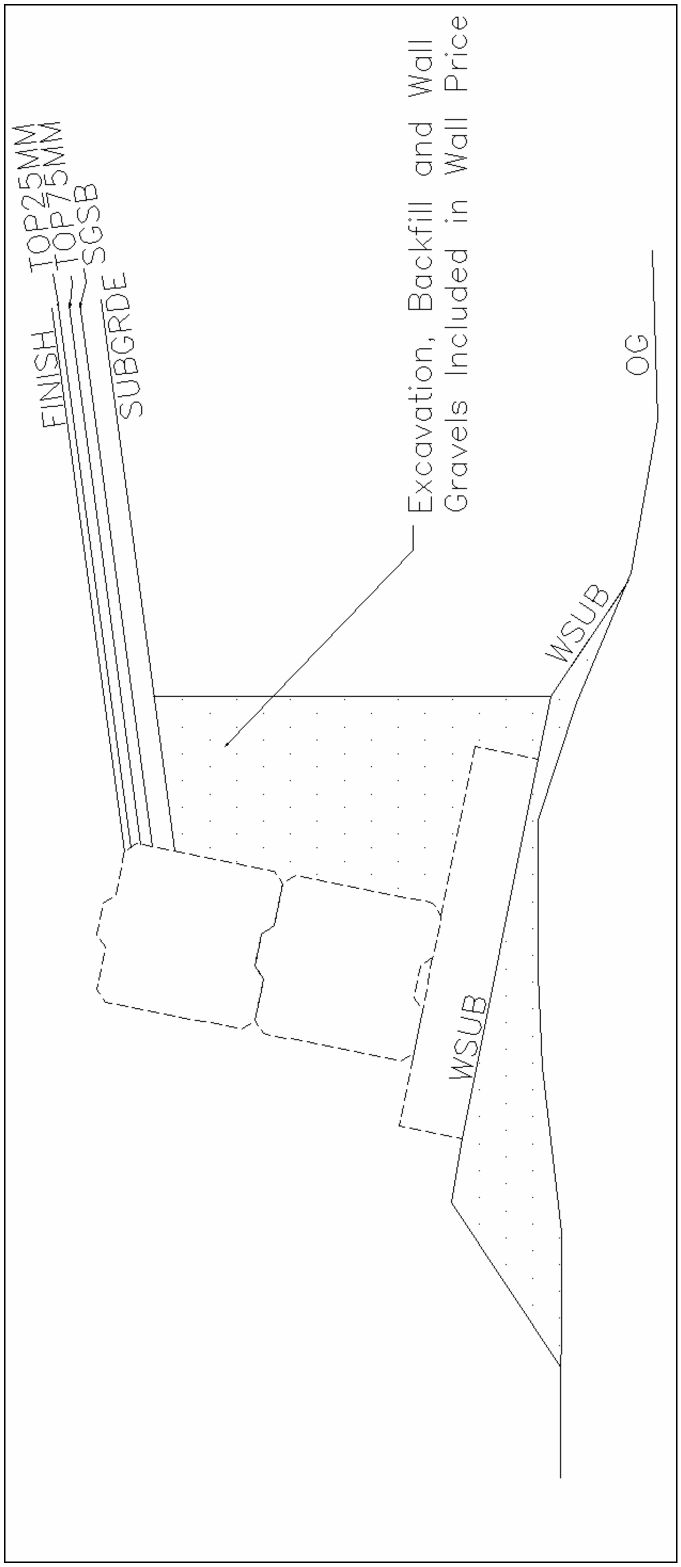
Gravity Wall (Fill Scenario)
Excavation, Backfill and Gravels Included in Wall Price



Modular Concrete Wall (Flat Pad)
Excavation, Backfill and Gravels Included in Wall Price



Modular Concrete Wall (Sloped Pad)
Excavation, Backfill and Gravels Included in Wall Price



Design Cross Section Surface Names

Archive Requirement

- Preliminary Design – No
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

The basic design cross section surface naming conventions that must be used are those that have been defined by the Ministry standard Rural, Urban, Pavement Overlay, Barrier, Miscellaneous and Labelling Annotation fragment input parameter defaults. Renaming of the design cross section surfaces by changing fragment input parameter defaults, should only be done if there is a legitimate requirement for the design situation to deviate from the Ministry standard conventions.

An example of this would be when there is no 75mm crushed base course gravel available and 50mm crushed base course gravel is being used in its place. In this example, the design cross section surface name that defaults to "TOP75MM" would be changed to something descriptive such as "TOP50MM".

If a designer must deviate from the standard defaults, then the design cross section surface names used must be descriptive, maximum of 7 characters and added as new line features into the project feature table.

Generic Link Design Cross Section Surface Names

Archive Requirement

- Preliminary Design – No
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

When a designer requires the use of the generic link fragments to define a complex design situation, the designer must rename the default design cross section surface name input parameter from "LINK" to something descriptive. This may be either a new surface name or a name that already exists as a line feature in the project feature table.

If new design cross section surface names are used, they must be descriptive, maximum of 7 characters and added as new line features into the project feature table.

Design Fragment Application Geometry Chains

Archive Requirement

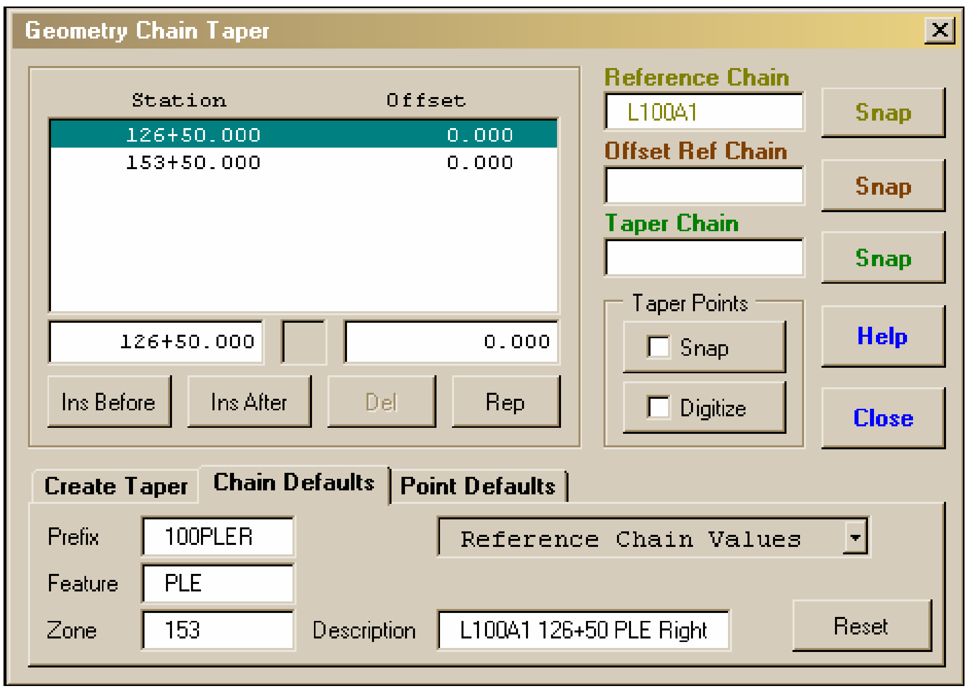
- Preliminary Design – No
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

Ministry design fragments provide the capability to define specific typical section widths using longitudinal geometry chains. For widths, this functionality is used when there is a requirement to introduce roadway tapers. Examples of some of these geometry chains are as follows:

- Geometry chain to control depressed median widths
- Geometry chain to control lane width
- Geometry chain to control sidewalk width
- Geometry chain to control edge of pavement width for barrier flares

The basic design fragment application geometry chain naming convention that must be used is to prefix the geometry chain name with the alignment name, geometry chain type and left or right side. Geometry chain type would be the proposed roadway feature that is being generated such as PSH for proposed shoulder or PLE for proposed lane edge to identify the geometry chain. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

100PSHR65, 100PLEL79, etc.



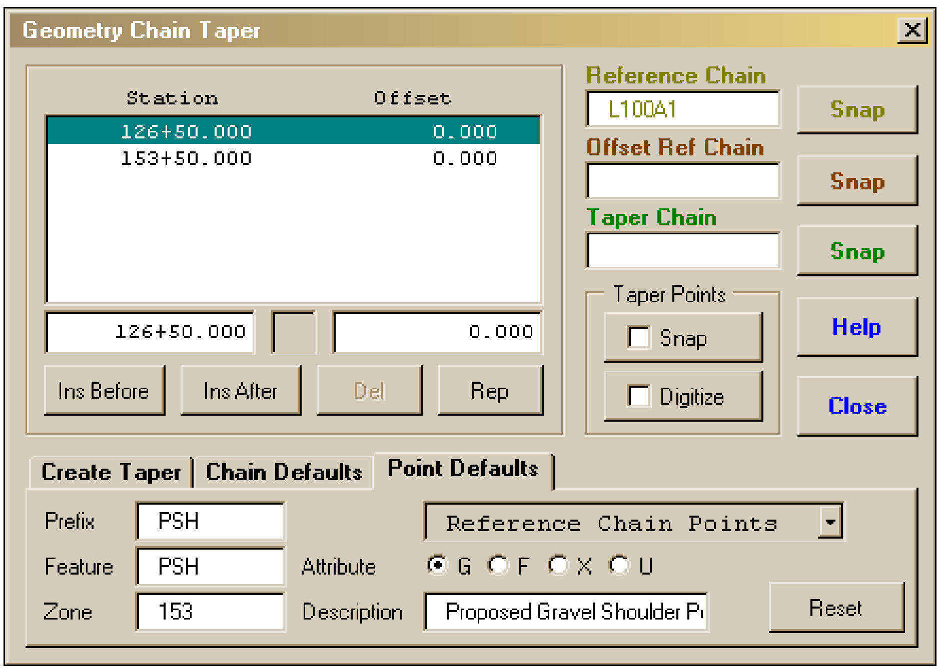
It is preferable that design fragment application geometry chains be generated in CAiCE using the BCMoT Geometry Chain Taper Macro, but geometry chains created in AutoCAD and then imported into CAiCE are acceptable. The BCMoT Geometry Chain Taper Macro will generate a more accurate spiral and curve representation.

Design Generated Points

Archive Requirement

- o Preliminary Design – No
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

When creating design related points in the CAiCE survey database, the point name must be prefixed with the proposed point feature. The point feature must reflect the type of feature being defined such as proposed shoulder (PSH), proposed edge of pavement (PEP) and horizontal geometry point (HGPNT) etc. The example below shows the BCMoT Geometry Chain Taper Macro generating points on a geometry chain created with a point name prefix of PSH, feature of PSH and a point description input as proposed gravel shoulder point.



Design Fragment Marked Point Names

Archive Requirement

- o Preliminary Design – No
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

Ministry design fragments provide the capability to mark specific typical section points. This capability is provided to assist the designer in using the generic link fragments to define typical section details that cannot be accommodated by the current Ministry suite of rural, urban and pavement overlay design fragments.

The designer is encouraged to use marked points, as it will significantly reduce the time spent working with generic links. The basic naming convention that must be used is to prefix all marked points with “Z” followed by a descriptive 6 character maximum name.

ZEPL (Edge of Pavement Left), *ZDCR* (Ditch Centre Right), etc.

Design Fragment Application Profiles

Archive Requirement

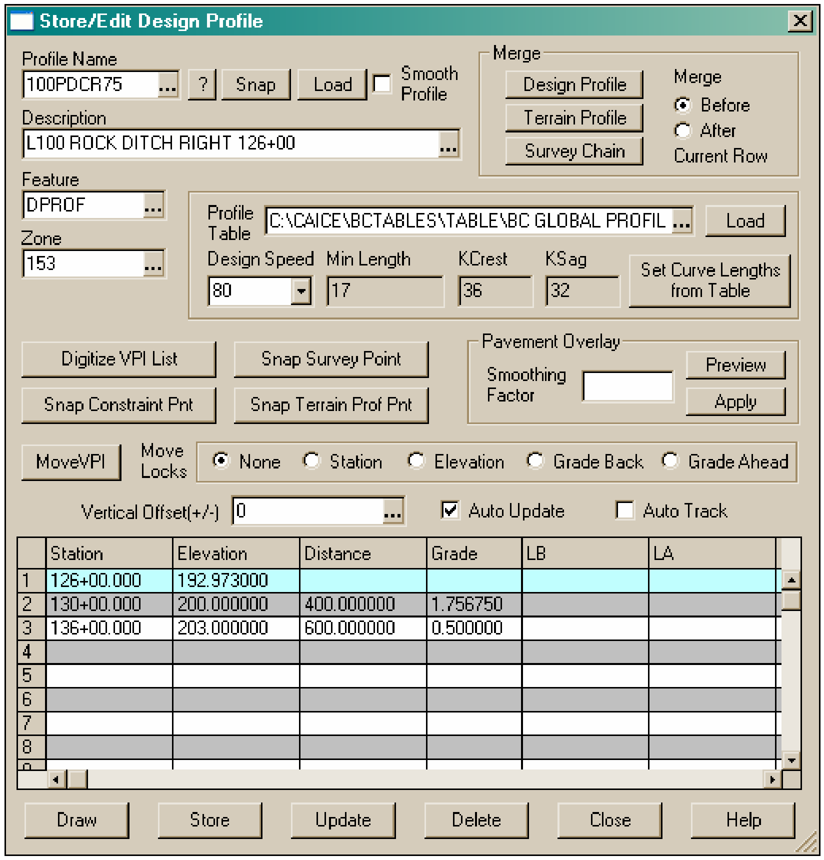
- o Preliminary Design – Yes
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

Ministry design fragments provide the capability to define specific typical section elevations using a longitudinal profile. Examples of some of these profiles are as follows:

- Profile to control the depressed median centre depth elevations
- Profile to control the depth of ditches in cut
- Profile to control the elevation of berms in cut and fill

The basic design fragment application profile naming convention that must be used is to prefix the profile name with the alignment name, profile type and left or right side. Profile type would be the proposed roadway feature that is being generated such as PDC for proposed centre of ditch or PBE for proposed berm to identify the profile. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

100PDCR75, 100PBEL88, etc.



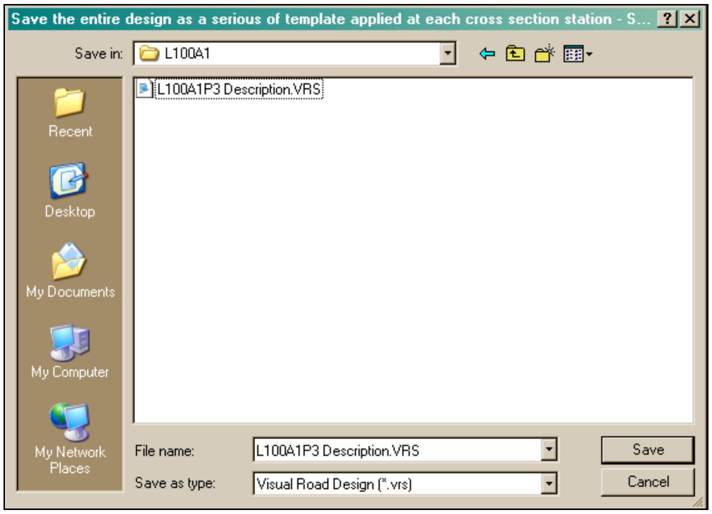
Design VRS Files

Archive Requirement

- Preliminary Design – No
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

The basic design VRS File naming convention that must be used is to prefix the name with the combined horizontal alignment and profile name followed by a descriptive name that describes the design.

L100A1P3 Description.VRS



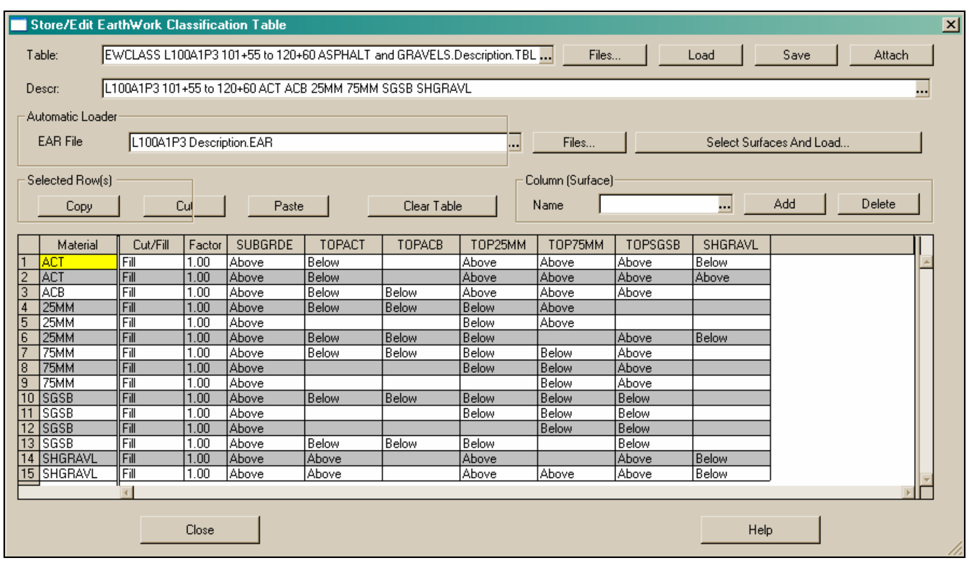
Design Earthwork Classification Table Files

Archive Requirement

- o Preliminary Design – No
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

The basic design earthwork classification table file naming convention that must be used is to prefix the name with “EWCLASS”, the combined horizontal alignment, profile name, station range (if there are multiple tables for an alignment), material types and then followed by an optional description if there is additional information needed to describe the file’s contents.

EWCLASS L100A1P3 101+55 to 120+60 ASPHALT and GRAVELS.Description.TBL
EWCLASS L100A1P3 101+55 to 120+60 EXCAVATION and EMBANKMENT Description.TBL.
EWCLASS L100A1P3 101+55 to 120+60 STRIPPING Description.TBL
EWCLASS L100A1P3 101+55 to 120+60 STRUCTURES EXCAVATION Description.TBL



The only exception to this would be if an earthwork classification table is used for multiple horizontal alignments. If this is the case, then the table must be prefixed with "EWCLASS", any horizontal alignments the table is associated with, the material types and then followed by an optional description if there is additional information needed to describe the file's contents. For this situation, because the file is generic, it must be saved in the project miscellaneous folder.

EWCLASS L100A1P3 L100A1P4 ASPHALT and GRAVELS.Description.TBL
EWCLASS L100A1P3 L100A1P4 EXCAVATION and EMBANKMENT Description.TBL.
EWCLASS L100A1P3 L100A1P4 STRIPPING Description.TBL
EWCLASS L100A1P3 L100A1P4 STRUCTURES EMBANKMENT Description.TBL

Driveway Requirements

Archive Requirement

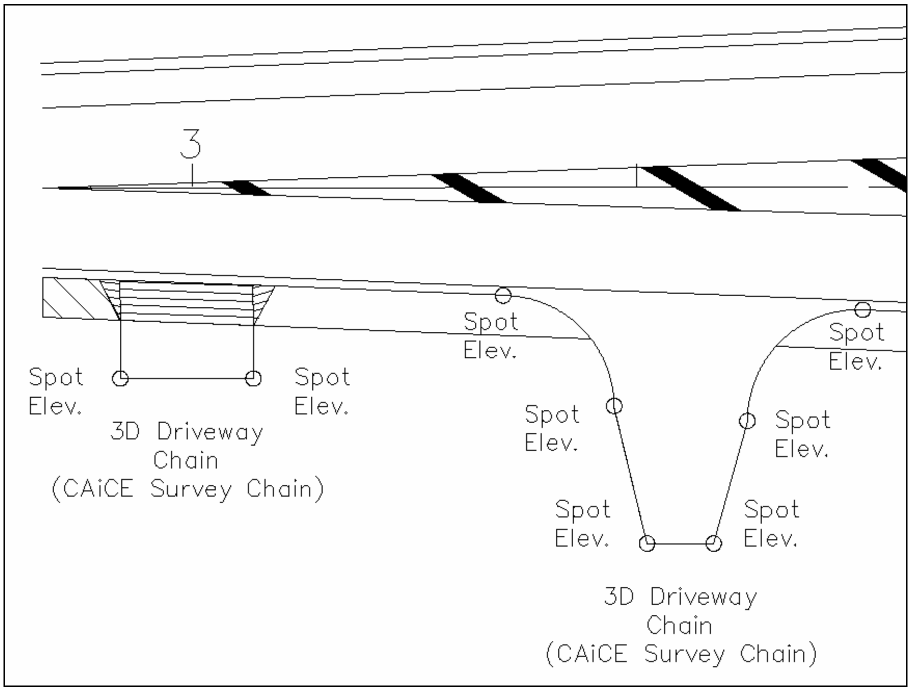
- o Preliminary Design – No
- o Functional Design – No
- o Detailed Design – Yes
- o Construction – Yes

In the past, typically there has been insufficient information supplied for construction supervision to indicate how and where a driveway would tie to the existing original ground. For the sake of driveway requirements of the CAiCE Design Project Data Format Terms of Reference, driveways will be broken down into three different types: simple, intermediate and advanced.

- Simple Driveway Design
  When there is minimal grade difference between the new highway construction and the property requiring access and minimal material is required to tie to the existing original ground, then there will be no special CAiCE design deliverable driveway requirement.

- Intermediate Driveway Design
  When there is a difference in grade between the new highway construction and the property requiring access and there is a requirement to move material to tie the driveway to the existing original ground, then there is a special CAiCE design deliverable driveway requirement.

  If the difference in grade, length of driveway and driveway complexity do not warrant a driveway design utilizing similar criteria as a minor or sideline roadway, then a special 3D Driveway Chain (CAiCE Survey Chain) must be generated to provide sufficient tie-in information for construction supervision. Refer to the diagram below:



The basic naming convention that must be used is to prefix the survey chain with the alignment name, the proposed feature code "PDW" (proposed driveway) and left or right side. The designer must assign the survey chain a feature of PDW. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

100PDWR117, 100PDWL57, etc.

- Advanced Driveway Design
  If the difference in grade, the length of driveway and driveway complexity warrant an actual driveway design, then the same design practices as utilized for minor or sideline roads should be used and identified as a minor or sideline alignment design.

Right of Way Geometry Chains

Archive Requirement

- Preliminary Design – No
- Functional Design – No (Unless used in VRS file)
- Detailed Design – Yes
- Construction – Yes

The basic naming convention that must be used is to prefix the geometry chain name with "PRW". The designer must assign the geometry chain a feature of PRW. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

PRW43, PRW57, etc.

Right of way geometry chains must not be closed (not cross a roadway) at any of the limits of construction and therefore the project may require the creation of multiple right of way geometry chains.

T.L.C.A. Temporary License for Construction Access Geometry Chains

Archive Requirement

- o Preliminary Design – No
- o Functional Design – No (Unless used in VRS file)
- o Detailed Design – Yes
- o Construction – Yes

The basic naming convention that must be used is to prefix the geometry chain name with “PTLCA”. The designer must assign the geometry chain a feature of PTLCA. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

PTLCA32, PTLCA46, etc.

T.L.C.A. temporary license for construction geometry chains must not be closed (not cross a roadway) at any of the limits of construction and therefore the project may require the creation of multiple T.L.C.A. geometry chains.

Clearing and Grubbing Geometry Chains

Archive Requirement

- o Preliminary Design – No
- o Functional Design – No (Unless used in VRS file)
- o Detailed Design – Yes
- o Construction – Yes

The basic naming convention that must be used is to prefix the geometry chain name with “PCLGR”. The designer must assign the geometry chain a feature of PGC. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

PCLGR18, PCLGR23, etc.

Clearing and grubbing geometry chains must not be closed (not cross a roadway) at any of the limits of construction and therefore the project may require the creation of multiple clearing and grubbing geometry chains.

Cut/Fill Toe Geometry Chains

Archive Requirement

- o Preliminary Design – Yes
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

The basic naming convention that must be used is to prefix the geometry chain name with the alignment name, one of three proposed feature codes "PTC" (proposed toe of cut), "PTF" (proposed toe of fill), "PTO" (proposed toe) and left or right side. The designer must assign the geometry chain a feature of PTC, PTF or PTO. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

100PTCL23, 100PTFR43, 100PTOL76, etc.

Vertical Cutoff Geometry Chains

Archive Requirement

- Preliminary Design – No
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

The basic naming convention that must be used is to prefix the geometry chain name with the alignment name, the proposed feature code "PVC" (proposed vertical cutoff) and left or right side. The designer must assign the geometry chain a feature of PVC. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

100PVCL12, 100PVCR27, etc.

Gutter Geometry Chains

Archive Requirement

- Preliminary Design – No
- Functional Design – No (Unless used in VRS file)
- Detailed Design – Yes
- Construction – Yes

The basic naming convention that must be used is to prefix the geometry chain name with the alignment name, the proposed feature code "PGU" (proposed gutter) and left or right side. The designer must assign the geometry chain a feature of PGU. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

100PGUR87, 100PGUL99, etc.

Back of Sidewalk (Outermost) Geometry Chains

Archive Requirement

- Preliminary Design – No
- Functional Design – No (Unless used in VRS file)
- Detailed Design – Yes
- Construction – Yes

The basic naming convention that must be used is to prefix the geometry chain name with the alignment name, the proposed feature code "PSW" (proposed sidewalk) and left or right side. The designer must assign the geometry chain a feature of PSW. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

100PSWR14, 100PSWL53, etc.

Barrier (Not Controlled by Edge of Pavement) Geometry Chains

Archive Requirement

- Preliminary Design – No
- Functional Design – No (Unless used in VRS file)
- Detailed Design – Yes
- Construction – Yes

The designer must describe the insertion point, insertion left side, centre or right side of barrier in the CAiCE Design Project Data Archive Log File.

The basic naming convention that must be used is to prefix the geometry chain name with the alignment name and the proposed feature code "PNEB" (proposed barrier). The designer must assign the geometry chain a feature of PNEB. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

100PNEB34, 100PRNEB147, etc.

Island Curb (Curb and Pavement Intersect) Geometry Chains

Archive Requirement

- Preliminary Design – No
- Functional Design – No (Unless used in VRS file)
- Detailed Design – Yes
- Construction – Yes

The basic naming convention that must be used is to prefix the geometry chain name with the alignment name and the proposed feature code "PIC" (proposed island curb). The designer must assign the geometry chain a feature of PIC. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

100PIC47, 100PIC253, etc.

Asphalt Curb (Curb and Pavement Intersect) Geometry Chains

Archive Requirement

- o Preliminary Design – No
- o Functional Design – No (Unless used in VRS file)
- o Detailed Design – Yes
- o Construction – Yes

The basic naming convention that must be used is to prefix the geometry chain name with the alignment name and the proposed feature code “PAC” (proposed asphalt curb). The designer must assign the geometry chain a feature of PAC. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

100PAC47, 100PAC253, etc.

Raised Median Curb (Curb and Pavement Intersect) Geometry Chains

Archive Requirement

- o Preliminary Design – No
- o Functional Design – No (Unless used in VRS file)
- o Detailed Design – Yes
- o Construction – Yes

The basic naming convention that must be used is to prefix the geometry chain name with the alignment name and the proposed feature code “PRMC” (proposed raised median curb). The designer must assign the geometry chain a feature of PRMC. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

100PRMC48, 100PRMC254, etc.

Concrete Median Centre Divider Geometry Chains

Archive Requirement

- o Preliminary Design – No
- o Functional Design – No (Unless used in VRS file)
- o Detailed Design – Yes
- o Construction – Yes

The basic naming convention that must be used is to prefix the geometry chain name with the alignment name and the proposed feature code “PMC” (proposed median centre). The designer must assign the geometry chain a feature of PMC. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

100PMC26, 100PMC365, etc.

Storm Drain / Storm Sewer Line Pipe Geometry Chains

Archive Requirement

- Preliminary Design – No
- Functional Design – No (Unless used in VRS file)
- Detailed Design – Yes
- Construction – Yes

The basic naming convention that must be used is to prefix the geometry chain name with the proposed feature code "PDS". The designer must assign the geometry chain a feature of PDS. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

PDS25, PDS342, etc.

Sanitary Sewer Line Pipe Geometry Chains

Archive Requirement

- Preliminary Design – No
- Functional Design – No (Unless used in VRS file)
- Detailed Design – Yes
- Construction – Yes

The basic naming convention that must be used is to prefix the geometry chain name with the proposed feature code "PSU". The designer must assign the geometry chain a feature of PSU. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

PSU13, PSU134, etc.

Water Line Pipe Geometry Chains

Archive Requirement

- Preliminary Design – No
- Functional Design – No (Unless used in VRS file)
- Detailed Design – Yes
- Construction – Yes

The basic naming convention that must be used is to prefix the geometry chain name with the proposed feature code "PWR". The designer must assign the geometry chain a feature of PWR. The designer should make full use of the description field if there is additional information needed to describe the element beyond what is required by the element naming convention.

PWR17, PWR589, etc.

Report Files

Archive Requirement

- o Preliminary Design – No
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

These include such reports as volumes, horizontal alignment, vertical alignment, superelevation, cross section design logs etc. When creating design related report files, they must be generated using descriptive names that relate directly to the design function performed and the data being used.

Any reports produced in CAiCE for the hardcopy design folders must be retained in the CAiCE project saved in their appropriate alignment folder.

Parameter Files

Archive Requirement

- o Preliminary Design – No
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

When using a CAiCE command or BCMoT macro and an option is used to save the parameter settings (.INI, .TXT, PXS, PPF etc.) for repetitive use, then they must be generated using descriptive names that directly relate to the design function performed and the data being used.

1270.9 Zone Designations

Archive Requirement

- o Preliminary Design – Yes
- o Functional Design – Yes
- o Detailed Design – Yes
- o Construction – Yes

CAiCE zones are a method of segregating data within a design project that can be used to select information for viewing, editing, reporting etc. The designer must use only zones 101-499. Zone numbers 1-100 will be used for survey and zones 500 and above will be used for construction supervision purposes.

For survey data, surveyors must make use of these working zones to segregate individual survey segments because of the CAiCE restriction that when elements are edited they are automatically removed from the original segment.

The CAiCE Design Project Data Archive Log File Generator Macro described in section 1270.6 populates the log file spreadsheet with all zones found in the CAiCE project. The zones identified in the log file must be supplemented with sufficient descriptive detail by the designer so that construction supervision staff and anyone reviewing the completed design can understand what zones have been utilized and what is contained in each zone.

For the CAiCE project data archives, zone assignments must be made as follows to provide an easy method of isolating data within the final design.

Major Alignment and Associated Details

The major horizontal alignment and its associated detail must be assigned to a specific range of zones within zones 101 to 499. Associated details may include, but are not limited to the following:

- Design profile L100A1P1 etc.
- All related design fragment application profiles 100PDCR75, 100PBEL88, etc.
- All related ditch horizontal alignments D10, D11, D12, etc.
- All related structure horizontal alignments S20, S21, S22, etc.
- All related design fragment application geometry chains 100PSHR65, 100PLEL79, etc.
- All 3D driveway chains (CAiCE survey chains) 100PDWR117, 100PDWL57, etc.
- All related right of way geometry Chains PRW43, PRW57, etc.
- All related temporary license for construction access geometry chains PTLCA32, PTLCA46, etc.
- All related clearing and grubbing geometry chains PCLGR18, PCLGR23, etc.
- All related cut/fill toe geometry chains 100PTCL23, 100PTFR43, 100PTOL76, etc.
- All related vertical cutoff geometry chains 100PVCL12, 100PVCR27, etc.
- All gutter geometry chains 100PGUR87, 100PGUL99, etc.
- All back of sidewalk (outermost) geometry chains 100PSWR14, 100PSWL53, etc.
- All barrier (not controlled by edge of pavement) geometry chains 100PNEB34, 100PNEB147, etc.
- All island curb (curb and pavement intersect) geometry chains 100PIC47, 100PIC253, etc.
- All asphalt curb (curb and pavement intersect) geometry chains 100PAC47,100PAC253, etc.
- All raised median curb (curb and pavement intersect) geometry chains 100PRMC48, 100PRMC254, etc.
- All concrete median centre divider (curb and pavement intersect) geometry chains 100PMC26, 100PMC365, etc.
- All related storm drain / storm sewer line pipe geometry chains PDS25, PDS342, etc.
- All related sanitary sewer line pipe geometry chains PSU13, PSU134, etc.
- All related water line pipe geometry chains PWR17, PWR589, etc.
- All related geometry chains not identified above
- All related superelevation lines L100A1SE, etc.
- All related design generated points 100PLER1, 100PEPL1, etc.

Minor, Sideline and Access/Intersection Curve Horizontal Alignment and Associated Details

Each minor, sideline and access/intersection curve horizontal alignment and its associated detail must be assigned to its own specific range of zones. Associated details would normally be the same as what has been described above for the major horizontal alignment.

1270.10 Design Project Data Archive Preparation

Archive Requirement

- Preliminary Design – Yes
- Functional Design – Yes
- Detailed Design – Yes
- Construction – Yes

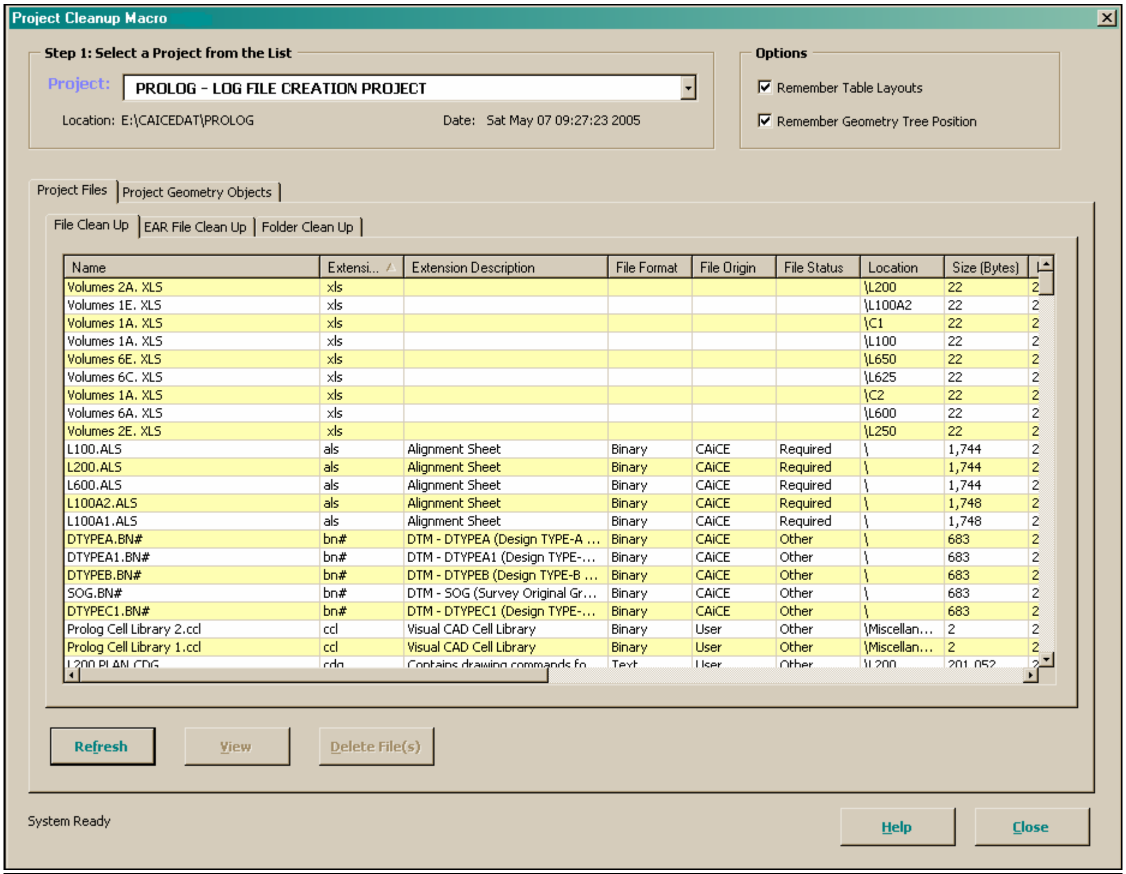
The Survey Project Data Archive and Survey Project Data Archive Log File as required by the CAiCE Survey Project Data Format TOR will be kept separate from the design project archives and log files. Only a clean copy of the project survey (survey, mapping, 3DLaser, LiDAR) database elements, related survey DTM databases and related survey DTMs, are to be included in the design project archive files.

A copy of the CAiCE Survey Project Data Archive and CAiCE Survey Project Data Archive Log File must be supplied with all completed design project archives and log files on separate CD.

A project archive file is the standard format used by the Ministry to retain completed projects in a repository of engineering data that can be easily utilized in the future. The archive file is also the format used to transfer completed projects from the designer to a construction supervision office, whether that design has been completed by the Ministry or by a design consultant. The designer after completing the design assignment, depending on the project lifecycle phase, must supply a PRELIMINARY DESIGN , FUNCTIONAL DESIGN, DETAILED DESIGN and/or CONSTRUCTION archive(s) submitted on compact disk.

Project data archive preparation should be based on the strict adherence to the project data archive content and naming conventions detailed in sections 1270.5 Design Project Folders and Organization, 1270.7 Design Project Data Archive CDG Files and 1270.8 Design Project Data Archive Content and Naming Conventions.

To assist the designer with cleaning up their CAiCE project data prior to the creation of an archive file, the Ministry has developed a CAiCE Project Cleanup Macro. This macro can be used to clean up CAiCE project folders, files and database elements. The macro will display a list of all files in the CAiCE project with an explanation of each file. The folders and files can be sorted by different criteria and folders and/or files can be deleted that are not required in the archive. The macro provides the capabilities to display project database elements sorted by various criteria and delete any that are not required in the archive.



PRELIMINARY, FUNCTIONAL and DETAILED DESIGN Archive

The PRELIMINARY, FUNCTIONAL and DETAILED DESIGN archive files are required by the Ministry to retain an electronic record of all additional design options/alternatives included in the contract design report. These options/alternatives will include anything shown to the public, municipal councils and prepared as part of the environmental review process.

The archive file name must be prefixed by the project name, design type and “DESIGN”:

@@@@@@@-PRELIMINARY DESIGN.ZIP
@@@@@@@-FUNCTIONAL DESIGN.ZIP
@@@@@@@-DETAILED DESIGN.ZIP

CONSTRUCTION Archive

The CONSTRUCTION archive containing only the final design is required by the Ministry as a detailed record of the final design and to provide the necessary information for Ministry construction supervision purposes.

The CONSTRUCTION archive file must be cleaned up so that it only contains the final design and related work. All data related to preliminary iterations or rejected design alternatives must be deleted from the project database and project folders.

The data that is to be deleted will typically include, but not be limited to, items such as:

- CAiCE database elements such as horizontal alignments, geometry chains, profiles, design points, superelevation lines, cross section scanlines, etc.
- CAiCE project files such as design VRS, template VRD, earthwork classification tables, report files, text files, etc.

It is important to note that the designer must ensure that all relevant data that is used by the final design VRS files, to generate the final design cross section EAR files, are not deleted. This will include items such as the horizontal alignments, design profiles, fragment application geometry chains and fragment application profiles.

The archive file name must be prefixed by the project name and "CONSTRUCTION":

@@@@@@@-CONSTRUCTION.ZIP

The consultant must provide a completed Design Project Electronic Deliverables Quality Checklist as detailed in section 1270.13.

1270.11 Contract Drawings

Typical Sections

As all designs must be completed in CAiCE design project data format, contract typical section drawings must be based on the designs completed in CAiCE and the corresponding content of the design cross section EAR files.

Any typical section exceptions that do not directly relate to the requirements of these terms of reference must be noted in the design project data archive project log file.

Contract AutoCAD DWG Drawings

Contract design drawings and location survey plan drawings must be saved to a separate compact disk other than the one(s) supplying the CAiCE design project archive files. The compact disk must utilize subfolders to separate major classes of drawings such as plans, profiles, typical sections etc.

Contract drawings that represent horizontal alignments must have the horizontal alignment names match the names used within the CAiCE design project. This will ensure consistency between CAiCE designs and the resulting contract drawings.

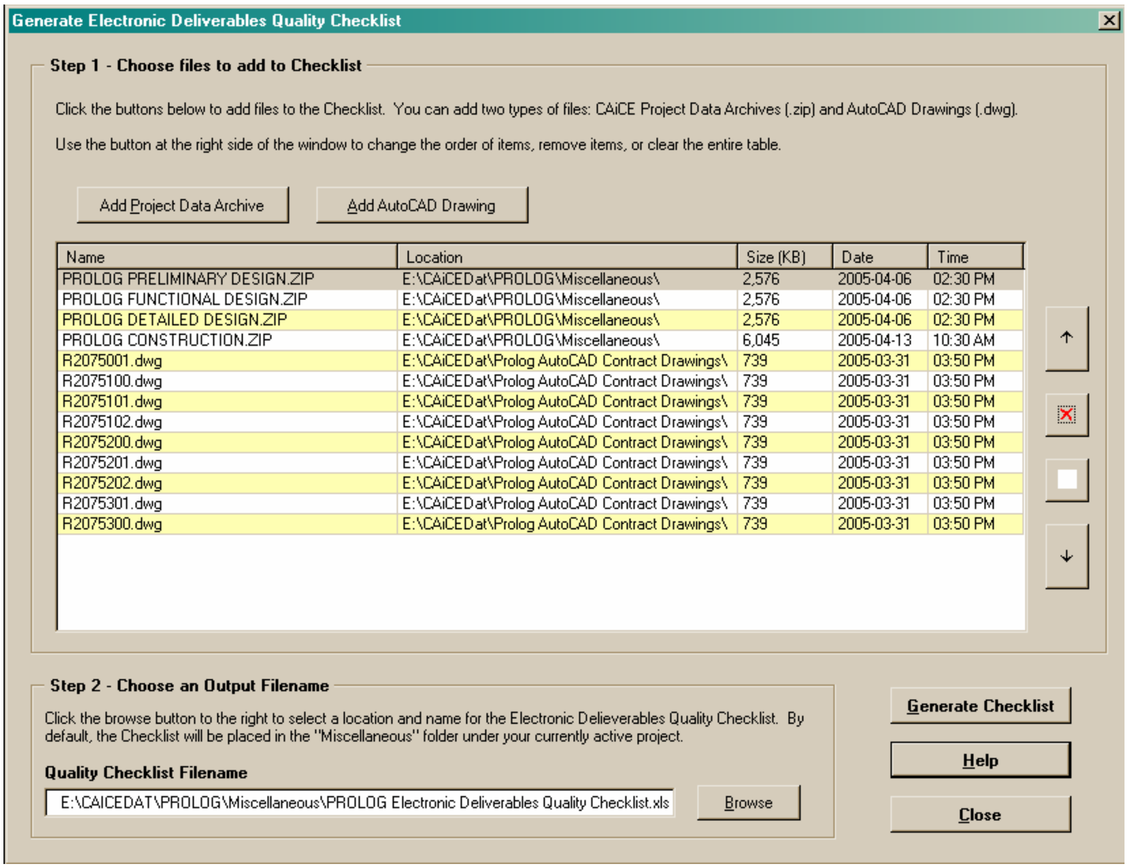
1270.12 Contract Material Volumes

All final design neat line volumes must be calculated directly from CAiCE design cross sections only.

1270.13 Design Project Electronic Deliverables Quality Checklist

The designer must provide a completed and signed Design Project Electronic Deliverables Quality Checklist to ensure that the project has been reviewed and that the CAiCE Design Project Data Format Terms of Reference requirements have been met. Checklist items refer to specific sections of the CAiCE Design Project Data Format TOR that must be initialled by the designer or marked as N/A if the item does not apply to the specific design assignment.

To establish a standard for the creation of all Design Project Electronic Deliverable Quality Checklists, the Ministry has developed the Design Project Electronic Deliverables Quality Checklist Generator Macro that will generate an EXCEL spreadsheet checklist.



	Designer Initials
Project Folders and Organization	________
Project Data Archive Project Log Files	________
Project Data Archive CDG Files	________
Project Data Archive Content and Naming Conventions	
CAiCE Project Name	________
Design Project Specific Feature Table and Cell Library File	________
Cadastral	________
Plan Detail	________
CAiCE Database Element and File Naming Descriptions	________
Horizontal Alignment Geometry Chains	________
Horizontal Alignment Elements	________
Design Element Feature Codes	________
Superelevation Lines	________
Cross Section Stations Text Files	________
DTM Naming	________
Data Source and Extent Boundary Definition	________
Terrain Profile PF$ Files	________
Base Cross Section EAR Files	________
Design Profiles	________
Design Cross Section EAR Files	________
Design Cross Section Surface Names	________
Generic Link Design Cross Section Surface Names	________
Design Fragment Application Geometry Chains	________
Design Generated Points	________
Design Fragment Marked Point Names	________
Design Fragment Application Profiles	________
Design VRS Files	________
Design Earthwork Classification Tables Files	________
Driveway Requirements	________
Right of Way Geometry Chains	________
T.L.C.A. Temporary License for Construction Access Geometry Chains	________
Clearing and Grubbing Geometry Chains	________
Cut/Fill Toe Geometry Chains	________
Vertical Cutoff Geometry Chains	________
Gutter Geometry Chains	________
Back of Sidewalk (Outermost) Geometry Chains	________
Barrier (Not Controlled by Edge of Pavement) Geometry Chains	________
Island Curb (Curb and Pavement Intersect) Geometry Chains	________
Asphalt Curb (Curb and Pavement Intersect) Geometry Chains	________
Raised Median Curb (Curb and Pavement Intersect) Geometry Chains	________
Concrete Median Centre Divider Geometry Chains	________
Storm Drain / Storm Sewer Line Pipe Geometry Chains	________
Sanitary Sewer Line Pipe Geometry Chains	________
Water Line Pipe Geometry Chains	________
Report Files	________

Parameter Files _______

Zone Designations _______

Project Data Archive Preparation

Preliminary Design Archive _______
Functional Design Archive _______
Detailed Design Archive _______
Construction Archive _______

Contract Drawings

Typical Sections _______
Contract AutoCAD DWG Drawings _______

Contract Material Volumes _______

The designer must complete the tables on the following pages identifying the Design Project CAiCE and AutoCAD Contract Drawing Electronic Deliverables that are being provided with the completed design assignment.

The Design Project CAiCE Electronic Deliverables table identifies the CAiCE Project Data Archives file name, file size, date/ time the file was created and the initials of the designer that has generated the archive files. Design revisions and the resultant CAiCE Design Project Data Archive versions, must be added to the table and the revised Design Project Electronic Deliverables Quality Checklist provided with the revised Design Project CAiCE Electronic Deliverables. An example table has been provided in this section.

For the Design Project CAiCE Electronic Deliverables table, any entries that identify a new version of a CAiCE Project Data Archive File should be documented in the Design Project Data Archive Project Log File. The designer must provide sufficient detail to allow anyone reviewing the project to understand why revisions have been made and, specifically related to construction, what new CAiCE database elements and files have been created or revised.

The Design Project AutoCAD Contract Drawing Electronic Deliverables table identifies the AutoCAD Drawings file name, file size, data/time the file was created and the initials of the designer that has generated the drawing files. Design revisions and the resultant AutoCAD Contract Drawing versions, must be added to the table and a revised Design Project Electronic Deliverables Quality Checklist provided with the revised Design Project AutoCAD Drawing Electronic Deliverables. An example table has been provided in this section.

Design Project CAiCE Electronic Deliverables Table

Rev	CAiCE Project Data Archive File Name	Size (KB)	Date (yyyy-mm-dd)	Time (##:## am/pm)	Designer Initial

Design Project AutoCAD Contract Drawing Electronic Deliverables Table

Rev	AutoCAD Contract Drawing File Name	Size (KB)	Date (yyyy-mm-dd)	Time (##:## am/pm)	Designer Initial

Checklist Verification

Design Office: ____

Designer Name and Signature: ____

Date Signed: ____

Reviewed By: ____

Date Reviewed: ____

Example Design Project CAiCE Electronic Deliverables Table

Rev	CAiCE Project Data Archive	Size (KB)	Date (yyyy-mm-dd)	Time (##:## am/pm)	Designer Initial
	@@@@@@-PRELIMINARY DESIGN.ZIP	5,356	2005-02-05	1:15 pm	JS
	@@@@@@-FUNCTIONAL DESIGN.ZIP	7,356	2005-03-05	2:15 pm	JS
	@@@@@@-DETAILED DESIGN.ZIP	12,356	2005-04-05	3:15 pm	JS
	@@@@@@-CONSTRUCTION.ZIP	9,356	2005-05-05	4:15 pm	JS
A	@@@@@@-DETAILED DESIGN.ZIP	12,356	2005-04-05	3:15 pm	JS
A	@@@@@@-CONSTRUCTION.ZIP	9,356	2005-05-05	4:15 pm	JS

Example Design Project AutoCAD Contract Drawing Electronic Deliverables Table

Rev	CAiCE Project Data Archive	Size (KB)	Date (yyyy-mm-dd)	Time (##:## am/pm)	Designer Initial
	R2075001.DWG	5,356	2005-02-05	1:15 pm	JS
	R2075100.DWG	7,356	2005-03-05	2:15 pm	JS
	R2075200.DWG	12,356	2005-04-05	3:15 pm	JS
	R2075300.DWG	9,356	2005-05-05	4:15 pm	JS
A	R2075200.DWG	5,356	2005-02-05	1:15 pm	JS
A	R2075300.DWG	7,356	2005-03-05	2:15 pm	JS

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BRITISH
COLUMBIA

File Number: 410-20/AMBIENT

All Design Manual Holders

June 18, 1999
Engineering Branch
PO Box 9850 Stn Prov Govt
Victoria BC V8W 9T5
Telephone: (250) 387-1264
Facsimile: (250) 387-3736

Re: Implementation of Corridor Ambient Geometric Design Element Guidelines

The Corridor Ambient Geometric Design Element Guidelines Policy has been approved by the MoTH Executive Committee and signed by the Deputy Minister. A photocopy of the signed policy is enclosed with this package for your Design Manual.

Your attention is drawn to the last paragraph of the policy statement which indicates that the Corridor Ambient Geometric Design Element Guidelines apply to all roads under MoTH jurisdiction unless specifically exempted by the MoTH Executive Committee. At the signing of this document the Executive Committee exempted two highway corridors. The only corridors currently exempted from the Corridor Ambient Geometric Design Element Guidelines are:

- The Trans Canada Highway, #1, from Cache Creek to the Alberta Border, known as the CCR (Cache Creek to the Rockies) Project
- The Vancouver Island Highway Project

The following documents are included for insertion behind Tab 13 of your Design Manual:

- A copy of the signed policy statement;
- A White Paper: "Ambient Conditions – Development of the Policy";
- Guidelines for the Preparation of the Ambient Condition Rationale;
- Guidelines for the Development and Preparation of the Project Design Criteria for Construction and Rehabilitation Projects.

....2

During the year MoTH staff will be working together in implementing this new policy. This process has been intiated through a series of Regional Meetings and will culminate in a MoTH workshop, to be scheduled.

The Engineering Branch will provide support to Regions in the application of this policy and if questions arise where Region desires our input, they should call:

Richard Voyer, P. Eng.
A/Sr. Standards and Design Engineer
(250) 387-7761

Merv Clark
Chief Engineer

Enclosures

CORRIDOR AMBIENT GEOMETRIC DESIGN ELEMENTS GUIDELINES

POLICY

The Ministry will identify highway corridors and within these corridors determine geometric design element dimensions or controls where the highway is performing satisfactorily from the standpoint of traffic safety and efficiency. Those geometric design elements or controls that have proven to provide satisfactory performance on the highway corridor will form the basis to which poor performing sections within the corridor should be designed and upgraded.

This policy will apply to all highway construction and rehabilitation projects. MoTH Executive Committee approval is required to exempt any highway corridors from this policy.

DISCUSSION

Demand for highway upgrading will exceed any reasonable level of funding allocation if all corridors were to be fully upgraded to new highway standards. Upgrading along the full length of corridors will not be possible in the foreseeable future, with the possible exception of a few high volume highways that will be approved by the MoTH executive Committee.

BC highway corridors generally perform well from the point of capacity, efficiency and safety; however, within these corridors there are sections of identified poor performance. These poor performing sections generally have poorer geometry or access controls than the good performing sections of highway along the corridor. These poorer performing sections of highway within the corridor require upgrading to reflect the geometric elements of the acceptably performing length of the corridor, thus providing, "corridor geometric design consistency".

Focusing available funds to correct identified safety or efficiency deficient sections within corridors to the same geometric character as those sections with proven good performance rather than attempting to fully upgrade the whole corridor will result in better network safety and efficiency at given resource levels.

Approved by the Ministry of Transportation and Highways Executive Committee.

Signed original in file — Signed on March 1, 1999

Deputy Minister

Ministry of Transportation and Highways — Date

m: ambient\guidelines5.doc

WHITE PAPER

Ambient Condition

Development of the Policy

Ministry of Transportation and Highways
British Columbia
Engineering Branch
Feb. 10/99 Revised (layout only) June, 1999

TABLE OF CONTENTS.

WHITE PAPER: Ambient Condition, Development of the Policy

INTRODUCTION

This paper describes how a number of recent events has changed the thinking regarding geometric design standards and their application, and how that in turn has caused a review of the MoTH processes of identifying and scoping rehabilitation projects and identifying the appropriate standard to use for such projects.

These events are:
- Changes in thinking of influential bodies such as AASHTO, FHWA and TAC regarding geometric design standards and their application.
- Changes in the Provincial budget for minor capital improvement projects.
- The results of a number of studies of the interrelationships between human factors, design, and safety.

The MoTH policies and procedures that require review are:
- Identifying and determining the scope of minor capital improvement projects, (rehabilitation) and reconstruction projects. These projects are generally funded under one of two budgets; minor capital improvement or rehabilitation.
- Identifying the appropriate geometric standards to use for each individual project.

This paper begins by briefly describing the 4 types of highway improvement projects that are generally recognized by the industry, new construction, reconstruction, rehabilitation (3R) and maintenance. It continues by explaining how the thinking regarding geometric standards and their application have changed ; first by outlining the methods used to establish existing standards; outlining some studies regarding the relationship between standards and safety, and finally describing how the results of these studies has affected the current thinking regarding geometric standards and their application. The paper continues by outlining changes to parts of the MoTH budget and how it has and will affect the scope of some types of projects. The report goes on to discuss the affect of the changes regarding the application of standards and study results has on certain MoTH policies and processes. Finally conclusions and recommendations are made.

DEFINITIONS/DESCRIPTIONS

Highway Improvement Project Types

Highway improvements projects fall into one of four types: new construction; reconstruction; resurfacing, restoration, rehabilitation often referred to as 3R; and maintenance.

New construction, as the name applies, is the construction of a highway where no highway presently exists such as a by-pass.

Reconstruction involves a major change to an existing highway to improve its capacity and/or efficiency. Reconstruction generally falls within the corridor of an existing highway, but in some instances may deviate from the existing alignment.

Rehabilitation; often called 3R for resurfacing, restoration, rehabilitation; is to restore the existing highway to it's initial condition. The project may include some safety enhancements. The primary objective of projects falling under a 3R program is to extend the service life and improve safety of an existing highway.

Maintenance activities typically consist of keeping an existing highway in its current condition.

Budgets

Highway improvement projects are funded from three possible budgets, maintenance, rehabilitation or capital. Each is described briefly below.

- Maintenance budgets, as the name implies, are for the general maintenance of the highway system.

- Rehabilitation budgets are generally spent on activities such as resurfacing and restoration. The projects generally include only minor improvements.

- Capital budgets are used for new construction, reconstruction and rehabilitation. The rehabilitation projects generally include major improvements. The capital budget may be divided into Major Capital and Minor Capital, sometimes referred as Capital Rehabilitation, Capital Reconstruction, or Minor Capital Improvements.

It is interesting to note that the type of project is often identified by the budget from which it is funded rather than the activity. For example a project that involves rehabilitation could be called a capital project or a rehabilitation project, depending upon the source of the funding.

GEOMETRIC DESIGN STANDARDS

Development of Existing Geometric Standards

Current geometric standards have evolved over the past 40 or so years. As quantitative relationships between safety and an individual geometric design element was not well understood the standards have been, for the most part, arrived at by consensus of a committee of knowledgeable, experienced, expert highway designers. As this was a period of rapid expansion of the primary highway system in North America, the geometric standards were developed primarily to aid in the design of new highways. Minor increases in shoulder width or other design elements have a minor impact on the cost of the road in new construction. Therefore a philosophy of bigger is better prevailed with less thought given to the cost effectiveness of the resulting design.

This thinking, along with the lack of understanding of the relationship between standard and safety, lead to geometric standards or elements that are not based on quantitative data, but rather a consensus of the opinions of knowledgeable designers. These elements or standards are a best judgment of a single value taken from a range of values and are appropriate for new construction as intended, although the cost effectiveness in terms of safety is not well established.

The following paragraphs help to verify that the development of standards by AASHTO, TAC, and British Columbia was largely by consensus.

> The following statement is quoted directly from the Transportation Research Board Special Report 214, Designing Safer Roads.
>
> "The American Association of State Highway and Transportation Officials (AASHTO), which has historically assumed primary responsibility for setting design standards used in the United States, relies on committees of experienced highway designers to do this work. The committees use a participatory process that relies heavily on professional judgment. In general, relationships between safety and highway features are not well understood quantitatively, and the linkage between these relationships and highway design standards has been neither straightforward nor explicit. Thus quantitative estimates of the overall safety or cost implications of recommended design policies are not usually developed, although the process takes into account not only safety but also cost and other factors (such as the effect of design on traffic operations and capacity, maintenance implications, and design consistency for similar traffic conditions). "
>
> The Transportation Association of Canada, TAC, uses a similar participatory process involving experience, expert highway designers to develop geometric standards. The committee relies heavily on the AASHTO standards as a basis for the standards, which are modified to recognize Canadian conditions.
>
> The current MoTH Geometric Design Manual relies on both AASHTO and TAC in the development of the standards shown in the manual. Each individual geometric element or standard may have been used directly or altered to recognize conditions unique to British Columbia. Additional standards or geometric elements were also developed to again recognize uniqueness in BC.

During this time of extensive growth of the highway system, a growth that moved the highway system from narrow, low standard, poorly surfaced roads of the pre-war era to modern, high speed, all weather roads, projects were large, extending the length of entire corridors. The need for rehabilitation was not present. The primary highway network, of most Canadian and American jurisdictions are now mature. Many present road works do not result in the full reconstruction of a corridor, but rather are to correct some identified deficiency within a short segment of a corridor, i.e. rehabilitation projects. There are two notable results. The resulting highway corridor consists of sections of varying standards along its length. This results due to the use of the current standard for those 'rehabilitation' projects regardless of the standard to which the highway was built. The second notable point is that the costs of improvements are often high as incremental improvements to some key geometric elements are costly.

Standards and Safety

There is a growing interest in the scientific community regarding highway geometric standards, the vehicle, human factors, and safety. These four areas of study are of special interest.

Highway Elements

Recent US studies have shown that the relationship between incremental improvements to the geometric values of highway elements and improved safety is not linear. That is, the law of diminishing returns applies to many highway elements. For example; on a highway with a lane width of 11 feet the widening of a shoulder from 0 to 2 feet will reduce the relative accident rate by about 0.42. Widening of the shoulder from 2 feet to 4 feet reduces the relative accident rate by a lesser amount, 0.34, while adding 2 feet to an existing 4 foot shoulder reduces the relative accident rate by about 0.27. Thus there is a greater gain in terms of accident reduction by adding smaller widths of shoulder to highways without shoulder, than by adding that same width of shoulder to those highways that have a shoulder. Similar relationships have been found for other highway elements.

Design Consistency

Experienced highway designers know intuitively that an inconsistent design in terms of the geometric elements is not as safe as one that is consistent. There are anecdotal instances where a highway with narrow lanes and shoulders has been widened, with a resulting increase in accidents. The observed reason was that drivers were traveling faster because the road with its wider lanes and shoulders appeared to have a higher design speed than it actually did. The lane and shoulder widths were designed to a higher design speed than were perhaps the longitudinal elements of the roadway, thus it was inconsistent design resulting in some drivers developing an incorrect interpretation of the appropriate operation of a vehicle on that road.

Lamm et al, (XIIIth World Road Congress, 1997) in their work on a highway safety module, identified three requirements for a safe highway; consistency of alignment, harmonization between design and operating speed, and the provision of dynamic safety of driving. Lamm was able to predict accident rates by identifying geometrically inconsistent sections of highway.

Consistency has the strongest links with the human factors of expectancy and workload. In his paper, "Human Factors Issues in Highway Design" Kanellaidis et al states that inconsistency in highway geometric design may arise from, among others, changes in design guidelines and adjacent sections of highway constructed at different times.

There are some important conclusions of these studies. The first is that design consistency, both of the geometric elements themselves and of consistency along a highway corridor is desirable as it results in a safer highway. Therefore care must be taken when doing rehabilitation work to select appropriate values for the geometric elements so as to maintain some level of design consistency along the corridor. The present policy of using the standard of the day for rehabilitation does not accomplish this.

Standards, Current Thinking

A greater understanding of the relationships between safety and design elements as well as other considerations has changed the thinking of agencies responsible for the development of geometric standards. The latest thinking is to suggest a range of suitable values for the various geometric elements rather than define a single value. Thus the standards of the past are becoming guidelines in the future.

The Transportation Association of Canada is in the final stages of rewriting their Manual of Geometric Design Standards for Canadian Roads following this thinking. The manual, expected to be published in the Spring 1999, will have ranges of values called domains, for many of the highway elements. It is significant to note the TAC will also change the name of this new document to "Guide" rather than the present "Standard".

The Transport Research Board published their special report 214, "Designing Safer Roads, Practices for Resurfacing, Restoration, and Rehabilitation". This report deals with the cost effectiveness in terms of improved safety for various incremental design improvements.

The FHWA (Federal Highway Administration) has, in concert with AASHTO, issued a companion book to the AASHTO manual, "A Policy on the Geometric Design of Highways and Streets", often referred to as the Green Book. This FHWA guide, Flexibility in Highway Design, encourages highway designers to expand their considerations when designing with the Green Book and not to apply the criteria listed blindly, but to use it as a guide. A second publication by the FHWA, Flexibility in Highway Design" furthers this encouragement.

US federal law had required that any road built with the help of federal funds be constructed in accordance with Green Book standards. Now this is no longer a requirement.

The State of Vermont has enacted a state law, which allows local officials to depart from conventional AASHTO standards when carrying out design on many State roads.

The city of Phoenix has passed a city ordinance that offers developers the option of constructing narrower streets than standards had required, in future residential developments.

The above examples illustrate that agencies responsible for the development of geometric standards are recognizing that standards are not absolute, and are moving toward suggesting ranges of suitable values for geometric highway elements rather than single values. Thus in the future the road authority and the designer will have the responsibility of selecting the appropriate values for the various geometric elements.

BUDGETS

There is increasing pressure on the highway budget in a number of areas. Growth and development in various areas of the province call for increasing the capacity of sections of the highway network. As MoTH's highway system is a critical element in the support of the provincial and national economy, this need cannot go unfulfilled without negative results on both our economy and well being.

To name a few examples, the Vancouver Island Highway Project will cost in the order of $1.2 billion. Long sections of the Trans Canada Highway between the Alberta border and its junction with Highway 97 to the north are in need of major improvements. Highway 97 in the Okanagan Valley has significant tourist demands with resultant capacity constraints. The Lower Mainland has capacity and corridor problems along both sides of the Fraser River that require major improvements to the highway network. Highway 99 between Vancouver and the Whistler area is in need of a major upgrading.

Another area of concern is that of the large number of bridges which were constructed prior to the mid-1980's and are prone to structural damage in the event of a major earthquake. As the West Coast of BC is in a moderate to high seismic zone with a major earthquake being predicted for the future, seismic upgrade of structures is a priority. This seismic retrofitting of the bridges at risk is estimated at $250 million.

The result of these increasing pressures on the highway budget is that a reasonable level of funding will not meet the demand. Thus the priority and cost effectiveness of projects and associated processes are important to gain the greatest benefit from the funds available.

DISCUSSION

Historically, geometric standards were developed, somewhat intuitively due to the lack of knowledge of the relationship between safety and individual geometric design features, to aid in the design of new highways. Many standards were not developed to achieve a specific level of safety nor were they developed to obtain a specific return in terms of improved safety for moneys invested, but rather arbitrarily based on the intuitive notion that, within certain general limits, larger is safer. Therefore our policy of using the current standard for all minor capital improvement projects may not result in the most cost-effective designs in terms of safety improvements.

Some national agencies responsible for developing geometric design standards have recognized the need to for revision. Singular values for geometric elements are being replaced with a range of suitable values. There is flexibility in the determination of the most appropriate values to use for each geometric value for each individual highway construction project. Again our policy of using the current standard for all construction does not follow current thinking regarding geometric standards.

Geometric design consistency both of the individual design elements and along a corridor results in a safer highway. Therefore the selection of the geometric standard to use for an individual project should be made such that the result is design consistency along the corridor. This may require the use of a standard that is different than the current standard, thus our current policy of using the current geometric standards for rehabilitation projects should be revised.

Historically, the highway network has been in a state of rapid expansion, thus capital works projects covered complete corridors from end to end, thereby achieving corridor consistency in the design. There was little need for rehabilitation. As the Provincial highway system matures there is a greater emphasis on rehabilitation projects. Thus many highway improvement projects do not result in the full reconstruction of a corridor, but rather to correct some identified deficiency within a short segment of a corridor. The present policy of applying the standard of the day to all projects may result in design inconsistencies, an undesirable result.

Incremental improvements to design elements do not always result in equal incremental improvements to safety. They tend to be less, that is an incremental improvement results in a smaller improvement to safety. Therefore to gain the greatest safety improvement to the highway network for a given budget, a greater number of smaller improvements is generally superior to a fewer number of large improvements. Therefore the policy of always applying the standard of the day to all projects may be resulting in a smaller overall improvement to safety.

In general terms there are two criteria used to identify capital improvement projects: identify those sections of highway that are of the lowest standard and reconstruct a portion to the current standard; and identify locations that experience a high number of accidents and rebuild the highway to current standards.

Those projects aimed at improving a section of highway to the current standard is based on the notion that if it is below the current standard, then it is less safe than it should be regardless of its safety record. This results in some rehabilitation projects being undertaken mainly to upgrade to the current standard rather than to address a defined operational problem. This practice will, in some cases, not give good value in terms of safety improvements for the monies spent. Therefore decision criteria for the identification of a safety related design problem and a method to determine the scope of the problem are required.

Those projects aimed at improvement at a high accident location often tend to expand in length far beyond the problem location often based on the above stated notion that a section of highway below the current standard should be upgraded, regardless of it performance record. This could be defined as creeping scope. This results in excess funding being used in a single area and fewer problem areas being addressed within the available budget allocation.

The budgets available for rehabilitation of the provincial highway system have diminished over the last decade. Therefore there is an increasing need to gain the greatest benefit in terms of improved operation and safety from the budget. Projects for rehabilitation must be cost effective, both in terms of identification, scope, and geometric design standard used. Procedures to achieve this are required.

CONCLUSIONS

Two main conclusions result from the above discussion:

1. The current policy of using the standard of the day for all highway construction including rehabilitation projects results in projects that give less than optimum return in terms of safety improvements. Revisions to the present policy are required.

2. There is a greater need to gain the most value from monies spent on rehabilitation. Criteria for the identification of problem areas and procedures for determining the scope of projects are required.

RECOMMENDATIONS

The main goal of the recommendations is to; identify, scope, and design projects that result in the most cost effective capital rehabilitation program in terms improvements to the operations and safety of the highway network as a whole.

To achieve this goal it is recommended that policies and procedures be adjusted/developed that:

- Determine safety performance criteria for the identification of capital rehabilitation projects.

  The majority of the numbered highways have an acceptable level of performance in terms of safety. Within these corridors there are sections whose performance falls below that which is acceptable. Improving those deficient sections to the same level as the acceptable sections would provide design consistency along the corridor as well as good levels of performance at a reasonable cost.

  By identifying those sections of highway within each corridor, or major section there-of, that are operating at the acceptable level of performance and applying the geometric design of those sections, the ambient condition, to deficient sections within that corridor, the resultant designs will be to a standard that has shown to give the acceptable level of safety, achieve design consistency throughout the corridor (in itself achieving greater safety). Thus the standard used will be based on what exists and is working acceptably rather than a theoretical value based somewhat on intuition.

- Develop geometric standards that result in design consistency along highway corridors, have shown to provide an acceptable level of safety, and are cost effective from a network perspective.

  For each corridor an ambient condition will be determined that will reflect the standard to which the corridor has been built and is operating satisfactorily in terms of safety. The design criteria for each project will be determined individually based on the ambient condition defined for the corridor as well as other factors such as the long-term plans for the corridor.

- Address specific, well-defined problems of level of service, operations, and/or safety and restrict the project scope to that required to address the engineering problem that has been identified.

  Each capital rehabilitation project will require a design criteria document. This will include the identification and definition of the specific problem(s) being addressed, the engineering solution to the problem, the scope of the work required to address the problem, and the design criteria (values for the major geometric elements) to be used in the design.

ACTION PLAN

Ambient Condition

A set of design parameters to be used for improvements on each individual corridor or major section thereof will be determined by regional staff. These parameters, called the ambient conditions, will be based on the present standards of portions of the corridor, which have demonstrated acceptable safety performance.

The measure of safety performance that is generally used is the accident rate per million vehicle kilometers. Other measures available are the critical rate, the rate at which there is a significant difference between it and the accident rate, the accident severity ratio which is a weighted measure considering the severity of accidents, and the fatality rate. Generally a section of highway with a high fatality rate or accident severity ratio has specific locations or short sections that require improvement.

It is recommended that the measure for acceptable performance with respect to safety will be the provincial average accident rate for that classification and volume of traffic. Therefore sections of highway which have an acceptable safety performance record will be those that have an accident rate less than the critical rate.

Project Identification and Scope

Each project will be undertaken to correct an identified and defined operational problem. The scope will be limited to the work required to correct the deficiency, i.e. the engineering solution. The accident severity ratio is an aid to identifying locations or sections of highway that have deficiencies. Identifying high accident locations, carefully defining the problem and developing and applying the solution, with a design criteria based on the ambient condition and philosophy of corridor consistency, will address the high accident locations with a cost effective design.

Project Design Criteria

Each project will have the mandate to develop an appropriate standard to be used for that project, based on the ambient condition defined for the corridor but with flexibility so that adjustments can be considered to achieve design consistency and cost effectiveness.

Design Criteria Document

Each design will require the preparation of a Design Criteria Document. This document will identify the operational or safety problems, define the problem and outline the engineering solution. The scope of the project will be described, limited to the work necessary to address the defined problem. The design parameters to be used for the project will be outlined. Project approval will be by appropriate regional staff unless there are exceptions to the ambient condition. These will require approval of the Chief Engineer. The design criteria document will become part of the project file, which is subject to audit.

GUIDELINES FOR THE PREPARATION
of the
AMBIENT CONDITION RATIONALE

Ministry of Transportation and Highways
British Columbia
Engineering Branch
Mar 1/99 – Some editing June 10, 1999

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Introduction

The policy, *Corridor Ambient Geometric Design Elements Guidelines*, states that the Ministry will identify highway corridors, and within those corridors, determine geometric design elements that have been performing well in terms of safety and traffic operation. These geometric elements, collectively called the ambient condition, will be used as the basis for the design parameters for the rehabilitation of poor performing sections of the highway corridor. This document gives guidance to the regions for the determination of the ambient condition and the preparation of the Ambient Condition Rationale. The audience for the Ambient Condition Rationale is the layperson.

Background

Recent studies have indicated two noteworthy aspects of geometric design: consistency of design along a highway corridor tends to be safer than a highway that exhibits inconsistencies, and incremental increases to some geometric elements do not result in corresponding incremental increases to safety.

The following quote from the policy states the rationale for the new policy and the development of the ambient condition.

"BC highway corridors generally perform well from the point of capacity, efficiency and safety; however within these corridors there are sections of identified poor performance. These poor performing sections generally have poorer geometry or access controls than the good performing sections of highway along the corridor. These poorer performing sections of highway within the corridor require upgrading to reflect the geometric elements of the acceptably performing length of the corridor, thus providing , "corridor geometric design consistency.""

Definitions

Corridor: A highway corridor is the highway corridor within the Region.

Section: A section is a portion of a highway corridor that exhibits uniform characteristics of terrain, development/access, and traffic volumes and composition.

Procedural Guidelines for Determining Ambient Condition

The following suggests the general procedures to use to determine the Ambient Condition for each corridor or section thereof. The objective is to determine the existing standard of those portions of the highway within a corridor that are operating satisfactorily from a safety and operational perspective. That standard will be the *basis* for the recommended ambient condition to which those portions that require rehabilitation will be improved.

- Separate each highway corridor into sections, i.e. portions of highway that exhibit uniform characteristics of terrain, development/access and traffic volumes and composition.
- Within each section, identify those portions of highway that have the same apparent design speed, lane width, and shoulder width. Thus each highway corridor will be separated into sections and they in turn into sub-sections exhibiting uniform geometry. Judgement is needed so that small changes or very short sections are not included.
- Next, determine what sections of the highway are generally operating satisfactorily from a safety and operational perspective. For each of the identified sub-sections, determine the Accident Rate, Critical Rate, and Accident Severity Ratio. It may be worthwhile to contact local officials such as the police and the district staff to obtain their opinion as to the performance of the highway, i.e. what sections of the highway is performing satisfactorily and which locations have a safety or operational related problem. There may be specific problematic locations in a section of highway that is otherwise operating satisfactorily.

  Where a regional boundary separates a section of highway that is uniform in terms of terrain, development, access and traffic, discussion should take place between the two regions so as to arrive at the same ambient condition for that section of highway.
- Analyze the data to identify those sections of highway that exhibit a satisfactory safety and operational performance. A satisfactory safety performance will be the provincial average accident rate for the type of highway and volume of traffic. Thus an accident rate that is less than the critical rate will be deemed to be performing satisfactorily. Satisfactory performance from an operational perspective will be based on judgement after discussion with others such as district staff.

  The lowest existing condition that is performing satisfactorily will be the *basis* for the ambient condition for that corridor or section.
- Applying the above principles, Ministry design guidelines, and other relevant considerations, determine the ambient condition appropriate to each highway section. Other relevant considerations could include such things as consistency, or terrain when determining shoulder widths, maximum grades or minimum curves with advisory signing. For example a section of highway with a 1.8 m shoulder may be performing satisfactorily, but the majority of the highway is constructed to a 2 m shoulder. An argument could be made to make the ambient condition include a 2 m shoulder.
- Prepare the Ambient Condition Rationale including the spreadsheet of recommended ambient conditions.
- Forward the Ambient Condition Rationale to the Chief Engineer for sign-off.

Use of the Ambient Condition

The design principle is to use the established ambient condition for all improvements to the highway. Thus the elements of a rehabilitated section will be the same as those of the ambient condition defined for that corridor or section. Project Design Criteria will be prepared for each project using the ambient condition set for that corridor or section, as the basis. The values for the basic geometric elements will be defined in the Project Design Criteria. These values will be based on the ambient condition defined for the corridor/section, but variation from these values is possible with rational explanation.

The following geometric elements will be used to describe the ambient condition.

- Design speed
- Minimum advisory speed curve
- Maximum superelevation
- Maximum grade
- Lane width
- Shoulder width, paved
- Shoulder width, gravel
- Setback distance to utilities

Design speed

The ambient condition will include a design speed which in turn defines certain minimum or maximum geometric elements. When determining the design speed of your existing highways it is expected that this value be arrived at by way of a considered judgement, not a measured value, hence the term apparent.

Minimum Advisory Speed Curve

This is the minimum design speed for a substandard curve that would be tolerated when rehabilitating. Thus in locations with tight constraints of whatever type, a substandard curve with appropriate signing could be considered when making improvements. The minimum advisory speed curve on your existing highways would be the signed value.

Maximum Superelevation

The ambient condition includes the maximum superelevation to be used when making highway improvements. Including this as a variable in defining the ambient condition gives the flexibility to determine the appropriate value based on local conditions.

Maximum grade

The setting of the maximum grade in the ambient condition statement may be done with the notion that the grade may be exceeded in a limited number of locations. For example, if a corridor had one section where the minimum grade attainable would be 8% due to difficult terrain, but a maximum grade of 6% would be attainable throughout the remainder of the corridor, the ambient condition could be set at 6%, with an exception to the grade for improvements in the section of difficult terrain. The exception would be stated in the project design criteria.

Lane width
This element should have little or no variation.

Shoulder width
Small differences in shoulder width can be tolerated. For example, a 1.8m or 2 m width would be viewed as being the same. Therefore which dimension is selected to be the ambient condition would depend, in part, on the extent of each current shoulder width in the corridor.

Setback
This refers to the setback for utility poles and other obstructions. The majority of existing highways were constructed before the application of clear zone as a standard. Thus clear zone is not part of the ambient condition.

Ambient Condition Rationale

The Ambient Condition Rationale is a document that explains the logical reasoning behind the ambient condition recommended by the Region. The following is a suggested layout for the Ambient Condition Rationale. The general content of each section of the document is set out below. It is meant as a guide to the preparation of the document, not an instruction.

Introduction
The introduction will include the purpose of the document and the background as to why ambient conditions are being determined and how they will be used. Reference to the discussion paper," Policy and Procedures regarding Project Identification, Scope, and Geometric Standards" and the source of the mandate to determine the ambient condition and to use them, the policy statement, should be included in the introduction.

Methodology
This section should outline the general procedures used to arrive at the ambient conditions. The measure used to determine the satisfactorily performance of the highway sections from the standpoint of safety and operations should be included.

Existing Conditions
This section deals with the data collected regarding the geometry and safety of the highway. The limitations of the data should be stated. This section of the Rationale should walk the reader through the process and reasoning behind decisions made, e.g. the separation of the corridor into sections of uniform terrain, etc.

Geometry

The first procedure in the ambient conditions exercise is to separate each highway corridor into sections that exhibit uniform characteristics of terrain, development, access and traffic volumes and composition. This portion of the document will outline these sections and include some dialogue explaining the reasoning behind the selection. Any unique situations would be noted.

The second procedure is to identify, within each section, sub-sections that have the same apparent design speed, lane width, and shoulder width. As with the previous procedure, some dialogue would be included and unique situations noted and explained.

Safety Data

This section would include the safety and operational performance statistics for each sub-section section as well as pertinent anecdotal information obtained from other sources. Comments regarding the highway sections with respect to safety and operation would be contained here. Notes regarding the accident severity ratio may be appropriate.

Discussion/Recommendation

This section of the document should explain the analysis of the existing conditions and the safety and operational performance record of the highway sub-sections, which lead to the recommendations. The section need not be long, but it must clearly explain the connection between the existing condition, the safety and operational performance data and the recommended ambient condition for each corridor or section. A suggestion is to discuss each element used to define the ambient condition. A “reduced version” of a spreadsheet for documentation of the recommended ambient condition is shown in Appendix A. For Ministry of Transportation and Highway Staff, the master Excel File for this spreadsheet is on the Standards and Design Public Drive:

FS_Public@HQA@TH, in the eng\standard\bulletin Sub-Directory

APPENDIX A

"Recommended Ambient Conditions"

Sample Form

Recommended Ambient Conditions

REGION: ______________________________ **Date:** ______________________________

Highway Corridor	Section From	Section To	Length	Design Speed	Min advisory curve speed	Maximum superelevation	Maximum Grade	Lane Width	Shoulder width, paved	Shoulder width, gravel	Set back distance	Comments

Recommended - Regional Manager of Professional Services ______________________________ Date:__________________

Approved - Chief Engineer ______________________________ Date:__________________

GUIDELINES FOR THE DEVELOPMENT AND PREPARATION
of the
PROJECT DESIGN CRITERIA
for
CONSTRUCTION AND REHABILITATION PROJECTS

Ministry of Transportation and Highways
British Columbia
Engineering Branch
Mar 3/99

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Introduction

The MoTH policy, *Corridor Ambient Geometric Design Elements Guidelines*, states that the Ministry will identify highway corridors, and within those corridors, determine geometric design elements that have been performing well in terms of safety and traffic operation. These geometric elements, collectively called the ambient condition, will be used as the basis for the design parameters for the improvement of poor performing sections of the highway corridor. Each region will determine the ambient condition for all the numbered highway corridors within their region. The ambient condition for each corridor will be outlined in the region's "Ambient Condition Rationale" document.

The ambient condition for a corridor is the basis for the design criteria to be used for all improvement projects in that corridor. The design criteria developed for each project are included in a Project Design Criteria Document; a document prepared for each project. The following guidelines are for the preparation of the Project Design Criteria Document.

Project Design Criteria Document

A Project Design Criteria Document will be produced for all highway design projects. This document will identify and define the problem(s) being addressed, the options considered, the scope of the project, and the development of the design criteria. Note that the Project Design Criteria Document is a required part of the project design file and subject to audit.

The design criteria are the geometric design limiting values that apply specifically to the project. The design criteria are determined for each individual project based on the ambient condition for the corridor where the project is located, taking into account the Ministry's rehabilitation and capital programs, project location and other relevant considerations.

The following outlines the topics to be addressed in the document and gives some guidance as to its content.

Problem Identification and Definition

Identify the operational or safety problem(s) to be addressed. Problem(s) may include such things as a high accident location, an operational problem at an intersection, or a lower than acceptable level of service. The requirement is that a specific problem(s) be identified.

Once identified, the problem is to be defined in sufficient detail to ensure that the correct problem is being addressed. This may require contact with local officials, police etc. An example: Drivers having off-road accidents at a sharp corner, the majority being off-road right through the corner, and a lesser number of off-road left from the other direction. The project design criteria document will outline the contacts made and the data gathered including its source and any limitations of the data, the analysis of the data, and the conclusions reached, i.e. the problem defined. The design project objectives must be clearly identified and defined.

Options Considered

All viable solutions should be considered, developed and compared. Viable options should not be eliminated from consideration without proper development and evaluation. Solutions for the example given above could range from extra signing and/or delineation to construction to reduce the curve radius. The document outlines the options considered, the evaluation of the options (some form of comparison) and the recommended solution.

Project Scope

Use the recommendations to determine the scope of the design project. The project limits should be restricted to that needed to carry out the engineering solution. The scope statement should include all known items and issues to be addressed in the design so as to minimize changes later.

Project Design Criteria

The development of the design criteria to be used in the project is a multi-stage procedure. The first step is to determine the ambient condition for in the project location. This information is contained in the region's Ambient Condition Rationale. The existing conditions at the project location and adjacent to the project should be documented as these will be a factor in the final determination of the design criteria. The project design criteria are then developed based on the Ambient Condition defined for the corridor and other considerations, as explained in more detail below.

Use of the Ambient Condition

The design principle is to maintain the ambient condition for the corridor when rehabilitating or reconstructing a section of the corridor Thus the elements of the rehabilitated section will essentially be the same as those of the ambient condition set for the corridor. Any decision to vary from the ambient condition defined for the corridor is based on the following considerations:

Project Location

The location of the project may justify a variation from the ambient condition defined for the corridor. Two examples are presented.

First example: A project located at the interface between different ambient conditions may wish to use the ambient condition of the adjacent section.

Second example: There may be justification to raise specific elements of the highway geometry above that of the ambient condition if such action would be part of the engineering solution to the identified problem being addressed.

Rehabilitation and Capital Program

The anticipated rehabilitation and capital plans may influence the selection of the project design criteria. For example, if the rehabilitation program includes an upgrading such as widening the shoulders, then a project within the area should be constructed with the widened shoulders. Another example: if the anticipated capital or rehabilitation program over a number of consecutive years includes a continuing upgrade to the geometry of a portion of highway, then the project design criteria for construction within that portion of highway should be selected accordingly.

Justification

Carry out an economic or other appropriate analysis as required justifying any variation of the project design criteria from the ambient condition established for the corridor. Justification may be quantitative as well as qualitative. Quantitative evaluations include any objective that can be measured such as: benefit-cost ratio, reduced delays, or level of service improvements. Qualitative measures include such factors as: environmental impact, land access, or functionality.

Project Design Criteria Sheet

Complete the Project Design Criteria for design start-up. An Ambient Based Design Criteria sheet is attached in Appendix A. The project design criteria contains the following as a minimum. Additional items may be included if relevant to the project.

Design Speed

This is the design speed to be used for the project, with few exceptions the ambient condition.

Minimum Horizontal Curve

The minimum horizontal curve is derived from the design speed and the maximum superelevation to be used.

Minimum Stopping Sight Distance

The minimum stopping sight distance is derived from the design speed. There may be some variation in this value depending upon the selection of the variables used in the calculation. The current MoTH design standard assumes an eye height of 1.05 m and an object height of either 150 mm or 380 mm depending on the situation. These values apply to crest curves. Sag curve stopping sight distances, in areas where there is no illumination, are calculated using a headlight height of 600mm. In rare instances there may be justifiable reason for using values other than those contained in the Design Manual.

K factor: Sag and Crest

The K factor for both sag and crest curves is derived from the design speed and the associated sight distance variables.

Minimum advisory speed curve

This value will be as per the ambient condition except in rare cases such as an isolated curve in a corridor where the costs to achieve the ambient condition are prohibitive. In such a case the justification for the reduction and mitigative measures would be included in the documentation.

Maximum superelevation

This element will, in most cases, be the ambient condition. There is the flexibility to deviate with justification.

Maximum grade

The maximum grade stated in the ambient condition would be adhered to except in isolated cases where an isolated grade or short section of highway may justifiably differ from the ambient condition.

Lane width

This element should have little or no variation on through lanes. Auxiliary lane widths such as right and left turn lanes are determined independently.

Shoulder width, paved

There may specific project locations where there is a justifiable reason for suggesting a shoulder width other than that stated as the ambient condition. An example of such a location would be a project at the interface between different ambient conditions. The design of the wider shoulder may be justified. Conversely, shoulders adjacent to climbing lanes may be narrower.

Shoulder width, gravel

This element should have little or no variation on projects where there is a paved portion of shoulder. On projects without paved shoulder, the appropriate width should be based on the ambient condition for the corridor as well considerations similar to that for paved shoulders.

Setback

The setback is the distance that objects such as utility poles will be set back from the edge of the shoulder. This value is a minimum. Greater setbacks are desirable.

Other information:

Additional project specific information should be supplied to assist in the understanding of the project and the development of the design criteria. Any project information relevant to the understanding of the Project Design Criteria should be included. The following data should always be included.

- Traffic data:

  Examples of traffic data are: SADT, AADT, Design Hour Volumes, and Intersection turning movements.

- Level of Service

  The current level of service of the highway or intersection should be included.

- Truck Volume %

  The percentage of trucks, especially if they exist in unusually high numbers, can have a considerable affect on the design

- Design vehicle

  The design vehicle to be used for intersection design should be included. In some instances it may be prudent to include a design vehicle to which intersections are designed to accommodate with encroachment into adjacent lanes.

Approval Process

Ministry approval of the design criteria is required before the design starts and upon completion of the design. The project design criteria sheet is included in the project design criteria document, which in turn is an essential part of the Project design folder.

i) Design start-up:

- Project Design Criteria meet or exceed the Ambient Criteria:

  Recommended by: *One of the following* ____________-
  Regional Manager of Design/Highway Engineering
  Regional Manager, Planning
  District Highways Manager, if applicable

  Approved by: ___________________________________
  Regional Manager of Professional Services

- Project Design Criteria below the Ambient Criteria:

  Recommended by: ______________________________
  Regional Manager of Professional Services

  Approved by: _________________
  Chief Engineer

ii) Design Completion:

- Achieved values meet or exceed the Project Criteria from Step i) above:

  Recommended by: ______________________________
  Manager of Design/Highway Engineering

  Approved by: ___________________________________
  Regional Manager of Professional Services

- Achieved values below the Project Criteria from Step i) above:

  Recommended by: ______________________________
  Regional Manager of Professional Services

  Approved by: ___________________________________
  Chief Engineer

Appendix A

AMBIENT-BASED PROJECT

Design Criteria

Form

Page__of__.
Date: _/_/_.
File No. :______________.

AMBIENT-BASED PROJECT

DESIGN CRITERIA

HIGHWAY ROUTE NAME/NUMBER : ______________________________

L.K.I. INVENTORY SEGMENT: __________ From km: __________ To km: __________

CORRIDOR UPGRADING PROJECT: Yes: ☐ No: ☐

TOPOGRAPHY (Mountainous, Rolling, etc.) : ______________________________

DITCH TEMPLATE MATERIAL : TYPE : __________

PROJECT DESCRIPTION : ______________________________

____

	GEOMETRIC DESIGN ELEMENTS	EXISTING GEOMETRIC ELEMENTS			DESIGN GEOMETRIC ELEMENTS		
		PRIOR TO PROJECT LIMITS	WITHIN PROJECT LIMITS	BEYOND PROJECT LIMITS	AMBIENT CRITERIA VALUE	PROJECT CRITERIA VALUE	ACHIEVED CRITERIA VALUE
	A	B	C	D	E	F	G
1	Functional Classification :						
2	Design Speed :						
3	Posted Speed :						
4	Minimum Horizontal Curve Radius :						
5	Minimum Stopping Sight Distance :						
6	Min. "K" Factor : Sag V.C. :						
7	Min. "K" Factor : Crest V.C. :						
8	Maximum Superelevation :						
9	Maximum Gradient (%) :						
10	Lane Width(s) :						
11	Shoulder Width :						
12	Clear Zone Width :						
13	Right of Way Width :						
14	Current Traffic Volume : SADT :						
15	Design SADT/Design Hourly Volume :						
16	Truck Volume % :						
17	Accident Rate :						
18	Level of Service :						
19	Etc. :						
20							
21							
22							
23							

RECOMMENDED BY : ______________________________

DESIGNER DATE

(See overleaf)

File No. :_____________.

AMBIENT-BASED PROJECT

DESIGN CRITERIA

HIGHWAY ROUTE NAME/NUMBER : ______________________________
L.K.I. INVENTORY SEGMENT: __________ From km: __________ To km: __________

1) Design Start-up Sign-off

PROJECT CRITERIA MEET OR EXCEED AMBIENT CRITERIA:

RECOMMENDED BY : ______________________________
MANAGER OF DESIGN DATE

APPROVED BY : ______________________________
MANAGER OF PROFESSIONAL SERVICES DATE

PROJECT CRITERIA BELOW AMBIENT CRITERIA:

RECOMMENDED BY : ______________________________
MANAGER OF PROFESSIONAL SERVICES DATE

APPROVED BY : ______________________________
CHIEF ENGINEER DATE

2) Design Completion Sign-off

ACHIEVED CRITERIA MEET OR EXCEED THE PROJECT CRITERIA (from Step 1 above):

RECOMMENDED BY : ______________________________
MANAGER OF DESIGN DATE

APPROVED BY : ______________________________
MANAGER OF PROFESSIONAL SERVICES DATE

ACHIEVED CRITERIA BELOW THE PROJECT CRITERIA (from Step 1 above):

RECOMMENDED BY : ______________________________
MANAGER OF PROFESSIONAL SERVICES DATE

APPROVED BY : ______________________________
CHIEF ENGINEER DATE

1400 SUBDIVISION ROADS CHAPTER

1410 SUBDIVISION ROAD CONSTRUCTION SPECIFICATIONS

1420 DESIGN PARAMETERS

1400 SUBDIVSION ROADS CHAPTER TABLES

1400 SUBDIVSION ROADS CHAPTER FIGURES

1410 SUBDIVISION ROAD CONSTRUCTION SPECIFICATIONS

Where there are existing agreements between the Ministry of Transportation and other parties, those agreements shall prevail. Where excerpts from the Standard Specifications for Highway Construction or from the MoT Supplement to TAC Geometric Design Guide are different from the said current version, the actual publications shall prevail.

Exceptions to these standards shall be directed through the District Manager, Transportation to the Regional Director.

1410.01 GENERAL

1. All construction practices and procedures shall conform to the **current** edition of the Ministry's ***Standard Specifications for Highway Construction*** book unless specified otherwise in the text below or by the Ministry Representative. Excerpts from that book have been included in an attempt to provide a more comprehensive handout for one or two lot subdivisions. Copies of the Standard Specifications can be obtained from the MoT website (www.gov.bc.ca/tran) by going to the Site Index, then to Standard Specifications.
2. The developer shall conform to the conditions contained in the Standard Specifications as well as any Special Provisions specified by the District Manager, Transportation and/or the Ministry Representative*. These Special Provisions shall take precedence over the Standard Specifications.
3. Roadways may not be approved:
   a) If road construction has been undertaken during periods of snow, heavy rains, freezing, or other such unsuitable weather conditions.
   b) If granular aggregate has been placed upon a frozen, wet, muddy, or rutted subgrade or base course.
   c) Without a Ministry accepted design plan.

* This and all further references to the Ministry Representative include the District Manager, Transportation.

1410.01.01 Right-Of-Way Width

Right-of-Way shall be of sufficient width to include the road fill, ditches and backslopes, plus a minimum 3 metres on each side or as directed by the District Manager, Transportation. For all subdivision roads other than lanes, frontage roads and pedestrian facilities, the minimum Right-of-Way width shall be 20 metres.

1410.01.02 Inspections

Testing and/or inspections by an independent testing agency with Professional Engineer or AScT registration shall be considered as an acceptable alternate if or when requested by the Ministry Representative. Inspections shall be carried out upon completion of each of the following stages of construction:

a) Clearing and Grubbing and Subgrade Slope Staking.
b) Roadway and Drainage Excavation and Subgrade Construction Slope Stakes.
c) Select Granular Sub-Base Construction and Slope Stakes for Surface Course Construction.
d) Paving (when required).

The developer shall give a minimum of one (1) week's notice prior to completion of each stage to allow for the scheduling of inspections. If required notice is not given, the roadways may not be approved.

1410.01.03 Other Regulating Agencies

The developer shall comply with any and all statutory regulations and bylaws and all applicable Federal, Provincial, Regional District, and Improvement District regulations during construction work.

1410.01.04 Miscellaneous

All roads shall be slope staked as requested by the Ministry Representative. The Ministry Representative may also request that all utilities be staked when the project is greater than 100 metres in length.

1410.02 CLEARING AND GRUBBING

The Right-of-Way shall be cleared and grubbed to the full width specified by the Ministry Representative or the default shall be the full Right-of-Way width. Trees, stumps, roots, brush and embedded logs, and all debris shall be grubbed to a depth of 600 mm and shall be disposed of to the satisfaction of the Ministry Representative. No debris shall be buried within the fill.

NOTE: Inspection and approval of clearing and grubbing by the Ministry Representative are required prior to proceeding with sub-grade construction. See Section 200 of the Standard Specifications.

1410.03 ROADWAY AND DRAINAGE EXCAVATION

Description: Roadway and Drainage Excavation shall include all necessary excavation and the construction of all embankments required for the formation of the roadbed and associated drainage works and additional work as outlined in subsection 201.01 of the Standard Specifications.

1410.04 EARTH EMBANKMENTS

Subsections 201.37 and 201.38 of the Standard Specifications will apply. The entire roadway including the roadbed, slopes and ditches shall be neatly finished and trimmed to the designed cross section. Density tests shall be the responsibility of the developer. See 1410.01.02.

1410.05 ROCK EMBANKMENTS

Rock embankments shall be in accordance with Subsection 201.36 of the Standard Specifications.

1410.06 SPECIAL SLOPE TREATMENT

Slopes shall be treated in accordance with Drawing SP201-01 in the Standard Specifications. Hydro seeding shall be done as directed by the Ministry Representative.

1410.07 GRANULAR SURFACING, BASE AND SUB-BASES

1410.07.01 Aggregate Quality

Aggregate quality shall conform to Subsection 202.04 of the Standard Specifications.

1410.07.02 Pavement Design Standards

Four Design Standards, based on general roadway classification, are used to categorize British Columbia's provincial road network. Twenty (20) year design Equivalent Single Axle Loads (ESALs) are the primary criteria used for selection of the appropriate standard with additional subgrade material criteria applied to low volume roads and subdivision roads. These are summarized as follows:
NOTE: one ESAL = one standard axle load = 8,165 kg (18,000 lb.)(i.e. Benkelman Beam Truck)

STANDARD TYPE	ROADWAY DESIGNATION	20 YEAR DESIGN ESAL CRITERIA
TYPE "A"	HIGH VOLUME ROADS	> 1,000,000
TYPE "B"	MEDIUM VOLUME ROADS	100,000 to 1,000,000
TYPE "C"	LOW VOLUME ROADS	< 100,000
TYPE "D"	SUBDIVISION ROADS	< 100,000

TYPE "A"
HIGH VOLUME ROADS: > 1,000,000 ESAL's
100 mm A.P.
150 mm C.B.C. (-25 mm)
150 mm C.B.C. (75 mm MAXIMUM size)
S.G.S.B. (See 1410.07.03)

TYPE "B" (See Figure 1420.B)
MEDIUM VOLUME ROADS 100,000 to 1,000,000 ESAL's
75 mm A.P.
150 mm C.B.C. (-25 mm)
150 mm C.B.C. (75 mm MAXIMUM size)
S.G.S.B. (See 1410.07.03)

TYPE "C(see Type "D" below)
LOW VOLUME ROADS

TYPE "D(See Figures 1420.C & D)
SUBDIVISION ROADS < 100,000 ESAL's
50 mm A.P.
225 mm C.B.C. (-25 mm MAXIMUM size)
S.G.S.B. (See 1410.07.03)

1410.07.03 Aggregate Gradation and Surfacing

The Ministry Representative, in consultation with the Regional Geotechnical and Materials Engineer, may specify alternative designs than stated below in consideration of local soils and climatic conditions. Granular surfacing, base and sub bases shall be in accordance with Section 202 of the Standard Specifications.

There are typically three gravel courses:

1. The lower course (S.G.S.B). shall consist as follows:

- A minimum thickness of 300 mm of S.G.S.B. shall be applied over fine-grained subgrade (Unified Soils Classification System - ML-CL-OL-MH-CH-OH)
- A minimum thickness of 150 mm of S.G.S.B. shall be applied over coarse-grained subgrade (Unified Soils Classification System - GW-GP-GM-GC-SW-SP-SM-SC) where ground water does not pose a drainage problem and frost penetration does not affect the structure.
- A minimum 150 mm S.G.S.B. shall be applied over rock.
- No S.G.S.B. is required in exceptional circumstances where the following criteria has been met:
  - Structural Design Criteria is satisfied

    and
  - Subgrade material consists of clean granular deposits that satisfy the S.G.S.B. gradation and construction criteria of the BC MoT Standard Specifications for Highway Construction - Section 202 “Granular Surfacing, Base and Sub-bases”, (Subsection 202.06).

Note: All leveling materials applied directly to blasted rock cuts shall be of S.G.S.B. quality.

2. The mid course shall consist of 150 mm of 50 mm or 75 mm Crushed Base Course (C.B.C.) in accordance with Subsection 202.05 of the Standard Specifications.

3. The upper course shall consist of 225 mm of 25 mm minus Crushed Base Course (C.B.C.) in accordance with the following:

a) Crushed Surfacing Aggregate gradation used for surfacing gravel roads is defined in Table 202-B of the Standard Specifications.

b) Where paving is required or anticipated in the reasonable future, 25 mm crushed Base Course Aggregate as specified in Subsectoin 202.05 of the Standard Specifications, shall be used.

- Gravel depths are the compacted measurements. Subject to local conditions, the Ministry Representative may request additional gravel depths.
- Roadways shall be graded and compacted with crossfall for road drainage as follows:
  a) For paved roads – 0.02 m/m crossfall (normal crown) on tangents and appropriate superelevation as specified on curves.
  b) For gravel roads – 0.04 m/m crossfall on tangents and appropriate superelevation as specified on curves.
- Gravel shall be spread and compacted in lifts not exceeding 150 mm in depth or as specified by the Ministry Representative. If requested by the Ministry Representative, water shall be applied during gravel compaction to achieve 100% proctor density as described in the Standard Specifications for Highway Construction Sections 202.33 and 202.34.
- The owner/contractor shall hire a qualified inspector (see 1410.01.02), to provide written confirmation of compliance with Section 202 of the Standard Specifications.

THE FINAL S.G.S.B. THICKNESS MUST BE APPROVED BY THE REGIONAL GEOTECHNICAL AND MATERIALS ENGINEER.

NOTE: Inspection and approval by the Ministry Representative (or at their request, a qualified Professional Engineer or Limited Licensee practicing in this scope of engineering) of granular material used for each gravel course is required prior to placement of the upper gravel courses (see 1410.01.02)

1410.08 CONSTRUCTION

1. Back slopes shall be 1.5:1 or flatter, except in sand or similar material which shall be 2:1 or flatter, except as specified by the Ministry Representative. For rock ditches refer to Figure 1420.D
2. All fill slopes shall be 2:1 or flatter, with the exception of slopes qualifying for road side barrier.
3. All materials, silts, sands and gravels shall be laid in 150 mm lifts. The contractor should use the appropriate equipment required to obtain the compaction as specified in the Standard Specifications for Highway Construction Book. Watering shall be carried out as required to provide optimum water content during compaction. Grades containing soft spots will not be approved until such sections have been excavated and backfilled with suitable material and compacted. Other methods of compaction will be considered by the Ministry Representative upon request.

1410.09 STORM DRAINAGE

1410.09.01 General

This guideline is intended for the use of personnel competent to evaluate the significance and limitations of its content and recommendations, and who will accept responsibility for the application of the material it contains. The Ministry of Transportation disclaims any or all responsibility for the application of the stated guidelines and for the accuracy of the material contained herein.

Drainage shall be adequate to the satisfaction of the Ministry Representative. All ditches and storm drainage pipes are to be carried to a natural drainage course. The original drainage pattern for the site shall not be altered without permission of the Provincial Ministry of Environment, Water Management Branch.

Drainage easements or statutory Rights-of-Way may be required. Drainage easements shall be a minimum of 6 metres in width or as determined by the Ministry Representative.

1. Only Ministry approved Corrugated Steel, Concrete, PVC or High Density Polyethylene pipe may be used for storm sewers.
2. The minimum size driveway culvert shall be 400 mm diameter with a minimum required cover of 300 mm. The minimum size culvert for a frontage road or collector (network) road shall be 500 mm diameter (some areas may require a 600 mm minimum) with a minimum cover of 450 mm. See **Table 1040.A** for a comprehensive listing of minimum cover requirements for network roads. These minimum dimensions may be increased at the discretion of the Ministry Representative.
3. Culvert grade shall be a minimum of 0.5% percent unless otherwise approved by the Ministry Representative.
4. Culverts shall be bedded and backfilled within the subgrade zone with a fine graded gravel free of rock over 25 mm.
5. The ditch invert grade shall be a minimum of 150 mm below the bottom of select granular sub base but shall be deep enough to ensure adequate cover, regardless of pipe size.
6. All cul-de-sacs must be drained and all drainage across private property shall be carried on registered easements or statutory Rights-of-Way.
7. The inlet and/or outlet of culverts subject to erosion shall have sandbags or a headwall respecting clear zone principles and shall not introduce a further hazard.

1410.09.02 Requirements for Drainage Design

When information is presented in two locations or publications, difficulties can arise if both are not synchronized for changes. Rather than run that risk, Drainage Design is discussed as part of **Chapter 1000, Hydraulics and Structures** of the BC Supplement to TAC.

The Ministry's design philosophy for subdivision storm drainage is such that all storm drainage facilities be designed according to the major/minor storm drainage concept.

The Subdivision Development Drainage Plan must provide sufficient information to allow the reviewer to understand the developer's objectives and to thoroughly assess the hydraulic impacts of the development.

1410.09.03 Hydrology and Design Flow Calculations

For Hydrology and Design Flow Calculations see **Section 1020** of the BC Supplement to TAC.

NOTES:
Inspection and approval of drainage and subgrade construction are required prior to gravelling, (see 1410.01.02.).

1410.10 HAMMERHEADS/CUL-DE-SACS

Cul-de-sac turnarounds shall be constructed on all rural dead end roads and dead end roads that cannot be further extended. Construction shall be in accordance with 1420.05.04 of this Guideline. In general, most cul-de-sacs are locals, except design Standards for Commercial or Industrial subdivisions may be considered collectors as per 1420.02.03

NOTE: Hammerhead and temporary turnarounds shall be considered instead of cul-de-sacs in rural situations where it is reasonable to expect a road extension within five years. Dimensions and widths shall be in accordance with 1420.05.04. Where temporary turnarounds cannot be constructed within standard Right-of-Way, a statutory Right-of-Way plan to encompass the additional width is recommended.

1410.11 PAVING

1. All gravel surfaces shall be primed prior to paving in accordance with subsection 501.19 of the Standard Specifications.
2. A minimum 50 mm asphalt pavement thickness may be adequate in certain situations where traffic volumes are low and there is very little heavy truck traffic. As determined by the Pavement Designer, a 75 mm asphalt pavement thickness may be warranted in situations where traffic volumes, in particular heavy truck traffic, is high.
3. In rural areas, other methods of hard surfacing (such as seal coat) may be considered by the Ministry Representative.
4. Prior to paving, the developer shall contact the Ministry Representative to ensure that on-site inspection will take place before and during paving operations.
5. The decision to pave and the pavement design shall be as directed by the Ministry Representative. Considerations for paving are as follows:
   - When leaving a paved road.
   - More than four lots under five acres each.
   - Proximity to the batch plant.
   - Availability of materials.
6. Upon completion of paving, shoulders will consist of either 19 mm Shouldering Aggregate or 25 mm Well Graded Base Course. Compaction of the shouldering material shall be in accordance with the Standard Specifications.

1420 SUBDIVISION ROAD DESIGN PARAMETERS

1420.01 CONSIDERATIONS

A Road Network Plan is based on a hierarchy of streets that is related to the amount and type of traffic served. It takes into account such factors as public transit, shopping and community facilities, and other land uses. The changing nature of the area over time is also a major factor. For example, a rural area may change into an urban one in the course of time. The future requirements for the entire road network are considered when a subdivision application is evaluated.

- Municipal and Regional District Major Road Network plans must be checked to ensure that the major roads are protected by the proposed subdivision.
- Where possible, new developments should have at least two connections to the existing road network in case of emergency.
- Pedestrian and cyclist volumes should be considered and walkways provided where considered necessary.

1420.02 ROAD CLASSIFICATION

1420.02.01 Arterial/Primary

A general term denoting a road primarily for through traffic usually on a continuous route. Direct access to abutting land is not a priority. Arterial roads will not be discussed in these guidelines.

1420.02.02 Collector/Secondary

A road that provides for traffic movement between arterials and local streets with some direct access to adjacent property.

1420.02.03 Local

A road primarily for access to residences, businesses, or other abutting property.

Note: Local streets intended for commercial or industrial development are considered as collector roads.

1420.02.04 Cul-de-sac

A road termination providing a U-turn area of constant radius.

1420.02.05 Frontage Road/ Backage Road

A local road that parallels the major through road and that provide access to property or business.

*Note: For this guideline, **URBAN** implies a curb and gutter cross section and **RURAL** implies an open shoulder cross section.*

1420.03 PLANS

The developer shall submit metric road design plans to the Ministry which include:

1. **Location Plan:** Scale 1:500 or 1:1000 showing horizontal alignment, lot lines, legal description of lots, proposed subdivision, signing, existing and proposed culvert locations and proposed drainage pattern.
2. **Profile:** Scale 1:1000 horizontal and 1:100 vertical, showing the existing ground line and proposed finished road grade.
3. **Laning Drawings:** Same scale as plan drawings, road markings, location and type of warning, regulatory, directional, and if necessary, special signs to be installed.
4. **Cross Sections** when required by the Ministry Representative.
5. **Typical Cross Sections:** as required.

The developer will commence road construction only after the Ministry Representative has accepted the road design.

1420.04 ACCOMMODATING CYCLISTS

It is recognized by the nature of subdivision roads, that cyclists will use these roads for travel within the subdivision and to connect to collectors and the general roadway system. As such, cycle traffic simply shares the roadway with motorized traffic.

1420.05 ALIGNMENT

The developer shall complete all road designs within the design speed range of 30 km/h to 80 km/h, as determined by the road classification, or as requested by the Ministry Representative. When selecting a design speed, the ultimate road classification must be considered (e.g. if a dead end road will be extended as a through road in the future, it should be designed to the ultimate classification).

Vertical curves shall be standard parabolic curves. The length of vertical curve (in metres) should not be less than the design speed (in km/h).

The developer shall demonstrate that every reasonable effort has been made to minimize the road grades. Short pitches of steeper grades may be acceptable on tangent sections provided the overall grade is less than 8%.

Minimum parameters for various design speeds shall be as shown in **Table 1420.A**. The developer shall consult with the local Ministry Maintenance Contractor to ensure that road maintenance equipment can manoeuver within the proposed parameters. Design speeds of 40 km/h should typically be limited to lot access roads that do not perform a collector function. The developer must submit written justification when proposing roads with 30 km/h design speeds.

1420.05.01 Arterials/Primary

Arterials are generally network roads which are built and maintained by the Ministry of Transportation and shall not be discussed in this guideline.

1420.05.02 Collectors (Network Roads)

Rural Collector/Secondary

The Right-of-Way shall be 25 metres wide or the cross section width, plus 3 metres on each side, whichever is greater.

- Minimum finished top: 10 metres.
- Minimum paved top: 8 metres.
- Gravel Shoulder: 1.0 metres.

Urban Collector /Secondary (Curb and Gutter)

The desirable minimum Right-of-Way width is 25 metres, or the cross section width plus 3 metres on each side, whichever is greater.

- Minimum finished top: 10 metres.
- Minimum paved top: 8.2 metres to leading edge of curb (parking one side).
- Gravel Shoulder: 0.3 metres behind curb, see **Figure 1420.B**.

Table 1420.A – Design Parameters

Road Classification	**Local Roads*** **		**Local/Collector**	**Collector Roads**		
Speed (km/h)	**30**	**40**	**50**	**60**	**70**	**80**
Radius, (metres)*	20	40	75	120	190	250
Minimum stopping sight distance, (metres)	30	45	65	85	110	140
Decision Sight Distance, DSD (metres)**	40-110	55-110	75-145	95-175	125-200	155-230
K value crest, vertical curves, taillight height	2	4	7	13	23	36
K value sag, vertical curves, Headlight control	4	7	12	18	25	32
Minimum Overhead Clearance (metres)	5.0	5.0	5.0	5.0	5.0	5.0
Maximum desirable grade in percent*	8	8	8	8	8	8

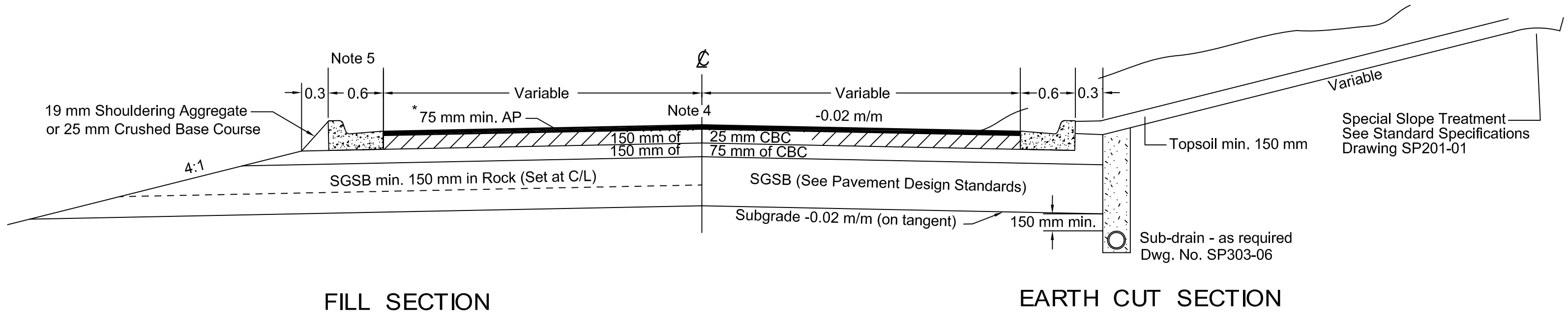
Parameters based on E max: 0.06 m/m, normal crown: 0.02 m/m.

*Avoid the combined use of maximum grade and minimum radius. Maximum grades are to be reduced by 1% for each 30 metres of radius below 150 metres.
** Lower DSD values are appropriate at intersections within a subdivision, while the higher values should be used at more complex intersections. DSD along numbered highways may even be higher.
*** This includes cul-de-sacs, frontage roads, and backage roads.

MoT Section	1420		TAC Section	Not Applicable

Figure 1420.B Two-Lane Urban Subdivision Road

N.T.S.



PAVEMENT DESIGN STANDARDS - When "Equivalent Single Axle Loads, (ESAL's)" are >100,000 and <1,000,000. See 1410.07.02

- These are typical gravel and asphalt depths to be used in the absence of geotechnical investigation.
- 75 mm A.P. to be constructed in 2 lifts for 19 mm MAXIMUM size aggregate and 1 lift for 25 mm MAXIMUM size aggregate. (In accordance with the latest version of the B.C. MOT Standard Specifications for Highway Construction - Section 501, Subsection 501.23.06)
- No S.G.S.B. is required in exceptional circumstances where the following criteria have been met:

  Structural Design Criteria is satisfied

  and

  Subgrade material consists of clean granular deposits that satisfy S.G.S.B. gradation and construction criteria (i.e. rutting criteria) in accordance with the latest version of the B.C. MoT Standard Specifications for Highway Construction - Section 202 "GRANULAR SURFACING, BASE AND SUB-BASES"
- MINIMUM 150 mm S.G.S.B. in Rock.
- All levelling materials applied directly to blasted rock cuts shall be of S.G.S.B. quality.
- THE FINAL S.G.S.B. THICKNESS MUST BE APPROVED BY THE REGIONAL GEOTECHNICAL AND MATERIALS ENGINEER.

* When "Equivalent Single Axle Loads, (ESAL's)" are > 1,000,000 use 100 mm A.P.

Notes:

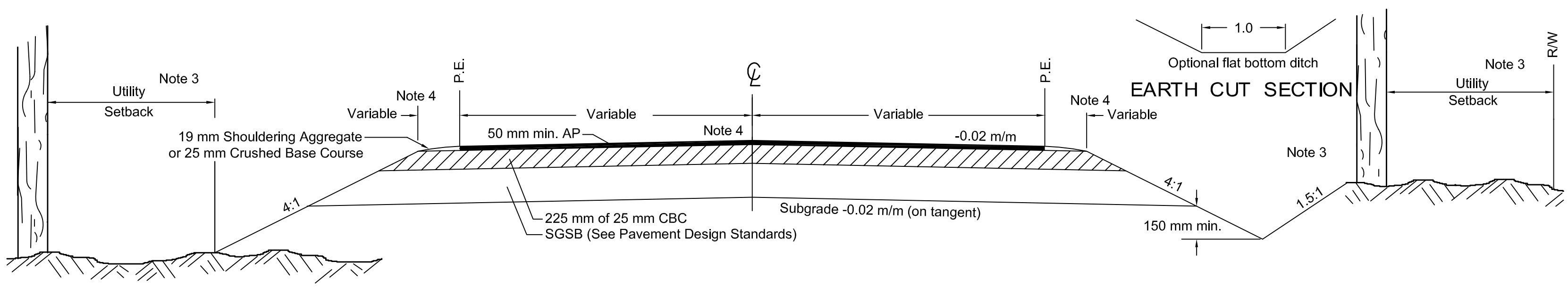
1. For bikeway design, see Section 430 and TAC
2. For roadside barrier and drainage curb details, see Section 440
3. Utility setback is 2 m from the base of fill/top of cut slope or 2 m from property boundary, whichever gives the greater offset from the road
4. For variable shoulder and top widths, refer to Table 1420.E
5. For typical curbs see SP582-01.01 to SP582-01.03 in the Standard Specifications
6. For rock ditches, see Section 440

Abbreviations:

AP Asphalt Pavement
CBC Crushed Base Course
SGSB Select Granular Sub Base

Figure 1420.C Two-Lane Two-Way Subdivision Road

N.T.S.



PAVEMENT DESIGN STANDARDS - When "Equivalent Single Axle Loads, (ESAL's)" are <100,000. See 1410.07.02

- These are typical gravel and asphalt depths to be used in the absence of geotechnical investigation.
- MINIMUM 150 mm S.G.S.B. on Coarse Grained Subgrades (Unified Soils Classification System - GW/GP/GM/GC/SW/SP/SM/SC) where groundwater does not pose a drainage problem and frost penetration does not affect the structure.
- MINIMUM 300 mm S.G.S.B. on Fine Grained Subgrades (Unified Soils Classified System - ML/CL/OL/MH/CH/OH).
- No S.G.S.B. is required in exceptional circumstances where the following criteria have been met:

  Structural Design Criteria is satisfied

  and

  Subgrade material consists of clean granular deposits that satisfy S.G.S.B. gradation and construction criteria (i.e. rutting criteria) in accordance with the latest version of the B.C. MoT Standard Specifications for Highway Construction - Section 202 "GRANULAR SURFACING, BASE AND SUB-BASES"

- MINIMUM 150 mm S.G.S.B. in Rock.
- All levelling materials applied directly to blasted rock cuts shall be of S.G.S.B. quality.
- THE FINAL S.G.S.B. THICKNESS MUST BE APPROVED BY THE REGIONAL GEOTECHNICAL AND MATERIALS ENGINEER.

Notes:

1. For bikeway design, see Section 430 and TAC
2. For roadside barrier and drainage curb details, see Section 440
3. Utility setback is 2 m from the base of fill/top of cut slope or 2 m from property boundary, whichever gives the greater offset from the road
4. For variable shoulder and top widths, refer to Table 1420.E
5. For typical curbs see SP582-01.01 to SP582-01.03 in the Standard Specifications
6. For rock ditches, see Section 440

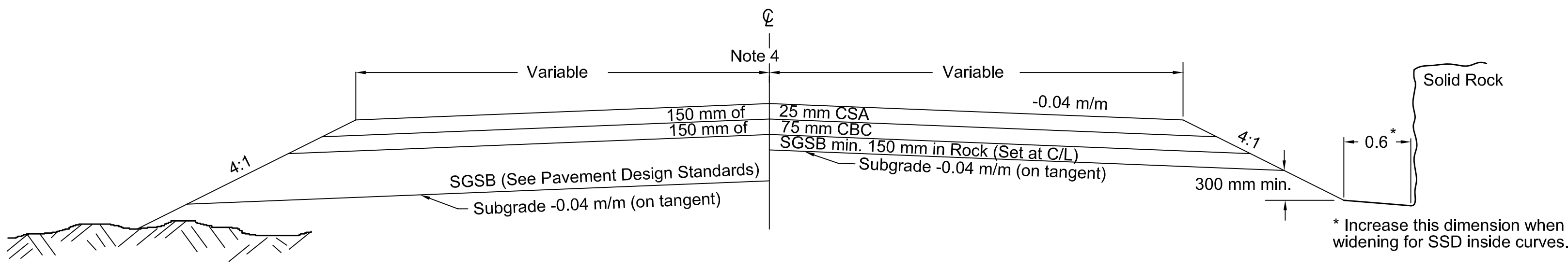
Abbreviations:

AP Asphalt Pavement
CBC Crushed Base Course
SGSB Select Granular Sub Base

MoT Section	1420		TAC Section	Not Applicable

Figure 1420.D Gravel Subdivision Road

N.T.S.



FILL SECTION

ROCK CUT SECTION

PAVEMENT DESIGN STANDARDS - When "Equivalent Single Axle Loads, (ESAL's)" are <100,000. See 1410.07.02

- These are typical gravel and asphalt depths to be used in the absence of geotechnical investigation.
- MINIMUM 150 mm S.G.S.B. on Coarse Grained Subgrades (Unified Soils Classification System - GW/GP/GM/GC/SW/SP/SM/SC) where groundwater does not pose a drainage problem and frost penetration does not affect the structure.
- MINIMUM 300 mm S.G.S.B. on Fine Grained Subgrades (Unified Soils Classified System - ML/CL/OL/MH/CH/OH).
- No S.G.S.B. is required in exceptional circumstances where the following criteria have been met:

  Structural Design Criteria is satisfied

  and

  Subgrade material consists of clean granular deposits that satisfy S.G.S.B. gradation and construction criteria (i.e. rutting criteria) in accordance with the latest version of the B.C. MoT Standard Specifications for Highway Construction - Section 202 "GRANULAR SURFACING, BASE AND SUB-BASES"
- MINIMUM 150 mm S.G.S.B. in Rock.
- All levelling materials applied directly to blasted rock cuts shall be of S.G.S.B. quality.
- THE FINAL S.G.S.B. THICKNESS MUST BE APPROVED BY THE REGIONAL GEOTECHNICAL AND MATERIALS ENGINEER.

Notes:

1. For bikeway design, see Section 430 and TAC
2. For roadside barrier and drainage curb details, see Section 440
3. Utility setback is 2 m from the base of fill/top of cut slope or 2 m from property boundary, whichever gives the greater offset from the road
4. For variable shoulder and top widths, refer to Table 1420.E
5. For typical curbs see SP582-01.01 to SP582-01.03 in the Standard Specifications
6. For rock ditches, see Section 440

Abbreviations:

CSA Crushed Surfacing Aggregate
CBC Crushed Base Course
SGSB Select Granular Sub Base

1420.05.03 Locals

Rural Local

The Right-of-Way width is 20 metres, or the cross section width plus 3 metres on each side, whichever is greater.

- Minimum finished top: 8 metres*, **.
- Minimum paved top: 7 metres*, **.
- Ditch inverts: earth cut - minimum 150 mm below subgrade, see Figure 1420.C; rock cut – minimum 300 mm below subgrade, see Figure 1420.D
- Gravel shoulder: 0.5 metre.

*Add 1 metre per side snow storage when requested by the Ministry Representative.
**Add 1 metre per side for pedestrian walkway in high volume, low speed tourist areas when requested by the Ministry Representative. Sidewalks may be a considered option where the minimum sidewalk width would be 1.5 metres.
For Two-Lane Two-Way asphalt & gravel surfaces, See Figures 1420.C & 1420.D

Urban Local (Curb and Gutter)

The Right-of-Way width is 20 metres, or the cross section width plus 3 metres on each side, whichever is greater.

- Curb and gutter:
  Finished top – 11.8 metre top, 10.0 paved, on street parking, both sides.
  Finished top – 10.0 metre top, 8.2 paved, on street parking, one side.
- Ditch inverts minimum: 150 mm below subgrade, see Figure 1420.B.
- Gravel shoulder: 0.3 metres behind curb, see Figure 1420.B.

1420.05.04 Cul-de-sac

Rural: 15 metre radius finished top
14.5 and 14.0 metre radius paved top
0.5 and 1.0 metre gravel shoulder,
see Figures 1420.F and 1420.G
Urban: 15 metre radius finished top
14.1 metre radius paved top
0.6 metre curb width
0.3 metre gravel shoulder, see Figure1420.H and 1420.I
Maximum length: 150 metres

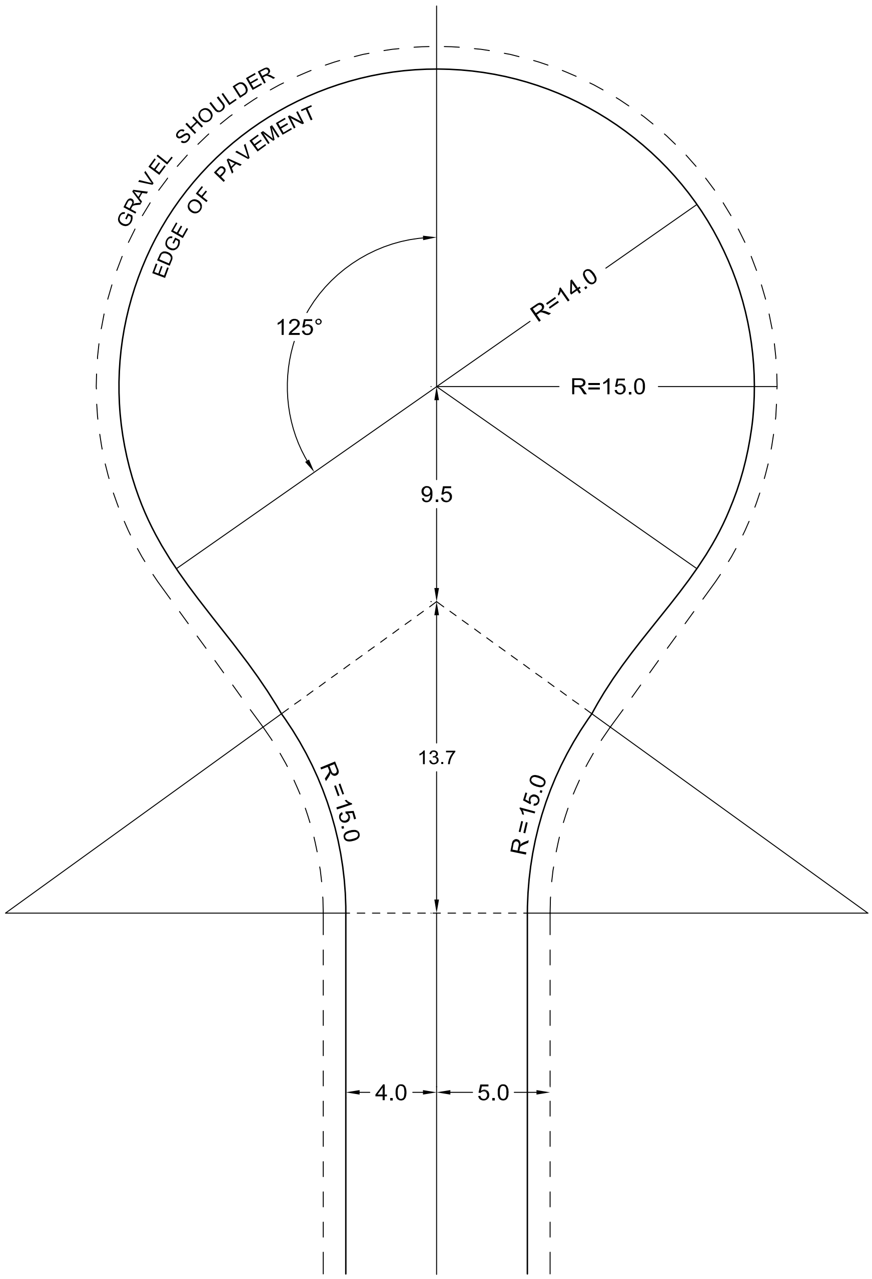
Offset Cul-de-Sac - see Figure 1420.J

Hammerhead Cul-de-Sac - see Figures 1420.K and 1420.L

Table 1420.E – Finished Top and Shoulder Widths

Collector				
Rural (Fig. 1420.F)		**Urban** (Fig. 1420.H)		
Top Width	Paved Width	Top Width	Paved Width	Parking
10.0	8.0	10.0	8.2	one side
1.0 gravel shoulder		0.6 curb plus 0.3 gravel shoulder		
Local				
Rural (Fig. 1420.G)		**Urban** (Figs. 1420.H and I)		
Top Width	Paved Width	Top Width	Paved Width	Parking
8.0	7.0	11.8	10.0	both sides
		10.0	8.2	one side
0.5 gravel shoulder		0.6 curb plus 0.3 gravel shoulder		

Figure 1420.F Collector/Rural Cul-de-Sac
N.T.S.



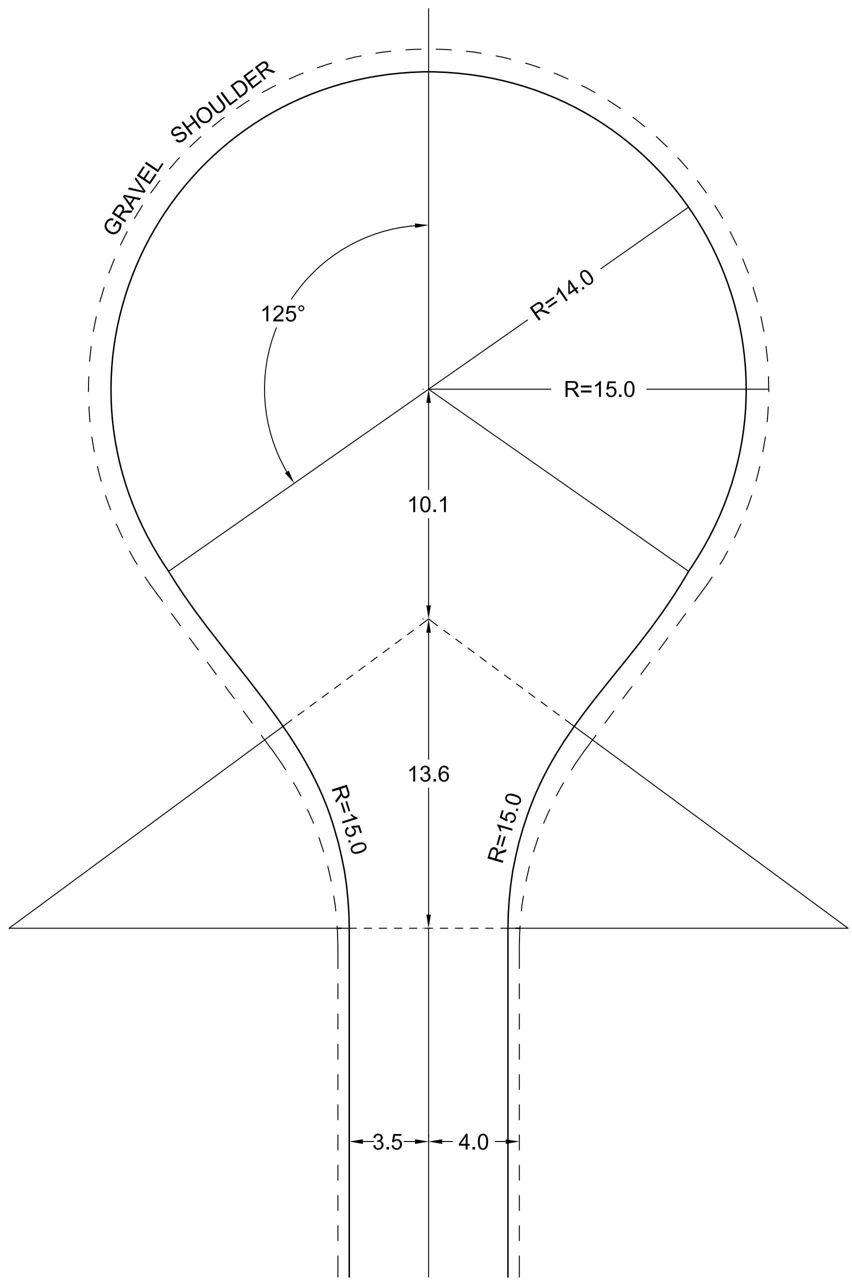
Note:

The distance from centreline of the intersecting road to the radius point of the Cul-de-Sac is maximum 150 metres.

MoT Section	1420		TAC Section	Not Applicable

Figure 1420.G Local/Rural Cul-de-Sac

N.T.S.



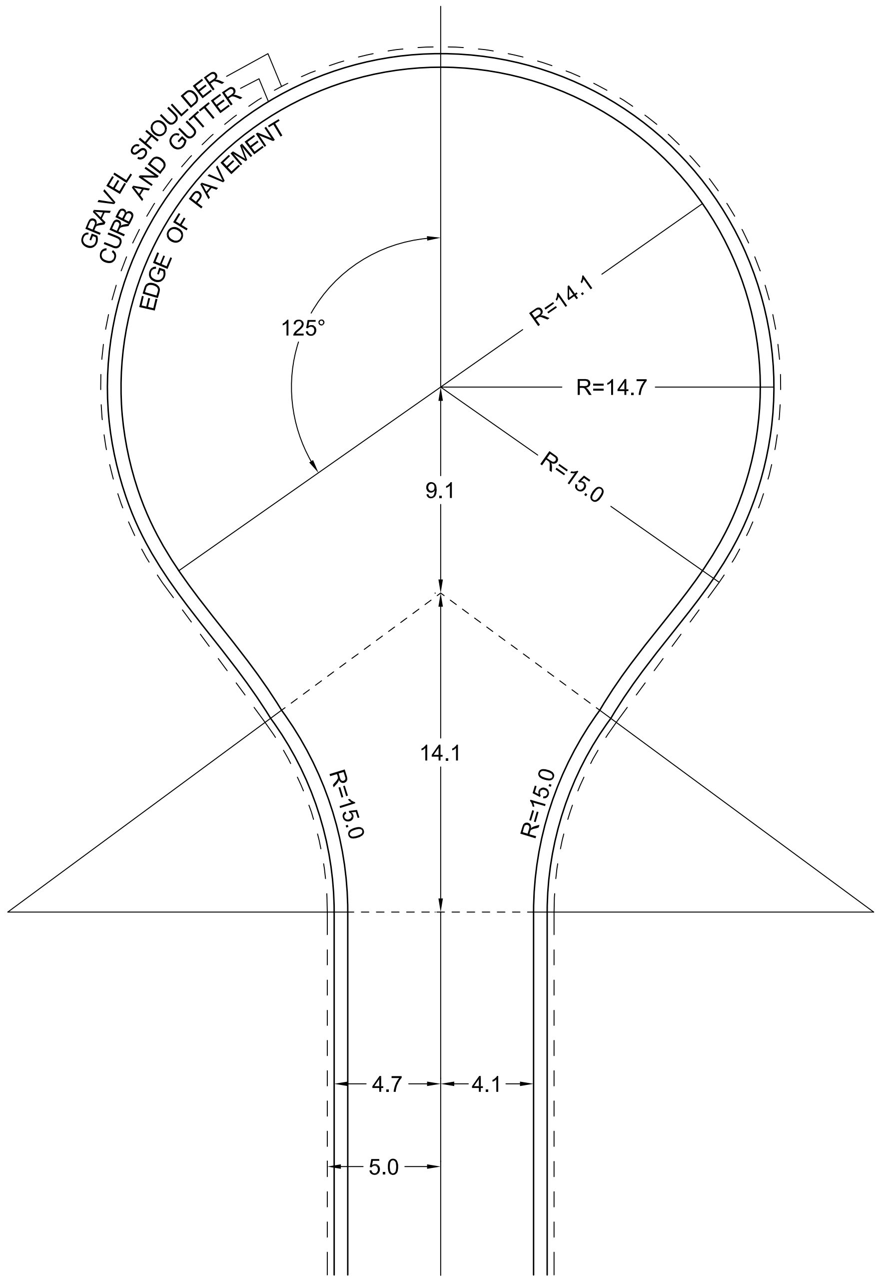
Note:

This is a local rural road with Cul-de-Sac; therefore, the distance from the centreline of the intersecting road to the radius point of the Cul-de-Sac is variable.
Maintain shoulder dimensions for gravel roads.

MoT Section	1420		TAC Section	Not Applicable

Figure 1420.H Collector/Local Urban Cul-de-Sac

N.T.S.



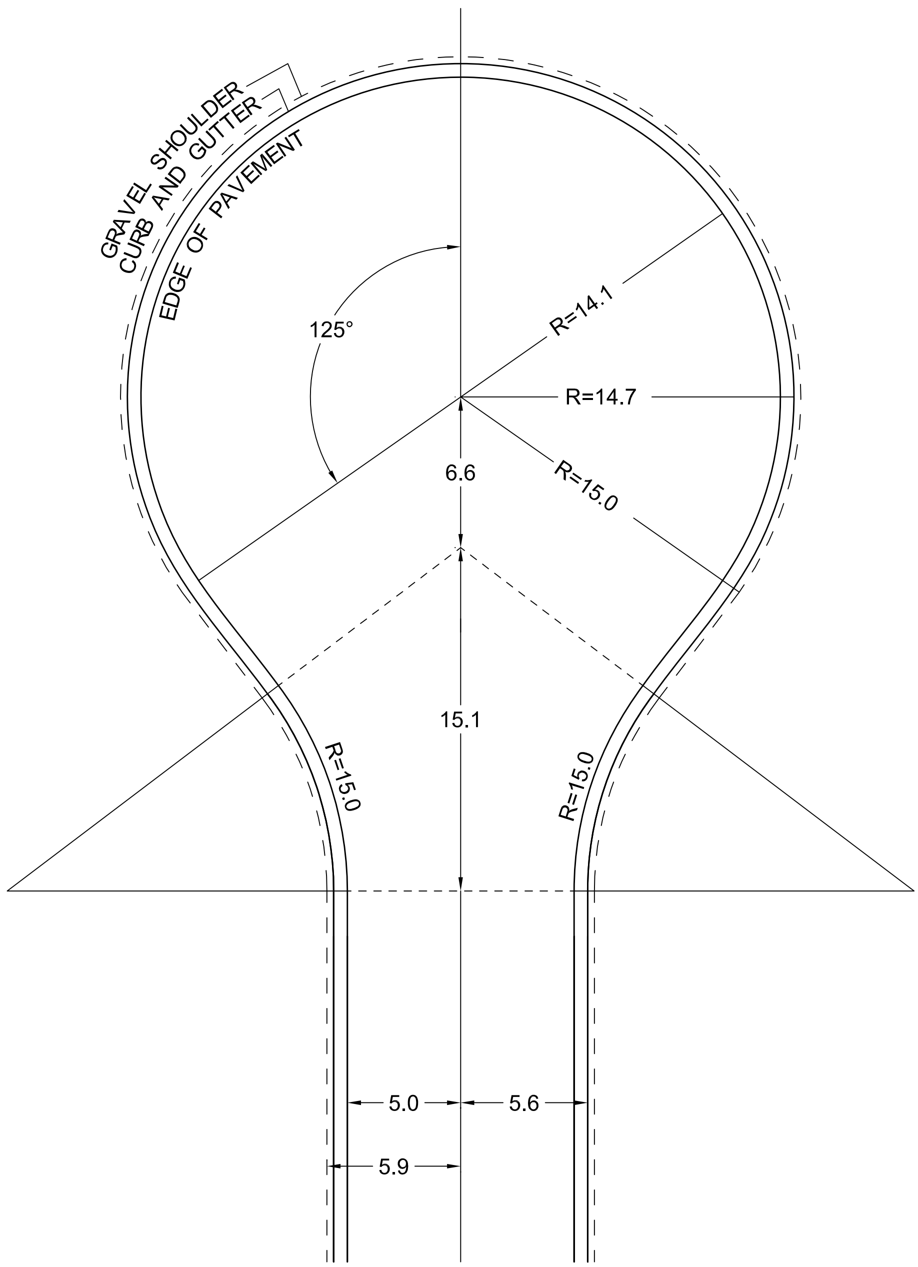
Note:

The distance from centreline of the intersecting road to the radius point of the Cul-de-Sac is maximum 150 metres.

MoT Section	1420		TAC Section	Not Applicable

Figure 1420.I Local/Urban Cul-de-Sac

N.T.S.



Note:

The distance from centreline of the intersecting road to the radius point of the Cul-de-Sac is maximum 150 metres.

MoT Section	1420		TAC Section	Not Applicable

1420.J Offset Cul-de-Sac

N.T.S.

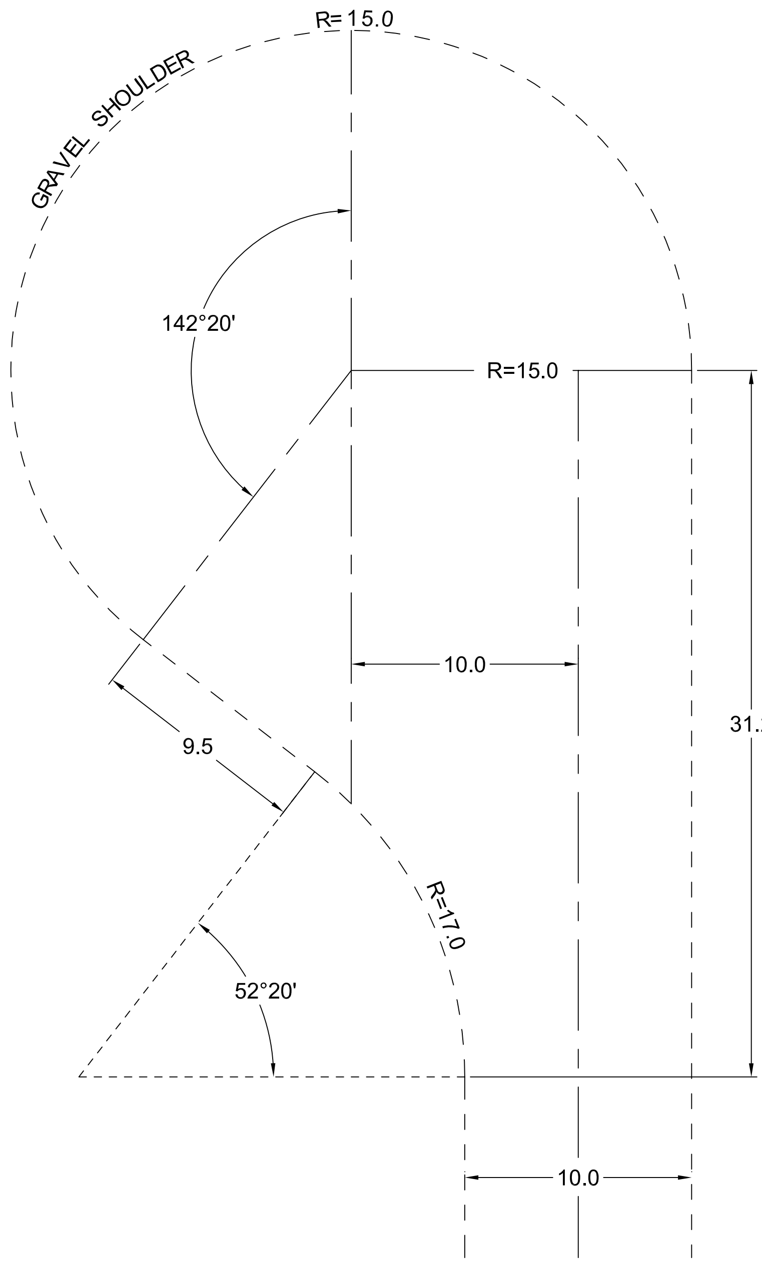


Figure 1420.K Typical Hammerhead
N.T.S.

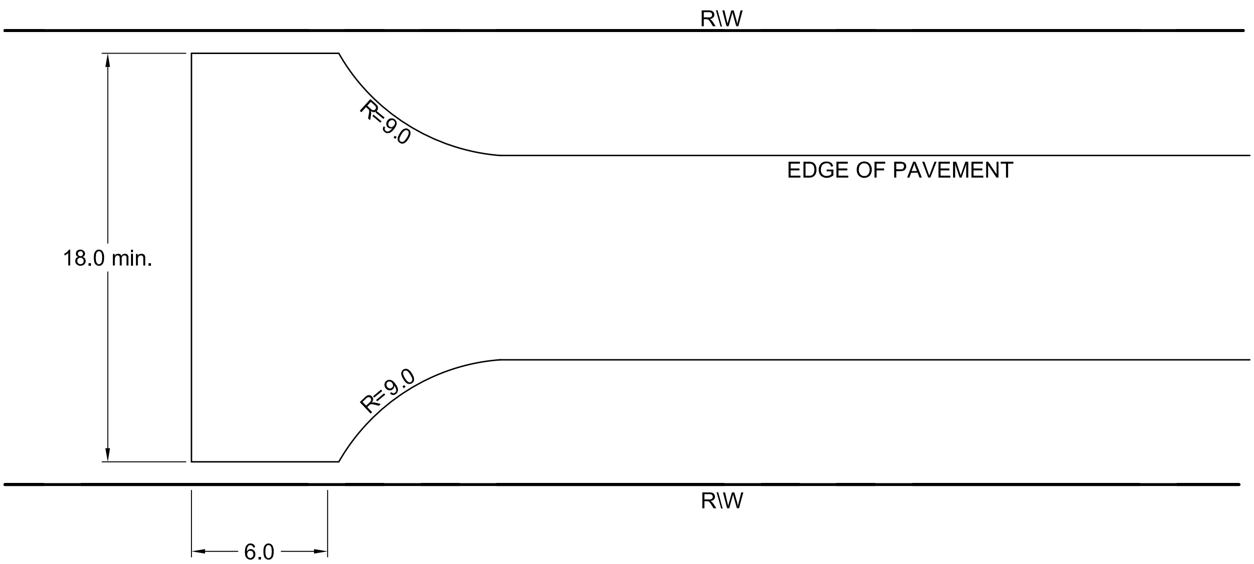
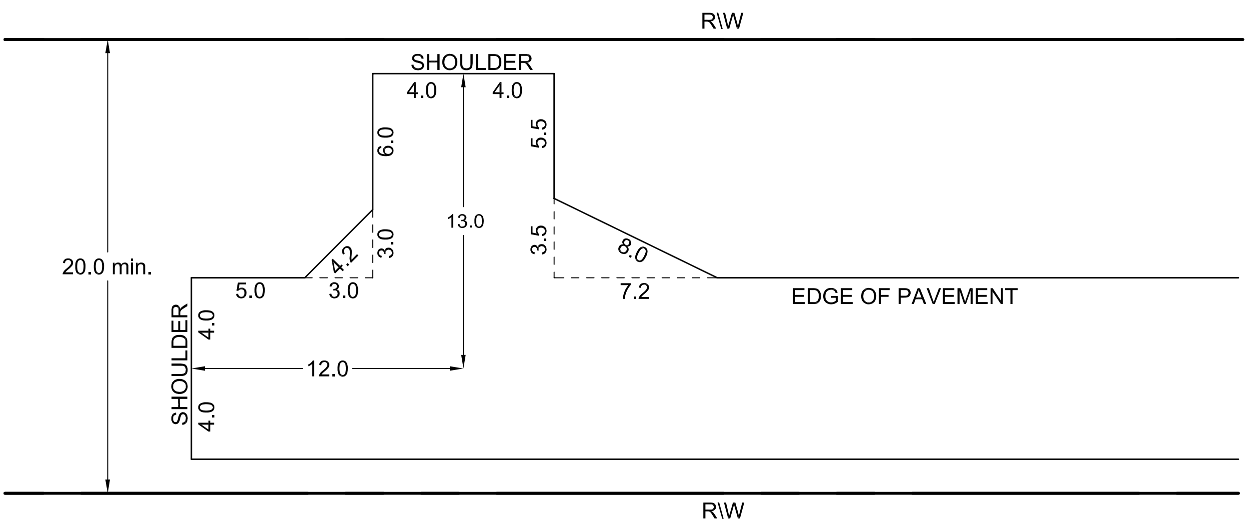


Figure 1420.L Modified Hammerhead



1420.05.05 Frontage Roads

The Right-Of-Way width shall be 15 metres or the cross section width plus 3 metres, whichever is greater. (This is additional to the through road requirements.) Ensure sufficient setback at intersections to accommodate turn slots, etc., thus ensuring a bulbed connection is necessary at all frontage road intersections.

1420.05.06 Backage Roads

For these standards, backage roads shall be considered local roads.

1420.05.07 Cross Slopes

All roadways shall be constructed using a centerline crown and shall be graded and compacted with the following crossfall to ensure road drainage:

- Normal cross slopes shall be 2% for paved roads and 4% for gravel roads.

1420.05.08 Superelevation

Superelevation is generally not applied on local subdivision roads or cul-de-sacs; reverse crown is usually maintained in ≤ 800 metre radius curves @≤ 50 km/h. Rural roads of a continuous nature that provide access to a subdivision would be better classified as Low-volume roads and should be superelevated accordingly. Refer to the Low-volume Road Chapter of the BC Supplement to TAC. When the decision has been made to superelevate curves, a maximum rate of 0.04 m/m shall be used for local urban street systems. This is appropriate for design speeds up to 70 km/h and where surface icing and interrupted traffic flow are expected. Superelevation rates of 0.04 m/m and 0.06 m/m are applicable for design of new urban streets in the upper range of the classification system where uninterrupted flow is expected and where little or no physical constraints exist.

1420.06 INTERSECTIONS/ACCESSES

1420.06.01 General

Intersections shall be as near as possible to right angles. The minimum skew angle of the intersection shall be 70 degrees and the maximum skew angle shall be 110 degrees.

1420.07 UTILITY SETBACK

Utility poles or signs should be within 2 metres of the property boundary or a minimum 2 metres beyond the toe of the fill, whichever gives the greater offset from the road. See Figure 1420.C.

1420.08 DRIVEWAYS

1. Driveway location, spacing and approval shall be at the discretion of the Ministry Representative.

2. The first 5 metres (measured from the ditch centerline) of all residential driveways shall be constructed at or near a right angle (70° to 110°) to the road and at a maximum ± 2 % grade.

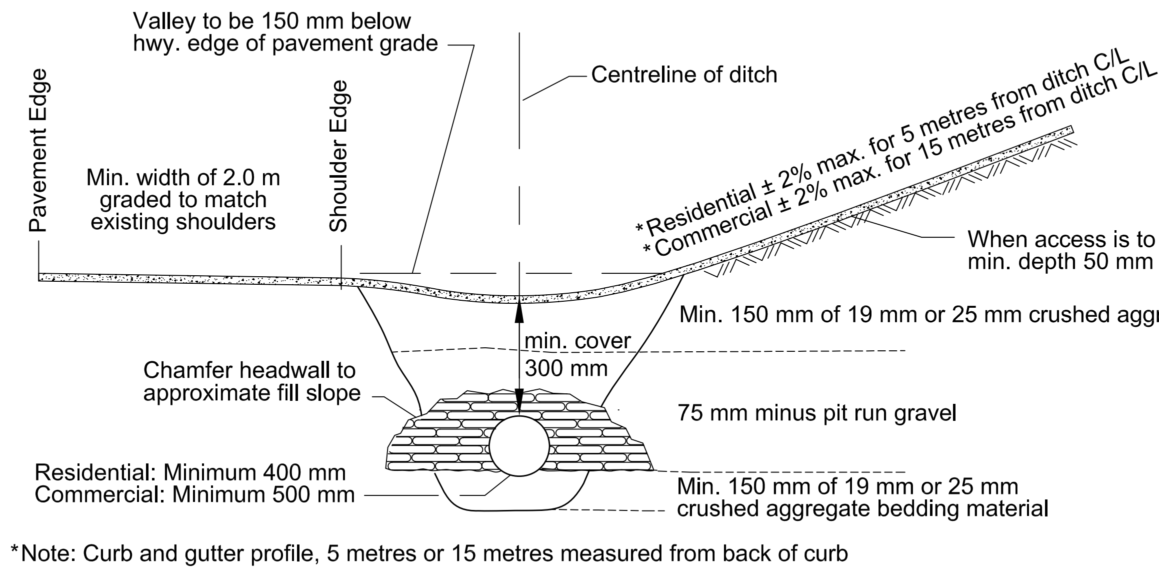
3. All open shoulder driveways with a level or rising grade are to be constructed with a "valley" or "swale" over the ditch line to ensure surface water enters the ditch and does not enter the road. See Figure 1420.N

4. Driveway grades shall not exceed 8% within the Right-of-Way.

5. Driveway radius and widths:
   Residential/Farm – 6 metre radius and minimum width
   Logging/Commercial – 9 metre radius and minimum width

6. All lots with cuts or fills greater than 1.8 metres shall have engineered drawings when requested by the Ministry representative.

Figure 1420.M Culvert Installation
N.T.S.

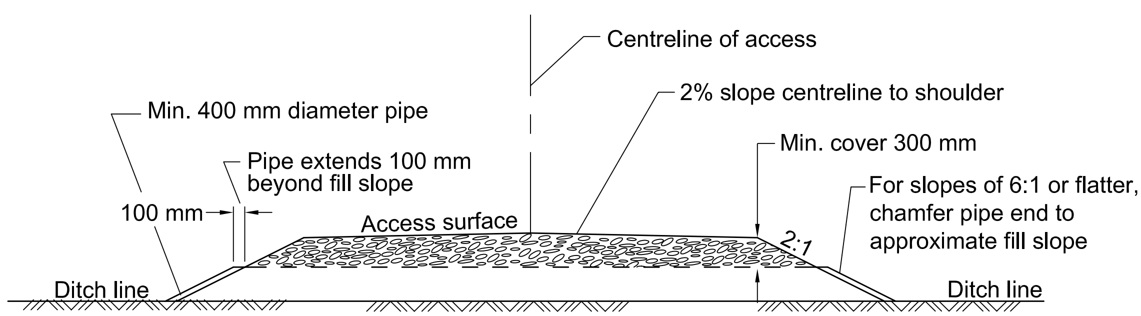


Note:

- Refer to Chapter 1000 for comprehensive bedding and backfill details.
- Minimum pipe size may be increased at the discretion of the Ministry representative.
- Minimum cover shall dictate invert elevation.
- Inlet and/or outlet of culverts subject to erosion shall have sandbags or headwall respecting clearzone principles and shall not introduce a further hazard.

See notes under Figure 1420.B

Figure 1420.N Driveway Cross Section



Driveway Culvert Installation: See Figures 1420.M, 1420.N, and 1420.O

Residential Driveways: All driveway culverts shall be a minimum 400 mm diameter but may be increased at the discretion of the Ministry Representative.

Commercial Driveways: Cross and side culverts require a 500 mm minimum diameter.

Hydraulic requirements may necessitate larger diameter culverts.

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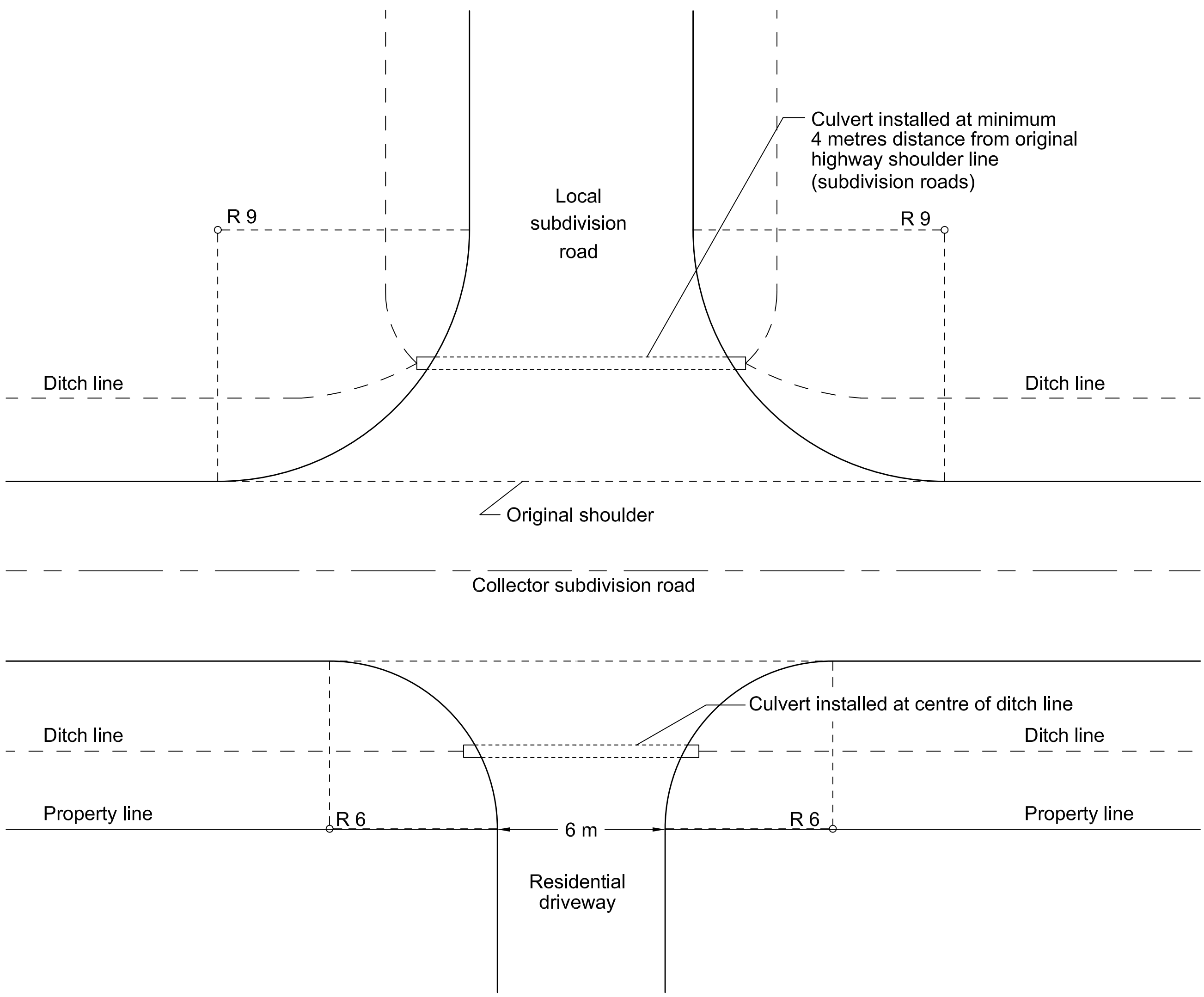
MoT Section	1420		TAC Section	Not Applicable

Figure 1420.O Driveway and Culvert Installation Layout

N.T.S



Residential Driveway:	Minimum 6 metre width at property line.	
Logging/Commercial Driveway:	Minimum 9 metre width at property line.	
Turning Radius:	Residential/Farm	Min. 6 metres
	Logging/Commercial	Min. 9 metres

1420.09 BRIDGES

All bridges must be designed to Ministry bridge design standards by a Professional Engineer who is registered in British Columbia and is experienced in bridge design. The design must be reviewed and approved by the Regional Bridge Engineer. The Professional Engineer shall certify that the completed structure has been constructed to Ministry standards.

1420.10 SIGNING/SPEEDS

All unregulated/unposted roads in unorganized territory in British Columbia are limited to a maximum speed of 80 km/h (Motor Vehicle Act 146.1); therefore, all roads designed at less than 80 km/h shall be posted accordingly.

1500 ALPINE SKI VILLAGE ROADS CHAPTER

1500 ALPINE SKI VILLAGE ROADS CHAPTER TABLES

1500 ALPINE SKI VILLAGE ROADS CHAPTER FIGURES

1510
ALPINE SKI VILLAGE ROAD CONSTRUCTION SPECIFICATIONS

Where there are existing agreements the Ministry of Transportation (MoT) and other parties, those agreements shall prevail. Where excerpts from the Standard Specifications for Highway Construction or from the BC Supplement to the TAC Geometric Design Guide are different from the said current version, the actual publications shall prevail.

These guidelines only apply to the construction of Alpine Ski Village roads. They do not apply to the construction of the access roads leading up to Alpine Ski Villages.

Exceptions to these guidelines shall be directed through the District Manager, Transportation to the Regional Director

1510.00 PREAMBLE

1510.00.01 Project Teams

For Districts regularly involved in alpine ski village road developments and approvals, a Project team should be created with the mandate of addressing ski village road developments. The Project team shall be responsible for setting the design criteria including the right-of-way requirements. A formal design criteria sheet shall be completed as part of the project documentation. The Project team should consist of a local developer(s) and/or consultant(s), a District development approvals representative*, appropriate Regional engineering representative(s), appropriate District representative(s), a maintenance contractor representative and others, as is seen fit. This Project team could be put together on a project by project basis, although the creation of a permanent Project team would be more desirable.

** District development approvals representatives should liaise with Provincial Approving Officers.*

1510.00.02 Design Criteria Variance and Dispute Resolution Process

If exceptions to geometric design guidelines are desired, a design criteria sheet must be submitted to the Regional Manager of Engineering requesting approval. If the requested exception is a substantial variation from Ministry guidelines, the Regional Manager of Engineering may forward the criteria sheet to the Chief Engineer for a decision. The design criteria sheet shall list the MoT guidelines criteria and the proposed criteria along with supporting rationale of the variance signed by a Professional Engineer registered in British Columbia.

The District shall formally notify all parties when the dispute resolution process is initiated. Any disputes that arise within the Project team shall first be adjudicated by the Regional Manager of Engineering. If this adjudicated decision is not agreeable to both parties, it becomes the responsibility of the Proponent and District Manager Transportation or Regional Manager of Engineering to each prepare a “Briefing Note for Decision” that describes the issue and their recommendation. The Decision is to be signed off by the MoT Chief Engineer within 14 working days from the submission. The Chief Engineer may discuss the issues with Headquarters engineering staff, the Regional Manager of Engineering, the District and the Proponent, as he sees fit, for the purpose of clarification and decision. The formal decision shall be provided to the Proponent by the final sign off authority.

1510.01 GENERAL

1. All construction practices and procedures shall conform to the **current** edition of the Ministry's ***Standard Specifications for Highway Construction*** unless specified otherwise in the text below or by the Ministry Representative. Copies of the Standard Specifications can be obtained from the MoT website (www.gov.bc.ca/tran) by going to the Site Index, then to Standard Specifications.

2. The developer shall conform to the conditions contained in the Standard Specifications as well as any Special Provisions specified by the Ministry. These Special Provisions shall take precedence over the Standard Specifications.

3. The Developer must follow the Quality Management section of the Standard Specifications. For any construction started prior

to the District approval of design plans, the Developer must have an accepted Quality Control Plan and a Quality Control Manager in place. If not, the MoT may hire a 3rd party Quality Control engineer at the Developer's expense.

4. Roadways shall not be accepted if any one of the following occurs:

   a) If road construction has been undertaken during periods of snow, heavy rains, freezing, or other such unsuitable weather conditions.
   b) If granular aggregate has been placed upon a frozen, wet, muddy, or rutted subgrade or base course.
   c) If a design plan has not been accepted by the Ministry.
   d) For reasons other than those outlined above, as per the discretion of the Ministry representative. Justification from the Ministry representative will be required if a roadway is not accepted.

1510.01.01 Right-of-Way Width

In order to optimize land use within an alpine ski development area, MoT is prepared to accept a "dedicated" right-of-way width sufficient to contain, but not limited to: roadway lanes, shoulders, parking aisles (if applicable), necessary utilities (including setbacks), dedicated snow storage aisles, and sidewalks. It is left to the Project team to discuss, define, and agree upon the extents of the dedicated right-of-way, including which roadway features are to be encompassed within this right-of-way width. The dedicated right-of-way must be viewed on an intersection to intersection basis only, rather than parcel by parcel, in order to maintain a consistent right-of-way width over the corridor.

In addition to the dedicated right-of-way width, there shall also be a requirement for a "statutory" right-of-way width. This statutory right-of-way is required at the developmental stage and must be of sufficient width to contain all works[1] plus 3 metres beyond the top of cut or toe of fill.

Based on the definitions outlined in the above paragraphs, the "total" right-of-way shall be defined as the dedicated right-of-way plus the statutory right-of-way (refer to Figure 1510.A). This total right-of-way will allow MoT to freely carry out its responsibilities to ensure a safe and effective roadway is maintained. This concept of total right-of-way (dedicated plus statutory) will require Project team flexibility in developing a mutually agreeable combination of both dedicated and statutory rights-of-way.

For zoning purposes, the intent is that the setback would be from the dedicated right-of-way; however, property owners will not be permitted to erect a building within the statutory right-of-way until the Ministry is satisfied that the cut and fill slopes adjacent to the road have been stabilized. The setback would either be the Provincial requirement of a minimum 5 metre building setback or the Regional District or local government setback requirement, whichever is greater.

As described above, the purpose of the statutory right-of-way is to provide MoT with unencumbered access to all parts of the roadway works to carry out any necessary maintenance or remedial works. If, after completion of the development infrastructure (i.e. residential, commercial construction), the property owners have fully resolved the Ministry's concerns, the Ministry will then be prepared to have the statutory right-of-way released from the Title. Until this time, or if the property owner chooses not to stabilize or infill the slopes, the statutory right-of-way will remain registered against the Title to allow the Ministry continued access to the roadway works, if and when required.

The Ministry may consider the posting of the road rights-of-way and the statutory rights-of-way adjacent to Crown Land after construction, subject to assurances that the pinning will be completed after and upon satisfactory approval of the construction.

MoT concerns, including but not limited to: cut and fill sections, geotechnical instability, storm/flood hazards, future widening, and maintenance including snow/ice storage will need to be addressed prior to the release or partial release of the statutory right-of-way. These situations may require the construction of mitigative works, satisfactory to the Ministry, first being completed at the owner's cost, before release or partial release of the statutory right-of-way would be considered.

[1] Includes, but not limited to: roadway lanes, shoulders, parking aisles (if applicable), necessary utilities (including setbacks), dedicated snow storage aisles, sidewalks, ditches, cut slopes, and fill slopes.

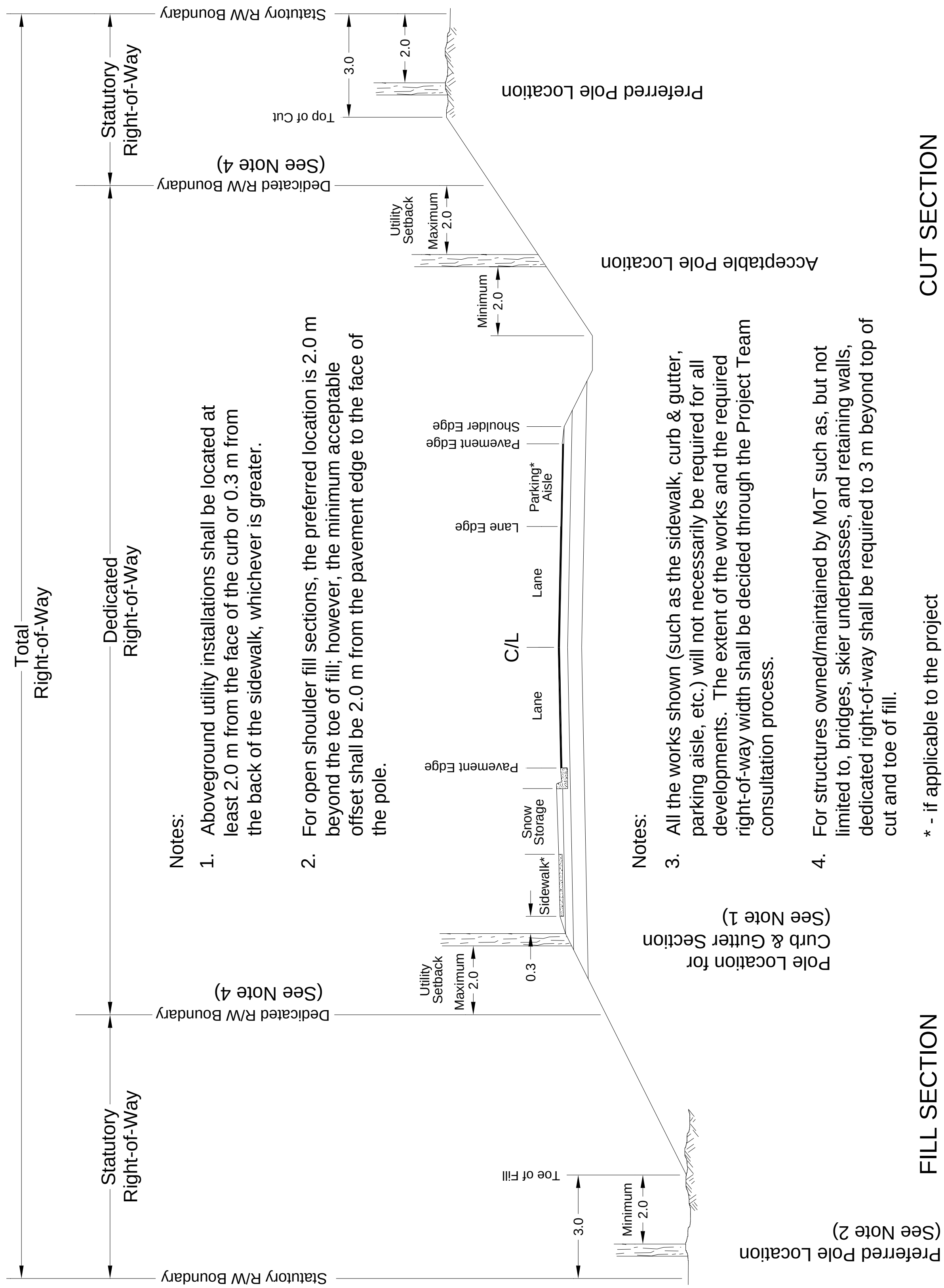
See Table 1510.A for minimum right-of-way widths. These minimum widths were developed as guidelines based on the minimum width required to encompass a basic roadway cross-section. Provincial Approving Officers may request additional dedicated right-of-way width to ensure all roadway features are adequately encompassed within the dedicated right-of-way envelope.

NOTE: Additional Right-of-Way may be required for bridges to adequately accommodate bridge guardrail flares.

Table 1510.A – Right-of-Way Width

	MINIMUM DEDICATED RIGHT-OF-WAY
Local Urban	14 m
Local Rural	18 m
Collector Urban	18 m
Collector Rural	20 m

Figure 1510.A Right-of-Way Requirements



1510.01.02 Inspections

Inspections shall be carried out upon completion of each of the following stages of construction:

a) Clearing and Grubbing and Subgrade Slope Staking
b) Roadway and Drainage Excavation and Subgrade Construction Slope Stakes
c) Select Granular Sub-Base Construction and Slope Stakes for Surface Course Construction
d) Paving (when required)
e) Completion (signs, pavement markings, etc.)

The developer shall give a minimum of one (1) week's notice prior to completion of each stage to allow for the scheduling of inspections. If required notice is not given, the roadways may not be accepted.

A Letter(s) of Assurance is required at the end of construction. This letter(s) must be signed on behalf of the Developer by the responsible Professional Engineer.

Testing and/or inspections shall be carried out by the Ministry representative. Testing and/or inspections by an independent testing agency with a qualified Professional Engineer or Limited Licensee, practicing in this scope of engineering and registered with APEGBC, shall be considered as an acceptable alternative if agreed to by the Ministry Representative and the Developer.

1510.01.03 Other Regulating Agencies

The developer shall comply with any and all statutory regulations and bylaws and all applicable Federal, Provincial, Regional District, and Improvement District regulations during construction work.

1510.01.04 Miscellaneous

All roads shall be slope staked as requested by the Ministry Representative.

All utility lines as part of new subdivisions shall be inspected by the Ministry Representative for appropriateness of location.

1510.02 CLEARING AND GRUBBING

Clearing and grubbing shall be in accordance with Section 200 of the Standard Specifications. No debris shall be buried within the fill.

NOTE: Inspection and approval of clearing and grubbing by the Ministry Representative are required prior to proceeding with sub-grade construction.

1510.03 ROADWAY DRAINAGE EXCAVATION

Roadway and Drainage Excavation shall be in accordance with Subsection 201.01 of the Standard Specifications.

1510.04 EARTH EMBANKMENTS

Earth embankments shall be in accordance with Subsections 201.37 and 201.38 of the Standard Specifications.

1510.05 ROCK EMBANKMENTS

Rock embankments shall be in accordance with Subsection 201.36 of the Standard Specifications.

1510.06 SPECIAL SLOPE TREATMENTS

Slopes shall be treated in accordance with Drawing SP201-01 in the Standard Specifications. Hydro seeding shall be done as directed by the Ministry Representative.

1510.07 GRANULAR SURFACING, BASE AND SUB-BASES

1510.07.01 Aggregate Quality

Aggregate quality shall conform to Section 202 of the Standard Specifications.

1510.07.02 Pavement Design Standards

Pavement structure shall be designed by a Registered Member of APEGBC with appropriate qualifications in geotechnical design. Technical Circular T-01/04 “Pavement Structure Design Guidelines” (available on-line at: http://www.th.gov.bc.ca/publications/Circulars/lister.asp?set=Current&circ=T&year=2004) shall be used by the pavement designer as a guide.

Four Design Standards, (Types A, B, C and D) based on general roadway classification, are used to categorize British Columbia’s provincial road network. Twenty (20) year design Equivalent Single Axle Loads (ESALs) are the primary criteria used for selection of the guideline base.

For alpine ski village roads, Type "A" and Type "B" design standards are not applicable as the 20 year design criteria (> 100,000 ESAL) will not be met.

NOTE: one ESAL = one standard axle load = 8,165 kg (18,000 lb.)(i.e. Benkelman Beam Truck)

Applicable designs to be considered by the Pavement Designer are summarized as follows:

STANDARD TYPE	ROADWAY DESIGNATION	20 YEAR DESIGN ESAL CRITERIA
TYPE "C"	LOW VOLUME ROADS	< 100,000
TYPE "D"	SUBDIVISION ROADS	< 100,000

1. **TYPE "C"** (see Type "D" below)
LOW VOLUME ROADS

2. **TYPE "D"** (See Figures 1520.D & E)
SUBDIVISIONS ROADS < 100,000 ESAL's
50 mm A.P.
225 mm C.B.C (`25 mm MAXIMUM size)
S.G.S.B. (See 1510.07.03)
NOTE: Gravel depths are the compacted measurements.

1510.07.03 Aggregate Gradation and Surfacing

The Ministry Representative, in consultation with the Regional Geotechnical and Materials Engineer, may specify alternative designs than stated below in consideration of local soils and climatic conditions. Granular surfacing, base and sub bases shall be in accordance with Section 202 of the Standard Specifications.

Regional Geotechnical and Materials Engineers shall review alternate pavement design specifications and material selection on an individual project basis, if requested from the developer's engineer with valid rationale.

There are typically two gravel courses for paved roads and three for gravel roads:

1. The lower course (S.G.S.B). shall consist as follows:
   - A minimum thickness of 300 mm of S.G.S.B. shall be applied over fine-grained subgrade (Unified Soils Classification System - ML-CL-OL-MH-CH-OH)
   - A minimum thickness of 150 mm of S.G.S.B. shall be applied over coarse grained subgrade (Unified Soils Classification System - GW-GP-GM-GC-SW-SP-SM-SC) where ground water does not pose a drainage problem and frost penetration does not affect the structure.
   - A minimum 150 mm S.G.S.B. shall be applied over rock.
   - No S.G.S.B. is required in exceptional circumstances where the following criteria has been met:
     - Structural Design Criteria is satisfied and
     - Subgrade material consists of clean granular deposits that satisfy the S.G.S.B. gradation and construction criteria of Section 202 of the Standard Specifications.

NOTE: All leveling materials applied directly to blasted rock cuts shall be of S.G.S.B. quality.

2. For gravel roads, the mid course shall consist of 150 mm of 25 mm Crushed Base Course (C.B.C.) in accordance with Section 202 of the Standard Specifications.

3. For paved roads, the upper course shall consist of 225 mm of 25 mm C.B.C. in accordance with Section 202 of the Standard Specifications.

   For gravel roads, the upper course shall consist of 150 mm of Crushed Surfacing Aggregate in accordance with Section 202 of the Standard Specifications.

- Subject to local conditions, the Ministry Representative may request additional gravel depths or confirmation of pavement structure design as specified in **1510.07.02**.
- Roadways shall be graded and compacted with crossfall for road drainage as follows:
  a) For paved roads - 0.02 m/m crossfall (normal crown) on tangents and appropriate superelevation as specified on curves.
  b) For gravel roads - 0.04 m/m crossfall on tangents and appropriate superelevation as specified on curves.
- Gravel shall be spread and compacted in lifts not exceeding 150 mm in depth or as specified by the Ministry Representative. If requested by the Ministry Representative, water shall be applied during gravel compaction to achieve 100% proctor density as specified in Section 202 of the Standard Specifications.
- The owner/contractor shall hire a qualified inspector (see **1510.01.02**), to provide written confirmation of compliance with Section 202 of the Standard Specifications.

THE S.G.S.B. THICKNESS MUST BE ACCEPTED BY THE REGIONAL GEOTECHNICAL AND MATERIALS ENGINEER.

NOTE: *Inspection and approval by the Ministry Representative (or at their request, a qualified Professional Engineer or Limited Licensee practicing in this scope of engineering) of granular material used for each gravel course is required prior to placement of the upper gravel courses (see* ***1510.01.02)***

1510.08 CONSTRUCTION

All cut and fill slopes shall be designed by a registered member of APEGBC or Limited Licensee practicing in that scope of engineering. The following guidelines shall be considered:

1. Back (cut) slopes shall be 1.5:1 or flatter, except in sand or similar material which shall be 2:1 or flatter, unless otherwise specified by the Ministry Representative. For rock ditches refer to **Figure 1520.F.**
2. All embankment (fill) slopes shall be 2:1 or flatter. Slopes up to 1.5:1 shall be considered by the Ministry Representative upon request and the appropriate documentation from the designer. The Ministry Representative must approve slopes steeper than 2:1 prior to construction. The Ministry will not unreasonably withhold approval.
3. All embankment materials and gravel base courses shall be laid in 150 mm lifts. The contractor should use the appropriate equipment required to obtain the compaction as specified in the Standard Specifications for Highway Construction. Watering shall be carried out as required to provide optimum water content during compaction. Grades containing soft spots will not be accepted until such sections have been excavated and backfilled with suitable material and compacted. Other methods of compaction will be considered by the Ministry Representative upon request and must be approved by the Ministry Representative prior to implementation.

1510.09 STORM DRAINAGE

1510.09.01 General

When information is presented in two locations or publications, difficulties can arise if both are not synchronized for changes. Rather than run that risk, Drainage Design is discussed as part of Chapter 1000, Hydraulics and Structures of the *BC Supplement to TAC Geometric Design Guide*.

A detailed Master Drainage Plan must be submitted with the design drawings unless previously provided in a Master Plan. The construction shall be in accordance with the storm water practices identified in the Master Drainage Plan. An update to the Master Drainage Plan may be required if local drainage issues are not adequately addressed by the Plan.

Drainage shall be adequately designed and meet the satisfaction of the Ministry Representative. All ditches and storm drainage pipes are to be carried to a natural drainage course. The original drainage pattern for the site shall not be altered without permission of any government agency that may have regulatory jurisdiction.

Drainage easements or statutory Rights-of-Way may be required. Drainage easements shall be a minimum of 6 metres in width or as determined by the Ministry Representative.

1. Only Ministry approved Corrugated Steel, Concrete, PVC or High Density Polyethylene pipe may be used for storm sewers. PVC may be used for storm lines in the road but is not to be used for culverts.

2. The minimum size driveway culvert shall be 400 mm diameter with a minimum required cover of 300 mm. The minimum size culvert for a collector (network) road shall be 500 mm diameter with a minimum cover of 450 mm. The actual proposed culvert sizes must be determined by the calculated hydraulic requirements, but must be no smaller than the minimums mentioned above. See Table 1040.A for a comprehensive listing of minimum cover requirements for network roads. These minimum dimensions may be increased at the discretion of the Ministry Representative.
3. Culvert grade shall be a minimum of 0.5% percent unless otherwise approved by the Ministry Representative.
4. Culverts shall be bedded and backfilled within the subgrade zone with a fine graded gravel free of rock over 25 mm.
5. The ditch invert grade shall be a minimum of 150 mm below the bottom of select granular sub base but shall be deep enough to ensure adequate cover, regardless of pipe size. Design flood frequencies should be considered when determining the minimum depth of cover.
6. All cul-de-sacs and hammerheads must be drained and all accumulated drainage that is conveyed across private property shall be carried on registered easements or statutory Rights-of-Way.
7. The inlet and/or outlet of culverts subject to erosion shall have sandbags or a headwall respecting clear zone principles and shall not introduce a further hazard.

1510.09.02 Curb and Gutter

Installation of curb and gutter storm systems shall only be considered after full and complete consultation with the Project team outlined in **1510.00.**

If curb and gutter storm systems are decided on by the Project team, the following issues should be considered:

- Areas behind the curb and gutter shall have adequate snow storage within the Right-of-Way.
- Erosion control measures should be put into place to eliminate and/or limit damage from run off and/or snow melt behind the curb and gutter section.
- All commencement/terminal points of curbs and catch basins should be marked by sufficient means to prevent plow damage to curbs and allow catch basins to be easily located.

1510.09.03 Requirements for Drainage Design

The Ministry's design approach for alpine ski village storm drainage is such that all storm drainage facilities be designed according to the major/minor storm drainage concept, as per the *BC Supplement to TAC Geometric Design Guide*.

The alpine ski village Master Drainage Plan must provide sufficient information to allow the reviewer to understand the developer's objectives and to thoroughly assess the hydraulic impacts of the development.

Post development storm drainage issues may be handled on a site by site basis or, if the Master Drainage Plan addresses it, they may be handled on a broader system/sector wide basis.

1510.09.04 Hydrology and Design Flow Calculations

For Hydrology and Design Flow Calculations, see Section 1020 of the *BC Supplement to TAC Geometric Design Guide*.

*NOTE: Inspection and approval of drainage and subgrade construction are required prior to gravelling (see **1510.01.02**).*

1510.10 CUL-DE-SACS AND HAMMERHEADS

Cul-de-sac or hammerhead turnarounds shall be constructed on all dead end roads that cannot be further extended or are not to be further extended until a future phase of construction. Construction shall be in accordance with **1520.07.04** of this Guideline.

NOTE: Although Chapter 1400 of the BC Supplement to the TAC Geometric Design Guide stipulates that hammerhead turnarounds shall only be considered in place of cul-de-sacs in rural situations where it is reasonable to expect a road extension within five years, the same does not apply to alpine ski village developments, where hammerheads are allowed as a permanent feature.

1510.11 PAVING

1. In most circumstances, priming will be required and surfaces shall be primed prior to paving in accordance with Subsection 501.31 of the Standard Specifications. Priming will not be required only in those situations whereby schedule concerns, due to unfavorable weather conditions, would override considerations of the time required for prime to be

distributed and set. Discussion should be undertaken with the Project team, outlined in **1510.00.01** of this Guideline, to determine which weather conditions would override the need for priming.

2. A 50 mm asphalt pavement thickness should be adequate for alpine ski village developments where traffic volumes are low and there is very little heavy truck traffic. An increase in the asphalt pavement thickness may be warranted in situations where traffic volumes are high, as determined by the Pavement Designer.
3. In rural areas, other methods of hard surfacing (such as seal coat) may be considered by the Ministry Representative.
4. Prior to paving, the developer shall contact the Pavement Designer to ensure that on-site inspection will take place before and during paving operations.
5. The decision to pave and the pavement design shall be as directed by the Pavement Designer.
6. Upon completion of paving, shoulders will consist of either 19 mm Shouldering Aggregate or 25 mm Well Graded Base Course. Compaction of the shouldering material shall be in accordance with the Standard Specifications.

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1520
ALPINE SKI VILLAGE ROAD DESIGN PARAMETERS

1520.01 CONSIDERATIONS

A Road Network Plan is based on a hierarchy of streets that is related to the amount and type of traffic served. It takes into account such factors as public transit, shopping and community facilities, and other land uses. The changing nature of the area over time is also a major factor. The future requirements for the entire road network are considered when an alpine ski village application is evaluated.

- Proposed Road Network plans must be laid out in such a manner as to not compromise the mobility function of the major roads. These plans should be reviewed and accepted by the Ministry. Once a Master Plan has been accepted by the Ministry, a review is not required unless major changes have occurred to the Plan.
- Where possible, new developments should have at least two accesses, one to act as the main resort access and an additional access (which may be gated), to be used in case of emergency.
- Pedestrian and cyclist volumes should be considered. Walkways and cycling lanes should be provided where considered necessary and as shown in the development plan. Walkways and cycling lanes can be either along the road or separated within a trail network.

1520.02 ROAD CLASSIFICATION

1520.02.01 Arterial/Primary

Ski resort access roads shall be considered as arterial/primary roads and will not be discussed in these guidelines. Refer to T-circular 01/98 "Guidelines for the Determination of the Geometric Design Criteria for Access Roads to Ski Resorts" (available on-line at: http://www.th.gov.bc.ca/publications/Circulars/technical_circulars.asp) for geometric design criteria for ski resort access roads.

1520.02.02 Collector/Secondary

A road that provides for traffic movement between arterials and local streets with some direct access to adjacent property.

1520.02.03 Local

A road primarily for access to residences, businesses, or other abutting property.

NOTE: Local streets intended for commercial or industrial development are considered as collector roads.

1520.02.04 Cul-de-sac

A road termination providing a U-turn around area of constant radius.

1520.02.05 Hammerhead

An arrangement to allow a vehicle to turn around at the end of a dead end road. It is shaped like a "T" intersection and allows the vehicle to turn 90 degrees in one direction, back up and then turn 90 degrees to return in the opposite direction from original travel.

1520.03 DRAWINGS

The developer shall submit metric road design drawings to the Ministry which include, but are not limited to, the following:

1. **Location Plan**: Scale 1:500 or 1:1000 showing horizontal alignment, lot lines, legal description of lots, proposed alpine ski village, extents of cut and fill, proposed rights-of-way (dedicated and statutory), signing, existing and proposed culvert locations, existing water courses and proposed drainage pattern.
2. **Profile**: Scale 1:1000 horizontal and 1:100 vertical, showing the existing ground line and proposed finished road grade.
3. **Laning Drawings**: Same scale as plan drawings, road markings, location and type of warning, regulatory, directional, and if necessary, special signs to be installed.
4. **Cross Sections**: when required by the Ministry Representatives.
5. **Typical Cross Sections**: as required

The developer will commence road construction only after the Ministry Representative has accepted the road design in writing, unless under subdivision process requiring Preliminary Layout Approval (PLA). In this circumstance, Ministry approval to commence road construction is not required.

1520.04 ACCOMMODATING PEDESTRIANS AND CYCLISTS

It is recognized by the nature of alpine ski village roads, that cyclists and pedestrians will use these roads for travel within the village.

On local roads, consideration should be given to include an additional 1.8 m of roadway width in order to accommodate pedestrians. No special accommodations are required for cyclists.

On collector roads, consideration should be given to include an additional 3.6 m of roadway width, in order to provide pedestrians with 1.8 m walking spaces on each side of the roadway. In developing 4-season resorts, consideration should be given to provide 4.3 m wide shared travel lanes in order to accommodate cyclists. Where forecasted cycling volumes are not high, or at winter only locations, no special accommodations are required for cyclists.

If a trail network is provided independent of the road network, and services an area, it may be considered in substitution to a sidewalk adjacent to the road, provided that it has been agreed to by the Project Team.

NOTE: If a sidewalk is desired by the Developer, this should be discussed with the Project team. If the Project team decides that it is acceptable for a sidewalk to be constructed, maintenance and replacement of the sidewalk shall be solely the responsibility of the Developer and/or ski hill operator.

1520.05 SNOW STORAGE

Snow clearing storage shall be addressed and accommodated on a site specific basis based on snow course data and/or snowfall data, and knowledge of snowfall history for the area.

Snow clearing storage area, typically provided by ditches, will be designed to provide storage for snow compacted to a density of 500 kilograms per cubic metre (50% water equivalent). Accumulated volumes of snow are to be determined using a maximum storage height of 2.0 metres, with a maximum slope angle of 1:1 on the road/shoulder edge.

Accommodation for snow storage must also be provided in consideration of the number of parking spaces and/or access to parking spaces provided for the development(s).

Where alternate snow storage area is provided (non adjacent to the road storage), sites will be considered for approval in consideration of operational plowing capabilities.

Steps **I**, **II**, and **III**, shown below, outline the process for calculating snow storage requirements. A "Snow Storage Calculation" spreadsheet is available online to do these calculations at: http://www.th.gov.bc.ca/publications/eng_publications/geomet/TAC/TAC.htm

I

Snow accumulations for volume of snow storage requirements will be determined using either Method A or B. Wherever possible, calculations should be completed using Method A (based on snow course information).

NOTE: The Canadian convention for new snowfall density is 100 kilograms per cubic metre.

Method (A)

- Data provided from snow course readings from an on site location, or nearby, comparable data collection site, from readings taken on or near March 1st
- Average normal snow water equivalents will be used to calculate snow storage requirements
- Apply a 1:10 conversion rate for precipitation (Meteorological Standard), i.e. 1 mm water = 1 cm snowfall
- Convert to compacted snow volume @ a density of 500 kilograms per cubic metre. As the Canadian convention for new snowfall is 100 kilograms per cubic metre, the conversion ratio will be 5:1.

Sample Calculation

- Snow course @ March 1st identifies 600 mm average normal snow water equivalent
- Converted to snowfall amounts at 1:10 ratio, 600 mm of water = 600 cm of snow
- Converted to snowfall depth, 600 cm snow * (100 kg/m^3 / 500 kg/m^3) = *1.2 metres* of snow depth

OR

Method (B)

- An average annual accumulated daily snowfall to March 1st
- Convert to volume @ a density of 500 kilograms per cubic metre

Sample Calculation

- o Average annual accumulated snowfall to March 1st identified as 750 cm
- o Converted to snowfall depth,
  750 cm snow * (100 kg/m^3 / 500 kg/m^3)
  = *1.5 metres* of snow depth

II

Once the equivalent depth of snow is calculated from Methods A or B outlined above, the volume requirement for snow storage per lineal metre of road can be calculated.

Sample Calculation

- o 1.2 metres of snow depth (calculated as per Method A above)
- o Lane width to clear = 3.0 metres
- o Volume of snow per lineal metre,
  1.2 m * 3.0 m = 3.6 m^3/m

Based on this calculated volume of snow per lineal metre, the developer must then provide the Ministry with a roadway cross section, which can accommodate this volume of snow. Cross sections may include ditches, dedicated snow storage aisles or other concepts, but must comply with the maximum storage height of 2.0 metres and maximum slope angle of 1:1.

III

Additional snow storage accommodation must be made for parking accesses by adding capacity to the above calculations.

Sample Calculation

Given:

- o 1 access point of 2.4 metres width, plus an adjacent 3.0 metre lane width to clear
- o 1.2 metre of snow depth (calculated as per Method A above)

Calculations:

- o Volume of Snow Area = 2.4 m access width * 3.0 m lane * 1.2 m of snow depth = 8.64 m^3 of additional snow to accommodate
- o This additional snow can be distributed in two ways:
  - a) Along the road/shoulder @ a minimum road length along the shoulder edge of 3.0 metres
  - b) Other option proposed by the developer; ditches, etc.

- It is recognized that accumulated, plowed snow compacts to a higher density than 500 kilograms per cubic metre, but individual average maximum snowfall events must be accommodated in the defined storage area, and are not considered in these calculations.

- The defined density requirement provides flexibility to manage most individual snowfall events. Road shoulders will provide additional capacity to accommodate some snow during the larger snowfall events.

- The maximum snowfall events will not be accommodated in these calculations. During these maximum snowfall events, the availability of road surface will be compromised, but they are expected to be infrequent and for relatively short periods of time.

Other options for snow storage calculations can be conducted, and will be considered based on individual submissions from the developer(s) (e.g. an analysis of average and maximum individual snowfall events, their frequency and interval, plus a calculation for settlement, compaction, etc.)

Alternate snow storage options will also be considered, in consideration of operational capabilities, parking designation, alternate snow storage locations, and operational considerations provided by the developer and/or the community or owners associations.

1520.06 ON-STREET PARKING

As the requirement for on-street parking has a significant effect on the finished top width and Right-of-Way required for roadways, the provisions for on-street parking facilities shall be discretionary, and should be determined within the relative context of the various land uses within the various ski resorts. Where on-street parking is to be included in the design, 2.4 metres shall be added to the street width

Figure 1520.A depicts the practice for including on-street parking facilities in the roadway design.

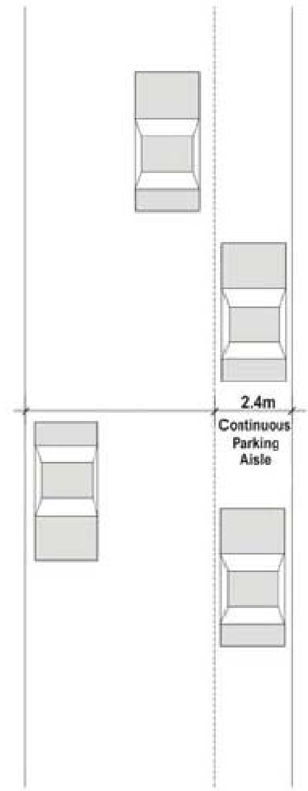
NOTE: Elevated parking aisles and add-on parking nodes are not considered to be acceptable provisions for ski resort areas as these types of parking facilities cause a major hindrance on winter maintenance activities.

- On-street parking shall only be considered after full and complete consultation by the Project team outlined in **1510.00** of this Guideline. Areas where parking is to be permitted should be carefully considered so as not to affect the safety of all other road users.
- It is MoT's preference to have no on-street parking as it significantly impairs snow removal operations, especially in these high alpine resort areas.
- Regardless as to whether on-street parking is allowed or not, consideration should be given to establishing a protocol at the local level regarding:
    - Notification and/or ticketing and/or towing of illegally parked vehicles
    - The administration of this activity
    - Location of a suitable on hill vehicle impound (if available)
- See below for some methods to accommodate on-street parking. Other methods may exist and be better suited for the resort in question.

Proposed Methods for Accommodating On-Street Parking:

- Developers and/or ski hill operators wishing to have on-street parking may want to consider strata type development options.
- Consider only allowing on-street parking on one side of the roadway, preferably on the up slope side.
- Use parking control signs to limit parking. Discussions should include maintenance contractors when determining when to restrict parking.

Figure 1520.A On-Street Parking



1520.07 ALIGNMENT

The developer shall complete all road designs within the design speed range of 30 km/h to 80 km/h, as determined by the road classification, or as requested by the Ministry Representative.

Vertical curves shall be standard parabolic curves.

For roads with design speeds of 70 km/h or more, the length of vertical curve (in metres) should not be less than the design speed (in km/h).

The developer shall demonstrate that every reasonable effort has been made to minimize the road grades. Short pitches* of steeper grades (10% for collector roads and 12% for local roads) may be acceptable on tangent sections provided the overall grade is less than 8% for collector roads and 10% for local roads. Steeper grades are not acceptable on curved sections of roadway.

Minimum parameters for various design speeds shall be as shown in **Table 1520.B**.

** Actual length of short pitches shall be at the discretion of the Project team.*

1520.07.01 Arterials/Primary

Refer to **1520.02.01.**

1520.07.02 Collectors (Network Roads)

Open Shoulder Collector/Secondary

- Cross Section: As per **Table 1520.C***
- Gravel Shoulder: 1.0 metres
- See **Figure 1520.E**

Curb and Gutter Collector/Secondary (Curb and Gutter)

- Cross Section: As per **Table 1520.C***
- Curb: 0.6 metres
- Gravel Shoulder: 0.5 metres behind curb
- See **Figure 1520.D**
- Refer to **1510.09.02.**

Requirements for snow storage are in addition to basic cross section width. Refer to **1520.05.*

Table 1520.B – Design Parameters

Road Classification	Local Roads		Local	Collector	Collector Roads		
Speed (km/h)	**30**	**40**	**50**	**50**	**60**	**70**	**80**
Minimum Radius, (metres)*	20	45	80	80	130	200	280
Minimum stopping sight distance, (metres)	30	45	65	65	85	110	150
Minimum decision sight distance, (metres)	not applicable				95	125	155
K value crest, vertical curves, taillight height	2	4	7	7	13	23	36
K value sag, vertical curves, headlight control	4	7	12	12	18	25	32
K value sag, vertical curves, comfort control	2	4	6	6	9	12	16
Minimum overhead clearance (metres)**	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Maximum desirable grade in percent*	10	10	10	8	8	8	8

Parameters based on E_{max}: 0.04 m/m

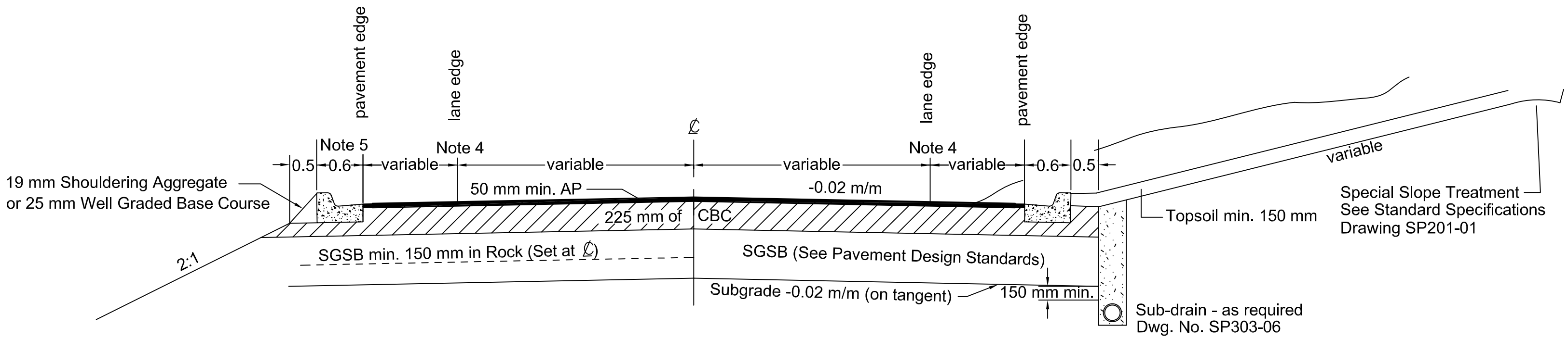
**Avoid the combined use of maximum grade and minimum radius. Maximum grades are to be reduced by 1% for each 30 metres of radius below 150 metres.*

***Overhead clearance <u>for structures</u>*

Table 1520.C – Finished Top and Shoulder Widths

	Basic Paved Width	Additional Paved Width for Parking (one side)	Additional Paved Shoulder Width to Accommodate Pedestrians – *refer to 1520.04*	Paved Width – 2 lanes shared by vehicles and cyclists
Collector	7.0 m	2.4 m	1.8 m (each side)	8.6 m (4.3 m per lane)
Local	6.0 m	2.4 m	0.9 m (each side)	n/a

Figure 1520.D Typical Two-Lane, Curb and Gutter, Alpine Ski Village Road



FILL SECTION EARTH CUT SECTION

PAVEMENT DESIGN STANDARDS - See 1510.07.02

- These are typical gravel and asphalt depths to be used in the absence of geotechnical investigation.
- 50 mm A.P. to be constructed in accordance with the latest version of the B.C. MOT Standard Specifications for Highway Construction
- No S.G.S.B. is required in exceptional circumstances where the following criteria have been met:

Structural Design Criteria is satisfied

and

Subgrade material consists of clean granular deposits that satisfy S.G.S.B. gradation and construction criteria (i.e. rutting criteria) in accordance with the latest version of the B.C. MoT Standard Specifications for Highway Construction - Section 202 "GRANULAR SURFACING, BASE AND SUB-BASES"

- MINIMUM 150 mm S.G.S.B. in Rock.
- All levelling materials applied directly to blasted rock cuts shall be of S.G.S.B. quality.
- THE FINAL S.G.S.B. THICKNESS MUST BE APPROVED BY THE REGIONAL GEOTECHNICAL AND MATERIALS ENGINEER.

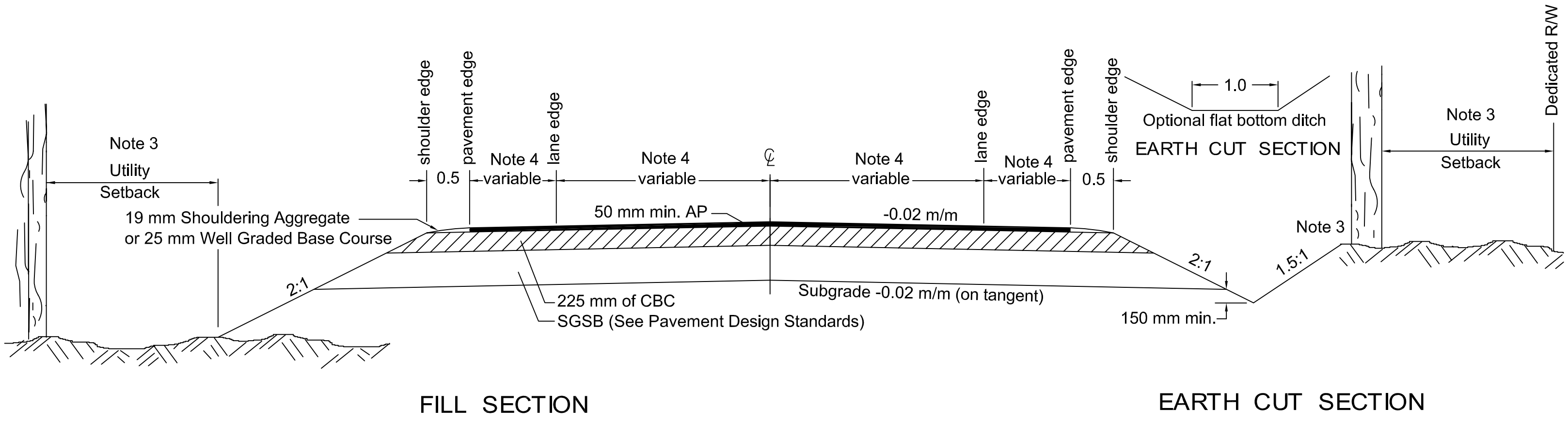
Notes:

1. For accommodating cyclists, refer to Table 1520.C
2. For roadside barrier and drainage curb details, see Section 440
3. For utiltiy installations, refer to Section 1520.09
4. For variable shoulder and top widths, refer to Table 1520.C
5. For typical curbs see SP582-01.01 to SP582-01.03 in the Standard Specifications
6. For rock ditches, see Section 440

Abbreviations:

AP Asphalt Pavement
CBC Crushed Base Course
SGSB Select Granular Sub Base

Figure 1520.E Typical Two-Lane, Paved, Open Shoulder, Alpine Ski Village Road



PAVEMENT DESIGN STANDARDS - See 1510.07.02

- These are typical gravel and asphalt depths to be used in the absence of geotechnical investigation.

- MINIMUM 150 mm S.G.S.B. on Coarse Grained Subgrades (Unified Soils Classification System - GW/GP/GM/GC/SW/SP/SM/SC) where groundwater does not pose a drainage problem and frost penetration does not affect the structure.

- MINIMUM 300 mm S.G.S.B. on Fine Grained Subgrades (Unified Soils Classified System - ML/CL/OL/MH/CH/OH).

- No S.G.S.B. is required in exceptional circumstances where the following criteria have been met:

Structural Design Criteria is satisfied

and

Subgrade material consists of clean granular deposits that satisfy S.G.S.B. gradation and construction criteria (i.e. rutting criteria) in accordance with the latest version of the B.C. MoT Standard Specifications for Highway Construction - Section 202 "GRANULAR SURFACING, BASE AND SUB-BASES"

- MINIMUM 150 mm S.G.S.B. in Rock.

- All levelling materials applied directly to blasted rock cuts shall be of S.G.S.B. quality.

- THE FINAL S.G.S.B. THICKNESS MUST BE APPROVED BY THE REGIONAL GEOTECHNICAL AND MATERIALS ENGINEER.

Notes:

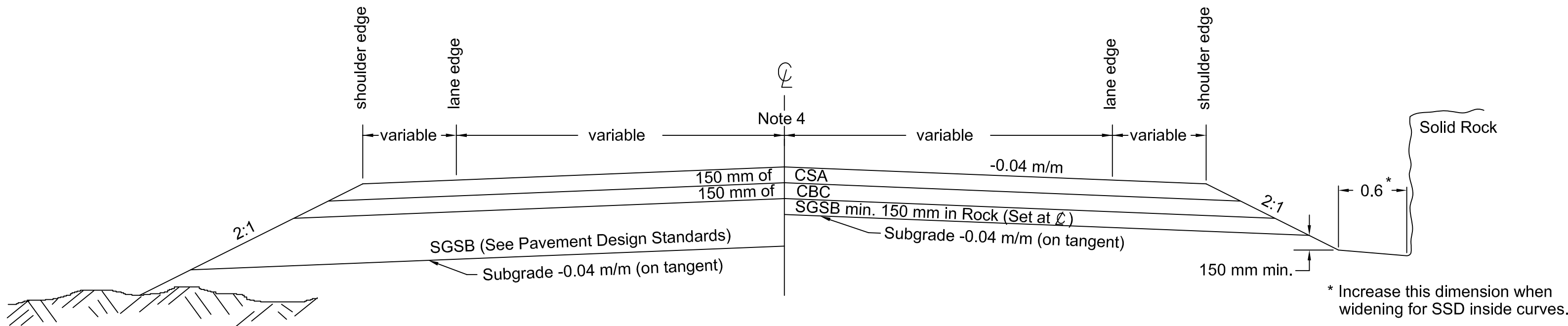
1. For accommodating cyclists, refer to Table 1520.C
2. For roadside barrier and drainage curb details, see Section 440
3. For Utility installations, refer to Section 1520.09
4. For variable shoulder and top widths, refer to Table 1520.C
5. For rock ditches, see Section 440

Abbreviations:

AP Asphalt Pavement
CBC Crushed Base Course
SGSB Select Granular Sub Base

MoT Section	1520		TAC Section	Not Applicable

Figure 1520.F Typical Two-Lane, Gravel, Open Shoulder, Alpine Ski Village Road



FILL SECTION

ROCK CUT SECTION

PAVEMENT DESIGN STANDARDS - See 1510.07.02

- These are typical gravel and asphalt depths to be used in the absence of geotechnical investigation.

- MINIMUM 150 mm S.G.S.B. on Coarse Grained Subgrades (Unified Soils Classification System - GW/GP/GM/GC/SW/SP/SM/SC) where groundwater does not pose a drainage problem and frost penetration does not affect the structure.

- MINIMUM 300 mm S.G.S.B. on Fine Grained Subgrades (Unified Soils Classified System - ML/CL/OL/MH/CH/OH).

- No S.G.S.B. is required in exceptional circumstances where the following criteria have been met:

Structural Design Criteria is satisfied

and

Subgrade material consists of clean granular deposits that satisfy S.G.S.B. gradation and construction criteria (i.e. rutting criteria) in accordance with the latest version of the B.C. MoT Standard Specifications for Highway Construction - Section 202 "GRANULAR SURFACING, BASE AND SUB-BASES"

- MINIMUM 150 mm S.G.S.B. in Rock.

- All levelling materials applied directly to blasted rock cuts shall be of S.G.S.B. quality.

- THE FINAL S.G.S.B. THICKNESS MUST BE APPROVED BY THE REGIONAL GEOTECHNICAL AND MATERIALS ENGINEER.

Notes:

1. For accommodating cyclists, refer to Table 1520.C
2. For roadside barrier and drainage curb details, see Section 440
3. For Utility installations, refer to Section 1520.09
4. For variable shoulder and top widths, refer to Table 1520.C (substitute paved for gravel width)
5. For rock ditches, see Section 440

Abbreviations:

CSA Crushed Surfacing Aggregate
CBC Crushed Base Course
SGSB Select Granular Sub Base

1520.07.03 Locals

Open Shoulder Local

- Cross section: As per **Table 1520.C***
- Ditch inverts: Minimum 150 mm below subgrade **
- Gravel shoulder: 0.5 metres
- See **Figures 1520.E & 1520.F**

Curb and Gutter Local

- Cross section: As per **Table 1520.C***
- Curb: 0.6 metres
- Gravel shoulder: 0.5 metres behind curb
- See **Figure 1520.D**
- Refer to **1510.09.02.**

Requirements for snow storage are in addition to basic cross section width. Refer to* ***1520.05.*
*********Design flows should be considered when determining the minimum depth of ditch.*

1520.07.04 Cul-de-sacs and Hammerheads

Grade:
Cul-de-sacs and hammerheads are only suitable in the alpine environment if the horizontal grade is 4% or less and the cross fall is 2% or less. Designs with a combined horizontal grade and cross fall exceeding an effective grade of 4% will not be accepted [ex. $(0.04^2 + 0.02^2)^{0.5} = 0.0447$, which is not acceptable] unless approved by the Regional Manager of Engineering as a design criteria exception.

Maximum Length:
Site specific conditions shall dictate the reasonableness of a proposed cul-de-sac or hammerhead and its length.

Parking:
Parking shall be restricted on cul-de-sacs and hammerheads in order to facilitate winter maintenance equipment.

Snow Storage:
Snow storage on cul-de-sacs and hammerheads must be specifically addressed. Refer to **1520.05.**

<u>Cul-de-sacs</u>

Open Shoulder: 15 metre radius finished top***
See **Figure 1520.G**

Collector:
14.5 metre radius paved top***
0.5 metre gravel shoulder
Local:
14.0 metre radius paved top***
1.0 metre gravel shoulder

Curb and Gutter: 15.2 metre radius finished top***
See **Figure 1520.H**

14.1 metre radius paved top***
0.6 metre curb width
0.5 metre gravel shoulder

*****The above mentioned radii are nominal. The final finished size shall be determined by the Project team.*

NOTE: Consideration will be given to using Offset Cul-de-sacs.

<u>Hammerheads</u>

See **Figures 1520.I & J**

Design Vehicles:
- Local: Heavy Single Unit (HSU) Truck
- Collector: WB-20 Tractor Semitrailer

NOTE: Designs that cannot accommodate the vehicles mentioned above will not be accepted. These design requirements are necessary in order to accommodate tandem snow plows without excessive maneuvering.

1520.07.05 Secondary Accesses and Mid Block Turn Arounds

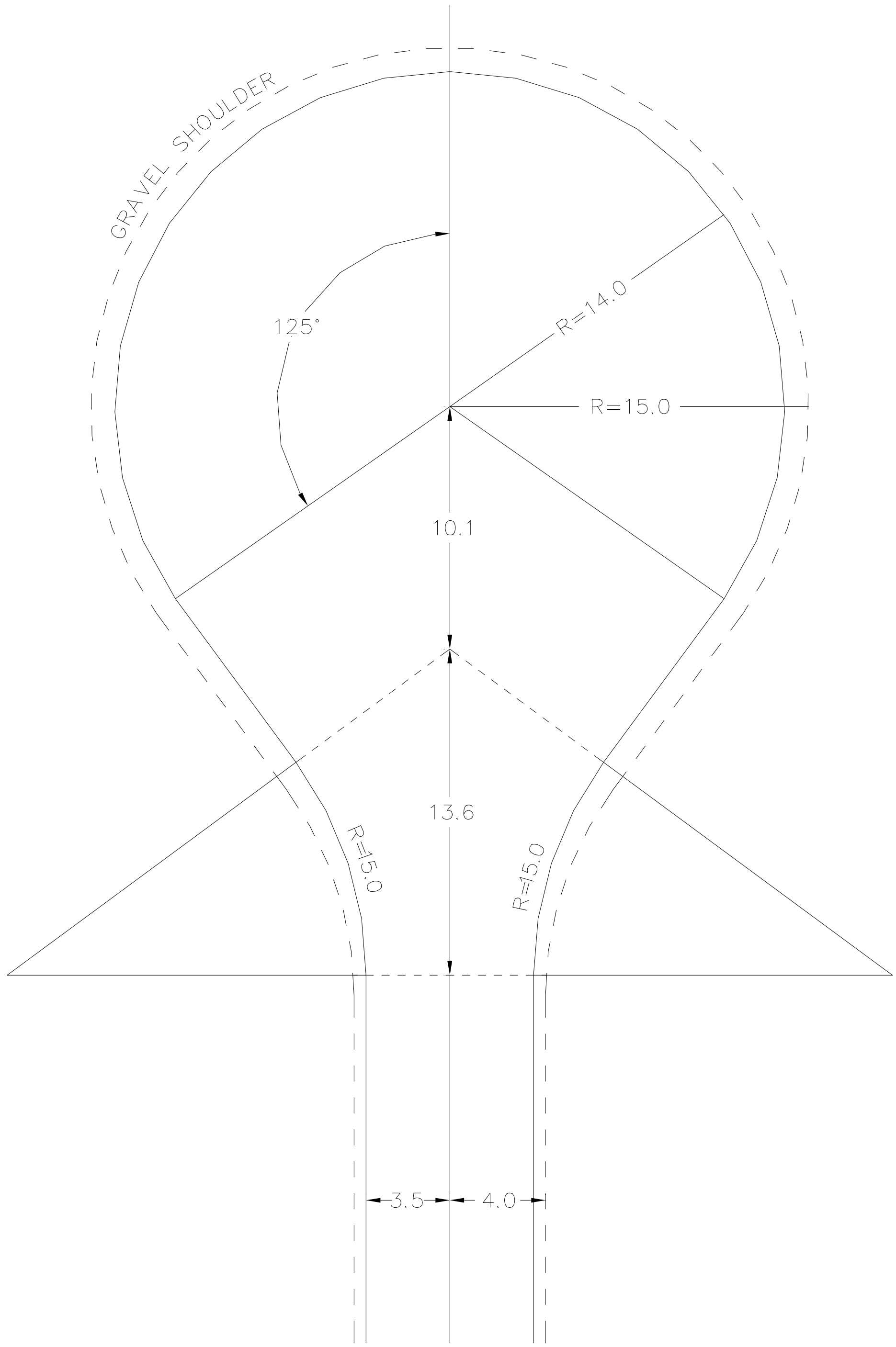
Where possible, considerations should be given to the implementation of a secondary emergency vehicle access point along the cul-de-sac or hammerhead. These secondary accesses do not need to form part of the public roadway network and do not necessarily need to be paved.

Design Parameters – Secondary Accesses:

- Maximum grade: 15%
- Minimum width: 3.0 metres

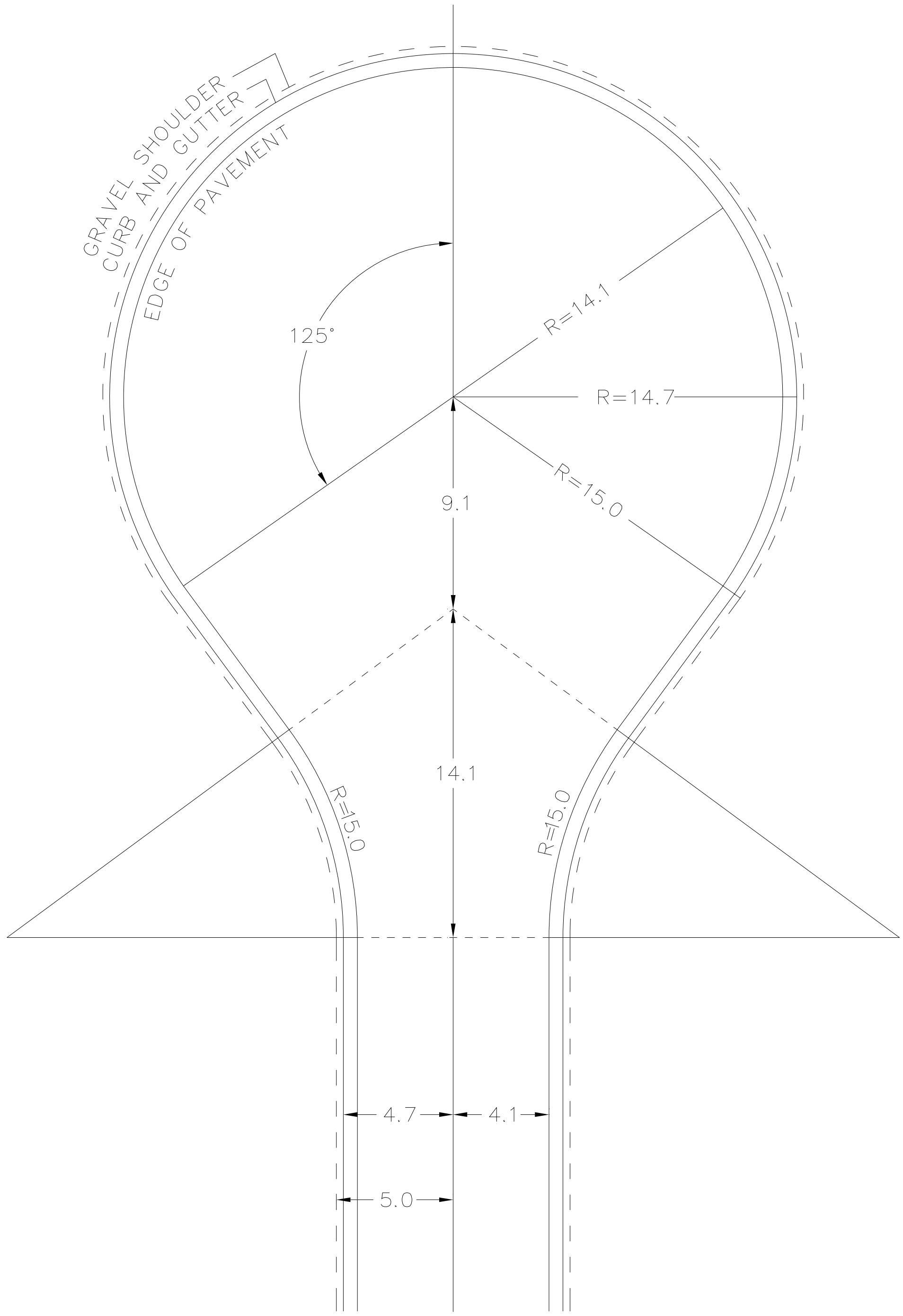
Where possible and appropriate, developers should introduce midblock turnarounds to allow for design vehicle return movements on long stretches of single access roadway. If midblock turnarounds are required, they shall be designed to the parameters outlined for secondary accesses.

Figure 1520.G Collector/Local Open Shoulder Cul-de-sac



*NOTE: As noted in **1520.07.04**, these distances are nominal.*
Site specific conditions will dictate the appropriateness of a design.

Figure 1520.H Collector/Local Curb and Gutter Cul-de-sac



*NOTE: As noted in **1520.07.04**, these distances are nominal.*
Site specific conditions will dictate the appropriateness of a design.

Figure 1520.I Typical Hammerhead

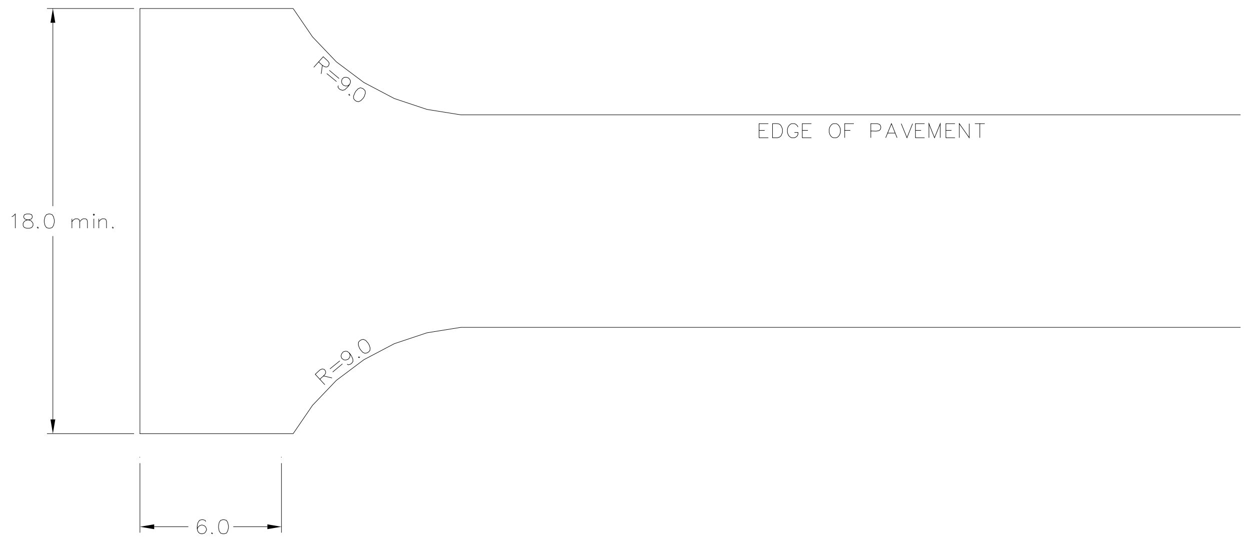
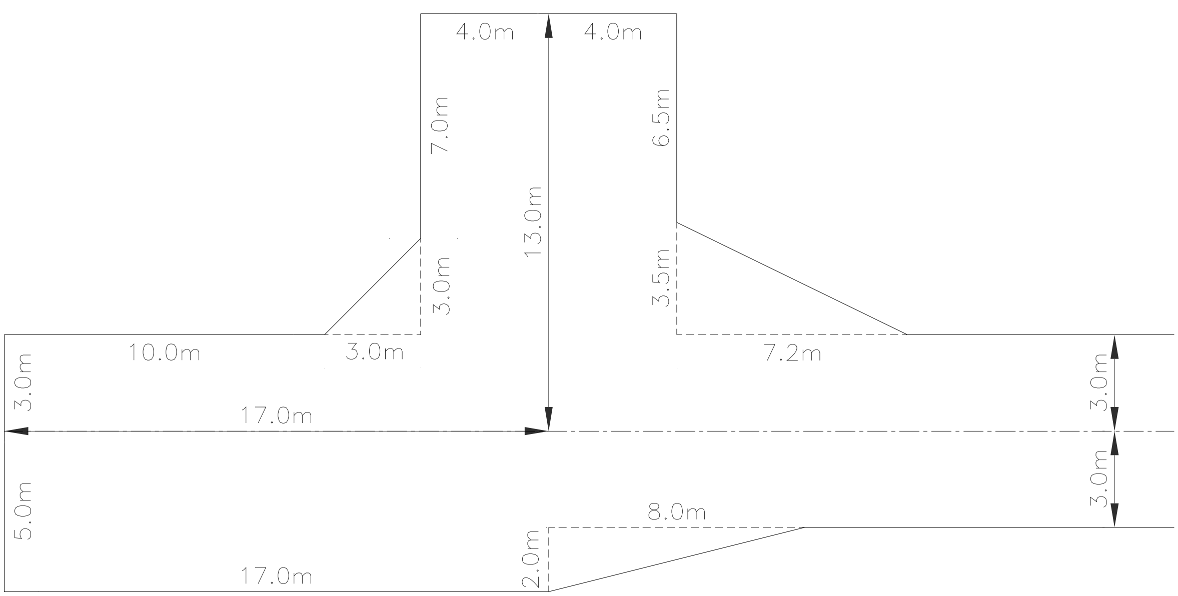


Figure 1520.J Modified Hammerhead



*NOTE: As noted in **1520.07.04**, these distances are nominal.*
Site specific conditions will dictate the appropriateness of a design.

1520.07.06 Cross Slopes

All roadways shall be constructed using a centerline crown and shall be graded and compacted with the following crossfall to ensure road drainage:

- Normal cross slopes shall be 2% for paved roads and 4% for gravel roads

1520.07.07 Superelevation

Superelevation is generally not applied on local alpine ski village roads or cul-de-sacs.

Rural roads of a continuous nature that provide access to an alpine ski village would be better classified as Low-Volume roads and should be superelevated accordingly. Refer to Chapter 500 Low-Volume Roads.

When the decision has been made to superelevate curves, a maximum rate of 0.04 m/m shall be used for local urban street systems. This is appropriate for design speeds up to 70 km/h and where surface icing and interrupted traffic flow are expected. Superelevation rates of 0.04 m/m and 0.06 m/m are applicable for design of new urban streets in the upper range of the classification system where uninterrupted flow is expected and where little or no physical constraints exist.

1520.08 INTERSECTIONS/ACCESSES

1520.08.01 General

Intersections shall be as near as possible to right angles. The minimum skew angle of the intersection shall be 70° and the maximum skew angle shall be 110°. If the through road grade is steeper than 8%, the intersection angle shall desirably be between 80° and 100°.

1520.08.02 Intersection Alternatives

Alternate intersection treatments, such as roundabouts, may be accommodated on a project by project basis, as per the discretion of the Ministry Representative.

1520.09 UTILITY SETBACK

Utility poles should be a maximum of 2 metres from the property boundary or a minimum 2 metres beyond the toe of the fill, whichever gives the greater offset from the road. See **Figure 1510.A**.

Open Shoulder Sections

In open shoulder sections, the underground utilities can be located within the Dedicated Right-of-Way with approval from the Ministry Representative, based on the permit that has been issued, as follows:

Deep Utilities (water, sanitary and storm):

- Buried infrastructure: subject to location specified in permit
- Flush service accesses*: subject to location specified in permit
- Above ground appurtenances: 1.5 m behind center of ditch

Shallow Utilities (hydro, telephone, TV and gas):

- Buried infrastructure, flush service accesses and above ground appurtenances: 1.5 m behind center of ditch

Curb and Gutter Sections

In curb and gutter sections, the underground utilities can be located within the Dedicated Right-of-Way with approval from the Ministry Representative, based on the permit that has been issued, as follows:

Deep Utilities:

- Buried infrastructure: subject to location specified in permit
- Flush service accesses**: subject to location specified in permit
- Above ground appurtenances, including protective structures (e.g. bollards): 2.0 m behind curb

Shallow Utilities:

- Buried infrastructure: 0.5 m behind curb
- Flush service accesses**: 0.5 m behind curb
- Above ground appurtenances, including protective structures (e.g. bollards): 2.0 m behind curb

**No flush service access permitted within ditch.*
***Flush service accesses within 1.5 m of curb are required to meet full H-20 design loading.*

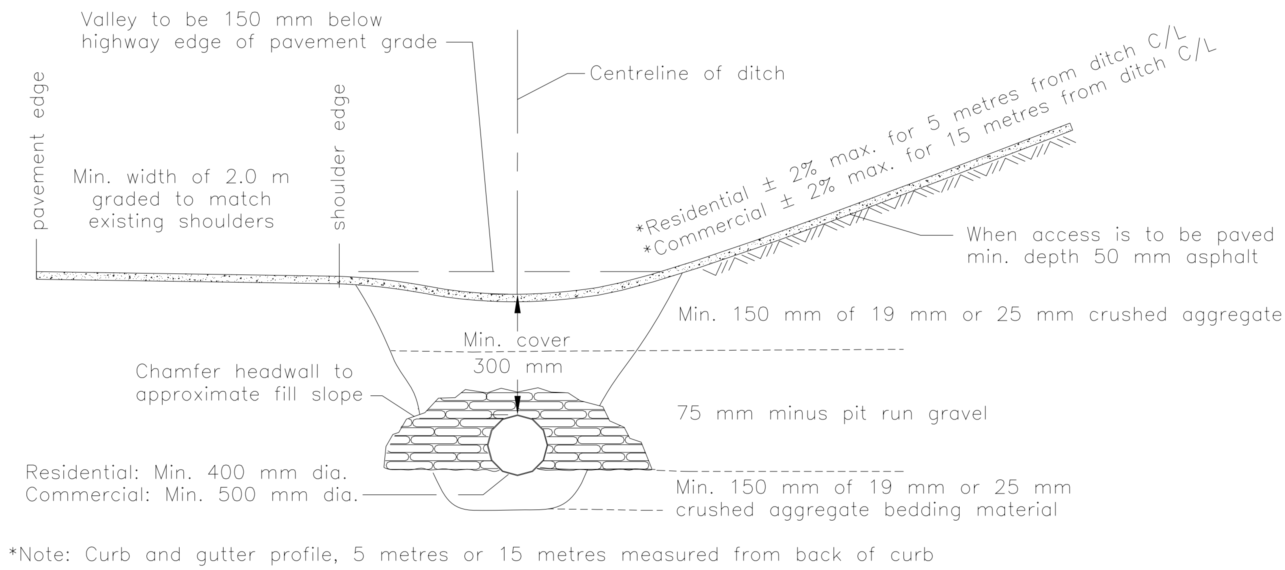
Comments and Considerations:

- Installation of utilities in ditches should be avoided wherever possible.
- Dedicated utility corridors should be considered wherever possible.
- Utilities should be looked at in the planning stages to prevent having to move them in the future due to road widening or ditching.

1520.10 DRIVEWAYS

1. Driveway location, spacing and approval shall be at the discretion of the Ministry Representative. Where zoning does not apply, the developer must show that construction of an adequate access is possible and sufficient off-street parking for 2 vehicles is obtainable.
2. The first 5 metres (measured from the ditch centerline or back of curb) of all residential driveways shall be constructed at or near a right angle (70° to 110°) to the road.
3. All open shoulder driveways with a level or rising grade are to be constructed with a "valley" or "swale" over the ditch line to ensure surface water enters the ditch and does not enter the road. See **Figure 1520.K.**
4. Driveway grades shall not exceed 2% for 2 m from the ditch centerline or 2% for 3 m from the back of the curb with a maximum of 8% within the Right-of-Way.
5. Driveway radius and widths:
   - Residential – 6 metre radius and minimum 6 metre width at the property line
   - Commercial – 9 metre radius and minimum 9 metre width at the property line
6. All lots with cuts or fills of heights greater than 1.8 metres shall have engineered drawings when requested by the Ministry Representative.
7. Consideration should be given to driveway densities along local roads as high driveway densities result in insufficient space available for snow storage. Refer to **1520.05**.

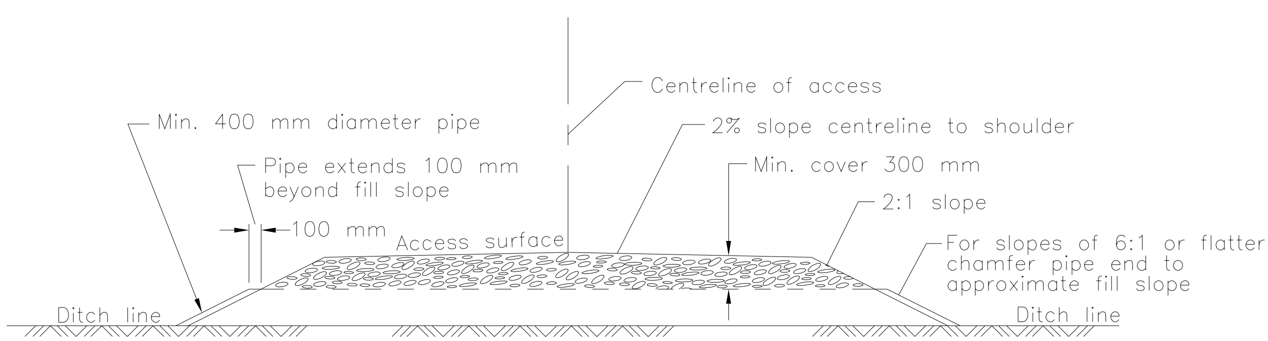
Figure 1520.K Culvert Installation



NOTE:

- *Refer to BC Supplement to TAC Geometric Design Guide for comprehensive bedding and backfill details.*
- *Minimum pipe size may be increased at the discretion of the Ministry Representative.*
- *Minimum cover shall dictate invert elevation.*
- *See Notes under **Figure 1520.D**.*

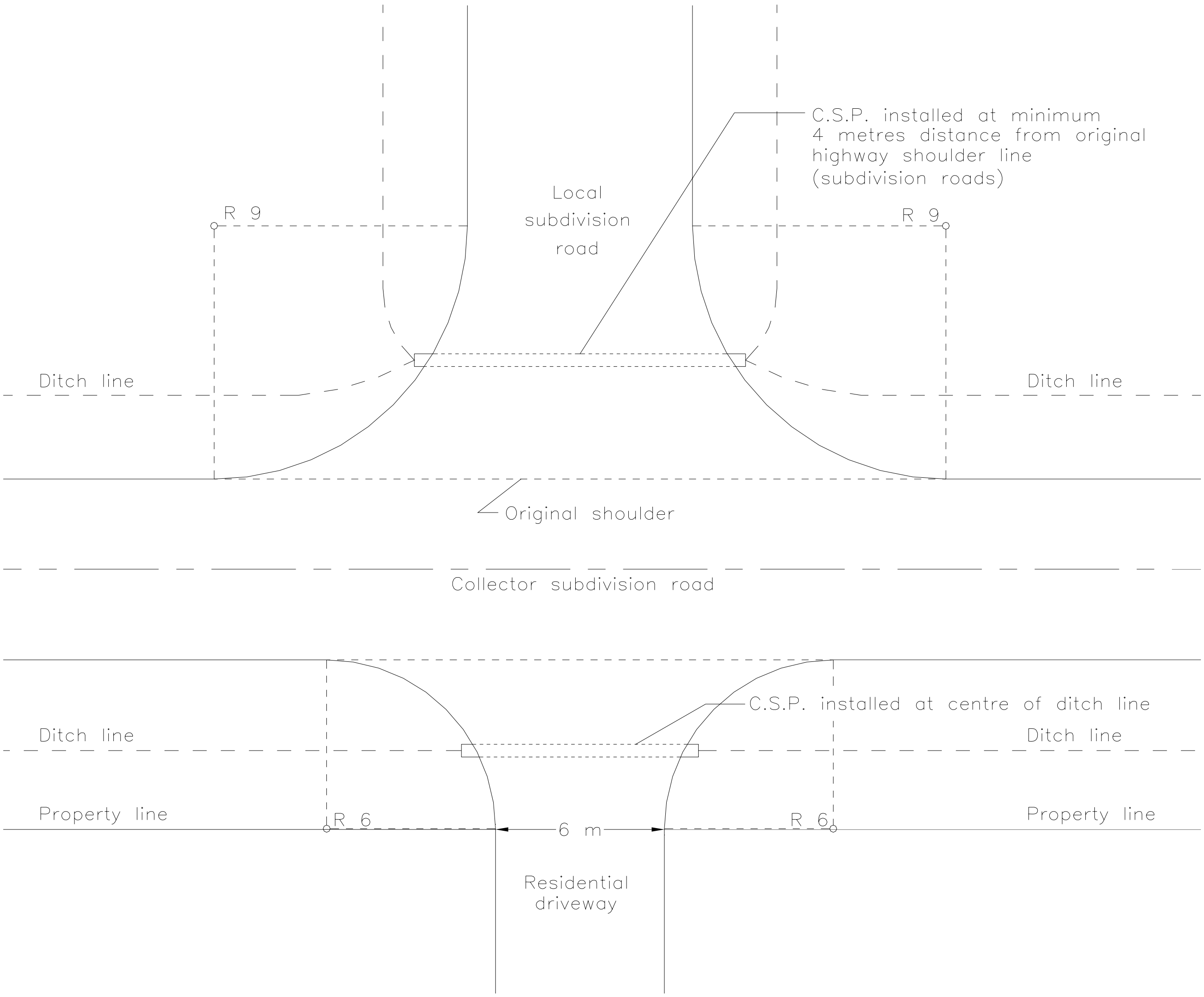
Figure 1520.L Driveway Cross Section



Driveway Culvert Installation: See **Figures 1520.K & 1520.M**

<u>*Residential Driveways:*</u> All driveway culverts shall be a minimum 400 mm diameter but may be increased at the discretion of the Ministry Representative.
<u>*Commercial Driveways:*</u> Cross and side culverts require a 500 mm minimum diameter.

Figure 1520.M Driveway and Culvert Installation Layout



Residential Driveway:
Minimum 6 metre width at property line

Commercial Driveway:
Minimum 9 metre width at property line

Turning Radius:
Residential – 6 metres
Commercial – 9 metres

1520.11 BRIDGES

All bridges must be designed to Ministry bridge design standards by a Professional Engineer who is registered in British Columbia and is experienced in bridge design.

The designs for bridges and overpasses must be reviewed by and accepted by the Regional Bridge Engineer. The Professional Engineer shall certify that the completed structure has been constructed to Ministry standards.

1520.11.01 Skier Overpass

Construction of a skier overpass requires a permit from the Ministry to pass over the Right-of-Way.

All skier overpasses must be designed by a Professional Engineer who is registered in British Columbia and is experienced in bridge design. Designs do not have to conform to Ministry bridge design standards but if a public hazard exists, the Ministry can request that the problem be rectified to ensure public safety.

Ownership and maintenance of a skier overpass shall be solely the responsibility of the ski hill operator.

Ski Lifts and Gondolas

As with skier overpasses, ski lifts and gondolas require a permit from the Ministry to construct over the Right-of-Way.

1520.11.02 Skier Underpass

The review and acceptance of the skier underpass by the Regional Bridge Engineer only pertains to the structural aspect of the design. This acceptance **does not** constitute acceptance for any geotechnical, safety, or any other issues. The developer should have a risk management plan, with inspection guidelines, in place to ensure the overall safety of all users (drivers and skiers).

For bridge design approval, the Ministry asks that the developer provide a risk identification and analysis to ensure the final bridge design provides safe passage to all users.

Risk considerations may relate to:

1. Maintenance/Design
    a. Ability of maintenance crews to adequately maintain bridge to provide safe passage to skiers
    b. Skiers potentially getting hit by materials falling from bridge causing injury or loss of control. Typical materials would include:
        i. Winter abrasives,
        ii. Salt,
        iii. Plowed snow, and/or
        iv. Ice chunks from melting snow
2. Skiers
    a. Skiers running into the bridge abutment walls
    b. Mountain Bikers running into bridge abutment walls in the off-season
    c. Inadequate grooming of ski-run within the Ministry’s Right-of-Way resulting in safety issues for skiers

1520.12 SIGNING

Roads shall be appropriately signed as per the Manual of Standard Traffic Signs and Pavement Markings.

1520.13 SPEED

All unregulated/unposted roads in unorganized territory in British Columbia are limited to a maximum speed of 80 km/h (Motor Vehicle Act 151.1), therefore all roads designed at less than 80 km/h shall be posted accordingly.

1520.14 OVERHEAD CLEARANCE

Minimum overhead clearance for structures: 4.5 metres

Due to the allowance for lower overhead clearance in alpine ski villages than expected on the British Columbia primary highway network, developers are required to post signs informing drivers of the lower available overhead clearance heights. These signs must be posted at a reasonable distance prior to entering the alpine ski village, as directed by the Ministry Representative.

This reduced clearance is only acceptable in alpine areas. Developers should be aware of the impacts that the reduced clearance may have on accessibility to the area.

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