CHAPTER J
LOW VOLUME RURAL ROADS

TABLE OF CONTENTS

J.1 INTRODUCTION ... 1
J.1.1 General ... 1
J.1.2 Cost Effectiveness ... 1
J.1.3 Definitions ... 2
J.2 CLASSIFICATION ... 2
J.2.1 Introduction ... 2
J.2.2 Design Speed ... 2
J.2.3 Posted Speed ... 3
J.3 ALIGNMENT ELEMENTS ... 4
J.3.1 Introduction ... 4
J.3.2 Sight Distance ... 4
J.3.2.1 General ... 4
J.3.2.2 Minimum Stopping Sight Distance ... 5
J.3.2.3 Passing Sight Distance ... 5
J.3.3 Horizontal Alignment ... 6
J.3.3.1 Curves ... 6
J.3.3.2 Spiral Curves ... 9
J.3.4 Vertical Alignment ... 9
J.3.4.1 Maximum Gradient ... 9
J.3.4.2 Vertical Curves ... 9
J.4 CROSS-SECTION ELEMENTS ... 12
J.4.1 Introduction ... 12
J.4.2 Roadway Width ... 17
J.4.2.1 Two-Lane Roads ... 17
J.4.2.2 One-Lane Two-Way Roads ... 17
J.4.2.3 Cross Slopes ... 17
J.5 ROADSIDE GEOMETRY ... 18
J.5.1 Sideslopes ... 18
J.5.2 Backslopes ... 18
J.5.3 Ditches ... 18
J.5.4 Drainage Structures ... 19
J.5.5 Right-of-Way ... 19
J.5.6 Approaches to Low Volume Roads ... 19
REFERENCES ... 20

CHAPTER J
LOW VOLUME RURAL ROADS

LIST OF FIGURES

Figure J-3-3-1a Method of Attaining Superelevation Revolved About Centreline 7
Figure J-3-4-2a Crest Vertical Curvature for Stopping Sight Distance on Two-Lane Low Volume Roads 10
Figure J-3-4-2b Crest Vertical Curvature for Stopping Sight Distance on One-Lane Two-Way Low Volume Roads 11
Figure J-3-4-2c Sag Vertical Curvature for Stopping Sight Distance on Low Volume Roads 11
Figure J-4-1a Typical Cross-Section for RLU-210 (209, 208) G-90 13
Figure J-4-1b Typical Cross-Section for RLU-208 (207) G-60 14
Figure J-4-1c Typical Cross-Section for RLU-207G-50/RLU-206G-40 15
Figure J-4-1d Typical Cross-Section for RLU-104G-50 (40,30) 16

CHAPTER J
LOW VOLUME RURAL ROADS

LIST OF TABLES

Table J-1-1a Traffic Volume for Low Volume Rural Roads 1
Table J-3-1a Summary of Alignment Controls for Low Volume Roads 4
Table J-3-2-2a Minimum Stopping Sight Distance for One-Lane Two-Way Low Volume Roads 5
Table J-3-2-2b Effect of Grade on Stopping Distance in Wet Conditions for Low Volume Roads 5
Table J-3-3-1a Superelevation and Minimum Spiral Parameter for Low Volume Roads 8
Table J-3-4-2a Crest Vertical Curvature for Passing Sight Distance for Two-Lane Low Volume Roads . 12
Table J-4-2-1a Roadway Width (M) for Low Volume Roads* 17

CHAPTER J
LOW VOLUME RURAL ROADS

J.1 INTRODUCTION

J.1.1 General

Low volume roads in Alberta are defined as rural gravel roads that have annual average daily traffic (AADT) of 200 or less. Where the AADT exceeds 200, designers may consider providing a wider subgrade in alignment with with the future functional class. Design AADT for low volume rural roads is summarized as in Table J-1-1a.

Table J-1-1a Traffic Volume for Low Volume Rural Roads

Design Designation	Design AADT*
RLU-206/207/208	0-200**
RLU-209	0-200**
RLU-210	0-200**

* Design AADT is defined as the maximum AADT projected for the design life of the roadway. Assuming a continuous growth and a 20-year design life, this will normally occur on the 20^{th} year after construction.
** Where the design AADT on a road is less than 200, the design guidelines shown in this chapter are applicable.

The purpose of this guide is to implement use of uniform standards and practices for the design and construction of safe and cost effective low volume roads.

Generally, this chapter supplements the road design standards and guidelines presented elsewhere in this guide. Geometric parameters have been provided for a lower range of design speeds (down to 30 km/h). Special road cross-sections based on traffic volume and design speed have been provided for low volume roads, because their final surface type is usually gravel. The standards described in this chapter apply only to low volume rural roads with an AADT less than 200. Other chapters should be used for other classes roads or roads with AADT exceeds 200.

For guidance on bridge design for low volume roads, refer to the Local Road Bridge Design Guidelines https://www.alberta.ca/local-road-bridges.aspx.

J.1.2 Cost Effectiveness

The standards developed for low volume roads are not directly based on an economic analysis. However, the fact that standards have been developed for low volume roads is in itself an economic consideration. Designers are encouraged to undertake an economic analysis, to develop the most economic road that satisfies both the agency and road user requirements. Designers should consider the future function and traffic volume on the roadway. Refer to Alberta Transportation *Benefit Cost Model and User Guide* [1] for more information regarding benefit cost analysis.

This chapter provides standards that are applicable exclusively to unpaved (gravel or dirt) roads. This is because unpaved roads are thought to be generally appropriate for low volume roads with less than 200 AADT. A review of the available literature from other jurisdictions has shown that a conventional roadway pavement cannot usually be justified economically on a roadway with AADT as low as 200. Analysis completed in 2002 by Alberta Transportation has suggested that an AADT of 400 is the break-even volume, where the benefits derived from having a pavement will generally exceed the premium costs incurred in construction and maintenance. Because low volume roads primarily perform a land access function, it is difficult to justify paving unless the volume reach 400 AADT.

There are examples of public roadways in Alberta with less than 200 AADT which are paved. The reasons for paving these roadways are normally not strictly based on the roadway economics of those particular segments. Justification for paving a particular low volume segment may be based on other considerations, such as network continuity, economic development for the area, or roads with heavier loads, such as haul roads. Also, in some cases a structure less costly than a conventional pavement has been used, for example, base course with double seal coat or single seal coat.

J.1.3 Definitions

It is appropriate to use Design AADT for design purposes to select roadway width, design speed, etc. on a new construction project. It is appropriate to use existing AADT when checking to see if an existing road meets standards.

Terminology used in this chapter applying to low volume roads is defined here.

- Two-lane roads are roads that provide sufficient roadway width for the safe passing of opposing vehicles. One-lane, two-way roads are roads with one lane that carries traffic in two directions.
- Earth roads are roads that have a driving surface consisting of subgrade (earth) material.
- Gravel roads are roads that have a driving surface consisting of coarse granular material.
- Surfaced roads are roads that have been covered, on the travelled lane(s) and possibly the shoulders, by an asphalt or concrete pavement.

J.2 CLASSIFICATION

J.2.1 Introduction

The classification system used for low volume roads is essentially the same as that used elsewhere in this guide. The letter G is added in the second part of the description to indicate that the finished surface is to be gravel. For example:

RLU-209G-90 indicates a rural undivided roadway with two lanes, a 9 m gravel surface and a design speed of 90 km/h.

These roads will always be undivided. The roadway width is variable but should be chosen based on consideration of design speed, traffic volume, traffic composition and function.

The number of lanes is normally two. However, one-lane two-way roadways are considered suitable in some cases where the AADT is less than 50 and the design speed is not more than 50 km/h.

J.2.2 Design Speed

One of the most important features of low volume road design is selection of design speed. Once selected, the various geometric features including sight distance, horizontal and vertical alignments, roadway widths, cross-section elements and right-of-way widths, are related to design speed to obtain a balanced and safe design.

Design speed has a large impact on the construction cost of a roadway, as well as the quality of service provided. The provision of safety and an appropriate level of service must be considered the primary factors in selection of design speed. Although cost is a consideration, it should be considered secondary.

In Alberta, running speeds recorded on rural roads have been very high. There has been only limited monitoring of speeds on gravel roads, but where data has been collected, the mean speed was about 85 km/h and the 85th percentile speed was about 102 km/h (that is, 15 percent of vehicles are exceeding this speed). It should be noted that the speed was monitored only on gravel surfaced highways. Low volume roads in Alberta are generally not posted for maximum speed limit and where this is the case, the legal speed limit is 80 km/h. Both of these considerations would indicate that 90 km/h should be adopted as the desirable design speed for low volume roads where possible within economic, right-of-way, and terrain constraints. Although it is appropriate to use 90 km/h as the desirable design speed for low volume roads, it is also important to ensure that engineering judgement is used to select design speed. With volumes less than 200 AADT, the high cost of construction that could be required in difficult terrain conditions, may not be offset by the road user benefits. A wide range of design speeds, from 90 km/h to 30 km/h, is consequently considered appropriate for low volume roads.

The following points should be considered when selecting design speed:

- Design speed should be consistent with the speed a driver is likely to expect. Low design speeds are not always appropriate for low volume roads because drivers tend to adjust their speeds to the context of the surrounding environment.

- Selecting low design speeds on open flat terrain is likely to produce an accident-prone and uneconomical design. However, under difficult terrain conditions, drivers accept lower speed operation.

- Where trips are long, higher design speeds are appropriate, especially in isolated areas where drivers tend to travel faster.

- Low design speeds may be appropriate for recreational roads (especially within parks) because of environmental constraints, aesthetic considerations and the desirability of slower traffic.

- Design speed is frequently set at 10 km/h above the proposed posted speed in order to provide for drivers exceeding the posted speed by that amount. In this way, the design speed will provide for all but the reckless driver, for whom it is not reasonable to design.

- Higher design speeds are generally easier to justify on higher volume roads due to the increased safety and road user benefits.

J.2.3 Posted Speed

Unposted rural roads in Alberta have a legal speed limit of 80 km/h, so posting of speeds is generally not necessary where the geometric elements are suitable for running speeds of up to 80 km/h.

In cases where the geometrics or other considerations dictate a lower speed in selective locations only, speed advisory signs are suggested.

A lower posted speed throughout a long section of low volume road is appropriate only where the entire section contains geometric features that dictate the lower speed.

J.3 ALIGNMENT ELEMENTS

J.3.1 Introduction

The alignment elements for low volume roads are primarily based on design speed using the same physical relationships as described in Chapter B. Sight distances, gradients, horizontal curvature and vertical curvature have been developed for design speeds of 30 km/h to 90 km/h.

Three exceptions to the general rules used in Chapter B are:

- The maximum superelevation rate is 0.08m/m
- Simple horizontal curves are permitted in some cases if supported by economic analysis
- The suggested maximum gradients are higher to allow for more economical design on low volume roads.

A summary of alignment controls is shown below in Table J-3-1a.

Table J-3-1a Summary of Alignment Controls for Low Volume Roads

Design Speed (km/h)	Maximum Gradient * (%)	Minimum Stopping Sight Distance** (m)	Minimum Passing Sight Distance (m)***	Maximum Superelevation (m/m)	Minimum Radius of Curve (m)
30	11-16	35	120	0.08	30
40	11-15	50	140	0.08	50
50	10-14	65	160	0.08	80
60	10-13	85	200	0.08	120
70	9-12	105	240	0.08	170
80	8-10	130	275	0.08	230
90	7-9	160	330	0.08	300

* The lower value is the maximum gradient on rolling terrain; the higher value is the maximum gradient in mountainous terrain. In certain site specific situations gradients above the maximums shown in this table may be appropriate as indicated in Section J.3.4.1.

** Minimum stopping sight distance as listed applies to two-lane roads only. Refer to Table J-3-2-2a for minimum stopping sight distances for one-lane two-way roads.

*** Minimum passing sight distance is based on TAC [2].

J.3.2 Sight Distance

J.3.2.1 General

Stopping sight distances is based on Chapter B. Minimum passing sight distance have been calculated using the same criteria as TAC [2]. The passing sight distance value only applies to two-lane two-way roads as passing is not a consideration on one-lane roads.

Decision sight distance and non-striping sight distance are not included for low volume roads. They are considered more applicable to higher volume and higher function paved roads.

J.3.2.2 Minimum Stopping Sight Distance

Minimum stopping sight distance on low volume roads is based on friction factors for wet pavement conditions and a 2.5 seconds perception-reaction time. Friction values for gravel roads and earth roads are assumed to be the same as that for pavements in poor condition with a wet surface. This is because friction values, which have been developed through research for gravel and earth roads, have not been translated into usable standards. Speeds tend to be lower under adverse conditions and drivers tend to follow further behind other vehicles where dust conditions exist. This provides an improved safety factor for stopping in poor conditions, when using friction factors based on smooth wet pavements.

On one-lane two-way roads, enough sight distance must be available for approaching vehicles to stop before colliding. The sight distance required for two approaching vehicles to stop is taken as twice the stopping sight distance required for a vehicle approaching a fixed object. This assumes that both vehicles are travelling at the design speed and both drivers have the same perception-reaction time.

Minimum stopping sight distance for one-lane two-way roads, for a range of design speeds of 30 km/h to 50 km/h, is shown in Table J-3-2-2a.

Table J-3-2-2a Minimum Stopping Sight Distance for One-Lane Two-Way Low Volume Roads

Design Speed (km/h)	Minimum Stopping Sight Distance (m)
30	70
40	100
50	130

To allow for the effect of grade on minimum stopping sight distance, Table J-3-2-2b may be applied.

Table J-3-2-2b Effect of Grade on Stopping Distance in Wet Conditions for Low Volume Roads

Design Speed (km/h)	Correction to Stopping Sight Distance (m)									
	Decrease for Upgrade (%)					Increase for Downgrade (%)				
	3	6	9	12	15	3	6	9	12	15
30	-	-	-	-	-	-	-	-	-	-
40	-	-	5	5	5	-	5	5	10	10
50	5	5	10	10	10	-	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	-	-

J.3.2.3 Passing Sight Distance

Passing sight distance is not considered to be a significant design element for low volume roads because the passing demand is typically very low due to the low volumes. However, for safety reasons, it is important to provide as many passing opportunities as possible on each road segment where economically feasible.

Passing sight distances are not applicable to one-lane two-way roads.

J.3.3 Horizontal Alignment

J.3.3.1 Curves

The design of horizontal curves on low volume roads is the same as on higher classification roads except that the superelevation table is different and simple curves are permitted for some combinations of radius and design speed.

Maximum safe side friction factors for gravel and earth roads are assumed to be the same as for paved roads throughout the range of design speeds.

The maximum superelevation rate for gravel surfaced low volume roads in Alberta is 0.08 m/m. The higher maximum rate is allowed because unpaved roads can be expected to provide better surface friction than paved roads in the worst ice condition.

The primary reason for using 0.06 m/m as the maximum superelevation rate on paved roads is to reduce the occurrence of low-speed side slip on sharp horizontal curves in the worst ice condition. The worst ice condition is expected to occur only under thin film quick-freeze conditions at a temperature of about -1ºC in the presence of water on the pavement. This is not a concern on unpaved roads.

The normal crown rate on gravel surfaced roads in Alberta is 0.03 m/m. This is also the minimum superelevation rate.

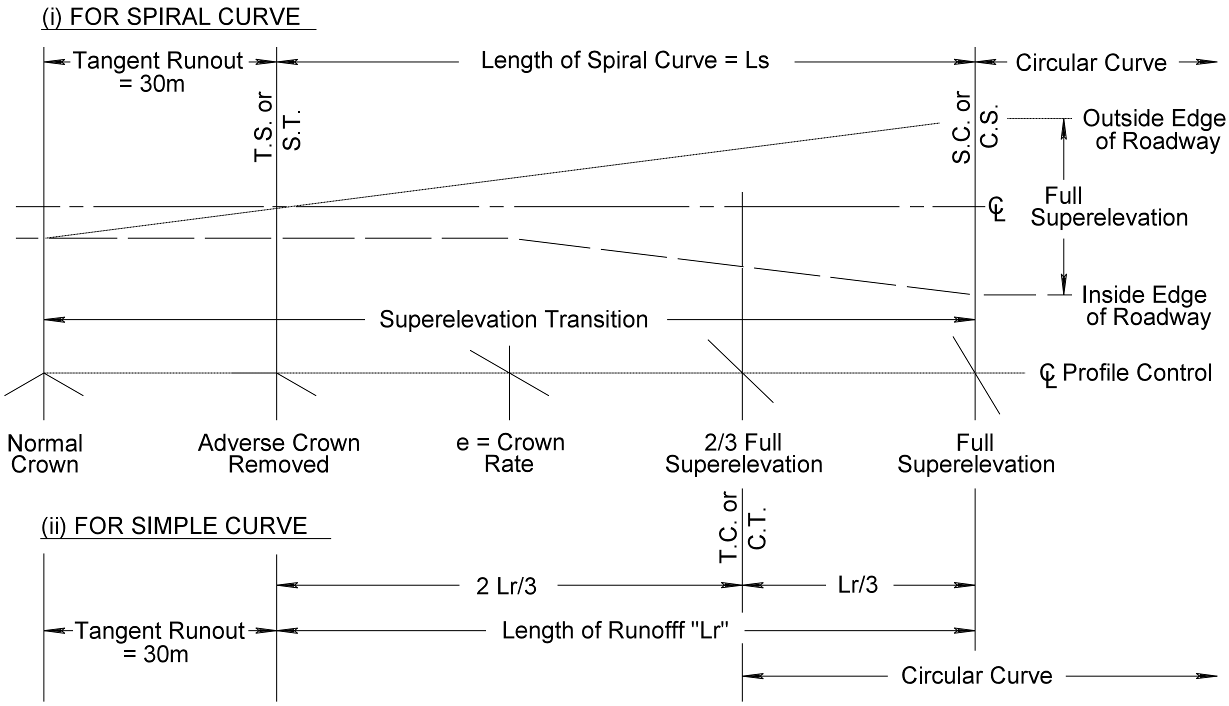
The distribution of superelevation rates for each design speed is a function of the maximum superelevation rate, the form of distribution chosen and the normal crown rate on tangent sections. Table J-3-3-1a gives the superelevation rates recommended for various speeds and radii based on a maximum rate of 0.08 m/m and a normal crown of 0.03 m/m.

In superelevating two-lane roadways, the road is normally rotated about its centreline. Alternatively, road can be rotated about either edge where necessary. The desirable method of developing superelevation on spiral and simple curves is illustrated in Figure J-3-3-1a.

On spiral curves the full superelevation is developed at the beginning of the circular curve. On simple curves, two-thirds of the full superelevation is developed before the circular curve begins. The superelevation is developed from an adverse crown removed stage to the full superelevation stage over a distance which is described as the superelevation runoff (Lr). In the case of spiral curves, the length of superelevation runoff is 1.5 times the length of spiral. In the case of simple curves, the Lr required is shown in a table in Figure J-3-3-1a.

The roadway cross section is changed from normal crown to adverse crown removed over a distance that is described as the tangent runout. The length of tangent runout is based on a 3.5 m lane. The standard length of runout is 30 m. This is based on an acceptable rate of change of elevation at the edge of the lane compared to the centreline. The rate is 286:1, that is, 3.5 x 0.03/30 = 1/286. This is considered comfortable for the lower speeds that are typical on low volume roads and minimizes the length of roadway that has less than desirable cross-slope for surface drainage.

Figure J-3-3-1a Method of Attaining Superelevation Revolved about Centreline



This method of attaining superelevation is to be used on 2-lane undivided local roads.
A 30m tangent runout is applicable for 2-lane undivided local roads. This tangent runout length is based on a 3.5m travel lane.

Ls is determined based on spiral perameter $Ls = \frac{A^2}{Radius}$

Lr (for simple curves) is determined from the table below.

LENGTH REQUIRED FOR SUPERELEVATION RUNOFF ON SIMPLE CURVES

e (m/m)	Length of Runoff "Lr" in metres for Design Speed (km/h)						
	30	40	50	60	70	80	90
0.03	30	30	30	30	30	30	40
0.04	30	30	30	40	40	40	50
0.05	40	40	40	50	50	50	60
0.06	40	50	50	60	60	70	70
0.07	50	50	60	60	70	70	80
0.08	60	60	70	70	80	80	90

The above runoff lengths, "Lr" are required for two-lane local roads.

Table J-3-3-1a Superelevation and Minimum Spiral Parameter for Low Volume Roads E_{max}=0.08, Normal Cross Slope = 0.03

design speed km/h	30		40		50		60		70		80		90		100	
radius m	e	A	e	A	e	A	e	A	e	A	e	A	e	A	e	A
7000	NC		NC		NC		NC		NC		NC		NC		NC	
5000	NC		NC		NC		NC		NC		NC		NC		0.030	530
4000	NC		NC		NC		NC		NC		NC		0.030	450	0.030	480
3000	NC		NC		NC		NC		NC		0.030	370	0.030	390	0.030	410
2000	NC		NC		NC		NC		0.030	275	0.030	300	0.030	300	0.030	335
1500	NC		NC		NC		0.030	225	0.030	255	0.030	250	0.032	270	0.037	290
1200	NC		NC		0.030	180	0.030	200	0.030	220	0.032	225	0.038	240	0.044	260
1000	NC		NC		0.030	170	0.030	175	0.030	200	0.036	220	0.043	225	0.049	240
900	NC		NC		0.030	150	0.030	175	0.032	180	0.039	200	0.046	200	0.052	225
800	NC		0.030	135	0.030	150	0.030	160	0.035	175	0.042	175	0.049	200	0.056	210
700	NC		0.030	125	0.030	140	0.030	150	0.038	165	0.046	175	0.053	185	0.060	200
600	NC		0.030	120	0.030	125	0.034	140	0.042	150	0.050	165	0.058	175	0.065	190
500	NC		0.030	100	0.030	120	0.039	125	0.048	140	0.056	150	0.064	160	0.071	190
400	0.030	80	0.030	90	0.031	100	0.045	115	0.054	125	0.063	135	0.071	160	0.078	190
350	0.030	75	0.030	90	0.035	100	0.049	110	0.058	120	0.067	125	0.075	160	0.080	190
300	0.030	70	0.031	80	0.039	90	0.053	100	0.063	120	0.072	125	0.080	160	minimum R=390	
250	0.030	60	0.035	75	0.041	85	0.059	100	0.069	110	0.078	125	0.080	160		
220	0.032	60	0.039	70	0.044	80	0.062	95	0.073	110	0.080	125	minimum R=300			
200	0.034	60	0.041	70	0.047	80	0.065	90	0.075	110	minimum R=230					
180	0.037	60	0.044	65	0.051	75	0.068	90	0.078	110						
160	0.041	55	0.047	65	0.055	75	0.072	85	0.080	110						
140	0.044	55	0.051	65	0.061	70	0.076	85	minimum R=170							
120	0.048	55	0.055	60	0.064	70	0.080	85								
100	0.053	50	0.061	55	0.067	65	0.080	85								
90	0.056	50	0.064	55	0.071	65	minimum R=120									
80	0.060	50	0.067	55	0.075	65										
70	0.064	50	0.071	50	0.080	65										
60	0.068	45	0.075	50	minimum R=80											
50	0.070	45	0.080	50												
35	0.080	40	minimum R=50													
30	0.080	35														
	minimum R=30															

e_{max}= 0.08
normal cross slope = 0.03

Notes

e is superelevation
A is spiral parameter in metres
NC is normal cross section

Spiral Length, $L = \frac{A^2}{Radius}$

Spiral parameters are minimum and higher values should be used where possible. Spirals are desirable but not essential above the dashed line.

J.3.3.2 Spiral Curves

On any type of roadway, vehicles naturally adopt a transition path when entering and leaving horizontal circular curves. The provision of a transition curve between tangent and the horizontal circular curve allows vehicles to travel around curves without encroaching on the opposing lane or the shoulder. The transition curve also provides a length over which superelevation can be introduced in a manner closely fitting the lateral friction demand that is being experienced by the vehicle due to the speed and radius (which is variable). Construction costs associated with implementing transition curves are negligible. As their use tends to promote uniformity in speed and reduce encroachment on adjacent lanes, they may reduce road user costs and collision costs.

Spiral parameters for low volume roads are given in Table J-3-3-1a. The length of spiral (Ls) is determined based on the spiral parameter and radius, that is, $Ls = A^2/R$.

J.3.4 Vertical Alignment

J.3.4.1 Maximum Gradient

The ideal maximum gradient for a particular roadway cannot generally be established without an economic analysis to strike a balance between reduced road user costs and increased construction costs. Steep grades may reduce construction costs, but they increase operating costs, which can be significant if the truck volume is high. Steep grades may also create hazardous conditions in areas where snow and ice prevail for several months of the year.

The potential for soil erosion in the roadside areas should be considered when selecting steep grades. Ditches adjacent to steep roadways will have fast flowing water and may require special erosion protection measures. Suggested maximum gradients for low volume roads are shown in Table J-3-1a. Higher maximum gradients are permitted on low volume roads than on roads of higher classification. The benefits gained from reducing road user costs may not offset the additional construction costs for flatter gradients on roadways with less than 200 AADT. However, gradients less than the maximum should be used where practical to increase the level of service and standard of operation, unless an economic analysis justifies using maximum gradients.

J.3.4.2 Vertical Curves

Minimum standards for crest vertical curves and sag vertical curves for low volume roads are based on the minimum stopping sight distances developed in Section J.3.2. In developing crest vertical curvature for stopping sight distance, a height of driver's eye of 1.08 m is used with a fixed object height of 0.6 m. The minimum values for vertical crest curvature are given in terms of K in Figure J-3-4-2a.

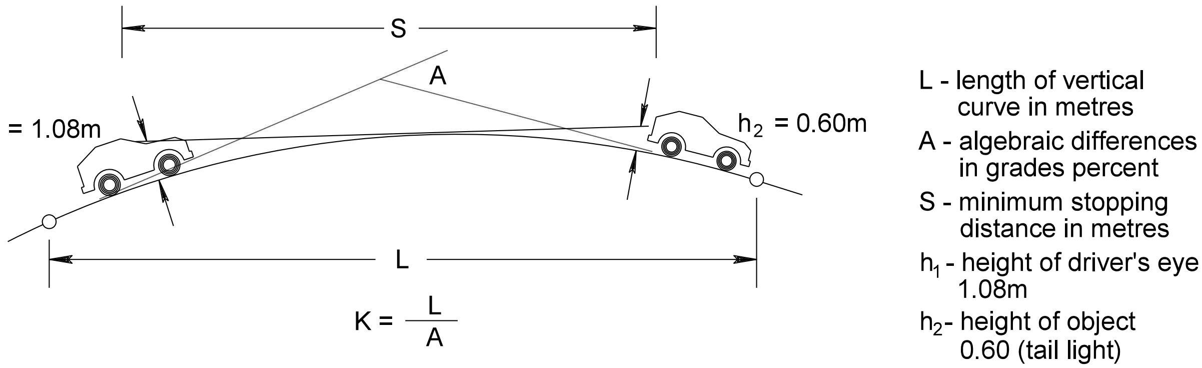
The parameters to be considered in developing crest vertical curvature for stopping sight distance for one-lane two-way roads are the height of driver's eye (1.08 m) and the height of opposing vehicle (1.30 m). The height of the roof of a passenger car is assumed to be 1.30 m. Figure J-3-4-2b gives crest K values for minimum stopping sight distance for one-lane two-way roads for design speeds of 30 km/h, 40 km/h and 50 km/h.

Sag vertical curvature for stopping sight distance is based on headlight control criteria. The minimum K values for sag curves on one-lane roadways are the same as on two-way roadways.

The sag vertical curvature for stopping sight distance for low volume roads is given in Figure J-3-4-2c.

Table J-3-4-2a gives crest K values for passing sight distance for two-lane low volume roads with design speeds from 30 km/h to 90 km/h.

Figure J-3-4-2a Crest Vertical Curvature for Stopping Sight Distance on Two-Lane Low Volume Roads



design speed km/h	minimum stopping sight distance (a) m	minimum crest, (K) (b)
30	35	2*
40	50	4*
50	65	7*
60	85	11*
70	105	17*
80	130	26*
90	160	39

* Note: Minimum K value for the lower design speeds is normally controlled by the minimum L value. i.e. L in metres should be "not less than the design speed in km/h."
(a) based on fixed perception reaction time of 2.5 seconds
(b) based on fixed perception reaction time of 2.5 seconds and object height of 0.60m

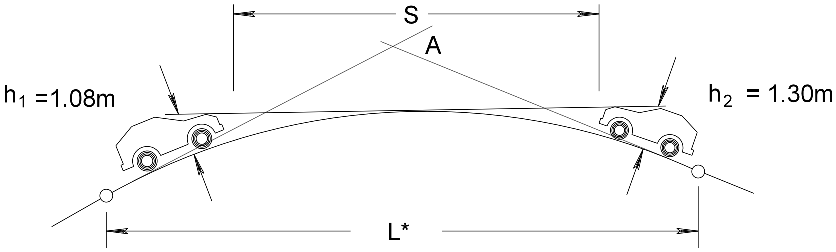
Note: The 'K' values listed above apply to vertical crest curves where the length of curve exceeds the stopping distance (s), in which case the K required is given by the following expression:

$$K = \frac{S^2}{200(\sqrt{h_1} + \sqrt{h_2})^2}$$

For cases where the length of curve is less than the stopping sight distance, K is given by the following expression:

$$K = \frac{2S}{A} - \frac{200(\sqrt{h_1} + \sqrt{h_2})^2}{A^2}$$

Figure J-3-4-2b Crest Vertical Curvature for Stopping Sight Distance on One-Lane Two-Way Low Volume Roads



L - length of vertical curve in metres
A - algebraic differences in grades percent
S - minimum stopping distance in metres
h_1 - height of driver's eye 1.08m
h_2 - height of object 1.30m (roof of passenger car)

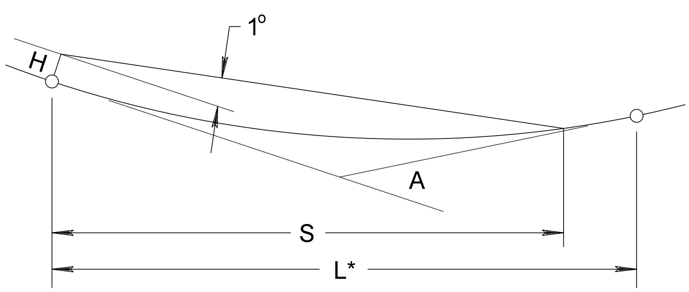
$K = \frac{L}{A}$

* L in metres should be "not less than the design speed in km/h."

design speed km/h	minimum stopping sight distance m	minimum crest, (K)
30	70	6*
40	100	11*
50	130	18*

Note: The minimum k values listed above apply to vertical crest curves where the length of curve exceeds the stopping sight distance. For cases where the length of curve is less than the stopping sight distance, the relevant formula from Table J-3-4-2A should be used with h_1 = 1.08m and h_2 = 1.30m. For some curves it may be found that the minimum curvature required to stop for a 0.60m stationary object is flatter than the curve required to stop for a passenger vehicle approaching, in which case the flatter curve should be used on one-lane two-way roads. The minimum K value on lower speed roads is frequently controlled by the guidelines which state that L in metres, should be "not less than the design speed in km/h."

Figure J-3-4-2c Sag Vertical Curvature for Stopping Sight Distance on Low Volume Roads



L - length of vertical curve in metres
A - algebraic differences in grades percent
S - minimum stopping distance in metres
h_1 - height of head lamps 0.60m
1° - angle of beam upward from plane of vehicle

$K = \frac{L}{A}$

* L in metres, should be "not less than the design speed in kilometres per hour." This may determine the minimum K on many crests.

design speed km/h	minimum stopping sight distance on sag m	minimum sag, (K) (a)
30	35	6*
40	50	9*
50	65	13*
60	85	18*
70	105	23*
80	130	30*
90	160	38*

(a) K values based on headlight control.

Table J-3-4-2a Crest Vertical Curvature for Passing Sight Distance for Two-Lane Low Volume Roads

Design Speed (km/h)	30	40	50	60	70	80	90
Minimum Passing Sight Distance (m)	120	140	160	200	240	275	330
Minimum Rounded Crest K	20	25	30	45	65	80	115

J.4 CROSS-SECTION ELEMENTS

J.4.1 Introduction

Cross-section elements for low volume roads have been developed based on traffic volumes, function and design speed. Figures J-4-1a, J-4-1b, J-4-1c, and J-4-1d show cross-section elements for two-lane gravel roads and one-lane two-way gravel roads. The elements are discussed in the following sections.

Figure J-4-1a Typical Cross-Section for RLU-210 (209, 208) G-90

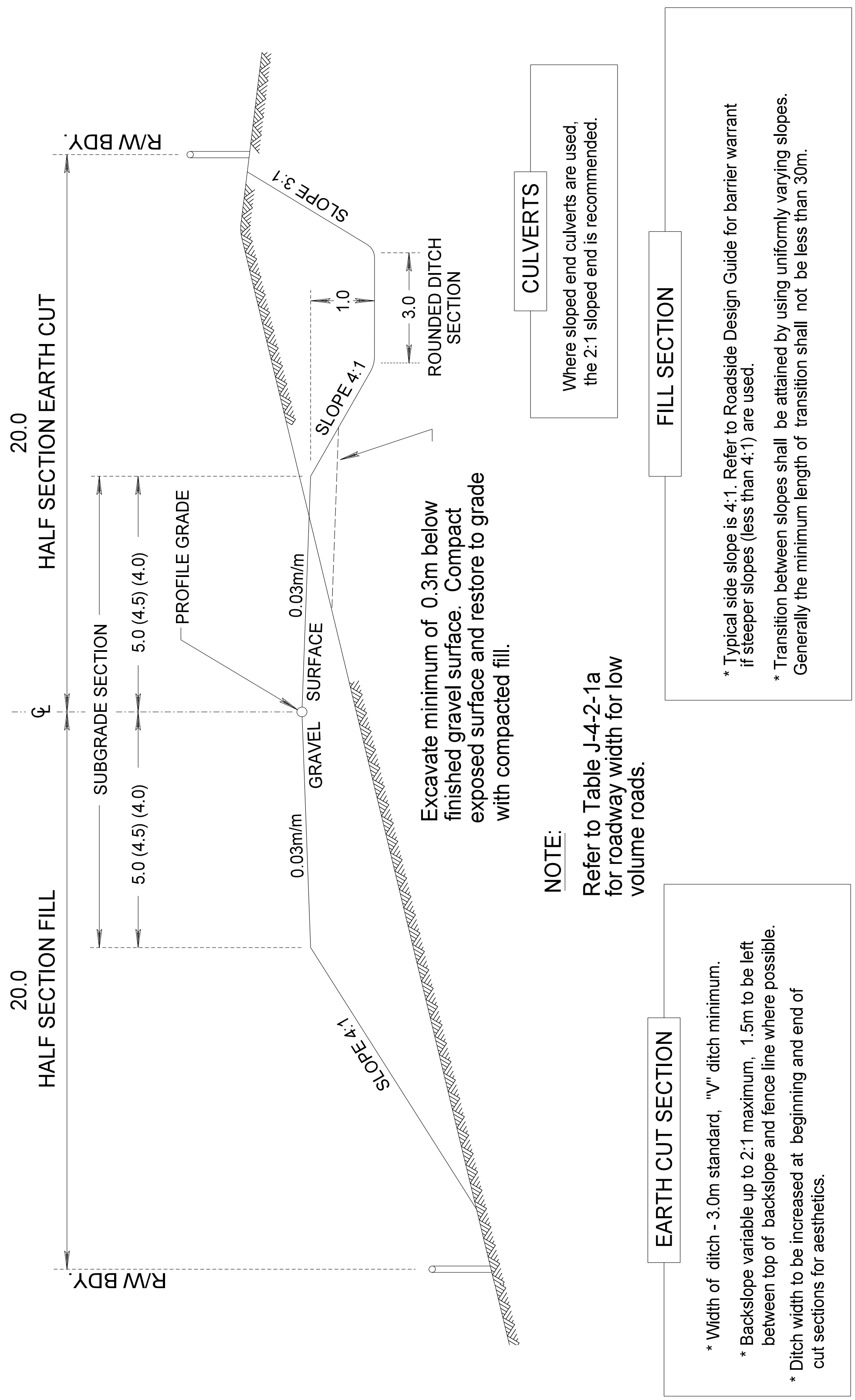


Figure J-4-1b Typical Cross-Section for RLU-208 (207) G-60

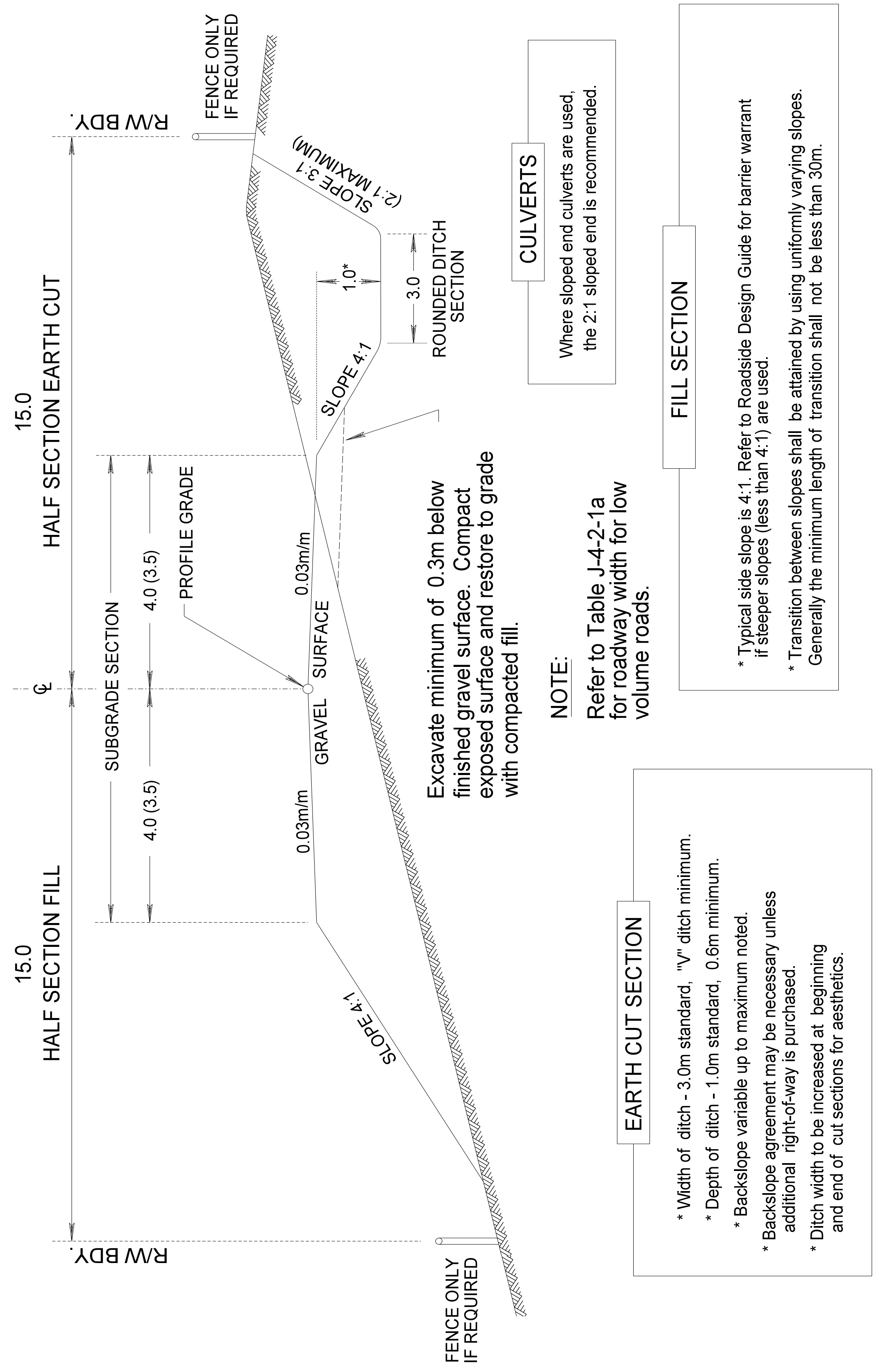


Figure J-4-1c Typical Cross-Section for RLU-207G-50/RLU-206G-40

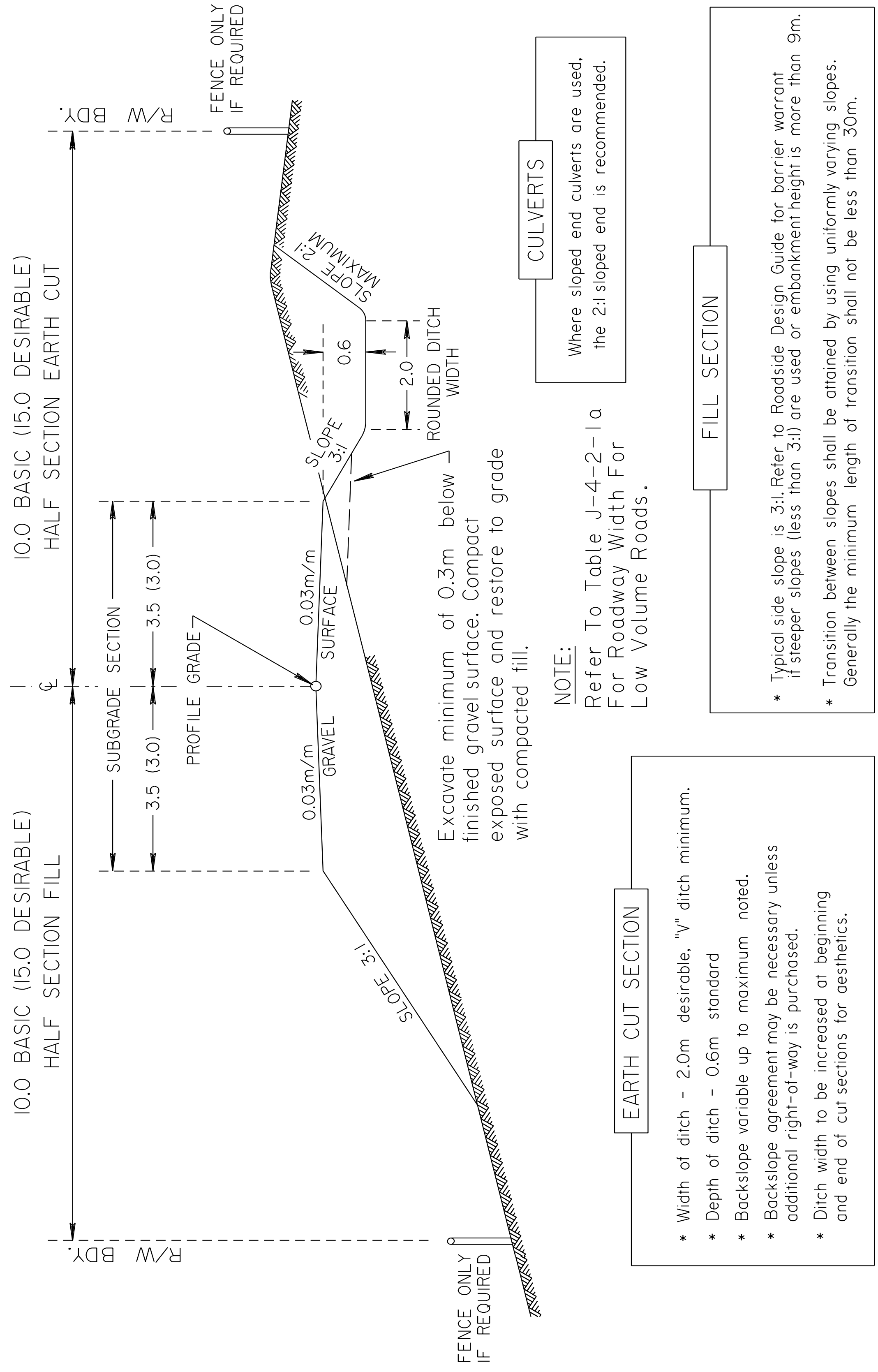
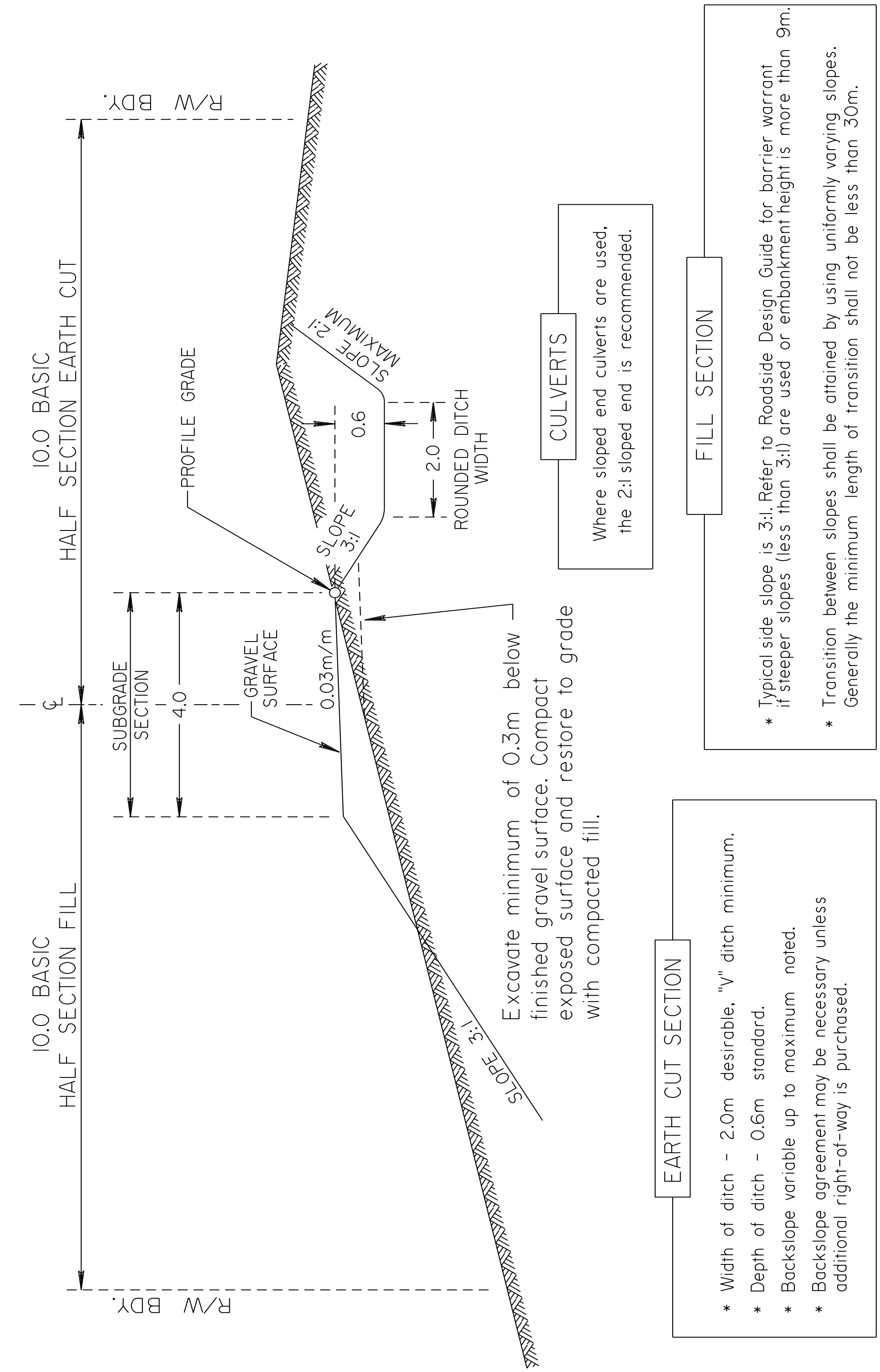


Figure J-4-1d Typical Cross-Section for RLU-104G-50 (40,30)



J.4.2 Roadway Width

J.4.2.1 Two-Lane Roads

Roadway widths for two-lane low volume roads are a function of traffic volume, traffic composition and design speed.

The widths shown on Table J-4-2-1a are considered appropriate for the volumes and speeds shown and have satisfied safety requirements for the passage of opposing vehicles. They do not provide sufficient roadway (shoulder) width for emergency or leisure stops because the frequency of conflicts associated with stationary vehicles on low volume roads does not justify the additional expense.

The roadway widths shown in Table J-4-2-1a are for gravel roads. Roadway widths greater than those shown may be required for earth roads to provide for future gravelling.

Roadway widths for gravel surfaced roads are influenced by truck volumes. On these roads, vehicles tend to encroach on the centreline of the roadway as drivers shy away from the edge. To provide for clearance requirements for the safe passage of opposing vehicles, roadway widths may be increased by 0.5 m or 1 m for routes which carry in excess of 15 trucks per day.

The decision to select a roadway width to accommodate future surfacing may require an economic analysis. Normally, in Alberta, low volume roads with AADT less than 200 are built as if the gravel surface is the final surface with no provision for future paving.

Table J-4-2-1a Roadway Width (m) for Low Volume Roads*

Design Speed (km/h)	AADT ≤ 25	25 < AADT ≤ 50	50 < AADT ≤ 100	100 < AADT ≤ 200
30	6	6	7	7
40	6	7	7	7
50	7	7	8	8
60	7	8	9	10
70	7	8	9	10
80	7	8	9	10
90	7	8	9	10

* Where the traffic composition is more than 20% trucks, a wider road than what is indicated by the AADT may be used (normally one metre wider). Where oversized vehicles are permitted to use the road on a regular basis, for example on log haul routes, the roadway width is to be selected based on the maximum permitted load width. An 11 m gravel roadway is considered standard for log haul resource roads.

J.4.2.2 One-Lane Two-Way Roads

In some cases, it is desirable to build one-lane two-way roads. Generally these roads are short, serve a single purpose and are not part of a continuous route.

For reasons of safety, these roads may only be considered if the AADT is less than 50 and the design speed is 50 km/h or less. The use of one-lane roads is not recommended where conditions encourage operating speeds in excess of 50 km/h.

Figure J-4-1d shows the cross-section elements for one-lane two-way roads. The roadway width of 4.0 m limits the road to one-lane and turnouts are required for passing.

J.4.2.3 Cross Slopes

On tangent sections of two-lane roadways, cross slope is applied from the centreline to each side of the roadway. On one-lane roads, a cross slope is applied from one edge to the other.

The recommended minimum cross slope on gravel surfaced low volume roads in Alberta is 0.03 m/m. The purpose of this minimum is to provide good surface drainage and hence minimize infiltration of storm water into the roadway subgrade.

At horizontal curve sections, superelevation may be required depending on the speed and radius. Maximum superelevation is 0.08 m/m. Superelevation values for design are given in Table J-3-3-1a. Cross slopes on shoulders are the same as on the adjacent roadway.

J.5 ROADSIDE GEOMETRY

J.5.1 Sideslopes

Slopes of 4:1 are desirable. A slope of 3:1 is considered adequate for design speeds up to 90 km/h. For the higher design speeds (60 km/h or greater), a 2:1 slope is generally not used unless barrier protection is provided.

For the lower design speeds, maximum sideslopes of 2:1 are allowed if the soil will remain stable as detemined by a geotechnical engineer. In these cases, consideration should be given to the installation of barrier especially on high embankments. Refer to Chapter H Roadside Design Guide for more information.

Gentle sideslopes increase safety, are more stable than steep sideslopes, aid vegetation and allow easier maintenance.

In mountainous terrain, maximum sideslopes of 1.5:1 may be appropriate for economic reasons. For high fill areas, warrants for traffic barriers should be examined.

J.5.2 Backslopes

Maximum backslopes of 2:1 are suggested. Steeper backslopes have been used in some areas. Backslopes of 3:1 are preferred. Where backslope agreements are made between the road authority and the land owner for the purpose of reducing right-of-way purchase requirements or obtaining fill material, flatter backslopes in the range of 6:1 to 10:1 may be used.

Where solid rock is encountered, backslopes of up to 0.25:1 may be used as detemined by a geotechnical engineer. Where rock that is prone to weathering is encountered, flatter slopes are usually necessary because very steep slopes would not be stable. Where rock can be easily excavated, the normal cross-section for the roadway designation may be used.

J.5.3 Ditches

Drainage channel cross-sections require adequate hydraulic capacity and are designed to keep water below the roadway surface, avoid impoundment, and limit erosion, where possible. A typical width of 2-3 metres flat bottom ditch is used on low volume roads to reduce erosion.

The invert of the ditch is normally 1.15 m below the edge of the roadway to provide adequate drainage for the roadway structure. This depth can be reduced to 0.6 m to suit other constraints, such as right-of-way or longitudinal drainage, if adequate freeboard (typically 1.0 m for a 1:100 year event) to the roadway surface can be achieved, or if the road authority allows for overtopping.

Other features to consider in design of ditches are: borrow requirements, snow storage capacity, snow drifting, erosion, and right-of-way constraints.

J.5.4 Drainage Structures

Culverts are typically used to provide connectivity for small drainage features and for highway cross-drainage needs, as further discussed in Chapter C. Structures with an equivalent diameter of 1500 mm diameter or greater, shall be designed as bridge structures. Refer to the Bridge Conceptual Design Guidelines [3] for more information.

Alberta Transportation is responsible for the design, construction, and maintenance of Alberta's provincially managed roadways, including watercourse crossing structures (i.e. bridges, culverts). This also includes fish passage requirements for non-bridge sized culverts. Refer to Chapter C for further details,

J.5.5 Right-of-Way

The desirable right-of-way width for 10 m and 9 m low volume roads is 40 m if the design speed is 90 km/h. The basic right-of-way width for these designations is considered to be 30 m.

The desirable right-of-way width for 8 m and 7 m low volume roads is 30 m if the design speed is 60 km/h. The basic right-of-way for these designations is considered 20 m.

The basic right-of-way width is considered to be 20 m for two-lane low volume roads with design speeds from 30 km/h to 50 km/h. Right-of-way widths for one-lane roadways may be less than for two-lane roadways because of the narrow subgrade.

Backsloping agreements may be used rather than purchasing wider right-of-way to achieve the roadway cross-section in difficult terrain or where either the road authority or the land owner prefer not to enter into a land purchase agreement.

In treed areas, a narrow, clear right-of-way (especially on an east-west alignment) results in shading of the roadway, which increases drying time and decreases snow melt. A narrow, clear right-of-way does, however, have a minimal impact on the forest environment.

In a wide, clear right-of-way, drivers tend to travel at higher speeds. If drivers exceed the design speed, this could create an unsafe condition. Wide, clear right-of-ways generally provide better stopping sight distance on sharp horizontal curves and a safer, more forgiving roadside area.

Other factors to be considered in selecting right-of-way are: borrow requirements, snow storage, snow drifting, future road upgrading, impact on utilities, sight lines, wildlife collision potential, and accommodation of construction and maintenance equipment.

J.5.6 Approaches to Low Volume Roads

For low volume roads where the design speed is 80 km/h or greater, the geometry required at approaches is as shown in Chapter D. Refer to CB6-2.3M4 and CB6-2.3M5 in Alberta Transportation CB-6 Highway Standard Plates – Active [4].

Where the design speed is less than 80 km/h and the AADT is 200 and less, refer to CB6-2.3M5a in Alberta Transportation CB-6 Highway Standard Plates – Active [4].

REFERENCES

[1] Alberta Transportation, "Benefit Cost Model and User Guide," [Online]. Available: http://www.transportation.alberta.ca/5847.htm.

[2] Transportation Association of Canada, Geometric Design Guide for Canadian Roads, Ottawa, 2017.

[3] Alberta Transportation, "Bridge Conceptual Design Guidelines," [Online]. Available: https://open.alberta.ca/publications/bridge-conceptual-design-guidelines-version-3-0.

[4] Alberta Transportation, "CB-6 Highway Standard Plates – Active," [Online]. Available: https://www.alberta.ca/cb-6-highway-standard-plates-active.aspx. [Accessed 6 April 2020].