

# CHAPTER A BASIC DESIGN PRINCIPLES

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# CHAPTER A

## BASIC DESIGN PRINCIPLES

### A.1 INTRODUCTION

This chapter includes content applicable to rural and urban roadways in the following categories:

- Description of Alberta Transportation's roadway classification systems
- Definition of design life
- Description and rationale for selection of design daily traffic volume and design hourly volume
- Guide on traffic statistics for planning and design
- Brief summary of benefit cost analysis
- Description of capacity, level of service
- Guidelines for level of service targets and design options
- Width Selection
- Definition of, and advice on, selection of design speed
- Guidelines for the selection of Design Designation
- Summary of all the principal geometric design parameters that apply to each Design Designation for rural and urban highways
- Introductory guidance to geometric design considerations for urban fringe highways
- Design Exceptions
- Abbreviated write-up on environmental considerations
- Option Selection

Designers may not need to use all of the information shown in this chapter on any particular project; for example, level of service and capacity calculations. However, the information is provided as background.

### A.2 ROADWAY CLASSIFICATION

Classification of roadway segments is an important early part of the project development process. Alberta Transportation uses three classification systems to define the character and importance of each segment in the system. This section describes the three classification systems, their use, and the relationship between them. Additionally, several special designations are given to certain roadways in order to accommodate specific needs of Alberta's industries.

#### A.2.1 National Highway System

Canada's National Highway System (NHS) was first established in 1988 by the Council of Ministers Responsible for Transportation and Highway Safety with a mandate to identify a "network of key interprovincial and international highway routes which are of vital significance to the national transportation system and the Canadian economy". In 2005, a comprehensive review of the NHS was undertaken which resulted in the adoption of three categories of NHS routes: core, feeder, and northern and remote routes. In addition, several short sections of roadway were included in the new "core" route category based on their "linkages to Intermodal Facilities".

Within Canada, and within Alberta, the designated NHS is either under federal, provincial, or municipal government control and administration. As of 2015 there are 4,448 km of NHS routes in Alberta (consisting of 4,036 km of Core Routes, 216 km of Feeder Routes, and 197 km of Northern and Remote

Routes), of which 94% are under the jurisdiction of Alberta Transportation. The remaining routes are either under federal or municipal control. A map of the designated National Highway System in Alberta is available at [http://www.transportation.alberta.ca/Content/docType329/Production/NHS\\_AB\\_map.pdf](http://www.transportation.alberta.ca/Content/docType329/Production/NHS_AB_map.pdf) [1].

**Note:** The 4,448 km of NHS routes is based on centreline distance i.e. divided highway lengths are counted only once rather than counting both roadways.

For new construction projects, Alberta Transportation strives to reach the Council's suggested minimum operating speeds of 90 km/h on core NHS routes [2]. There are several areas throughout the province where the minimum operating speed currently does not meet the National Highway System minimum service standards. These roadways are identified for future improvements over time.

For more information on the National Highway System, refer to the *Council of Ministers Responsible for Transportation and Highway Safety* [3] at <http://comt.ca>.

## A.2.2 Service Classification

### A.2.2.1 Definition

Service Classification is the categorization of the relative strategic importance of each highway in the network. A well-organized hierarchy of routes is fundamental to the transportation investment planning process. When used in conjunction with performance thresholds, the Service Classification promotes uniform service levels across roadway corridors of similar strategic significance.

The department's performance criteria and customer service objectives are developed and applied to each Service Classification, with the higher classed roadways subject to more stringent criteria. In this way, investments are targeted towards the higher class highways and users on these routes experience higher service levels.

Examples of Service Classification based performance criteria are: level of service (a measure of congestion/delay tolerance), safety parameters (such as width of roadway), pavement condition targets, maintenance service levels, etc. Service Classification also informs the selection of the appropriate Functional Class, when traffic and surrounding context are taken into consideration (see [Section A.2.3 – Functional Classification](#)).

### A.2.2.2 Service Classification Levels

There are currently four Service Classification levels, numbered 1 through 4, with 1 being the most strategically important highways. The four levels are described as follows:

- **Level 1:** These roadways accommodate the movement of people, goods and services inter-provincially and internationally. They connect Alberta's major population centres (population over 50,000) to key destinations outside the province and typically serve long trip lengths. All Level 1 highways are also core routes in the National Highway System.
- **Level 2:** These roadways are similar to the Level 1 roadways as they accommodate the movement of people, goods, and services but mainly intra-provincially. They serve to connect provincially significant areas such as population centres over 5,000 and also typically serve long trips.
- **Level 3:** These roadways typically carry traffic from major generators such as communities and/or resource and developments but with overall shorter travel distances. These roadways provide the connection between Level 4 and Level 2 roadways, and generally serve traffic of an inter-regional or inter-municipal nature.
- **Level 4:** These roadways typically serve traffic of an intra-regional nature or traffic within a municipality and therefore normally carry short distance trips.

### A.2.2.3 Service Class Designation

The Service Classification levels are developed with consideration of factors such as:

- Federal designations (National Highway System)
- Size and type of population centre served (for example, cities, towns, villages and rural areas)
- Trip purpose (for example, business, recreational and commuter)
- Trip length
- Network continuity and spacing

The Service Classification criteria are applied to the existing highway network, with consideration for future connections where appropriate. For example, Highway 947 south of Fox Creek is classified as a Level 2 (Intra-Provincial) in anticipation of a future extension to Highway 16 near Edson. Portions of roadways controlled by Alberta Transportation but not part of the designated highway network are excluded from the Service Classification designation at this time.

Service Classification levels are assigned independently of urban/rural boundaries and without consideration of traffic volumes. Instead, Service Classification levels are strictly about a segment's role in the overall network. As such, the Service Classification levels tend to be homogenous over long sections of highway, and often correspond to the entire numbered highway. This is despite the fact that these routes may undergo significant fluctuations in traffic volumes and abrupt changes in adjacent land uses through the length of the highway, particularly if the route passes through a series of rural and urban areas. Additionally, since Service Classification is independent of traffic volumes and the surrounding context, the levels generally do not change over time. An exception occurs, however, on portions of roadway that are expected to be re-aligned in the future, often due to a planned bypass of an urban area.

The Service Classification is reviewed periodically, with consideration of both the Service Classification hierarchy definitions and the individual roadway designations. The most recent network-wide review was conducted in 2007 and included a rationalization of the Service Classification categories. Minor adjustments are made periodically each year as required due to changes in the network (addition, deletions, or re-alignments).

### A.2.2.4 Service Classification Map

The *Service Classification Map* is available at [http://www.transportation.alberta.ca/Content/docType329/Production/Hwy\\_Service\\_Class\\_map.pdf](http://www.transportation.alberta.ca/Content/docType329/Production/Hwy_Service_Class_map.pdf) [4]. A detailed route log is also available by accessing the department's Transportation Infrastructure Management System (TIMS) or by contacting Alberta Transportation.

## A.2.3 Functional Classification

### A.2.3.1 Definition

Functional Classification is the grouping of roadways of similar operating characteristics. Unlike Service Classification, Functional Classification is an indication of how a roadway segment operates and its "look and feel", which relates directly to user expectations.

The components of the Functional Classification are described by the surrounding context (be it rural or urban), core function of the roadway segment (whether access to adjacent land or mobility is prioritized), and the physical form of the roadway (whether the opposing streams of traffic are separated or not). These three elements in combination create the "experience" of the user.

Alberta Transportation describes the Functional Classification in two different states: the existing condition and the expected future vision.

### A.2.3.2 Functional Classification Types

The Functional Classification types are described by a combination of three components. These descriptions are abbreviated in a three-letter code which also forms the first part of the design designation (see [Section A.9 – Design Designation](#)). The functional classes consist of the following three components:

- The first letter describes the surrounding context and is denoted as either Rural (R) or Urban (U).
- The second letter describes the core function of the roadway in terms of its emphasis on mobility versus access. These categories are: Freeway (F), Expressway (E), Arterial (A), Collector (C), and Local (L).
- The final letter indicates whether the opposing traffic streams are physically separated or not. This is indicated as either Divided (D) or Undivided (U).

Eleven combinations of these three attributes are the functional classes used by Alberta Transportation. They are given in Table A-2-3-2a along with their primary characteristics.

Additionally, Alberta's Highways Development and Protection Regulation describe four classes of provincial highways, namely:

- Freeways
- Multi-lane provincial highways that are not freeways
- Major provincial highways
- Minor provincial highways

These classes correspond to the generalized Freeway, Arterial Divided, Arterial Undivided, and Collector and Local Undivided functional classes respectively. At this time, urban and rural segments are not differentiated in the [Highways Development and Protection Regulation](#) [5] which may be updated in the future to distinguish between rural and urban segments.



Table A-2-3-2a New Roadway Functional Characteristics

Functional Class Code	Functional Class Description	Core User Function	Flow Characteristics	Connections with	Typical Vehicle Volumes Served (veh/day)	Typical Design Speeds	Number of Basic Lanes	Right-of-Way Width (m)
RFD	Rural Freeway Divided	Mobility is the primary consideration	Uninterrupted Flow	Freeways Arterials Collectors	≥ 10,000	110 – 130	4 – 8	100 – 120
RAD	Rural Arterial Divided	Mobility is the primary consideration	Uninterrupted Flow	Freeways Arterials Collectors Locals	3,000 – 30,000	110 – 120	4 – 6	100
RAU	Rural Arterial Undivided	Mobility is priority with some consideration of Access	Uninterrupted Flow	Freeways Arterials Collectors Locals Driveways	500 – 10,000	100 – 110	2	40 – 60
RCU	Rural Collector Undivided	Mobility and Access of equal importance	Uninterrupted Flow	Freeways Arterials Collectors Locals Driveways	100 – 1,000	90 – 110	2	40 – 60
RLU	Rural Local Undivided	Access is primary consideration	Interrupted Flow	Arterials Collectors Locals Driveways	< 1,000	70 – 90	2	20 – 60
UFD	Urban Freeway Divided	Mobility is the primary consideration	Uninterrupted Flow	Freeways Expressways Arterials	≥ 10,000	90 – 110	4 – 8	≥ 60
UED	Urban Expressway Divided	Mobility is the primary consideration	Interrupted Flow	Freeways Expressways Arterials	10,000 – 60,000	80 – 90	4 – 6	≥ 60
UAD	Urban Arterial Divided	Mobility is priority with some consideration of Access	Interrupted Flow	Freeways Expressways Arterials Collectors	10,000 – 30,000	60 – 80	4 – 6	45
UAU	Urban Arterial Undivided	Mobility is priority with some consideration of Access	Interrupted Flow	Freeways Expressways Arterials Collectors	1,000 – 15,000	60 – 70	2 – 4	20 – 45
UCU	Urban Collector Undivided	Mobility and Access of equal importance	Interrupted Flow	Freeways Expressways Arterials Collectors Locals Alleys/Lanes Driveways	500 – 10,000	50 – 60	2	20 – 24
ULU	Urban Local Undivided	Access is primary consideration	Interrupted Flow	Collectors Locals Alleys/Lanes Driveways	< 1,000	40 - 60	1 - 2	15 – 22

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### A.2.3.3 Functional Class Designation

Determination of the appropriate Functional Class is normally based on consideration of the roadway's Service Class, the volume/composition of traffic, and its location (be it urban or rural), which is in turn influenced by the expectations of the user and vice versa. For example, drivers expect that on an urban arterial, the development will be closer to the edge of the roadway, the speeds are lower, the intersections will be closer together, and the traffic volumes will be higher than on an equivalent section of road in a rural area; or for example, there is an expectation that a local road will provide frequent accesses and will not carry high volumes of traffic. Selection of the appropriate Functional Class is important as it can save effort later on in the planning process when design parameters are selected.

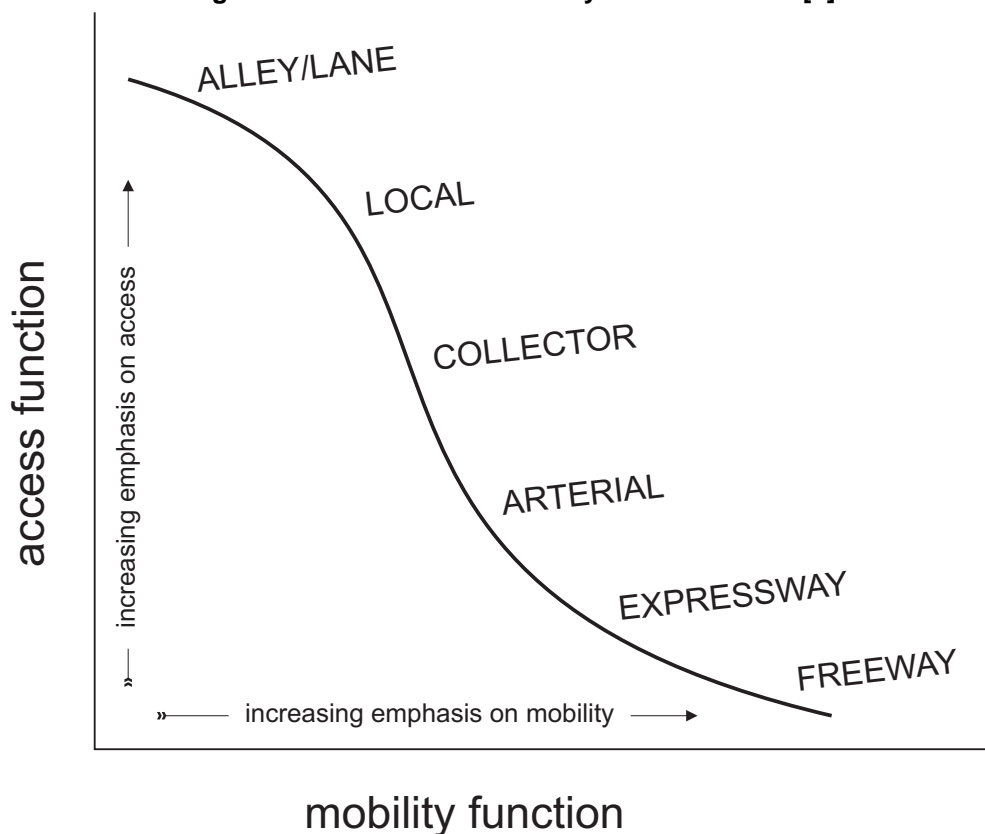
Unlike Service Class, the Functional Class of a roadway segment changes and evolves over time as a result of changing traffic levels and changes to the adjacent land use. For example, what is a Rural Arterial Undivided roadway today may over time become a Rural Arterial Divided and ultimately a Rural Freeway Divided as traffic volumes increase and user expectations change. Similarly, a Rural Arterial Undivided roadway may become an Urban Expressway Divided roadway as the surrounding land use transitions from rural to urban.

For roadside management and right-of-way protection purposes, a long term view must be taken to ensure that enough land is set aside to enable the implementation of the ultimate roadway configuration, and access should also be spaced appropriately for the long term in order to avoid disruptive closures in the future. Similarly, good roadway design will also consider the long term configuration as well as current needs so that costly reconstruction can be minimized or avoided in subsequent stages of development.

#### A.2.3.3.1 Core Roadway Function – Mobility versus Access

The core functional categories indicate the degree of priority placed on access to adjacent land versus mobility. This is shown in Figure A-2-3-3-1a. As seen in the figure, **Freeways** provide the most restrictive access and free-flow of traffic (no traffic signals, intersections, railway crossings, etc.); **Expressways** provide a similar level of mobility to freeways but may have traffic signals or other at-grade crossings with different types of control. **Arterials, Collectors, Locals, and Lanes/Alleys** provide progressively more consideration for land access versus mobility of through-traffic.

Figure A-2-3-3-1a Core Roadway Function Chart [6]



### A.2.3.3.2 Adjacent Land Use Context

Assigning the appropriate context (urban-rural component) of the Functional Class is important due to the wide difference in design attributes associated with each condition and the corresponding difference in user expectations. The determination of the appropriate urban-rural designation is normally based on the consideration of the surrounding land use, and not municipal boundaries. A roadway segment's Functional Class should match the user expectation for the segment. In many cases it is obvious as to whether a rural or urban Functional Class should apply, but there is also often a degree of judgement that is necessary to determine the prevailing surrounding context; that is, what the driver is most willing to accept as the prevailing condition. This is particularly the case for urban fringe areas and for areas which are transitioning over time from rural to urban conditions. There may also be cases where a deliberate choice is made to implement a rural Functional Class within a surrounding urban context. In these cases, care must be taken in terms of the interaction between the roadway and the adjacent land so that adequate clues about the expectations of the roadway are conveyed to the user.

It should be noted that typical roadway cross-sections employ specific design elements commonly referred to as "urban" or "rural" such as raised medians, curbs, gutters, and barriers for urban designs and depressed medians, open ditches, and side-slopes for rural designs. In many cases these design elements adequately correspond with the Functional Class; however, exceptions may be appropriate in some cases. In addition, some roadways may exhibit characteristics (and expectations) of both rural and urban roads, particularly in suburban or urban fringe areas.

Another special case arises at the transition between rural and urban areas. Further information and examples of transition segments and hybrid roadways can be found in [Section A.10.2 – Design Guidelines for Transition Segments and Hybrid Roadways](#).

### A.2.3.4 Functional Classification Maps

Functional Classification of the provincial network is depicted on two maps.

- The [Roadside Management Classification Map](#) [7] represents the Functional Classification - future vision. This classification guides planning decisions, development set-back requirements, and access management spacing requirements. It is primarily determined based on the consideration of Service Classification, the volume/composition of traffic projected up to 50 years in the future, as well as consideration of urban growth plans.
- The [Functional Classification – Existing Condition \(under development\)](#) [8] map depicts the Functional Classification of the provincial network as it exists today. This map informs the selection of the functional component of the design designation (e.g. Rural Collector Undivided), as a way to compare current and future conditions, and as an additional design and access management tool where use of the future designation is not appropriate.

Updates to the two Functional Classification maps are published from time to time based on changes to the existing network and a review of traffic growth projections or other roadway network studies.

### A.2.4 Relationship between Classification Systems

Each of the classifications described in Sections [A.2.1 – National Highway System](#), [A.2.2 – Service Classification](#), and [A.2.3 – Functional Classification](#) serve a different purpose in the overall management of the provincial highway system, although there is considerable overlap between them. Figure A-2-4a shows the relationship between the three classifications, and the various inputs used to formulate the classifications. It should be noted that Functional Classification – Existing Condition changes frequently over time as roadways are upgraded in stages. The Functional Classification – Future Vision is more stable and is updated periodically to account for the latest future travel forecasts. The National Highway System and Service Classification represent strategic importance, which rarely changes (particularly for Levels 1 and 2).

Figure A-2-4a Roadway Classification Inputs

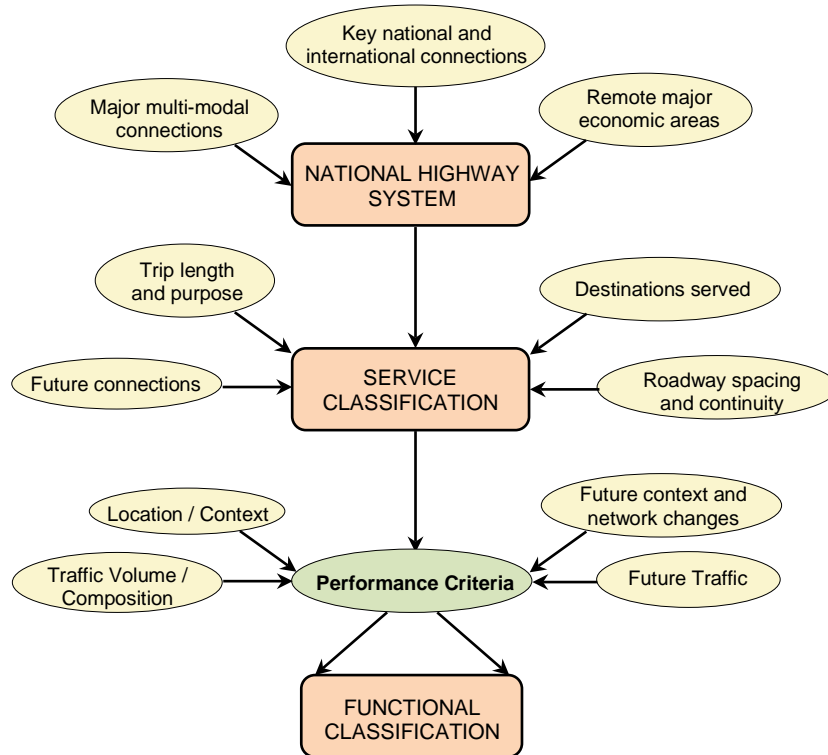


Figure A-2-4b describes the overlap between the three classifications. This chart emphasizes the difference between the strategic importance of a particular route (who is using the route and where are they going) versus the actual amount of use the route experiences (how many vehicles use the route). As an example, Highway 35 north of High Level is a Level 1 highway and is part of the National Highway System. It is of strategic importance to Alberta and Canada because it connects the Northwest Territories with the rest of the country. The traffic volume is low, however, and the department’s performance goals can be achieved with modest investments. It is likely to remain as a two-lane rural undivided roadway for many years or decades to come. On the other hand, Sherwood Park Freeway is a Level 4 highway because it primarily serves local, short distance commuter traffic. However, it is a freeway due to the high volume of traffic it experiences.

Figure A-2-4b Roadway Classification Relationships

		National Highway System			Functional Classification - Future Vision				Functional Classification - Existing			
		Core Routes	Feeder Routes	Northern and Remote Routes	Freeway	Arterial Divided	Arterial Undivided	Collector Undivided	Freeway	Arterial Divided	Arterial Undivided	Collector Undivided
Service Classification	Level 1	✓	x	x	✓	x	✓	x	✓	✓	✓	x
	Level 2	x	✓	✓	✓	✓	✓	✓	x	✓	✓	✓
	Level 3	x	x	x	x	✓	✓	✓	x	✓	✓	✓
	Level 4	x	x	x	✓	✓	✓	✓	✓	✓	✓	✓
Functional Classification - Existing	Freeway	✓	x	x	✓	x	x	x				
	Arterial Divided	✓	x	x	✓	✓	x	x				
	Arterial Undivided	✓	✓	✓	✓	✓	✓	x				
	Collector Undivided	x	x	x	x	x	x	✓				
Functional Classification - Future Vision	Freeway	✓	x	x								
	Arterial Divided	✓	✓	x								
	Arterial Undivided	✓	✓	✓								
	Collector Undivided	x	x	x								

✓	relationship exists
x	no relationship exists

Note: For simplicity, not all Functional Classes are listed

Other important points:

- All Level 1 highways are National Highway System (NHS) Core Routes, but not all NHS routes (in Alberta) are under the jurisdiction of Alberta Transportation such as Highway 1 within Banff National Park which is under the jurisdiction of the Federal government.
- One of the NHS performance objectives is that these routes should achieve a minimum operating speed of 90 km/h. This requires that traffic control along these routes (signals, stop, signs, roundabouts, railway and pedestrian crossings, etc.) will be removed and replaced via interchanges as required.
- The majority of the Level 1 highways are designated as freeways under the Freeways and Access Location Designation Order, but this is not a direct one to one relationship. Some designated freeways are not Level 1 routes (Highway 11, Highway 63 north of Ft. McMurray), while some Level 1 routes are not designated freeways (Highway 9). Additionally, some future freeways are not designated under the Order.

## A.2.5 Special Designations

In addition to Service and Functional Classifications, there are three special designations to further consider. These are: High Load Corridors, Long Combination Vehicle routes, and Log Haul routes (all design vehicles can be found in [Chapter D](#)).

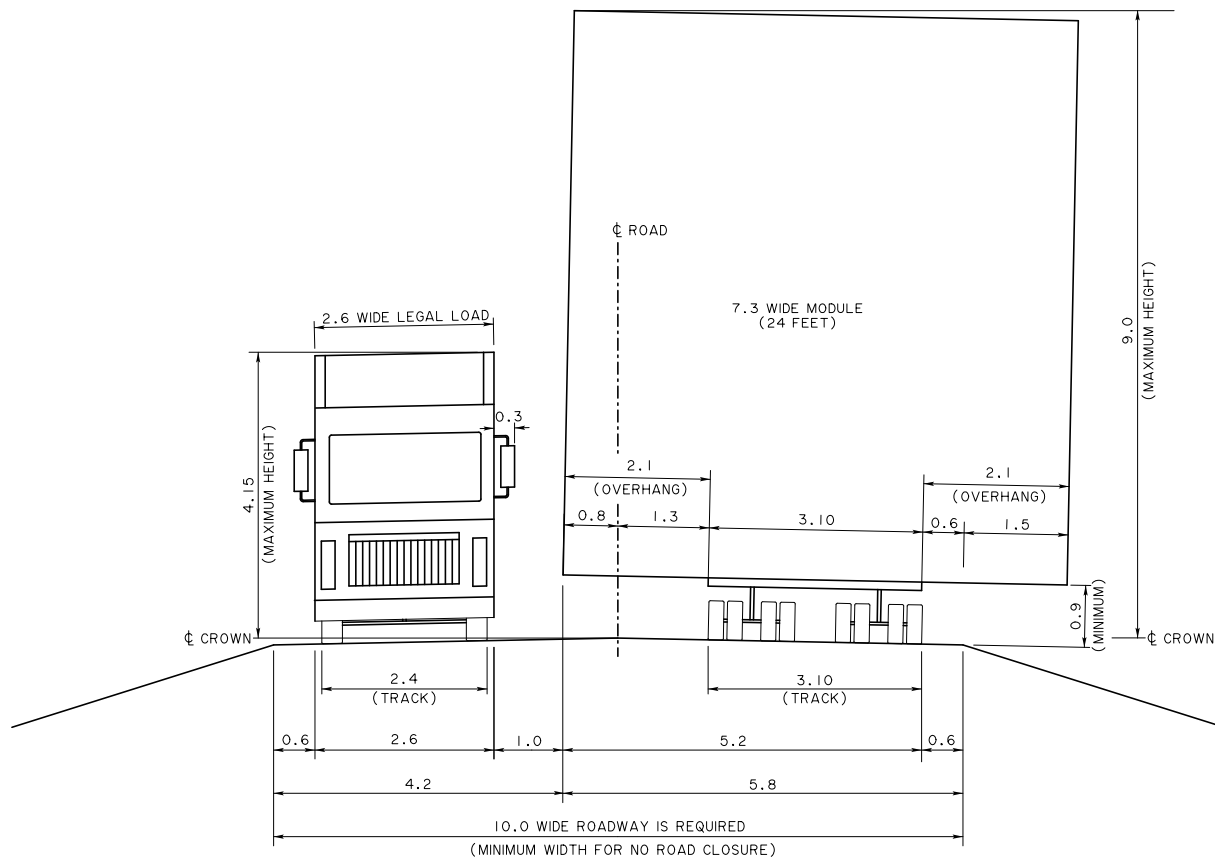
### A.2.5.1 High Load Corridor

The High Load Corridor consists of designated Alberta highways, which have been specially designed or retrofitted to accommodate highway traffic that may be up to 9.0 m high and 7.3 m wide (unless noted otherwise) as shown in Figure A-2-5-1a. The High Load Corridor network is designated under the Commercial Vehicle Dimension and Weight Regulation. The special features include overhead utility lines

which are installed higher, power lines installed underground, traffic signals and sign structures which have rotatable bases, traffic barriers with additional offset (as required), gates for counter flow, on and off ramp by-passes to avoid structures, and roundabout and bridge modifications. Special features, such as removable signs installed in sleeves or attached by a bolt and flange, should also be considered. Segments that are currently under construction or identified for future expansion of the high load network are also shown. The latest listing and map of highways designated as *High Load Corridor* [9] can be found on the following AT website: <http://www.transportation.alberta.ca/3192.htm>. The map also depicts a current listing of highways identified for potential future designation.

For any projects on the High Load Corridor, the designer must ensure the minimum overhead and lateral clearance is obtained. The loads are typically permitted to be significantly wider than normal loads. There are also designated highways with clearances of up to a height of 12.8 m reserved for pressure type vessels only such as Cokers and Reactor Transporters. Designers should be aware that oversized loads using this route can be up to 7.3 m wide. The width requirements may influence the placement of traffic barriers or other objects. In some cases, locations at bridge structures may have load restrictions and require permits, more information can be found in the *Bridge Load Evaluation Manual* [10].

Figure A-2-5-1a Maximum Oversize Vehicle Dimensions for Divisible Loads



**Note:** 0.9 m clearance height will only cover some typical barrier systems on Alberta Highways. Operators may choose to overhang the barrier system and/or provide traffic accommodation if required.



### **A.2.5.1.1 High Load Corridor Program**

The program started in 1986 when a pilot project was undertaken based on an agreed cost sharing mechanism amongst the three parties, i.e. Alberta Transportation, utility companies (power utilities) and users (petrochemical and hauling companies). Since 1994, the department has funded the entire cost, with the cost being recovered through permit fees. A High Load Corridor Working Committee comprised of representatives from the department, the utility companies and users has been established to develop, review and revise the High Load Corridor Five-year Plan. The committee is also responsible for the approval of High Load Corridor route proposals submitted by utility or petrochemical companies for funding assistance by the department. The committee meets annually to set the construction priorities and update the five-year program.

### **A.2.5.1.2 Oversize Vehicles**

Oversize vehicles are considered as occasional users and therefore can be accommodated travelling at low speeds through the use of pilot vehicles and special traffic control. There are many configurations of oversize vehicles which travel under permit on Alberta's roadway network. In order to provide consistent design guidelines at roundabout locations, three types of oversize vehicles were selected based on input/review of vehicle permit inventory, vehicle configurations, swept path, etc. by Alberta Transportation's Transport Engineering and Technical Services Branch (TSB). The three types/configurations of oversize vehicles are the Heavy Hauler (Lowboy), Platform Trailer and the Reactor Transporter (Superload). All of the oversized vehicles can climb the curbs (if semi-mountable). Also because these vehicles are piloted / escorted they may be permitted to travel in a counter flow direction such as through a roundabout. Turning movement templates and details for the three oversize vehicles are provided in [Chapter D](#).

### **A.2.5.2 Long Combination Vehicle Routes**

Long Combination Vehicle (LCV) Routes are designated highway sections where LCVs are allowed to operate under special permit. LCV routes and the associated operating regulations are coordinated across several other states and provinces in order to provide seamless travel between jurisdictions. LCVs consist of a tractor and two or three semitrailers or trailers that exceed the basic length limitation of 27.5 m specified by provincial regulatory agencies.

Details of the LCV program, a map of highways currently designated as LCV Routes, and information on the *Attached Conditions for the Operation of Long Combination Vehicles* [11] can be found at <http://www.transportation.alberta.ca/3191.htm>.

When undertaking projects on LCV routes, planners and designers should take note of the following Sections in the Conditions:

- Section H Turnpike Doubles and Triple Trailer Routes
- Section I Routes in Urban Centres
- Section J Exemptions to Length
- Section K Extended Length Double and Rocky Mountain Double Routes
- Section L LCV Travel off of Designated Routes

Section J - Exemptions to Length for example, includes aerodynamic devices and heavy duty bumpers (moose racks). Heavy duty bumpers installed on front of trucks/truck tractors are not included in the overall length to the design vehicle as long as they do not extend more than 0.3 m.

Refer to [Chapter D.5](#) of these guidelines for further details on LCV design vehicles.

### A.2.5.2.1 Long Combination Vehicle Network

The Alberta LCV network is defined pursuant to Section 62 of the [Traffic Safety Act](#) [12] in [Attached Conditions for the Operation of Long Combination Vehicles](#) [13]. This document defines LCV network routes in terms of two vehicle groups, which are:

- Turnpike Double and Triple Trailer Routes
- Rocky Mountain Double and Extended Length Double Routes

Turnpike Doubles and Triple Trailers are permitted on certain multi-lane (multi-lane refers to divided highway segments) highways with four or more driving lanes, and a few short two-lane undivided highway sections.

Rocky Mountain Doubles and Extended Length Doubles are permitted on all multi-lane highways with four or more driving lanes in addition to a specified network of two-lane undivided highways. A table of certain permitted two-lane undivided highways can be found in the [Attached Conditions for the Operation of Long Combination Vehicles](#) [13].

### A.2.5.2.2 Travel off of Designated Long Combination Vehicle Routes

LCVs may be permitted to operate off of designated LCV routes in order to access destinations in urban areas. Refer to [Section L of the Attached Conditions for the Operation of Long Combination Vehicles](#) [13] for details. Where travel is within cities and other urban municipalities, the cities and other urban municipalities will designate the routes and conditions for the operation of the long combination vehicle. Planners and Designers should contact the cities and other urban municipalities, for specific conditions, designated and future routes.

## A.3 DESIGN LIFE

Determining the appropriate design life is an essential part of the project development process. The lifespan of each component of a roadway varies depending on the relative cost and ease of implementation. Elements such as horizontal alignment and vertical profile are costly and disruptive to alter while other elements such as auxiliary lanes are easier to implement in stages over time. Therefore, various design elements would each have a different design life within the same project.

The minimum design life should correspond with the normal lifespan of the pavement surface, which is normally 20 years from year of project completion date. Project specific cost-benefit analysis can be undertaken where there is uncertainty or to test the cost effectiveness of a given design life.

When determining project requirements, consideration of the project completion date is required. For example, using a 20-year design life and assuming that a five year window is needed in order to complete the design, acquire land if required, and tender a project, the initial design calculations should therefore be based on a 25 year projection. Similarly, planning decisions normally require projecting out 30 years or more assuming that project planning begins at least 10 years prior to project completion.

For projects that only involve spot improvements (such as an intersection treatment), constructed independently of pavement rehabilitation, shorter design periods may be appropriate. In these cases, coordinating the design life of the improvement with the anticipated remaining lifespan of the pavement surface may be advantageous.

The following is a list of general design life considerations:

- Pavement (rural sections): 20 years
- Intersections: 20 years

- Climbing and passing lanes: 20 years
- Vertical and horizontal geometry: 50 years
- Pavement (urban sections including roundabouts): 40 years
- Bridge structures: 75 Years
- Access Management Planning Horizon: 50-100 years

## A.4 TRAFFIC STATISTICS FOR PLANNING AND DESIGN

Understanding current traffic behaviour is important when planning and designing roadways. To this end, traffic data is collected to produce traffic statistics that are inputs for design. Traffic statistics that are produced from traffic data include the following (defined in Sections A.4.1 to A.4.3):

- Annual Average Daily Traffic (AADT);
- Design Hour Volume (DHV); and
- Traffic Growth Rate.

These traffic statistics are produced using traffic data from Automated Traffic Recorders (ATR), which continuously record hourly volumes for every hour in a year. There are nearly 400 ATR sites and they are predominantly located on all major highways. The traffic data that is collected from ATR sites serves as the basis for all traffic information.

It is impractical and costly to provide full traffic data coverage of the highway network using only ATR sites. To fill in the data gaps between ATRs, intersection studies are performed at over 2,500 sites. Intersection studies are typically 12 to 24 hours in duration and are usually performed once every 5 years at each site. The data collected from intersection studies is adjusted using data from ATRs to produce AADT and DHV estimates of movements through the intersection.

Traffic data and statistics for Alberta highways [14] can be found on Alberta Transportation's website at <http://www.transportation.alberta.ca/3459.htm>.

### A.4.1 Annual Average Daily Traffic

Annual Average Daily Traffic (AADT) is a common statistic amongst highway agencies. It is used in the selection of an appropriate design designation on new construction projects. In its simplest terms, AADT is determined by counting the total number of vehicles crossing a point in both directions of a roadway during a year and dividing this value by the number of days in that year. AADT is an average of daily traffic volumes that vary over the year. This is known as the Simple Average method and should only be used when there are no gaps or errors in a full year's worth of data.

There are, however, many times where traffic counting devices produce erroneous data or are missing data for some time during a year. In these cases, it is not possible to determine AADT using the Simple Average method. The American Association of State Highway and Transportation Officials (AASHTO) presents a solution in the *AASHTO Guidelines for Traffic Data Programs* [15].

The AASHTO method was developed to reduce the bias caused by missing data by assuming similarities in traffic volumes by day-of-week and month-of-year; meaning that, for example, daily traffic volumes on Wednesdays in September will be similar to each other. This means that, at a minimum, to estimate AADT there must be data present for each of the 7 days-of-week for each of the 12 months in a given year. The steps for estimating AADT are as follows:

- The daily volumes for each day-of-week in a month are averaged to produce 7 monthly average day-of-week (MADW) values.

- The 7 MADW values are averaged to produce an estimate of the monthly average daily traffic (MADT).
- For a given year, there are 12 MADT values, which can be averaged to estimate the AADT.

The AASHTO method is commonly referred to as the average of averages method. It should be noted that there are other acceptable methods to calculate AADT. The Transportation Association of Canada's Traffic Monitoring Practices Guide for Canadian Provinces and Municipalities can be referenced for all methods.

The projected AADT for the design year should be used unless the Average Winter Daily Traffic (AWDT) or Average Summer Daily Traffic (ASDT) is at least 15 percent higher, in which case the higher value should be used. The ASDT is similar to AADT, except that ASDT only uses data from May 1<sup>st</sup> to September 30<sup>th</sup>. AWDT uses data from November 1<sup>st</sup> to March 31<sup>st</sup>.

## A.4.2 Design Hour Volume

Design Hourly Volume (DHV) is used in many detailed design tasks including intersection design. The DHV is normally the 100<sup>th</sup> highest hourly volume on the facility in the design year. The 100<sup>th</sup> highest hourly volume is obtained by ranking all 8,760 (or 8,784) two-way hourly volumes from highest to lowest and selecting the 100<sup>th</sup> highest value.

The 100<sup>th</sup> Highest Hourly Volume (100<sup>th</sup> HH) is chosen on the basis that it would be wasteful to base a design on the maximum peak-hour traffic of the year, yet using the average hourly traffic would result in an inadequate design. The hourly traffic volume used in design should not be exceeded very often or by very much. On the other hand, it should not be so high that traffic would rarely be great enough to make full use of the resulting facility.

Some agencies use the 30<sup>th</sup> highest hour for design purposes while others use different values. Alberta Transportation has decided to adopt the 100<sup>th</sup> HH as the default value to be used in general for all design calculations. Designers are asked to check other design hours to ensure that traffic operations will be acceptable.

The ratio of the 100<sup>th</sup> HH to AADT at a given location is known as the K-factor. In mathematical terms:

$$K = \frac{100^{th} HH}{AADT}$$

The percentage of traffic during the 100<sup>th</sup> HH that is in the peak direction is known as the directional split factor. It is recommended that directional split factors for the 90<sup>th</sup> to 110<sup>th</sup> highest hours be compared as well because there are occasions where the directional split factor for the 100<sup>th</sup> HH is exceptionally high or low. Common directional split factors are from 0.5 to 0.7.

The K-factor and directional split factor will be determined using the latest traffic data and then applied to the forecast AADT, as required, for planning and design calculations. If for any reason, data is not available, a K-factor of 0.13 and a directional split factor of 0.65 should be used, which are both conservative values that typically represent the 85<sup>th</sup> percentile.

Traffic characteristics on facilities vary depending on the location, size, and type of facility. Designers should make sure to use up-to-date traffic data at or near the design location.

A period of 20 years is widely used as the basis for selecting a DHV. It is difficult to forecast traffic beyond 20 years because of changes in the economy, population, and land development. The method for determining a 20 year-DHV is to apply a traffic growth rate to the existing AADT to produce a forecast AADT. The forecast AADT is then multiplied by the chosen K-factor to produce a DHV.

### A.4.3 Traffic Growth Rate

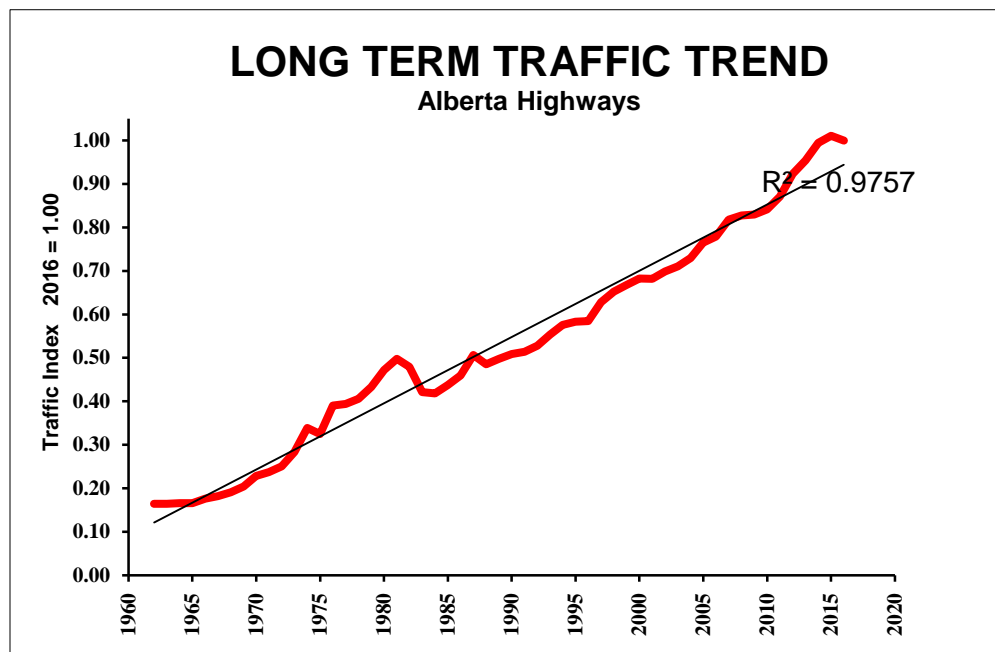
It is imperative that reliable forecasts of future traffic be available when planning and designing roadway infrastructure. There are two ways to determine future traffic. The first way is use historical traffic growth rates. The second is to calculate the future trip generation of land uses and assign these future trips to the road network. This can be done by using a travel demand model.

In the case of Alberta, for approximately 90 percent of the highway network, the use of historical growth rates is appropriate. The remaining highway network is located in areas that experience rapid, or non-linear, development growth. In these areas, it is more appropriate to use travel demand models. Currently, regional travel demand models exist for Calgary and surrounding region, Edmonton and surrounding region, and the Regional Municipality of Wood Buffalo. Alberta Transportation can be contacted to request outputs from these models.

Alberta Transportation has been monitoring traffic volumes since the early 1960's and has a wealth of historical traffic data that can be used to develop historic growth rates.

Designers should use linear growth when developing historic growth rates. The long term traffic growth on Alberta highways follows more of a linear growth pattern as opposed to exponential or compound growth, as shown in Figure A-4-3a.

Figure A-4-3a Long Term Traffic Trend on Alberta Highways



The following equation can be used to calculate a linear traffic growth rate.

$$TGR = \frac{(CT - PT)}{CT} \times \frac{1}{(CY - PY)}$$

Where TGR is the traffic growth rate in decimal form (e.g. 2.5% would be 0.025)  
CY is the current year (or latest year that data is available)

PY	is the previous year. The year that is used depends on time frame of the TGR that is sought.
CT	is the traffic volume at CY
PT	is the traffic volume at PY
	For historical TGR: PY = first year that data is available
	For 5-year TGR: PY = CY – 4
	For 10-year TGR: PY = CY – 9
	For 20-year TGR: PY = CY – 19

The TGR that is used for design requires some engineering judgement. It is recommended that TGRs for different timeframes be calculated for comparison purposes. It is difficult to forecast traffic beyond 20 years because of changes in the economy, population, and land development. Therefore, it is best to use a 20-year TGR when forecasting AADT. Existing traffic data should be used to develop a TGR, if at least 10 years' worth of data is available. If not enough data is available, a conservative TGR of 2.0% should be used. In situations where the historic traffic indicates negative or low growth, it is recommended that designers and planners use a minimum TGR of 1.0%.

The TGR that is calculated can be applied to the current or latest AADT to project a future AADT. The following equation can be used to calculate future AADT using a current TGR.

$$AADT' = AADT \times (1 + (TGR \times (FY - CY)))$$

Where	AADT'	is the projected AADT at FY
	AADT	is the AADT at CY
	TGR	is the traffic growth rate in decimal form (e.g. 2.5% would be 0.025)
	FY	is the future year or design year
	CY	is the current year (or latest year that data is available)

#### A.4.4 Factoring Intersection Count Data to Produce Traffic Statistics

Traffic data that is collected from intersection counts needs to be factored against ATR data to produce AADT, AM 100<sup>th</sup> HH, and PM 100<sup>th</sup> HH estimates, which can be used for designs. This factoring process helps to normalize any traffic anomalies that may have occurred on the day of the intersection count. In order to properly factor intersection count data, there should be, at a minimum, 12 consecutive hours' worth of intersection count data. Using 24 consecutive hours' worth of data is better as it shows temporal differences of traffic data throughout a full day. Any less than 12 hours and there is a risk that daily estimates will be too low or too high. All intersection count data should be collected on a non-holiday weekday. Collecting data on Fridays should be avoided, if possible.

The first step to factoring intersection count data involves assigning an ATR to the intersection whose data is being factored. This is an important and potentially time consuming step. The goal is to assign an ATR that is on a highway that follows a similar traffic pattern to that of the intersection that was counted. However, without a good inventory of historic traffic data at the intersection, it is difficult to establish a traffic profile to compare to ATR data.

The simplest way to assign an ATR to an intersection is based on the ATR's proximity to the intersection. It can be assumed that if an ATR is near an intersection, then both locations have a similar traffic profile. There are situations where there are not any ATRs near the intersection. In these cases, some engineering judgement will have to be used to assign an ATR. For these cases, the following are some factors to consider:

- Similar traffic characteristics, including hourly traffic distributions;
- Same highway Service Class;

- Proximity to urban centres; and
- Similar developments in the area.

Once an ATR has been assigned to the intersection, the factoring process can begin. The following are the steps to factor intersection count data to estimated AADT, assuming a 12-hour intersection count was performed (the same steps are used for any count duration, including 24-hour counts).

1. A typical intersection has 12 movements (through, right, and left movements at 4 legs). For each of the 12 movements, determine the total 12-hour traffic volume.
2. Divide the AADT of the assigned ATR by the total recorded ATR volume during the same 12-hour period of the intersection count.
3. Multiply the factor that was calculated in Step 2 by each of the 12 traffic volumes from Step 1. The resulting values are the AADT estimates for the movements in the intersection. Minor adjustments should be made to the AADT estimates to ensure the intersection is balanced (meaning that the total AADT that is entering the intersection is equal to the total AADT that is exiting the intersection).
4. At this point, a chosen TGR can be applied to the AADT estimates to produce AADT projections.

Once the AADT estimates for the intersection have been calculated, similar steps are followed to calculate the estimated AM 100<sup>th</sup> HH and PM 100<sup>th</sup> HH volumes. The following steps can also be used with AADT projections.

5. Determine the K-factor of the assigned ATR.
6. Add the AADT estimates for all 12 movements that were previously calculated. This is the estimated total daily traffic that is going through this intersection.
7. Multiply the K-factor from Step 5 with the total estimated AADT from Step 6 to determine the total estimated traffic going through the intersection during the 100<sup>th</sup> highest hour.
8. Add up the total volumes for all 12 movements for each hour of the intersection count data. Determine which hour in the AM was the busiest. The volume for this hour is the total intersection volume during the AM peak. Note that the hours do not have to begin and end at the top of an hour. For example, for data that is collected in 15-minute intervals, the busiest hour may be from 7:15-8:15.
9. Divide the volume from Step 7 by the volume from Step 8 to produce a factor.
10. Multiply the factor from Step 9 with the volumes for each of the 12 movements during the AM peak that was determined in Step 8 to end up with AM 100<sup>th</sup> HH estimates for the intersection.
11. For PM 100<sup>th</sup> HH estimates, repeat Steps 8-10 and replace AM with PM.

It should be noted that the same factoring procedures can be used for any short duration traffic count, including those performed at mid-blocks. The factoring procedures presented here are only one example of how short-term data can be factored. Other methodologies can be used; however, designers should be sure to have good justification and sound reasoning for any methodology that is used. Consultants that are working on behalf of Alberta Transportation and have collected intersection count data can contact Alberta Transportation to see if the traffic statistics consultant can factor the data.

**Example: Factoring Intersection Count Data**

Traffic Movement		Recorded Data from 12-Hour Count		
		Total Volume	AM Peak Hour Volume	PM Peak Hour Volume
NR	From north, turning right	249	27	43
NT	From north, proceeding through	1021	111	134
NL	From north, turning left	435	48	65
ER	From east, turning right	432	47	52
ET	From east, proceeding through	2342	255	324
EL	From east, turning left	126	14	21
SR	From south, turning right	109	12	15
ST	From south, proceeding through	1134	124	222
SL	From south, turning left	286	31	38
WR	From west, turning right	301	33	45
WT	From west, proceeding through	2524	274	351
WL	From west, turning left	262	29	45
<b>Totals</b>		<b>9221</b>	<b>1005</b>	<b>1355</b>

ATR Data (during same 12 hours as Count)													
Hour Ending	8	9	10	11	12	13	14	15	16	17	18	19	Total
Volume	472	444	271	382	302	256	297	362	603	642	426	271	4728
Current Year AADT = 5725													
100 <sup>th</sup> Highest Hour Volume = 625													

**Step 1:** Given in Table above

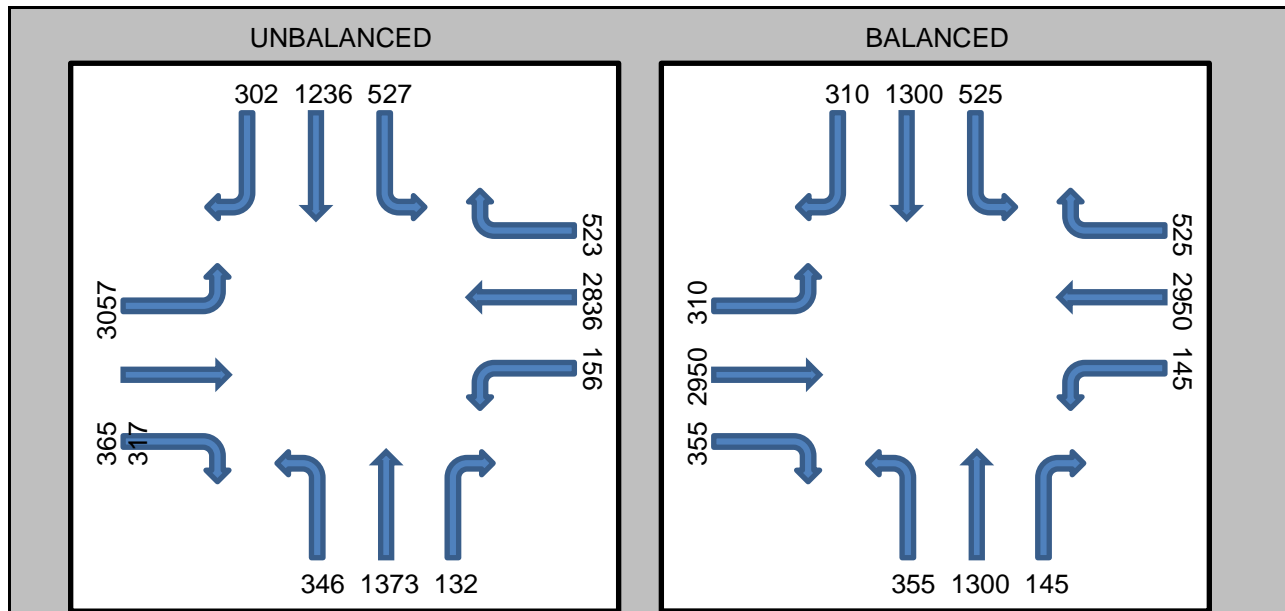
**Step 2:**  $ATR\ AADT\ Factor = \frac{AADT\ From\ ATR}{Sum\ of\ 12\ Hours\ From\ ATR} = \frac{5725}{4728} = 1.211$

**Step 3:** AADT estimates for each movement is:

NR =	[Count data] × [ATR AADT Factor] =	249 × 1.211 =	302
NT =	[Count data] × [ATR AADT Factor] =	1021 × 1.211 =	1236
NL =	[Count data] × [ATR AADT Factor] =	435 × 1.211 =	527
ER =	[Count data] × [ATR AADT Factor] =	432 × 1.211 =	523
ET =	[Count data] × [ATR AADT Factor] =	2342 × 1.211 =	2836
EL =	[Count data] × [ATR AADT Factor] =	126 × 1.211 =	156
SR =	[Count data] × [ATR AADT Factor] =	109 × 1.211 =	132
ST =	[Count data] × [ATR AADT Factor] =	1134 × 1.211 =	1373
SL =	[Count data] × [ATR AADT Factor] =	286 × 1.211 =	346
WR =	[Count data] × [ATR AADT Factor] =	301 × 1.211 =	365
WT =	[Count data] × [ATR AADT Factor] =	2524 × 1.211 =	3057
WL =	[Count data] × [ATR AADT Factor] =	262 × 1.211 =	317

The AADT estimates should be balanced, meaning that opposing movements should have similar traffic volumes in an average day. When balancing, it is important to ensure that the overall total traffic volume going through the intersection remains consistent between unbalanced and balanced volumes. Also there should not be a large difference from the unbalanced volumes and the balanced volumes for each movement.





**Step 4:** Step 4 is not shown in this example.

**Step 5:**  $K \text{ factor} = \frac{100^{\text{th}} \text{HH}}{\text{AADT of ATR}} = \frac{625}{5725} = 0.109$

**Step 6:** Total estimated daily traffic going through intersection is determined by adding all of the values calculated in Step 3. The total for this example is **11,170**.

**Step 7:** Total estimated volume through intersection during 100<sup>th</sup> highest hour is

$$K \text{ factor} \times \text{Total Daily} = 0.109 \times 11170 = 1218$$

**Step 8:** Busiest AM hour volume going through intersection from count data is 1005. Busiest PM hour volume going through intersection from count data is 1355.

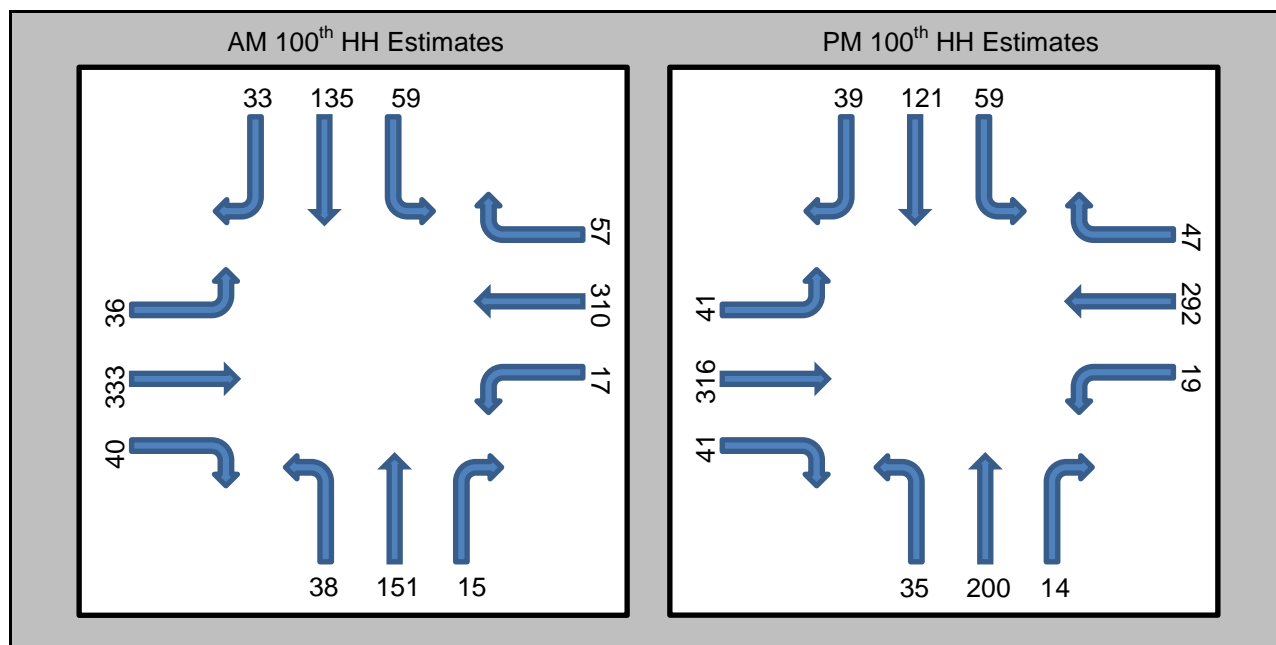
**Step 9:**

$$\text{AM } 100^{\text{th}} \text{ HH Count Factor} = \frac{\text{Estimate from Step 7}}{\text{AM Total from Step 8}} = \frac{1218}{1005} = 1.212$$

$$\text{PM } 100^{\text{th}} \text{ HH Count Factor} = \frac{\text{Estimate from Step 7}}{\text{PM Total from Step 8}} = \frac{1218}{1355} = 0.899$$

**Step 10:**

	AM	PM
NR = [AM/PM data] × [AM/PM Factor] =	27 × 1.212 = 33	43 × 0.899 = 39
NT = [AM/PM data] × [AM/PM Factor] =	111 × 1.212 = 135	134 × 0.899 = 121
NL = [AM/PM data] × [AM/PM Factor] =	48 × 1.212 = 59	65 × 0.899 = 59
ER = [AM/PM data] × [AM/PM Factor] =	47 × 1.212 = 57	52 × 0.899 = 47
ET = [AM/PM data] × [AM/PM Factor] =	255 × 1.212 = 310	324 × 0.899 = 292
EL = [AM/PM data] × [AM/PM Factor] =	14 × 1.212 = 17	21 × 0.899 = 19
SR = [AM/PM data] × [AM/PM Factor] =	12 × 1.212 = 15	15 × 0.899 = 14
ST = [AM/PM data] × [AM/PM Factor] =	124 × 1.212 = 151	222 × 0.899 = 200
SL = [AM/PM data] × [AM/PM Factor] =	31 × 1.212 = 38	38 × 0.899 = 35
WR = [AM/PM data] × [AM/PM Factor] =	33 × 1.212 = 40	45 × 0.899 = 41
WT = [AM/PM data] × [AM/PM Factor] =	274 × 1.212 = 333	351 × 0.899 = 316
WL = [AM/PM data] × [AM/PM Factor] =	29 × 1.212 = 36	45 × 0.899 = 41



## A.5 BENEFIT COST ANALYSIS

### A.5.1 Introduction to Benefit Cost Analysis

Benefit cost analysis evaluates changes in benefits and costs over time arising from an investment in one of several alternatives, as compared to a 'do minimum' (status quo) option. When the results of a benefit cost analysis show that benefits exceed costs, it can be concluded that a proposed project is economically beneficial. Benefit cost analysis provides comprehensive information about the cost-effectiveness of a particular alternative over another. It can also be used to compare the long-term economic effects of improvements that may accomplish different objectives, and to compare programs based on economic considerations. The key to doing a successful benefit-cost analysis is making sure to include all the costs and all the benefits and properly quantify them

### A.5.2 When to Use the AT Benefit Cost Model

The AT Benefit Cost Model and accompanying guide have been issued as the department's updated method of performing benefit cost analysis on transportation construction projects, refinement of practices and development of select programs as required. The model is suited for use when considering various project alternatives. Typically, the project location and basic site-specific information are already known (age of surface, traffic volume, collision history, speed, etc.)

The latest versions of the *AT Benefit Cost Model and User Guide* [16] can be found on the department's website at: <http://www.transportation.alberta.ca/5847.htm>.

### A.5.3 Overview of the AT Benefit Cost Model and User Guide

The user guide gives an overview of the model, explains how to work with the model (including how to input project-specific values), how to complete an analysis, how to interpret the results, and how the model is updated. The model allows the user to enter information where required; otherwise the cells are locked to avoid accidental alteration of a formula. However, the formulas remain visible to the user.

The Benefit Cost Model deals with all values expressed in real base year dollars which do not include inflation, i.e. their present estimated values. As a result, all base values and expenditure data used in the model need to be expressed in these terms. Where expenditures include inflation or are expressed in real values for another year (other than the base year), these values will need to be converted to the base year dollars using the typical discount rate of 4% (or an appropriate factor determined on a project-specific basis).

The analysis components include: initial construction costs (investment), operating and maintenance costs, rehabilitation costs, road user costs (vehicle operating costs, travel time costs, collision costs), and emissions costs.

The model allows for analysis of up to three alternatives (including the 'Do Minimum'). It also contains the capability for sensitivity analysis of each alternative, where the user may vary the discount rate, capital costs, operating and maintenance costs, road user costs and emission costs. The standard annual discount rate currently used in the model is 4%, which is considered appropriate for AT projects.

The analysis timeframe is user-defined. Future traffic growth is predicted by the model based on a user-selected rate and growth driver (linear or exponential).

Vehicle operating costs are calculated in one of two ways:

- California (fuel & non-fuel) approach: This is the **default** approach. It utilizes average fuel costs (liter/100 km) and non-fuel vehicle operating costs (\$/km) by vehicle type to estimate vehicle running costs. It is strongly recommended that the California approach be used for all projects unless the curvature/gradient varies significantly between alternatives, in which case the Texas (curvature & gradient) approach would be used.
- Texas (curvature & gradient) approach: utilizes curvature and gradient cost factors. This approach should only be used when the curvature/gradient varies significantly between alternatives.

The user must define each alternative, deciding whether project-specific values or defaults will be used. Rehabilitation costs must be entered for each alternative, taking design period into account (e.g. 20 years for roadway pavements (rural) and intersection treatments, 40 for pavements (urban including roundabouts), 75 for bridges).

As there are no profits, benefits are realized in the form of cost savings between alternatives. This could be in the form of time savings, emissions savings, collision cost savings, etc. If the user wishes to quantify a particular safety improvement, a collision modification factor may be applied to the collision rate as a project-specific value.

Tables A-5-3a through A-5-3c show some of the major default cost values used in the Benefit Cost Model, as they may be helpful for other uses. The sources are listed below; however, for further information please consult the user guide.

**Table A-5-3a Vehicle Occupancy and Unit Cost for Time**

Vehicle Type	Occupancy (2009)	Work/Bus \$/hr (2014)	Other \$/hr (2014)
Passenger	1.7	\$ 26.00	\$ 13.00
RV	2.0	\$ 26.00	\$ 13.00
Bus	10.0	\$ 21.00	\$ 10.50
Single Unit Truck	1.7	\$ 26.00	\$ 13.00
Semi-Trailer Combo	1.0	\$ 26.00	\$ 13.00
Hybrid Passenger	1.7	\$ 26.00	\$ 13.00
Electric Passenger	1.7	\$ 26.00	\$ 13.00

Occupancy rate is as reported by *Natural Resources Canada* [17]. The hourly work/business cost is from *Alberta Learning Information Services WageInfo* [18]. A study prepared for Transport Canada estimated that the 'overall or base valuation of Travel Time Savings would be 50% of the average wage rate'. As a result, it has been assumed that 'other' (leisure) travel time costs would be 50% of the rate used for 'business/work' travel time.

**Table A-5-3b Vehicle Operating Costs (2014 values)**

Vehicle Type	Non-Fuel Vehicle Cost/km	Fuel Cost/Litre	Fuel Taxes/Litre	Fuel Efficiency (Litre/100 km)
Passenger	\$ 0.16	\$ 1.15	\$ 0.25	8.5
RV	\$ 0.24	\$ 1.15	\$ 0.25	10.7
Bus	\$ 0.24	\$ 1.25	\$ 0.25	33.0
Single Unit Truck	\$ 0.24	\$ 1.15	\$ 0.25	25.0
Semi-Trailer Combo	\$ 0.24	\$ 1.25	\$ 0.25	33.0
Hybrid Passenger	\$ 0.16	\$ 1.25	\$ 0.25	5.0
Electric Passenger	\$ 0.16	\$ 1.25	\$ 0.25	-

The non-fuel vehicle cost calculation is based on the approach used in the California Department of Transportation (CalTrans) Benefit Cost Model. Average fuel consumption is reported by Natural Resources Canada. Fuel costs have been sourced from AlbertaGasPrices.com.

**Table A-5-3c Collision Costs by Type (2014 values)**

	Fatal Collisions	Injury Collisions	Property Damage Only Collisions
<b>Rural</b>	\$ 9,120,367	\$ 66,744	\$ 5,851
<b>Urban</b>	\$ 9,464,015	\$ 59,919	\$ 8,520

**Note:** The above costs are per collision rather than per fatality or per injury, etc.

Collision costs have been provided by AT's Traffic Safety Branch. These estimates are based on work being done nation-wide with Transport Canada. Based on the work to date, the collision costs by type of collision (average for 2006-2011) have been inflated to reflect more current values using the Consumer Price Index (CPI) inflation index. The social cost values reflect the total cost for each category of collision severity. The urban and rural allocations are based on where the collisions occurred, pinpointed to the control section and kilometre post of the provincial highway network, and whether the location is on a subsection that is predominantly rural or urban.

For hybrid situations, where there is a mix of rural and urban segments, an average may be taken; or, if one is predominant over the other, the cost associated with the majority setting could be used.

## A.5.4 Interpreting Analysis Results

Results of the benefit cost analysis are shown in the following indicators:

- Internal Rate of Return (IRR) at year 20 (or target year)
- Break Even Point
- Discounted Total Cumulative Costs
- Discounted Investment Costs
- Discounted Benefits (Non-Investment cost savings)
- Net Present Value (NPV)
- Benefit Cost Ratio

As AT's typical discount rate is 4%, a project will be considered economically viable once its IRR is greater than 4% (though the alternative with the highest IRR is preferred). A short period to the break-even point is desirable, as are low costs and high benefits. High NPV and high Benefit/Cost ratio values are very desirable and generally indicate economic feasibility. However, where two projects both have high NPVs, the NPV/investment cost can be used show which is the most cost-effective. It should be stressed that all of the economic indicators presented should be taken into consideration when analyzing the results and professional judgement should be used to make a recommendation, considering all of the results and the anticipated design life of the project.

**Note:** [Chapter G](#) contains examples of how the benefit cost model can be applied when considering various improvements: grade-widening vs overlay, horizontal curve improvements, sideslope flattening, and paving gravel road.

## A.6 HIGHWAY CAPACITY AND LEVEL OF SERVICE

Level of Service (LOS) is a qualitative measure of operational condition within a traffic stream generally described in terms of such factors as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort, convenience, and safety. The level of service concept is defined in the *Highway Capacity Manual* (HCM) [19].

The HCM methodology is recommended when designers want to determine the LOS and/or capacity of roadways in Alberta.

**Note:** See the glossary included at the end of this guide for definitions related to highway capacity and LOS.

As presented in the HCM, the LOS criteria for two-lane undivided highways in Alberta are based on three parameters:

- Percent time spent following (PTSF)
- Average travel speed (ATS)
- Percent of free flow speed (PFFS)

PTSF represents the freedom to maneuver and the comfort and convenience of travel. ATS reflects the time it takes for vehicles to traverse a certain length of highway during peak periods. PFFS represents the ability of vehicles to travel at or near the posted speed limit.

For most two-lane undivided highways in Alberta, the LOS of PTSF and ATS should be obtained. The worst of the two service measures is the prevailing LOS. PTSF is typically the primary service measure, while ATS is the secondary measure.

For two-lane undivided highway sections that pass through moderately developed areas, where local traffic often mixes with through traffic, have a noticeably higher number of accesses, and a reduced speed limit (typically 80 km/h or lower), the LOS of the PFFS should be used as the prevailing LOS.

The LOS criteria for multi-lane highway segments are defined in terms of density. Density is a measure that quantifies the proximity to other vehicles in the traffic stream. It expresses the degree of manoeuvrability within the traffic stream.

More refined LOS can also be calculated for specific facilities, including intersections, passing lanes, signalize arterial roadways, etc.

### A.6.1 Guidelines for LOS Targets and Design Options

The LOS target is the minimum LOS threshold that a facility should meet within the design period. Designers should reasonably strive for the best feasible LOS that at least meets the LOS target for a facility. Driver expectation and Service Classification are key considerations for the LOS targets. Higher class highways require a higher LOS to minimize delays and maintain economic competitiveness and vitality in the province. Drivers tolerate a lower LOS on lower class highways and around or within densely populated areas.

The designer needs to consider the safety impact and the cost effectiveness of the design to meet the LOS target within the design period. Below is a potential list of design options to improve the LOS:

- The addition of lanes (e.g. twinning)
- The addition of passing or climbing lanes
- Access management / service roads
- Building a parallel route
- Adding turning lanes at intersections
- Signal timing optimization

In densely populated areas, adding driving lanes on 6 or 8 lanes highways can attract new traffic demand and minimize the LOS improvement. In addition to adding lanes, the designer should also consider traffic demand management techniques. Traffic demand management may not improve the LOS of a facility, but will improve travel time reliability or increase total passenger throughput on the road.

Below is a potential list of traffic demand management techniques.

- Managed lanes
- Ramp metering
- Variable speed limits
- Active travel information systems
- Commuter programs (i.e. carpooling initiatives)
- High Occupancy Vehicle/High Occupancy Toll (HOV/HOT) lanes

LOS targets on Alberta's highways are given in Table A-6-1a. The LOS targets vary by Service Class and by the location of the highway within the province (either within a large metropolitan area, within a small metropolitan area, or outside a metropolitan area). Large and small metropolitan areas are defined as areas with urban population centres greater than 500,000 and 50,000 population, respectively. Highway segments which are considered to be within the metropolitan areas are indicated in the [Service Classification Map](#) [4]. Outside the metropolitan areas, there are separate targets for highways within a rural context versus highways within an urban context (i.e. highway segments within communities).

The LOS target is the maximum tolerable LOS within the design period. For example, the LOS on a Level 1 highway in a large metropolitan area cannot exceed LOS D at the end of the design period.

Table A-6-1a Maximum Tolerable LOS Target for Alberta’s Highways

Service Class	Outside Metropolitan Area		Small Metropolitan Area (population > 50,000)	Large Metropolitan Area (population > 500,000)
	Rural Context	Urban Context	Rural & Urban	Rural & Urban
Level 1	B	C	C	D
Level 2	C	D	D	D
Level 3	D	D	D	D
Level 4	D	D	D	D

## A.7 WIDTH SELECTION

The rural cross section in terms of roadway width selection typically consists of the travelled lanes and shoulders. Other cross-section elements include related drainage features, sideslopes and back slopes.

In urban and sub-urban areas, the cross section in terms of the roadway width also typically consists of the travelled lanes, shoulder, sideslopes and/or curb and gutters. Other cross-section elements may include the selection of provisions for pedestrians and cyclists (sidewalks, bicycle paths/lanes, multi-use paths), special purpose lanes (turning/storage lanes, parking lanes, bus lanes, etc.) and separators (medians, boulevards, outer separators), all of which are potential design considerations when selecting an interim or ultimate stage cross-section.

Nominal shoulder widths will vary depending if the roadway is divided or undivided. On divided roadways, nominal shoulder widths (left and right side) are dependent on the number of travel lanes. On undivided rural roadways, nominal shoulder widths are a function of the total surface width which is dependent on Service Class and traffic volumes. Shoulder widths on urban undivided roadways may vary depending on accommodation considerations for vulnerable road users, parking, drainage, design speed, etc.

### A.7.1 Rural Undivided Highways

The design width of rural undivided highways (on new construction and other projects) is a function of Service Classification and design traffic volume (AADT). Figure A-7-1a entitled Desirable Widths for Undivided Rural Highways is used to determine the required width of roadway. These width thresholds were developed in consideration of level of service (using typical rural Alberta traffic and terrain conditions), benefit-cost, safety, impact on construction program, the existing provincial network, and Engineering judgement. The thresholds vary according to Service Classification, with the higher class roadways having lower thresholds.

Figures A-7-1a and A-7-1b are to be used for new construction projects; for example, where a project or series of projects are being designed or planned on an alignment where there is no salvageable existing paved roadway. This chart may also be used on existing paved highways where major upgrading work involving horizontal realignment is planned.

The width requirements shown in Figure A-7-1a only consider basic two-lane undivided cross sections. Additional auxiliary lanes (for example, passing, climbing or turning lanes) may be necessary in some areas to achieve the desired level of service. Refer to [Chapters B and D](#) for climbing and passing lanes, and turning lane warrants, and typical auxiliary lane and shoulder widths.

Planners and Designers should typically determine desirable width based on the appropriate growth rate along with the rationale in determining the Design AADT based on a typical 20-year design life, not compounded. Refer to [Section A.4 - Traffic Statistics for Planning and Design](#) for further details.

The suggested desirable widths shown in Figure A-7-1a are generally applicable; however, exceptions may be made in some cases due to continuity needs or for other reasons. Other reasons may include designated or proposed High Load Corridors, transition zones between rural, suburban, and urban environment, design speed, posted speed, safety, operation, right of way, site specific constraints, etc.

Figure A-7-1b shows the suggested desirable widths for each Service Class based on existing traffic volumes. The Figure may be used to determine a desirable width on “new construction” projects where a projected AADT has not been calculated (or cannot be accurately calculated). This is essentially the same information as presented in Figure A-7-1a except that the traffic volume ranges for each designation have been adjusted based on a 20-year design life and an average annual traffic growth of 2.0 percent, not compounded.





Figure A-7-1b Desirable Widths for Two-Lane Undivided Highways (Based on Design Speed 110 km/h and Existing AADT)

## A.7.2 Urban Highways

Urban and semi-urban cross-section (including road width) will vary depending on site specific characteristics and/or constraints. Typical rural and urban cross-sections can be found in [Section A.10 – General Design Guidelines](#) and [Chapter C – Cross-Section Elements](#).

Maintaining driver expectation and continuity of roadway configuration, e.g. divided or undivided is desirable. Continuity of speed is also desirable, but not often practical or achievable. Generally, design speeds used in urban areas are substantially less than those used in rural areas. Refer to [Section A.8 – Design Speed](#) for suggested design speeds ranges based on rural and urban Functional Classification.

## A.7.3 Typical Travel Lane and Shoulder Widths

For undivided highways (for both rural and urban), the choice of lane width is based on the surface width at the time of line painting after construction. A 3.7 m lane width should be used for all undivided highways where the surface width exceeds 10 m. A 3.5 m basic lane width should be used on all other undivided highways. Under special circumstances a wider lane width may be used if required to accommodate cyclist and/or special vehicles.

The department has been constructing wide subgrades and base courses on new construction and grade-widening projects since 1999. The main purpose of this strategy is to extend the service life that is achieved (despite the need for periodic pavement rehabilitation) if wide shoulders are still available i.e. deferral of the need for grade-widening. New and grade-widening projects include roadway twinning, the addition of auxiliary lanes, intersection and interchange improvements, and non-paved roads to paved roads. The standard practice is to provide enough shoulder width for two future ACP overlays. Refer to [Figures C-8.1c to C-8.1g \(HGDG 1999\)](#) for pavement sideslope construction details for various widths and types of construction. The practice for provisions for two future ACP overlays normally does not apply to roadways with curb and gutters or on bridge structures.

Alberta Transportation’s practice is to not change the posted vertical clearance of a bridge structure over a structure’s lifetime. This ensures route consistency for the trucking industry and minimizes replacement of sign structures. Allowance for future pavement overlays is not considered beneath a bridge structure. To reflect this, the pavement design should account for mill and fill maintenance. Potential impacts include coordination with any planned future overlays (prior to the structure being built) to ensure appropriate clearance at the time of construction, and consultation with highway network planners to determine if the under passing road is (or will be) designated as part of a High Load or Over-dimensional Corridor. Further information can be found in the [Bridge Conceptual Design Guidelines](#) [20] and [Bridge Structure Design Criteria](#) [21].

Nominal and as constructed lane widths (with considerations for future overlays) are shown in Table A-7-2a - Typical Travel Lane and Shoulder Widths for Two Lane Undivided Highways.

**Table A-7-2a Typical Travel Lane and Shoulder Widths for Two Lane Undivided Highways**

Nominal Width			Allowance for Two Future Overlays		
Total Width (m)	Lane Width (m)	Shoulder Width (m)	Total Width (m)	Lane Width (m)	Shoulder Width (m)
12.4	3.7	2.5	14.0	3.7	3.3
12	3.7	2.3	13.6	3.7	3.1
11	3.7	1.8	12.6	3.7	2.6
10	3.5	1.5	11.3	3.7	1.95
9	3.5	1.0	10.3	3.7	1.45
8	3.5	0.5	9.3	3.5	1.15

For divided highways under Provincial jurisdiction (both rural and urban), regardless of posted speed, the basic lane width should typically be 3.7 m. For further details refer to Table A-7-2b - Typical Travel Lane and Shoulder Widths for Divided Highways. Under special circumstances a wider lane width may be used if required to accommodate cyclist and/or special vehicles.

**Table A-7-2b Typical Travel Lane and Shoulder Widths for Divided Highways**

Number of Travel Lanes	Nominal Pavement Width (m)	Travel Lane Width (m)	Nominal Shoulder Width (m)		Allowance for Two Future Overlays Shoulder Width (m)	
			Left Side	Right Side	Left Side	Right Side
2	12.4	3.7	2.0	3.0	2.8	3.8
3	16.6	3.7	2.5	3.0	3.3	3.8
4	20.8	3.7	3.0	3.0	3.8	3.8

**Note:** Pavement width shown is for one direction of travel.

Where curb and gutter is placed at the outside edge of a paved shoulder, the shoulder width is measured between the edge of the travelled way and the lip of the gutter [6]. Where curb and gutter is provided, the gutter pan width is not considered to be part of the basic travel lane width.

Urban Freeways and Expressways typically contain shoulder widths as for rural divided highways. Provisions for shoulder widths are not normally considered with urban arterial roads, which have curb and gutters, unless under certain site specific conditions. Where shoulders are not delineated in an urban environment, additional pavement widths may be provided as an offset from the edge of travel lane to the curb or gutter lip. This offset is chosen based on speed and type of curb/gutter configuration, allowance/prohibition of parking and whether or not vulnerable road users such as cyclists are being accommodated. See [Chapter C](#) regarding offsets from curbs and provisions of “shared” lane. Where curb and gutter is placed at the outside edge of a paved shoulder, the shoulder width is measured between the edge of the travelled way and the lip of the gutter [6]. Additional pavement width and/or curb type (mountable or semi-mountable) may also need to be considered on high volume undivided urban two-lane roads to accommodate for provisions to pass a parked or disabled vehicle.

## A.8 DESIGN SPEED

### A.8.1 Description

Design speed is considered to be the highest continuous speed that vehicles can safely travel on a road when weather conditions are favourable and traffic density is so low that the safe speed is determined solely by the geometric features of the road. Design speed is critical for establishing geometric design elements for a road or highway, as nearly all design elements relate either directly or indirectly to design speed. Some design elements such as horizontal and vertical alignment, superelevation are calculated using design speed as a variable in formulas that are based on the laws of physics. Other design elements such as shy distance, lane width, shoulder width, clearance to obstacles are based on empirical information collected over decades of research and observation. These elements are often related to driver psychology and explain why these elements vary from urban to rural settings and even by jurisdiction and country. A third category of design elements are related to both the laws of physics and driver psychology: elements related to interchange and intersection design are calculated using design speed and vehicle performance characteristics such as acceleration and deceleration rates with factors determined through empirical observations. Regardless of how the various design elements are chosen, the selected design speed, and the overall speed profile along a section of roadway should match driver expectation for a given roadway function and context.

## A.8.2 Selection of Design Speed

Design speed is set by the following factors:

- Core function: a higher design speed usually corresponds to those roads/highways with high mobility needs while lower design speeds correspond to those roads/highways with low mobility/high access needs
- Context: drivers expect to be able to travel faster in rural areas (where there are few visible constraints and destinations are farther apart), than in urban areas (where the surrounding built form presents a more intimate setting and where destinations are closer together)
- Topography: a highway in level or rolling terrain justifies a higher design speed than one in mountainous terrain. Approaching drivers are more apt to accept a lower design speed where a difficult location is obvious than where there is no apparent reason for it.
- Physical and environmental constraints: it is not always practical or possible to accommodate design elements associated with higher design speeds and lower design speeds may need to be considered and evaluated.

Table A-8-2a shows recommended design speed ranges by Functional Class for rural and urban roadways.

**Table A-8-2a Suggested Design Speeds Based on Rural and Urban Design Classifications**

Rural		Urban	
Functional Class	Design Speed Ranges (km/h)	Functional Class	Design Speed Ranges (km/h)
Freeway	110 – 130	Freeway	90 – 110
–	–	Expressway	80 – 90
Arterial Divided	110 – 120	Arterial Divided	60 – 80
Arterial Undivided – Flat and Rolling Terrain	110	Arterial Undivided	60 – 70
Arterial Undivided – Mountainous	80 – 110		
Collector Undivided – Flat and Rolling Terrain	90 – 110	Collector Undivided	50 – 60
Collector Undivided – Mountainous	80 – 110		
Local Undivided – Flat and Rolling Terrain	60 – 90	Local Undivided	40 – 60
Local Undivided – Mountainous	40 – 90		

**Note:** A design speed of 110 km/h is preferable for Collectors; however, for Level 4 segments where AADT is less than 400 veh/day, design speed of 90 km/h is acceptable.

It is desirable to provide a reasonable degree of consistency in the design speeds selected within each Functional Classification within a jurisdiction. When selecting a design speed for a given roadway within a municipality, the designer should review the design speed of similar roadways (i.e. similar characteristics or functions) before making a final decision. Where the speed limit is not posted in urban municipalities, the legal speed limit is 50 km/h as defined in the [Alberta Traffic Safety Act](#) [12].

An additional consideration, especially in the urban context, is the achievement of a degree of traffic calming if warranted due to the presence of more vulnerable road users such as children, pedestrians and cyclists mixed with motor vehicles.

### A.8.2.1 Relationship Between Operating Speed and Design Speed

Generally, drivers on most facilities in Alberta tend to drive at a speed somewhere between the posted speed and 10 km/h greater. Data collected from traffic monitoring devices for passenger vehicles on two-lane undivided highways and divided highways posted at 100 km/h and 110 km/h respectively in Alberta, indicated that the 85<sup>th</sup> percentile driver generally exceeded the posted speed limit (standard speed limit as per the Section 106 of the [Alberta Traffic Safety Act](#) [12]) on high speed rural facilities by approximately 10 km/h when weather and traffic conditions were favourable.

**Note:** The 85<sup>th</sup> percentile speed is defined as the speed that is exceeded by 15 percent of the sample taken.

Design speed must always be more than or at least equal to posted speed and lane capacity increases with posted speed. It is common design practice in Alberta for the design speed of a facility to be 10 km/h to 30 km/h greater than the posted speed. Other jurisdictions vary posted speed within a facility by vehicle type, although this practice does not occur in Alberta.

### A.8.2.2 Adapting Design Speed

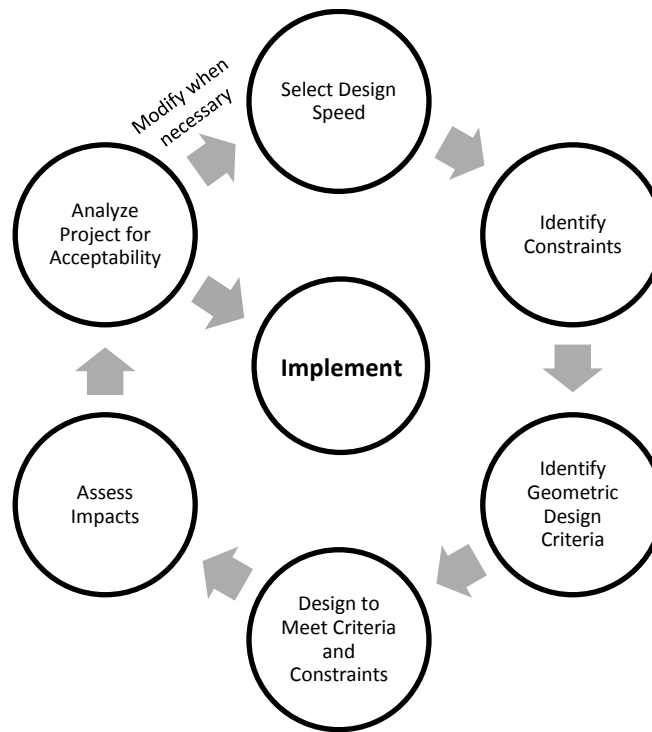
Special situations may arise in which engineering, economic, environmental or other considerations make it impractical to provide the minimum elements established by the design speed. Examples of these situations include sections of rough topography or tight curves where maintenance of full design speed is completely impractical, or brief horizontal or vertical sight distance restrictions caused by bridge rails, bridge piers, cut slopes and so forth.

The cost to correct such restrictions may not be justified with the result being a reduction in the effective design speed at the location in order to reduce the impact of the associated design elements. Such reductions in design speed are sometimes appropriate in mountainous terrain, where property acquisition would be difficult or when entering a built-up area that necessitates a conversion to interrupted flow conditions to provide access to adjacent land. Typically, design speed is normally reduced by 20-30 km/h with the posted speed reduced in increments of 20 km/h to avoid abrupt changes in alignment or surprises for the driver. Approaching drivers are more apt to accept a lower design speed where a difficult location is obvious than where there is no apparent reason for it. Reductions in design speed in response to a topographic or land use constraint should be evaluated on a case-by-case basis and justification documented as to why reductions in design speed is warranted.

Generally, the lowering of design speed is discouraged on new construction projects because the cost of grading is very low compared to other costs; for example, paving and road-user costs. This can be confirmed and quantified through an economic analysis using the department's [Benefit Cost Model](#) [16].

There can be an interactive aspect to the selection of an appropriate design speed and further information gleaned in early design and planning phases may necessitate the adjustment of a chosen design speed. Some factors can be mitigated or adjusted, possibly at an increased cost. Figure A-8-2-2a shows the iterative nature of the selection of design speed.

Figure A-8-2-2a Design Speed with Constraints Flow Chart



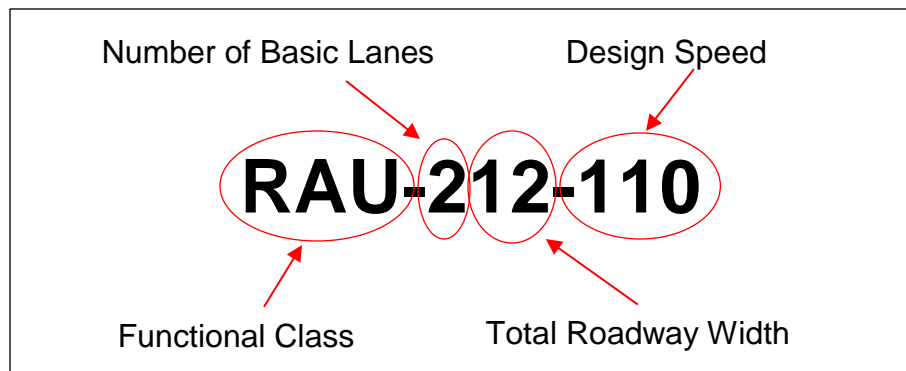
## A.9 DESIGN DESIGNATION

### A.9.1 Description of Rural and Urban Design Designation

The Design Designation is an alphanumeric abbreviation that informs the principal design values to be used in a particular geometric design. Once selected, the design designation establishes the basic design parameters as outlined in [Section A.10 – General Design Guidelines](#).

The Design Designation is a combination of three components: Functional Class, roadway width (consisting of a description of the number of basic lanes and total roadway width with shoulders), and the design speed. As shown in Figure A-9-1a, the Functional Class is listed first, followed by the total number of basic lanes and the total roadway width (m), and lastly the design speed (km/h). For the case of divided highways, the total number of lanes for both directions is listed, but the total roadway width only includes one direction of travel.

Figure A-9-1a Design Designation Parameters



Although certain alphanumeric characters are typically used together – for example, Rural Arterial Undivided (RAU) designations usually have a design speed of 110 km/h – this does not mean that other combinations are not permitted.

If a road is designated to be a gravel surface, the design designation parameters will follow with a G after the total roadway width. E.g. RLU-207G-60 is rural local undivided, 2 lane, 7m roadway width, and gravel surface, at 60 km/h design speed.

## A.9.2 Determining the Design Designation

Determining the appropriate design designation for a particular project is achieved by combining the three basic elements (Functional Class, Roadway Width, and Design Speed) through the methodologies outlined in Sections [A.2](#) through [A.8](#).

Table A-9-2a summarizes the basic Design Designation elements and the reference sections used in their selection.

When developing the Design Designation, special attention must be made to the design life of the roadway facility. Often, a design designation must be determined for two or more time horizons, depending on the expected staging of the roadway facility over time. This is because certain design elements have a design life that extends past the immediate construction horizon. For example, consider a rural highway twinning project on a future freeway. Those design elements that are specific to intersections (such as intersection sight distance, acceleration and deceleration lane lengths, etc.) should be designed according to typical Rural Arterial Divided (RAD) design speeds of 110 or 120 km/h. The future freeway designation is not relevant to the intersection design as they will be removed at the freeway stage. On the other hand, the horizontal and vertical geometry should be designed to achieve the typical Rural Freeway Design (RFD) speed of 130 km/h in order to avoid the need for costly future re-alignments.

When selecting a current design designation, as a minimum, planners and designer should also evaluate and recommend the ultimate rural or urban design designation and subsequent future staging if applicable. Further details on the department's existing and future Functional Classification on the Provincial network can be found in [Functional Classification – Existing Condition Map \(under development\)](#) [8] and [Roadside Management Classification Map](#) [7] (future vision) respectively in [Section A.2 – Roadway Classification](#).



**Table A-9-2a Design Parameters for Selection of the Design Designation**

Example: Design Designation RAU-212-110

Parameter	Element	Reference Chapter A Include
RAU	Functional Class	<a href="#">A.2 – Roadway Classification</a> <a href="#">A.3 – Design Life</a> <a href="#">A.4 – Traffic Statistics for Planning and Design</a> <a href="#">A.5 – Benefit Cost</a> <a href="#">A.6 – Highway Capacity and Level of Service</a>
212	Number of Basic Lanes and Roadway Width	<a href="#">A.2.5.1 – High Load Corridor</a> <a href="#">A.2.5.2 – Long Combination Vehicles</a> <a href="#">A.3 – Design Life</a> <a href="#">A.6 – Highway Capacity and Level of Service</a> <a href="#">A.7 – Width Selection</a>
110	Design Speed	<a href="#">A.8 – Design Speed</a> <a href="#">A.10 – General Design Guidelines</a>

## **A.10 GENERAL DESIGN GUIDELINES**

### **A.10.1 Design Guidelines for Rural and Urban Highways**

Table A-10-1a and Table A-10-1b provides a summary of all the principal geometric design parameters that apply to each design designation for rural and urban roadways respectively. Additional information for other design speeds etc. is provided throughout this manual.

The standards shown on Table A-10-1a and Table A-10-1b should be met or exceeded for all new construction and major re-construction projects involving horizontal alignment changes.

Some general notes regarding design standards, and more specific notes dealing with horizontal and vertical alignment design, are included in Table A-10-1a In addition to those general notes, planners and designers should consider general design controls identified in [Section A.10.3 – Other Considerations](#).

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Table A-10-1a Design Guidelines for Rural Highways (1 of 2)

DESIGN DESIGNATION		RFD-412.4-130 RFD-616.6-130 RFD-820.8-130	RAD-412.4-120 RAD-616.6-120	RFD-412.4-110 RFD-616.6-110 RFD-820.8-110	RAU-212.4-110 RAU-212-110 RAU-211-110	RAU-210-110 RAU-209-110	RCU-210-110 RCU-209-110 RCU-208-110	RCU-210-100 RCU-209-100 RCU-208-100	RCU-210-90 RCU-209-90 RCU-208-90	RLU-210-90 RLU-209-90 RLU-208-90	RLU-208-60 RLU-207-60		
DESIGN SPEED		130	120	110	110	110	110	100	90	90	60		
HORIZONTAL ALIGNMENT	MIN. CURVE RADIUS (m)	950	750*	600	600	600	600	440	300	300	120		
	SPIRAL PARAMETER A	REFER TO SUPERELEVATION TABLES FOR MINIMUM AND DESIRABLE "A" PARAMETERS FOR EACH CURVE RADIUS AND DESIGN SPEED IN <a href="#">CHAPTER B</a>											
VERTICAL ALIGNMENT $K = \frac{L(m)}{A(\%)}$	CREST K	PASSING SIGHT	N/A	N/A	N/A	585	585	585	495	495	410	190	
		NON-STRIPING SIGHT	N/A	N/A	N/A	250	250	250	250	N/A	N/A	N/A	
		MIN. STOPPING SIGHT	124	95	74	74	74	74	74	52	39	39	11
	SAG K	HEADLIGHT MIN.	73	63	55	55	55	55	55	45	38	38	18
		COMFORT MIN. (ILLUMINATION SECTIONS ONLY)	44	37	32	32	32	32	32	26	21	21	10
	DECISION SIGHT DISTANCE (m)	305-450	265-415	235-380	235-380	235-380	235-380	235-380	200-355	170-315	170-315	95-205	
	MAXIMUM GRADIENT (%)	3	3	3	5	5	6	6	6	6	7-9	10-13	
CROSS SECTION	LANE WIDTH (m)	3.7	3.7	3.7	3.7	3.5	3.5	3.5	3.5	5.0 4.5 4.0	4.0 3.5		
	OUTSIDE SHOULDER WIDTH (m)	3.0	3.0	3.0	2.5 2.3 1.8	1.5 1.0	1.5 1.0 0.5	1.5 1.0 0.5	1.5 1.0 0.5	1.5 1.0 0.5	1.5 1.0 0.5	0.5 -	
	INSIDE SHOULDER WIDTH (m)	2.0 2.5 3.0	2.0 2.5	2.0 2.5 3.0	-	-	-	-	-	-	-	-	
	TOTAL SURFACE WIDTH PER CARRIAGEWAY (m)	12.4 16.6 20.8	12.4 16.6	12.4 16.6 20.8	12.4 12.0 11.0	10.0 9.0	10.0 9.0 8.0	10.0 9.0 8.0	10.0 9.0 8.0	10.0 9.0 8.0	10.0 9.0 8.0	8.0 7.0	
	MEDIAN WIDTH (INSIDE SHOULDER LINE TO INSIDE SHOULDER LINE) (m)	32.6 (50.6) 32.6 (50.6) 25.2 (43.2)	37.6 (50.6)	32.6 (50.6) 32.6 (50.6) 25.2 (43.2)	-	-	-	-	-	-	-	-	
	CENTRELINE TO CENTRELINE SPACING (m)	40 (58 IN CROWN LAND)	45-58 (58 IN CROWN LAND)	40 (58 IN CROWN LAND)	-	-	-	-	-	-	-	-	
	DITCH WIDTH (m)	4.0 ROUNDED	4.0 ROUNDED	4.0 ROUNDED	4.0 ROUNDED	3.5	3.5	3.5	3.5	3.5	3	3	
	CLEAR ZONE DISTANCE	REFER TO <a href="#">ROADSIDE DESIGN GUIDE TABLE H4.1</a> [22]											
	SIDESLOPE RATIO (m) – SEE GENERAL NOTE 8	6:1	6:1	6:1	5:1	4:1	4:1	4:1	4:1	4:1	4:1	4:1	
	ON FILLS – MAX. – SEE GENERAL NOTE 8	3:1 OVER 6.5m	3:1 OVER 6.5m	3:1 OVER 6.5m	3:1 OVER 6.5m	3:1 OVER 4m	3:1 OVER 4m	3:1 OVER 4m	3:1 OVER 4m	3:1 OVER 4m	2:1 WITH GUARDRAIL	2:1 WITH GUARDRAIL	
	BACKSLOPE RATIO	NORMAL	5:1	5:1	5:1	5:1 4:1	3:1	3:1	3:1	3:1	3:1	3:1	
		MAX.	3:1	3:1	3:1	3:1	2.5:1	2.5:1	2.5:1	2.5:1	2:1	2:1	
BASIC R/W WIDTH	TYPICAL (m)	110	110-130	110	60 50	40	40 (DESIR.) 30 (MIN.)	40 (DESIR.) 30 (MIN.)	40 (DESIR.) 30 (MIN.)	40 (DESIR.) 30 (MIN.)	30 (DESIR.) 20 (MIN.)		
	MAX. [THROUGH UNDEVELOPED CROWN LAND] (m)	130	130	130	160	50	50	50	50	40	30		

Note: Table A-10a continued on next page

Table A-10-1a Design Guidelines for Rural Highway (2 of 2)

GENERAL NOTES	
<ol style="list-style-type: none"> <li>1. The following notes highlight certain key issues only. For a more through explanation, refer to <a href="#">Chapter B</a> of the text.</li> <li>2. Minimum design values for horizontal and vertical curvature should be reserved only for critical locations, with better standards being used in the majority of cases. A section of road might be designed to meet all minimum standards, but could still result in an unsatisfactory overall design.</li> <li>3. Horizontal and vertical alignment should be designed to accommodate the ultimate Functional Classification, as they are the most permanent design elements of a highway, and once a facility is constructed, poorly designed features will remain and be viewed by road users for many years. The importance of the initial design cannot, thus, be overemphasized.</li> <li>4. Horizontal and vertical alignment coordination principles as outlined in <a href="#">Section B.4</a> of this manual are to be given serious consideration during the location and design phases of the project.</li> <li>5. A design speed lower than normal standard for a certain section of roadway is sometimes used in rugged or mountainous terrain; however, the design speed is not normally reduced by more than 20 – 30 km/h. Such a section must be carefully designed so that there are no abrupt changes in alignment or surprises for the driver.</li> <li>6. Barrier type curbs should not be used on roadways where the design speed exceeds 70 km/h. semi-mountable or mountable type curbs should be considered for roadways where the design speed exceeds 70 km/h.</li> <li>7. Acceptable combination of curb and barrier systems are dependent on the operating speed of the highway, the cross-sectional shape of the curb, and the lateral offset of the curb from the barrier system. Refer to <a href="#">AT Roadside Design Guide, Table H4.1</a> [22] for further details.</li> <li>8. Sideslope Ratio and On Fills should refer to <a href="#">Chapter C</a> of the <i>Highway Geometric Design Guide</i> and the <a href="#">Roadside Design Guide</a> for further details.</li> </ol>	
NOTES: HORIZONTAL ALIGNMENT DESIGN	NOTES: VERTICAL ALIGNMENT DESIGN
<p>* The minimum horizontal curve radii for RAD-412.4-120 may, in theory, be 750 m, according to superelevation requirements. However, it is generally best to use the higher value as shown in the table to be consistent with 130 km/h design speeds as shown. When severe constraints exist, the minimum radii as required by superelevation may be used.</p> <ol style="list-style-type: none"> <li>1. Alignment should be as directional as possible but should be consistent with topography and with preserving developed properties and community values.</li> <li>2. The minimum radius curve for the applicable design speed should be reserved for critical locations, and otherwise avoided wherever possible.</li> <li>3. In general, the deflection angle of each curve should be as small as the physical conditions permit, so that the highway will be as directional as possible. A deflection angle of 60 degrees or less is desirable and should be strived for.</li> <li>4. Consistent alignment should always be sought. Sharp curves are not to be introduced at the ends of long tangents, or at or near the top of a pronounced vertical curve. Similarly, a minimum radius curve should generally not be introduced at the bottom of a long, steep grade.</li> <li>5. For small deflection angles, curves should be sufficiently long to avoid the appearance of a kink. A minimum curve length of 300 m – 400 m is suggested. A deflection angle of 0°30' or less does not require a curve.</li> <li>6. Spirals are to be used on all curves requiring superelevation to provide a proper transition from tangent to curve.</li> <li>7. Horizontal sight distances are to be verified on all curves. Where in a cut section or a treed area, and where a high percentage of trucks are anticipated, truck braking requirements may dictate the minimum radius of curve required for a certain design speed, and should be considered during the route location phase of the project.</li> </ol>	<ol style="list-style-type: none"> <li>1. For undivided highways, passing sight K values should be considered as ideal where grading considerations permit. Non-striping K values should be used a desirable minimum, although stopping sight Ks are acceptable from a safety and operations standpoint. Using a K value greater than the minimum stopping sight K, but less than the minimum non-striping K will increase the length of the barrier line.</li> <li>2. The non-striping K values are based on a sight distance of 475 m (110+ km/h). Present Alberta standards call for a solid barrier line where sight distance is less than 425 m. It may be possible to use a K value less than shown under the non-striping K category and not have barrier line. In cases where the minimum K is used, the sight distance should be verified using a height eye = height of object = 1.15 m</li> <li>3. For stopping sight distance an object height of 0.6m is used. This value represents the vehicle tail light height. Research indicates that 95% of tail light heights and 90% of headlight heights exceed this value. [6] [23]</li> <li>4. The crest K values apply when the length of vertical curve is greater than the applicable sight distance. For curves where the length is less than the sight distance, <math>K = (2 S/A) - 200 (\sqrt{h_1} + \sqrt{h_2})^2 / A^2</math>. As well, the length of both crest and sag vertical curves in metres should always be as great as or greater than the design speed in km/h.</li> <li>5. Minimum sag K values are based on stopping sight distance and a headlight beam sloping upward at an angle of one degree from the plane of the vehicle. Low K values may be allowable in certain situations, particularly for high speed conditions, as stopping sight distance values may exceed pavement visibility distances afforded by headlights.</li> <li>6. Decision sight distances should be considered for crests near major intersection. Each major intersection should be checked on a site specific basis, and analyzed individually to determine if decision sight distance is achieved. The bottom end of the range is suitable for simple situations; the top end for complex situations. Intersection sight distance requirements must, of course, also be met.</li> <li>7. The Gradient – Desirable Maximum percentage category provides maximum gradients that should not be exceeded wherever practical. The maximum gradient is site specific. In situations where costs increase substantially depending on the maximum gradients, an economic analysis should be undertaken to determine the suitable maximum gradient for that section of roadway. This economic analysis should consider road user costs as well as construction costs.</li> <li>8. As a general rule, vertical alignment with a series of successive sharp crest and sag curves should be avoided as it gives the impression of a roller coaster and has operational and safety disadvantages.</li> </ol>

Table A-10-1b Design Guidelines for Urban Highways (1 of 2)

DESIGN DESIGNATION		UFD-412.4-120 UFD-616.6-120 UFD-820.8-120	UFD-412.4-110 UFD-616.6-110 UFD-820.8-110	UFD-412.4-100 UFD-616.6-100 UFD-820.8-100	UFD-411.4-90 UFD-616.1-90 UFD-820.8-90	UFD-617.1-90 UED-411.4-90 UED-617.1-90	UED-409.4-80 UED-613.1-80	UAD-407.4-80 UAD-611.1-80	UAD-408-70 UAD-611.7-70	UAU-209-70 UCU-414-70 UCU-209-70	ULU-209-60	
DESIGN SPEED		120	110	100	90	90	80	80	70	70	60	
SUPERELEVATION (%) [SEE HORIZONTAL ALIGNMENT NOTE 10/11]		6	6	6	6	6	6	6 or 4	6 or 4	4 or 2	TYP. NORMAL CROWN	
HORIZONTAL ALIGNMENT	MIN. CURVE RADIUS (m)	750	600	440	340	340	250	250	190	200	130	
	SPIRAL PARAMETER A	REFER TO SUPERELEVATION TABLES FOR MINIMUM AND DESIRABLE "A" PARAMETERS FOR EACH CURVE RADIUS AND DESIGN SPEED IN <a href="#">CHAPTER B</a>										
VERTICAL ALIGNMENT $K = \frac{L(m)}{A(\%)}$	CREST K	PASSING SIGHT	WHERE THIS IS A CONSIDERATION, REFER TO <a href="#">CHAPTER B</a>									
		NON-STRIPING SIGHT	N/A									
		MIN. STOPPING SIGHT	95	74	52	39	39	26	26	17	17	11
	SAG K	HEADLIGHT MIN.	63	55	45	38	38	30	30	23	23	18
		COMFORT MIN. (ILLUMINATION SECTIONS ONLY)	37	32	26	21	21	17	17	13	13	10
	DECISION SIGHT DISTANCE (m)	415-470	380-430	355-400	315-360	315-360	370-315	270-315	225-275	225-275	195-235	
	MAXIMUM GRADIENT (%)	3	3	3	6	6	6	6	6	8	6	
CROSS SECTION	LANE WIDTH (m)	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7, 4.3 3.7, 3.7, 4.3	4.5 3.5 4.5	4.5	
	RIGHT SHOULDER WIDTH (m)	3.0	3.0	3.0	3.0	3.0	2.0	-	-	-	-	
	LEFT SHOULDER WIDTH (m)	2.0	2.0	2.0	1.0	3.0	-	-	-	-	-	
		2.5	2.5	2.5	2.0	1.0	-	-	-	-	-	
		3.0	3.0	3.0	3.0	3.0	-	-	-	-	-	
	FINISHED PAVEMENT WIDTH PER CARRIAGEWAY(m)	12.4	12.4	12.4	11.4	17.1	9.4	7.4	8	9	9	
		16.6	16.6	16.6	16.1	11.4	13.1	11.1	11.7	14	9	
		20.8	20.8	20.8	20.8	17.1	-	-	-	-	-	
	MEDIAN WIDTH (m)	22.8 DEPRESSED 15.4 DEPRESSED 8.0 WITH BARRIER	22.8 DEPRESSED 15.4 DEPRESSED 8.0 WITH BARRIER	22.8 DEPRESSED 15.4 DEPRESSED 8.0 WITH BARRIER	22.8 DEPRESSED 15.4 DEPRESSED 8.0 WITH BARRIER	8.0 WITH BARRIER 15.4 DEPRESSED 8.0 WITH BARRIER	6.0 RAISED	6.0 RAISED	6.0 RAISED	NONE	NONE	
	CLEAR ZONE DISTANCE	REFER TO <a href="#">ROADSIDE DESIGN GUIDE TABLE H4.1</a> [22]										
SIDESLOPE RATIO - NORMAL (m) – SEE GENERAL NOTE 11	6:1	6:1	6:1	5:1	5:1	4:1	4:1	4:1	4:1	4:1		
ON FILLS – MAX. – SEE GENERAL NOTE 11	3:1 OVER 6.5m	3:1 OVER 6.5m	3:1 OVER 6.5m	3:1 OVER 6.5m	3:1 OVER 6.5m	3:1 OVER 4m	3:1 OVER 4m	3:1 OVER 4m	2:1 W/ GUARDRAIL	2:1 W/ GUARDRAIL		
BACKSLOPE RATIO	NORMAL	5:1	5:1	5:1	4:1	4:1	3:1	3:1	3:1	3:1		
	MAX.	3:1	3:1	3:1	3:1	3:1	2.5:1	2.5:1	2.5:1	2:1		
BASIC R/W WIDTH - TYPICAL (m)		70	60	60	50	50	45	38-50	38-50	22-30	20	

Note: Table A-10b continued on the next page

Table A-10-1b Design Designations for Urban Highway (2 of 2)

GENERAL NOTES	
<ol style="list-style-type: none"> <li>1. The following notes highlight certain key issues only. For a more thorough explanation, refer to <a href="#">Chapter B</a> of the text.</li> <li>2. Minimum design values for horizontal and vertical curvature should be reserved only for critical locations, with better standards being used in the majority of cases. A section of road might be designed to meet all minimum standards, but could still result in an unsatisfactory overall design.</li> <li>3. Horizontal and vertical alignment should be designed to accommodate the ultimate Functional Classification as they are the most permanent design elements of a highway, and once a facility is constructed, poorly designed features will remain and be viewed by road users for many years. The importance of the initial design cannot, thus, be overemphasized.</li> <li>4. Horizontal and vertical alignment coordination principles are outlined <a href="#">Section B.4</a> of this manual are to be given serious consideration during the location and design phases of the project.</li> <li>5. A design speed lower than normal standard for a certain section of roadway is sometimes used in rugged or mountainous terrain; however, the design speed is not normally reduced by more than 20 – 30 km/h. Such a section must be carefully designed so that there are no abrupt changes in alignment or surprises for the driver.</li> <li>6. The median widths for the UFD-820.8-110 to UFD-412.4-110 are based on the ultimate configuration being a UFD-820.8-110. If the ultimate configuration is a UFD-616.6-110 then the median widths will be 15.4 m for the UFD-412.4-110 and 8.0 m for the UFD-616.6-110.</li> <li>7. UED-410.4-90 is Stage 1 for the ultimate UED-613.9-90.</li> <li>8. Barrier type curbs should not be used on roadways where the design speed exceeds 70 km/h. Semi-mountable or mountable type curbs should be considered for roadways where the design speed exceeds 70 km/h. Acceptable combinations of curb and barrier systems are dependent on the operating speed of the highway, the cross-sectional shape of the curb, and the lateral offset of the curb from the barrier system. Refer to <a href="#">AT Roadside Design Guide, Table H4.1 [22]</a> for further details.</li> <li>9. UFD-616.1-90 is preferred over UFD-614.6-90 at the ultimate stage because it can accommodate for 8 lanes in the median.</li> <li>10. The 4.3m lane provides accommodation for a 3.7m lane and a 0.6m bicycle lane.</li> <li>11. Sideslope Ratio and On Fills should refer to <a href="#">Chapter C</a> of the <i>Highway Geometric Design Guide</i> and the <a href="#">Roadside Design Guide</a> for further details.</li> </ol>	
NOTES: HORIZONTAL ALIGNMENT DESIGN	NOTES: VERTICAL ALIGNMENT DESIGN
<ol style="list-style-type: none"> <li>1. Because many UAD, UAU, and UCU are generally retrofitted instead of new construction, alternate method of superelevation may be required. Refer to the superelevation chart in <a href="#">Chapter B</a> to determine allowable superelevation/radius relationships.</li> <li>2. Alignment should be as directional as possible but should be consistent with topography and with preserving developed properties and community values.</li> <li>3. The minimum radius curve for the applicable design speed should be reserved for critical locations, and otherwise avoided wherever possible.</li> <li>4. In general, the deflection angle of each curve should be small as the physical conditions permit so that the highway will be directional as possible. A deflection angle of 60 degrees or less is desirable and should be strived for.</li> <li>5. Consistent alignment should always be sought. Sharp curves are not to be introduced at the end of long tangents or at or near the top of a pronounced vertical curve. Similarly, a minimum radius curve should generally not be introduced at the bottom of a long steep grade.</li> <li>6. For small deflection angles, curves should be sufficiently long to avoid the appearance of a kink. A minimum curve length of 300 m – 400 m is suggested. A deflection angle of 0°30' or less does not require a curve.</li> <li>7. Spirals are to be used on all curves requiring superelevation to provide a proper transition from a tangent to curve.</li> <li>8. Horizontal sight distances are to be verified on all curves. Where in a cut section or treed area, and where a high percentage of trucks are anticipated, truck braking requirements may dictate the minimum radius of curve required for a certain design speed, and should be considered during the route location phase of the project.</li> <li>9. Maximum superelevation through an intersection should be 4%.</li> <li>10. For urban roadways that may have an intersection on a curve, the first choice would be to select a radius large enough from the <math>e_{max} = 6\%</math> chart such that superelevation through the intersection is not greater than 4%. If this is not practical, then use <math>e_{max} = 4\%</math> chart.</li> <li>11. For collectors that may have an intersection on a curve, it is used occasionally with maximum rates of <math>e_{max} = 2\%</math> (adverse crown) or <math>e_{max} = 4\%</math>.</li> </ol>	<ol style="list-style-type: none"> <li>1. The crest K values apply when the length of vertical curve is greater than the applicable sight distance. For curves where the length is less than the sight distance, <math>K = (2 S/A) - 200 (\sqrt{h_1} + \sqrt{h_2})^2 / A^2</math>. As well, the length of both crest and sag vertical curves in metres should always be as great as or greater than the design speed in km/h.</li> <li>2. Minimum sag K values are based on stopping sight distance and a headlight beam sloping upward at an angle of one degree from the plane of the vehicle. Lower K values may be allowable in certain situations, particular for high speed conditions, as stopping sight distance values may exceed pavement visibility distances afforded by headlights.</li> <li>3. Decision sight distances should be considered for crests near major intersections. Each major intersection should be checked on a site specific basis, and analyzed individually to determine if decision sight distance is achieved. The bottom end of the range is suitable for simple situations; the top end for complex situations. Intersection sight distance requirement must, of course, also be met.</li> <li>4. The Gradient – Desirable Maximum percentage category provides maximum gradients that should not be exceeded wherever practical. The maximum gradient is site specific. In situations where costs increase substantially depending on the maximum gradient, an economic analysis should be undertaken to determine the suitable maximum gradient for that section of roadway. This economic analysis should consider road user costs as well as construction costs.</li> <li>5. As a general rule, vertical alignment with a series of successive sharp crest and sag curves should be avoided as it gives the impression of a roller coaster and has operational and safety disadvantages.</li> <li>6. For stopping sight distance an object height of 0.6 m is used. This value represents the vehicle tail light height. Research indicates that 95% of tail light heights and 90% of headlight heights exceed this value. [6] [23]</li> </ol>

## A.10.2 Design Guidelines for Transition Segments and Hybrid Roadways

Each roadway segment in the provincial network is classified as either a rural or urban section according to its Functional Class described in [Section A.2.3 – Functional Classification](#). The rural and urban functional classes have distinct design and operational characteristics in line with driver expectations for the respective land use context. Consideration is also needed for segments of roadways where characteristics of both rural and urban roadways are desired, such as in suburban or urban fringe areas, or at the interface between extended rural and urban sections. These two situations are described and expanded further in [Sections A.10.2.1 – Hybrid Roadways](#) and [A.10.2.2 – Transition Segments](#).

### A.10.2.1 Hybrid Roadways

Hybrid roadways contain characteristics of both urban and rural roadways and are typically found in suburban or urban fringe areas. Hybrid designs are often implemented in urbanizing areas where the surrounding land use is transitioning over time from rural to urban or suburban. Alternatively, a hybrid, or suburban type of roadway, may be selected because it provides the best balance of mobility needs and interaction with the surrounding land use.

Alberta's two Ring Roads (Anthony Henday Drive and Stoney Trail/Tsuu T'ina Trail) are examples of typical suburban highways. They serve a dual purpose of accommodating reasonable mobility for long distance traffic travelling through or around the urban area while also serving shorter trips within the metropolitan area. These ring roads allow heavy vehicles and regular traffic to avoid congested urban streets and can also reduce noise and air pollution in the major population centres. There is a desire to keep design speeds relatively high on Ring Roads for the purpose of reducing delay and allowing a high degree of mobility for through traffic.

### A.10.2.2 Transition Segments

A transition segment is a short section of roadway that is situated at the boundary between rural and urban sections. In these areas, it is important to implement special roadway design features in order to serve as a signal to drivers about upcoming changes in context and roadway operating conditions, and to reinforce a corresponding shift in driver expectations. Ideally, these changes are introduced gradually enough to facilitate a smooth transition from one to the other.

### A.10.2.3 Transition Segments Characteristics

Various design techniques can be used in order to convey to drivers that the roadway is about to transition from rural to urban or vice versa. The following sub-section outlines key considerations and potential design techniques that can be used to help drivers adjust their driving to fit the changing setting.

#### Visual Cues

Visual cues along the roadway are added or removed as influencers to driver behaviour. In a rural setting, it is uncommon to have adjacent land use such as structures (buildings and non-critical signage) on the side of the road in close proximity to the travel lanes. It is typical to have wide and open land to mitigate distractions for higher travelling speeds. As more visual cues appear, drivers become more alert of their surroundings and will likely slow down with respect to the appropriate environment.

Other indicators include gateway treatments such as a welcome sign entering an urban centre or oversized speed signs. As per the [Methods of Reducing Collisions on Alberta Roads \(MORCOAR\)](#) [24] report, speed-related collisions are frequently concentrated at transition and fringe areas, where motorists fail to make the correct adjustment to their speed and level of alertness. Gateway treatments are particularly useful when a rural highway is connecting to an urban street system which will go through an urban area (rather than around it). Gateway Treatments are aimed at reducing vehicle speeds and increasing alertness at transition points in the road network. Two key features in gateway treatments used

to affect driver behaviour are road narrowing or appearance of narrowing to reduce vehicle speed without introducing new hazards or obstacles, and conspicuous roadside vertical elements (e.g. gateway treatments) to bring alertness and reduce speed.

### **Right of Way**

From a rural to urban setting, a narrowing or the appearance of the right of way boundary (typically lined by bushes/trees) would create the illusion of reduction in width as users approach the transition zone. Similar to gateway treatments, the appearance of a narrower road surface and/or right of way encourages reduction in speed as less leeway is provided in surrounding areas including the driving lanes. The more open space that is available, the more drivers expect minimal conflicts and are likely to drive safely at a higher speed.

### **Layout**

Various factors within the road layout play a part in indicating a transition zone. The factors considered include type of illumination and its frequency, drainage type such as ditch vs curb and gutter, raised islands, lane widths, pavement markings and access management.

### **Speed**

A major factor in transitional highway is the change of speed limits. In a rural setting, the posted speed limit is typically 90km/h or higher. Most often it will be signed at 100 km/h on two-lane undivided highways. In an urban setting, the posted speed limit on arterial roadways is typically 70km/h or lower. Within the transition zone, the speed limits may drop between 10-30 km/h and gradually lower even further. Proper signage with adequate transition distance is required to achieve gradual deceleration. Typically as a driver approaches the sub-urban area, speed limit signs may be posted on both sides of the road on a divided highway rather than just on the right.

### **Transit**

In some areas where transitional highways exist, there may be transit presence (typically in larger urban centres). Accommodation of transit routes and stops within the suburban transition may be required. This includes planning for transit turnouts to pull over to board and let off passengers.

### **Active Modes**

Roadways closer to an urban setting will often show an increase in active modes of transportation such as bicyclist or pedestrians. This is typically the case as commuting between destinations is shorter in distance and more accessible in comparison to commuting via active modes in a rural location.

## **A.10.2.4 Examples of Existing Transition and Hybrids**

Below are some examples of existing transition zones in Alberta and their characteristics that indicate the segments of highway are truly hybrids or transitions rather than rural or urban highways.

Typical rural highways have the following characteristics:

- High design speed (100 km/h or higher)
- Wide right-of-way with lots of open land
- Ditch style drainage

Typical urban highways have the following characteristics:

- Lower design speed
- Narrow right-of-way with surrounding features such as trees and/or structures
- Increased illumination
- Curb and gutter drainage
- Frequent access and shorter intersection spacing
- Increased presence of vulnerable users



Anthony Henday Drive, Highway 216, City of Edmonton – Hybrid of urban and rural elements  
Anthony Henday Drive is a ring road encompassing City of Edmonton. It is considered to be a rural highway in an urban setting with the following distinctions:

- Interchange spacing is closer than typical rural highways
- Ditch drainage
- Design speed of 110 km/h
- Continuous highway lighting

Queen Elizabeth II, Highway 2, City of Airdrie – Rural highway in an urban setting  
Highway 2 passes through the City of Airdrie. This segment of highway has a look and feel consistent with a rural highway due to the rural cross-section, offset of adjacent development, and interchange spacing which occurred as the municipality developed over time. The following are its features:

- Rural freeway with ditch drainage
- Continuous high mast lighting in the median
- Design speed of 130 km/h
- Wide right of way
- Presence of commercial and residential buildings on both sides of the highway

Trans-Canada Highway 1, approaching Town of Redcliff from the west – Transition from rural highway into urban highway. This highway has the following distinctions approaching the Town of Redcliff:

- High speed rural arterial (design speed of 130 km/h with posted speed of 110 km/h) transitions to urban expressway (design speed of 90 km/h with posted speed 80 km/h) with signalized intersections
- Introduction of a raised median in advance of the change in land use from rural to urban
- Continuous illumination in advance of the traffic signals

Highway 11A, East of Town of Sylvan Lake – Transition from rural highway into urban via roundabout  
Highway 11A is the connecting highway between City of Red Deer and the Town of Sylvan Lake. As the highway approaches Sylvan Lake, there is a roundabout intersection which forces drivers to slow down and transition to urban driving conditions. Features of this highway include:

- Two lane undivided arterial with at-grade access
- Ditch drainage transitioning into raised curb and gutter when approaching roundabout
- Design speed of 110 km/h with a posted speed of 100 km/h which lowers to 60 km/h approaching roundabout
- Increased illumination
- Appearance of tighter right of way
- Introduction of sidewalks for pedestrians
- Visible right-of-way dramatically reduced going through town

### **A.10.3 Other Considerations**

#### **Roadside Design**

The forgiving roadside design philosophy emerged in the mid-1960s to address the fact that vehicles can run off the roadway. Most highway agencies in North America now accept that the severity of a collision, measured in terms of personal injury and/or extent of property damage, can be reduced if a more traversable recovery area is provided. A principal objective of the forgiving roadside philosophy is to provide a generally clear traversable area adjacent to the highway — a Clear Zone area — to accommodate the occasional errant vehicle that enters the roadside. The Clear Zone should be free of non-traversable hazards, such as unyielding fixed objects or steep sideslopes.

There are several design strategies for the treatment of roadside features within the Clear Zone area. The following is a list of strategies for dealing with identified roadside hazards, in order of priority:

- remove the hazard
- redesign the hazard so that it can be safely traversed or contacted
- relocate the hazard to reduce the probability of it being traversed or contacted
- reduce the severity of the hazard
- shield the hazard
- delineate and increase the driver's awareness of the hazard when other mitigation measures cannot be made to work.

### **Longitudinal Traffic Barrier System Selection**

Designers are encouraged to select the most forgiving longitudinal traffic barrier system that will provide the required Test Level (TL) of protection for the given circumstances and constraints. This practice is intended to minimize injuries and fatalities sustained during traffic crashes. Longitudinal traffic barrier systems with increased flexibility generally absorb more of the impact energy during a collision. This limits the impact effects on the vehicle's occupants. In order of most forgiving to the most rigid barrier systems typically used in Alberta, high tension cable barrier (HTCB) is the most forgiving. Concrete barrier systems are the least forgiving (most rigid).

Existing non-compliant longitudinal traffic barrier systems and/or end treatments, not meeting the department's current referenced testing criteria, should be upgraded to current standards during reconstruction and/or widening projects, where practical and feasible.

### **Barrier Replacement Strategy**

Existing non-compliant longitudinal traffic barrier systems should be allowed to stay in place unless one of the following conditions exists:

- the barrier system has deteriorated to a condition that it needs to be replaced
- the height of the barrier system will not meet the required installation tolerances after resurfacing.
- maintaining the barrier system will pose operational and/or hazardous conditions
- it is required to accommodate the upgrading of bridge transitions (or rehabilitation)
- end treatments are non-compliant

Refer to [AT's Roadside Design Guide](#) [22] for further details.

### **Pavement Markings**

Designers should consider the pavement markings that will be placed on the finished pavement of a highway. In particular, designers should note the amount and location of barrier line indicating no passing allowed. Barrier lines may be required for the following:

- Insufficient sight distance for passing
- Highway transitions
- Climbing/Passing lanes
- At-grade intersections, including roundabouts
- Interchanges

Planners and designers should take into consideration the passing demand that will exist on two-lane undivided highways and review the availability of passing opportunities based on pavement markings as well as traffic conditions (i.e., probability of on-coming traffic eliminating passing opportunities). For typical pavement marking schemes, refer to [AT's Traffic Control Standards](#) [25].

### Traffic Control Guidelines

Highway signing requirements present a design constraint that should be addressed at the design stage. The typical sign spacing and layout relative to junctions and other key geometric features are presented in [AT's Traffic Control Standards](#) [25].

Other AT traffic control standards that designers should be aware of include:

- Recommended Practices Guidelines
- Guidelines for School and Playground Zones and Areas
- Highway Guide and Information Sign Manual
- Highway Lighting
- Special Events Guidelines
- Typical Signage Drawings
- Standard Drawings for Traffic Signals
- Sign Catalogue and Images
- Trails in Alberta Right-of Way Policies, Guidelines, and Standards

### Snow and Ice Control

A designer should call upon experience and knowledge of site conditions when designing for snow and ice control. Where snow drifting is a problem due to high cross winds, deep cuts or other local features, the problem can often be alleviated by construction of flatter backslopes and/or wider ditches. Localized snow-drifting problems on the roadway surface are often caused by barrier systems on the shoulder or median. This problem can sometimes be addressed by eliminating or mitigating the hazard or otherwise protecting vehicles from the hazard without installing barriers. If a barrier system is required, a high tension cable barrier (HTCB) system should be considered. Depending on the application, along with reduced snow drifting, HTCB generally has many advantages over other types of barrier systems.

Ice build-up on the roadway can be a problem on bridges. Although geometric design cannot eliminate this condition, the consequences can be mitigated by reducing or eliminating horizontal curvature on bridges.

### Bridge Geometry

Constraints due to bridges can have a significant impact on road geometry. These constraints can be more restrictive than normal roadway geometric design criteria. Identification of potential bridge constraints and accounting for them during geometric layout of the road is often the most cost effective method of optimizing the overall project. Some constraints include the presence of bridge barriers (shy line offset, sight distance), potential for preferential icing on bridge decks, and drainage requirements. Further information pertaining to bridge geometric design can be found in the [Bridge Conceptual Design Guidelines](#) [20].

## A.11 DESIGN EXCEPTIONS

Design Exceptions (DE) are defined as instances where a designer has chosen or is requested to use a parameter, guideline, principle or product which is different from the currently published standards and/or practices. DEs can be initiated at any stage of a project, and may be initiated by the Consultant or by the department. DEs accepted at an early stage may be revisited and re-submitted at a later stage if conditions change or new pertinent information becomes available.

The purpose of DEs is to allow for deviations from normal design standards or practices to be made in a thoughtful and consistent way where warranted by the project specific conditions and constraints. This practice allows for innovation, “flexible design” and/or “context sensitive design” to be applied to Alberta roadways in a way that gives appropriate consideration to roadway safety, risk and mitigation. By following a consistent documented process the department is aware of common deviations from normal practise and is able to undertake timely reviews of any practices as warranted.

More information on Design Exceptions is available in the [Design Exceptions Guideline](#) [26] available on the department's website at: <http://www.transportation.alberta.ca/6137.htm>.

## A.12 ENVIRONMENTAL CONSIDERATIONS

Alberta Transportation is committed to managing the transportation network in a manner that minimizes impacts on the environment, including the land, water and air, and human health. It has enhanced its ability to meet this commitment by developing an [Environmental Management System \(EMS\)](#) [27] and related documents such as the [Terms of Reference for Environmental Evaluation of Highway Infrastructure Projects](#) [28].

The [EMS manual \(Chapter 3\)](#) [27] provides an initial reference regarding the primary statutes, regulations, bylaws, codes of practice, standards and guidelines that relate to Alberta Transportation's key environmental impacts and activities. It also identifies any proposed regulatory changes related to Alberta Transportation's activities. It is important to recognize that the required authorizations (i.e. approval, permit, licence, etc.) must be obtained prior to commencing the activity. Failure to have the proper authorization in hand prior to commencing the activity could result in contravention of legislation, and enforcement measures being imposed. This applies to all legislation under which authorizations are needed for a given activity, for example: [Fisheries Act](#), [Navigation Protection Act](#), [Environmental Protection and Enhancement Act](#), [Water Act](#), etc. There are also legislative instruments that do not have authorization requirements but non-compliance to these acts may result in severe penalty and these include, but are not limited to, the [Migratory Birds Convention Act](#) and the [Species at Risk Act](#).

The [Terms of Reference for Environmental Evaluation](#) [28] is to be utilized for both functional planning studies and preliminary design work. Environmental Evaluations must identify and provide sufficient detail of environmentally sensitive features, including but not limited to, fish bearing watercourses, wetlands and federally/provincially protected species. The level of detail required may vary depending on whether or not the project is on the five year construction program. For projects not on the five year construction program the work requires that a desktop evaluation, supplemented by at least one field visit, be completed to the satisfaction of Alberta Transportation. The scope of the evaluation includes the environmental effects of the construction phase only. Once the project is identified on the five year construction plan the environmental reports should be updated to meet the requirements stated below.

For projects that are on the five year construction program the work must provide sufficient detail to support application to relevant regulators in order to secure approvals/authorizations. In cases where both preliminary design and detailed design are required within the scope of work the Consultant is required to prepare relevant regulatory applications for signature by Alberta Transportation. The Consultant will be required to facilitate meetings with relevant regulators. The scope of the evaluation includes the environmental effects of both the construction and operations phases.

All work is to be completed to the satisfaction of Alberta Transportation. It is important to note that the environmental effects of the construction and operation of any future utilities in the right-of-way will be assessed as part of the future utility applications (power lines/gas lines). Please refer to [The Terms of Reference for Environmental Evaluation](#) [28] which details the necessary requirements for environmental reports.

Environmental Evaluations should be included within relevant engineering assignments. Environmental Evaluations identify and provide sufficient detail of valued ecosystem components, including but not limited to:

- Fish bearing watercourses
- Wetlands
- Soils

- Landscape and dugout borrows
- Navigation
- Noise
- Air quality
- Historical resources
- First Nations consultation
- Contaminated sites
- Socio-economics
- Water quality (drainage)
- Federally/provincially protected species

Environmental considerations within urban environments include the additional consideration of noise, air quality, and socio-economics. Detailed noise guidelines that pertain to urban areas can be found at: <http://www.transportation.alberta.ca/Content/docType490/Production/NoiseGuidelines.pdf> [29]. It is critical that these guidelines be adhered to during the study as noise attenuation is expensive therefore it is important to understand when and where attenuation is appropriate. Municipalities may also have noise guidelines that may be considered by Alberta Transportation. Requirements for air quality and socio-economic considerations within environmental assessments may be outlined within the regulators terms of reference for the project (which is included in the project's engineering assignment, or added as a subsequent scope change).

It is important that the user familiarize themselves with the latest storm water requirements (i.e. provincial policy and/or guideline) to ensure that storm water facilities meet water quality and quantity objectives. In addition, it is strongly advised that historical resources are addressed as early as possible. It is not uncommon for the provincial regulator to require multiple field investigations which can add significant delay to project schedule.

Lastly, the information contained within environmental reports has a shelf life of approximately five years, after which the information is considered outdated and unreliable. In these cases, the information must be revisited in order to ensure that all regulatory requirements are satisfied.

These environmental reports will also identify the specific federal/provincial regulations that apply to the project. The *Environmental Evaluation Terms of Reference* [28] is located on Alberta Transportation's website at: <http://www.transportation.alberta.ca/5815.htm>.

Please refer to Alberta Transportation's website for access to all current environmental guidelines and standards: <http://www.transportation.alberta.ca/571.htm> [30].

## A.13 OPTION SELECTION

Decision making is an integral part of the planning and design processes. The department uses Benefit Cost Analysis as a tool to provide guidance on making decisions regarding alternative courses of action and the ranking of projects within a program. It may also be used to compare the cost effectiveness of various programs. While the tool provides guidance, it does not make decisions. Decisions are made by humans exercising judgement and considering all factors which may include financial, timing and other constraints.

The department is willing to accept analysis undertaken with different software tools or done by hand as long as the principles and mandated parameters are used. For example, bridge options sometimes don't readily align with the tool, but the basic parameters (collision costs, discount rate, etc.) would be the same. Some consultants may prefer to build simplified/customized versions of the model for specific types of work (e.g. pavement overlay vs mill and inlay, etc.). As a consistent methodology is used, the results from the analysis on one project may be readily compared to the results from another project. The

approach taken in the [Benefit Cost Guide](#) [16] is that considering all project costs together is better than fragmenting the analysis into separate pieces.

For functional planning studies, it may be difficult or impractical to monetize all of the costs and benefits associated with a project. This may involve impact on communities, environment or local economies. The department may choose to use an alternative analysis method known as the *Multiple Account Evaluation* (MAE) [31] to evaluate a number of options based on a unique set of criteria developed specifically for the project but using monetized costs from the [Benefit Cost Guide](#) [16] whenever practical. More information about the MAE may be found at: <http://www.transportation.alberta.ca/5925.htm>. The MAE process is used by internal stakeholders, experts and others within the department's project team. Consultant may be asked to provide the initial analysis of options. The intent of the MAE is to build consensus at a time when some of the significant factors are not readily quantified as costs and benefits.

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