CHAPTER A
BASIC DESIGN PRINCIPLES

TABLE OF CONTENTS

CHAPTER A
BASIC DESIGN PRINCIPLES

LIST OF FIGURES

CHAPTER A
BASIC DESIGN PRINCIPLES

LIST OF TABLES

CHAPTER A
BASIC DESIGN PRINCIPLES

A.1 INTRODUCTION

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

- Description of the Alberta Transportation 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 and 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 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; and
- Option selection.

Designers may not need to use all of the information shown in this chapter on any particular project (e.g., 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 the specific needs of industries in Alberta.

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. The mandate was 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 under the control and administration of the federal, provincial, or municipal governments. As of 2017, there were 4,501 km of NHS routes in Alberta (4,088 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 under federal or municipal control. The 4,501 km of NHS routes is based on the centreline distance (i.e., divided highway lengths are counted only once rather than counting both roadways).

The "National Highway System Map" [1] indicates the designated National Highway System in Alberta.

For new construction projects, Alberta Transportation strives to reach the Council's suggested minimum operating speed of 90 km/h on core NHS routes [2]. Currently, there are several locations in Alberta where the minimum operating speed does not meet the NHS minimum service standard. These roadways are identified for future improvements.

For more information on the National Highway System, refer to the website, "Council of Ministers Responsible for Transportation and Highway Safety" [3].

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 Alberta Transportation 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 toward 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 and maintenance service levels. Service classification also informs the selection of the appropriate functional classification, when traffic and surrounding context (rural or urban) are considered (see Section A.2.3, Functional Classification).

A.2.2.2 Service Classification Levels

There are currently four service classification levels, numbered one through four, with one being assigned to the most strategically important highways. The four levels are:

- **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 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 Classification Designation

The service classification levels were developed with consideration of factors such as:

- Federal designations (National Highway System);
- Size and type of population centre served (e.g., cities, towns, villages and rural areas);
- Trip purpose (e.g., business, recreational and commuter);
- Trip length; and
- 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 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 the role of a segment in the overall network. As such, the service classification levels tend to be homogenous over long sections of highway, and often are consistent along the entire numbered highway. This is despite 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 (rural or urban), 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, as required, due to changes in the network (e.g., addition, deletions, or re-alignments).

A.2.2.4 Service Classification Map

The "Provincial Highway Service Classification Map" [4] indicates the service classification for the provincial highway network. The latest service classification information is available by accessing the ATMaps application in the Alberta Transportation, "Transportation Infrastructure Management System (TIMS)".

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 (rural or urban), the 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 physically 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 classifications consist of the following three components:

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

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

Additionally, the Alberta “Highways Development and Protection Regulation” [5], describes four classes of provincial highways:

- freeways;
- multi-lane provincial highways that are not freeways;
- major provincial highways; and
- minor provincial highways.

These classes correspond to the generalized Freeway, Arterial Divided, Arterial Undivided, and Collector and Local Undivided, functional classifications, respectively. At this time, urban and rural segments are not differentiated in the Alberta “Highways Development and Protection Regulation”, which may be updated in the future to distinguish between rural and urban segments.

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

Functional Classification Code	Functional Classification Description	Core User Function	Flow Characteristics	Connections with	Typical Vehicle Volumes Served (veh/day)	Typical Design Speed	Number of Basic Lanes	Right-of-Way Width (m)
RFD	Rural Freeway Divided	Mobility is the primary consideration	Uninterrupted Flow	Freeways Arterials Collectors	≥ 8,000	110 – 130	4 – 8	110 – 130
RAD	Rural Arterial Divided	Mobility is the primary consideration	Uninterrupted Flow	Freeways Arterials Collectors Locals	3,000 – 20,000	120	4 – 6	120 – 130
RAU	Rural Arterial Undivided	Mobility is the priority with some consideration of Access	Uninterrupted Flow	Freeways Arterials Collectors Locals Driveways	400 – 10,000	110	2	50 – 60
RCU	Rural Collector Undivided	Mobility and Access of equal importance	Uninterrupted Flow	Freeways Arterials Collectors Locals Driveways	100 – 2,000	90 – 110	2	40 – 50
RLU	Rural Local Undivided	Access is the primary consideration	Interrupted Flow	Arterials Collectors Locals Driveways	< 1,000	60 – 90	2	40 – 50
UFD	Urban Freeway Divided	Mobility is the primary consideration	Uninterrupted Flow	Freeways Expressways Arterials	≥ 10,000	90 – 110	4 – 8	80 – 90
UED	Urban Expressway Divided	Mobility is the primary consideration	Interrupted Flow	Freeways Expressways Arterials	10,000 – 60,000	80 – 90	4 – 6	70 – 80
UAD	Urban Arterial Divided	Mobility is the priority with some consideration of Access	Interrupted Flow	Freeways Expressways Arterials Collectors	5,000 – 30,000	70 – 80	4 – 6	40 – 50
UAU	Urban Arterial Undivided	Mobility is the priority with some consideration of Access	Interrupted Flow	Freeways Expressways Arterials Collectors	1,000 – 15,000	70	2 – 4	30
UCU	Urban Collector Undivided	Mobility and Access of equal importance	Interrupted Flow	Arterials Collectors Locals Alleys/Lanes Driveways	300 – 8,000	70	2	30
ULU	Urban Local Undivided	Access is the primary consideration	Interrupted Flow	Collectors Locals Alleys/Lanes Driveways	< 1,000	60	1 – 2	20

A.2.3.3 Functional Classification Designation

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

Unlike service classification, the functional classification of a roadway segment may change and evolve because of changing traffic levels and changes to the adjacent land use. For example, a current Rural Arterial Undivided roadway may become a Rural Arterial Divided roadway and, ultimately, a Rural Freeway Divided roadway 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.

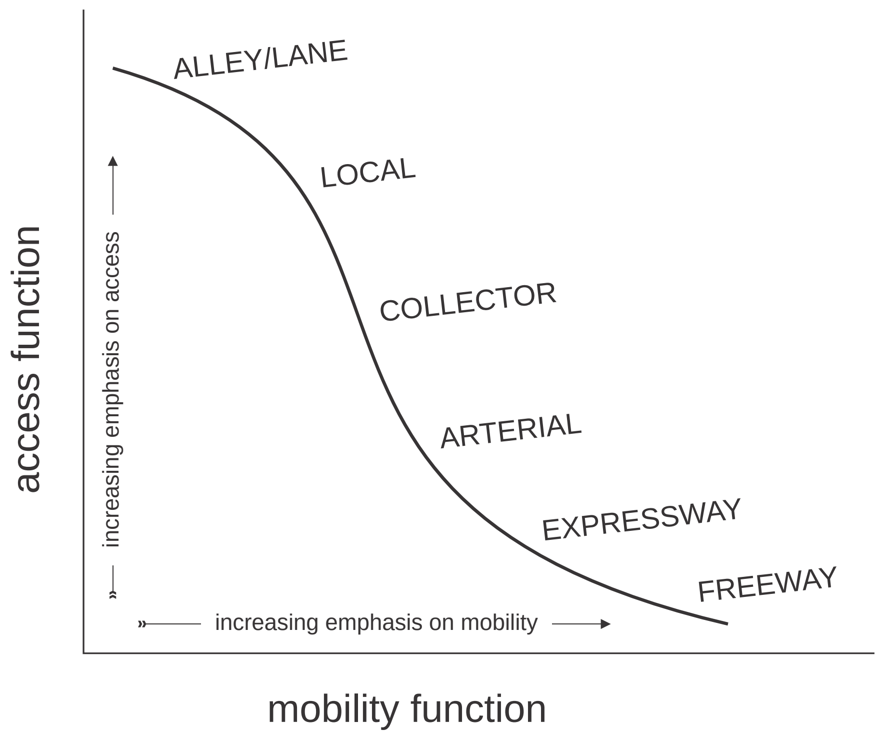
For roadside management and right-of-way protection purposes, a long-term view must be taken to ensure that enough land is set aside to enable the implementation of the ultimate roadway configuration, and accesses should be spaced appropriately for the long term in order to avoid disruptive closures 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 indicated in Figure A-2-3-3-1a. **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

(Source: Adapted from Figure 2.6.1 of TAC 2017 [6])



A.2.3.3.2 Adjacent Land Use Context

Assigning the appropriate context (urban or rural component) of the functional classification 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 or rural designation is normally based on the consideration of the surrounding land use, and not municipal boundaries. The functional classification of a roadway segment should match the user expectation for the segment. In many cases, it is obvious whether a rural or urban functional classification should apply, but there is often a degree of judgement that is necessary to determine the prevailing surrounding context (i.e., what the driver is most willing to accept as the prevailing condition). This is particularly the case for urban fringe areas and for areas that are transitioning from rural to urban conditions. There may also be cases where a deliberate choice is made to implement a rural functional classification 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.

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 sideslopes for rural designs. In many cases, these design elements adequately correspond with the functional classification, 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. Refer to Section A.10.2, Design Guidelines for Transition Segments and Hybrid Roadways, for further information and examples of transition segments and hybrid roadways.

A.2.3.4 Functional Classification Maps

The functional classification of the provincial highway network is depicted on two maps:

- The "Roadside Management Classification Map" [7] represents the future vision of the functional classification. This map informs the selection of the functional component of the design designation (e.g., Rural Collector Undivided), guides planning decisions, development setback requirements, and access management spacing requirements. The classifications are based on the consideration of approved roadway plans, context (rural or urban) and urban growth plans, service classification, and the volume/composition of traffic projected up to 50 years in the future.
- The "Functional Classification – Existing Conditions Map" [8] depicts the functional classification of the provincial highway network as it exists today. This map informs the selection of the functional component of the design designation where use of the future designation is not appropriate, and provides a way to compare current and future conditions.

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. The "Functional Classification – Existing Conditions Map" changes frequently over time as roadways are upgraded in stages. The "Roadside Management Classification Map" containing the future vision of the functional classification is more stable and is updated periodically to account for the latest plans and 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

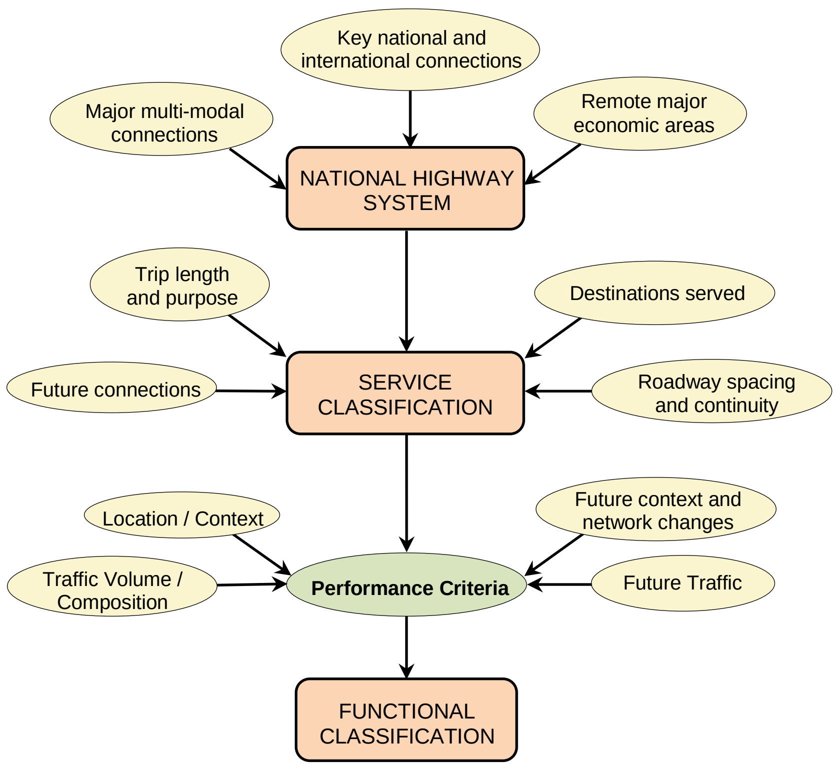


Figure A-2-4b illustrates the overlap between the three classifications. This chart emphasizes the difference between the strategic importance of a particular route (who is using the route and where are they going) versus the actual amount of use the route experiences (how many vehicles use the route). 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 Alberta Transportation 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. It is a freeway, however, due to the high volume of traffic.

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
	Level 2	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	√	√	√				
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 (e.g., 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 (e.g., signals, stop signs, roundabouts, railway and pedestrian crossings, etc.) be removed and replaced with interchanges, as required.
- The majority of the Level 1 highways are designated as freeways under the Alberta “Freeways and Access Locations Designation Order”, but this is not a direct one-to-one relationship. Some designated freeways are not Level 1 routes (e.g., Highway 63, north of Ft. McMurray, and Highway 11), while some Level 1 routes are not designated freeways (e.g., Highway 9). Potential Freeways are roadways where future access plans have been completed, but have not been approved by Order-In-Council.

A.2.5 Special Designations

In addition to service classification and functional classification, there are three special designations to consider: High Load Corridors, Long Combination Vehicle routes, and Log Haul routes. The design vehicles associated with these roadways are discussed in Chapter D, At-Grade Intersections.

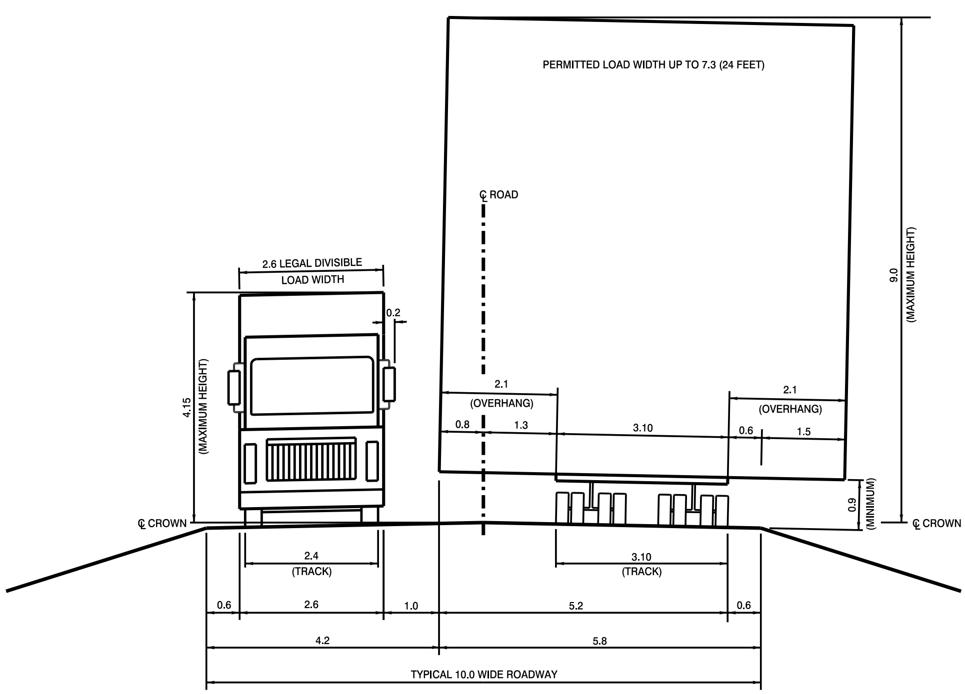
A.2.5.1 High Load Corridor

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 Alberta "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.

For the latest listing and maps of highways designated as High Load Corridor, refer to the Alberta Transportation website, "High Load Corridor" [9]. The maps also indicate segments of highways identified for future expansion of the high load network.

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 height clearances up to 12.8 m, reserved for pressure-type vessels only (e.g., Cokers and Reactor Transporters). Oversized loads using this route could be up to 9.0 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. For more information, refer to the Alberta Transportation, "Bridge Load Evaluation Manual" [10].

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



Note: The 0.9 m clearance height will only clear 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 among three parties (Alberta Transportation, utility companies [power utilities], and users [petrochemical and hauling companies]). Since 1994, Alberta Transportation has funded the entire cost, with the cost being recovered through permit fees. A High Load Corridor Working Committee, comprised of representatives from Alberta Transportation, 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 Alberta Transportation. 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 using pilot vehicles and special traffic control. There are many configurations of oversize vehicles, which travel under permit on the Alberta 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 the Alberta Transportation Technical Standards Branch and Program Support and Implementation. 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). Because these vehicles are piloted/escorted, they may be permitted to travel in a counter-flow direction (e.g., through a roundabout). Turning movement templates and details for the three oversize vehicles are provided in Chapter D, At-Grade Intersections.

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.

For details on the LCV program, including a map of highways currently designated as LCV routes and information on the “Attached Conditions for the Operation of Long Combination Vehicles”, refer to the Alberta Transportation website, “Long Combination Vehicle Program” [11].

When undertaking projects on LCV routes, planners and designers should be familiar with the following sections in the “Attached Conditions for the Operation of Long Combination Vehicles”:

- Section H Turnpike Double and Triple Trailer Routes;
- Section I Routes in Urban Centers;
- Section J Dimension Exemptions;
- Section K Extended Length Double and Rocky Mountain Double Routes;
- Section L LCV Travel off of Designated Highways;
- Section M Specific Conditions for Rocky Mountain Doubles;
- Section N Specific Conditions for Extended Length Doubles;
- Section O Specific Conditions for Turnpike Doubles; and
- Section P Specific Conditions for Triple Trailer Combinations.

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

Refer to Chapter D.5, Design Vehicle, 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 Alberta "Traffic Safety Act" [12], in the Alberta Transportation, "Attached Conditions for the Operation of Long Combination Vehicles" [13]. This document defines LCV network routes in terms of two vehicle groups:

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

Turnpike Doubles and Triple Trailers are permitted on certain multi-lane highways (multi-lane refers to divided highway segments) 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 indicating the specified two-lane undivided highways is included 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 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 operation of the long combination vehicle. Planners and designers should contact the cities and other urban municipalities for specific conditions, designated routes 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 alignment are costly and disruptive to alter, while other elements such as auxiliary lanes are easier to implement in stages. 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 the year of the project completion date. A project-specific benefit cost 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 to complete the design, acquire land, and tender a project, the initial design calculations should 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 constructed independently of pavement rehabilitation (such as an intersection treatment), shorter design periods may be appropriate. In these cases, co-ordinating 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; and
- Access management planning horizon: 50 to 100 years.

A.4 TRAFFIC STATISTICS FOR PLANNING AND DESIGN

Understanding current traffic behaviour is important when planning and designing roadways. 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 through 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 conducted 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.

Refer to the Alberta Transportation website, “Highway Traffic Counts” [14] for traffic data and statistics on Alberta highways.

A.4.1 Annual Average Daily Traffic

Annual Average Daily Traffic (AADT) is a common statistic among highway agencies. This term is also referred to as Average Annual Daily Traffic. It is used when selecting an appropriate design designation on new construction projects. AADT is determined by counting the total number of vehicles passing a location on a roadway during a year (in both directions) and dividing the value by the number of days in the year (i.e., 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 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 (e.g., daily traffic volumes on Wednesdays in September will be similar to each other). To estimate AADT there must be, at a minimum, 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:

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

- The seven 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 are averaged to estimate the AADT.

The AASHTO method is commonly referred to as the Average of Averages method. There are other acceptable methods to calculate AADT. Refer to the Transportation Association of Canada, "Traffic Monitoring Practices Guide for Canadian Provinces and Municipalities".

The projected AADT for the design year is 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 is used. The ASDT is similar to AADT, except that ASDT only uses data from May 1st through September 30th. AWDT uses data from November 1st through March 31st.

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 100th highest hourly volume on the facility in the design year. The 100th highest hourly volume is obtained by ranking all 8,760 (or 8,784) two-way hourly volumes from highest to lowest and selecting the 100th highest value.

The 100th Highest Hourly Volume (100th HH) is chosen because it would be wasteful to base a design on the maximum peak-hour traffic of the year and 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 30th highest hour for design purposes while others use different values. Alberta Transportation has adopted the 100th HH as the default value to be used in general for all design calculations.

The ratio of the 100th HH to AADT at a given location is known as the K Factor. In mathematical terms:

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

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

The K Factor and directional split factor is 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 is used. Both are conservative values that typically represent the 85th percentile.

Traffic characteristics on facilities vary depending on the location, size, and type of facility. Designers are 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 multiplied by the chosen K Factor to produce a DHV.

A.4.3 Traffic Growth Rate

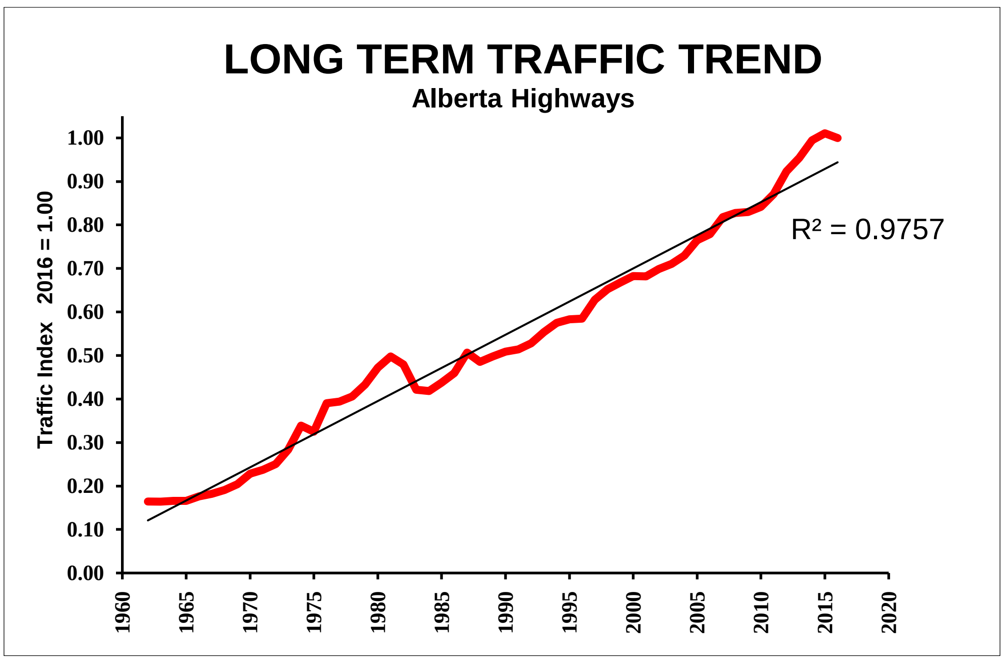
It is imperative that reliable forecasts of future traffic be available when planning and designing roadway infrastructure. There are two ways to determine future traffic. The first way is use a historical traffic growth rate (TGR). The second is to calculate the future trip generation of land uses and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

For approximately 90 percent of the Alberta highway network, use of a historical traffic growth rate 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. Contact the Alberta Transportation, Modelling and GIS Section for outputs from these models.

Alberta Transportation has been monitoring traffic volumes since the early 1960s and has a wealth of traffic data useful to develop historical traffic growth rates.

Designers should use linear growth when developing historical traffic 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 is used to calculate a linear traffic growth rate:

$$TGR = \frac{\left(\frac{CT - PT}{CY - PY}\right)}{CT}$$

where:

- TGR = Traffic Growth Rate in decimal form (e.g., 2.5% is 0.025)
- CY = Current Year (or latest year that data is available)
- PY = Previous Year. The year that is used depends on the time frame of the TGR that is sought.
- CT = traffic volume at CY
- PT = 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 judgement. TGRs for different timeframes should be calculated for comparison purposes. Forecasting traffic beyond 20 years is difficult 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 is 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% is used. In situations where the historical traffic growth rate indicates negative or low growth, designers and planners use a minimum TGR of 1.0%.

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

$$\mathrm{AADT}' = \mathrm{AADT} \times \Big(1 + \big(\mathrm{TGR} \times (\mathrm{FY} - \mathrm{CY})\big)\Big)$$

where:

AADT' = projected AADT at FY
AADT = AADT at CY
TGR = Traffic Growth Rate in decimal form (e.g., 2.5% is 0.025)
FY = Future Year or design year
CY = 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 100th HH, and PM 100th HH estimates, which are then used for designs. Refer to the Alberta Transportation website, “Highway Traffic Counts” [14] for ATR traffic data. The factoring process helps to normalize any traffic anomalies that may have occurred on the day of the intersection count. To properly factor the 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. Without a good inventory of historical traffic data at the intersection, however, 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 proximity of the ATR to the intersection. If an ATR is near an intersection, it can be assumed that both locations have a similar traffic profile. There are situations where there is not an ATR near the intersection. In these cases, some 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 classification;
- 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 same steps are used for any count duration, including 24-hour counts. The following are the steps to factor the intersection count data to an estimated AADT, assuming a 12-hour intersection count was performed:

1. A typical intersection has 12 movements (through, right, and left movements at each of the four legs). For each of the 12 movements, determine the total 12-hour traffic volume from the data recorded during the 12-hour count.
2. Divide the AADT of the assigned ATR by the total recorded ATR volume during the same 12-hour period of the intersection count to obtain the ATR AADT Factor.
3. Multiply the ATR AADT Factor calculated in Step 2 by each of the 12 traffic volumes from Step 1. The resulting values are the current AADT estimates for the movements in the intersection.
   - Minor adjustments should be made to the AADT estimates to ensure the intersection is balanced (i.e., 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 may be applied to the current 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 100th HH and PM 100th HH volumes. The following steps can also be used with AADT projections:

5. Determine the K Factor of the assigned ATR.
6. Add the current AADT estimates for all 12 movements that were calculated in Step 3. This is the estimated total daily volume (AADT) going through the intersection.
7. Multiply the K Factor from Step 5 with the estimated total AADT from Step 6, to determine the estimated total volume going through the intersection during the 100th highest hour.
8. For each hour of the intersection count data, add up the volumes for all 12 movements. Determine which hour in the AM was the busiest (i.e., which hour has the highest total volume). The volume for this hour is the total intersection volume during the AM peak. The hours do not have to begin and end at the top of an hour. For example, for data collected in 15-minute intervals, the busiest hour may be from 7:15 to 8:15.
9. Divide the volume from Step 7 by the volume from Step 8 to produce an AM 100th HH Count Factor.
10. Multiply the AM 100th HH Count Factor, from Step 9, with the AM peak volumes for each of the 12 movements (Step 8) to determine the AM 100th HH estimates for the intersection.
11. For the PM 100th HH estimates, repeat Steps 8 to 10 and replace AM with PM.

The same factoring procedures may 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 may be used; however, designers should be sure to have good justification and sound reasoning for any methodology that is used.

If desired, consultants that are working on behalf of Alberta Transportation, and have collected intersection count data, may 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 12-Hour 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
Totals		**9221**	**1005**	**1355**

ATR Data (during same 12 hours as the 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^{th} Highest Hour Volume = 625													

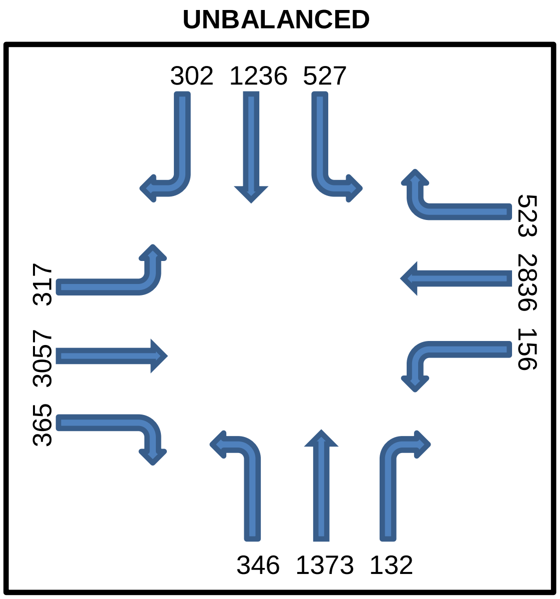
Step 1: Given in table, above.
Step 2:

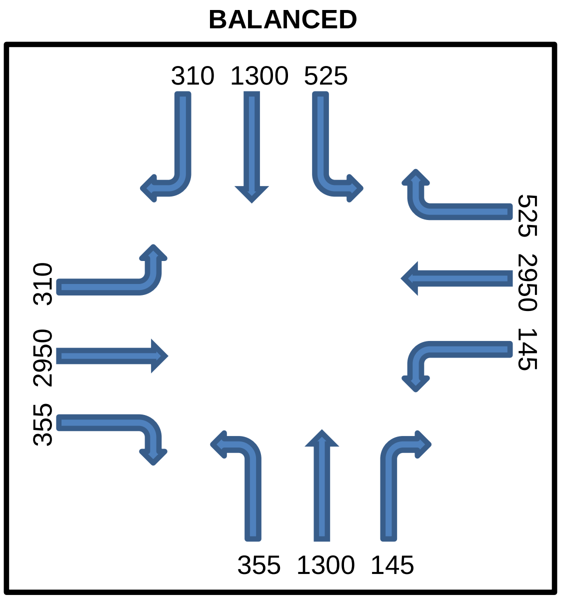
$$\text{ATR AADT Factor} = \frac{\text{AADT from ATR}}{\text{Sum of 12 Hours from ATR}} = \frac{5725}{4728} = 1.211$$

Step 3: The current AADT estimates for each movement are:

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
		Total:	11,170

The AADT estimates should be balanced (i.e., opposing movements should have similar traffic volumes in an average day). When balancing, 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 (applying a TGR to the current AADT to produce a future AADT) is not shown in this example.

Step 5:

$$\text{K Factor} = \frac{100^{\text{th}}\ \text{HH}}{\text{AADT from ATR}} = \frac{625}{5725} = 0.109$$

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

Step 7: The estimated total volume going through the intersection during the 100^{th} highest hour is:

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

Step 8: From the intersection count data, the busiest AM hour volume going through the intersection is 1005. The busiest PM hour volume going through the intersection is 1355.

Step 9:

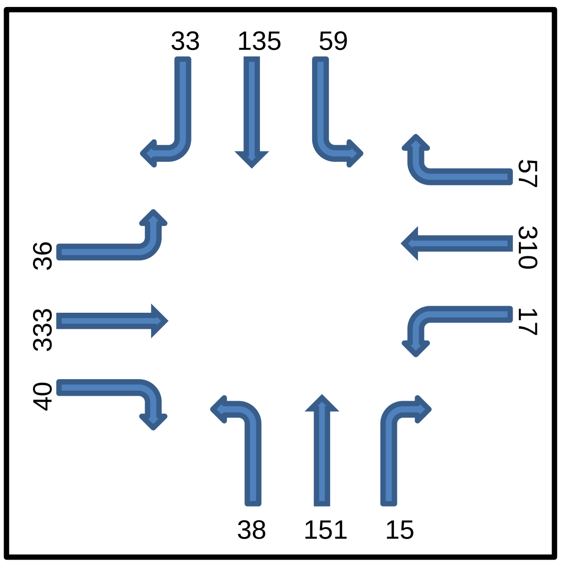
$$\text{AM } 100^{\text{th}}\ \text{HH Count Factor} = \frac{\text{Estimate from Step 7}}{\text{AM Total from Step 8}} = \frac{1218}{1005} = 1.212$$

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

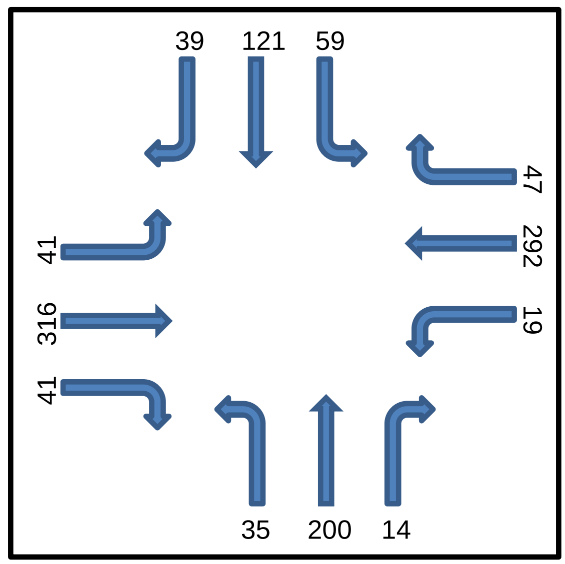
Step 10: Determine the AM 100th HH and the PM 100th HH estimates for the intersection.

		AM 100th HH		PM 100th HH	
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

AM 100th HH Estimates



PM 100th HH Estimates



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' (i.e., 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 a successful benefit cost analysis is including all costs and all benefits and properly quantifying them.

A.5.2 When to Use the AT Benefit Cost Model

The Alberta Transportation Benefit Cost Model and accompanying User Guide have been issued as the 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 (e.g., age of surface, traffic volume, collision history, speed).

Refer to the latest version of the Alberta Transportation, “Benefit Cost Model and User Guide” [16] for more information.

A.5.3 Overview of the 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, although 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 Alberta Transportation projects.

The analysis timeframe is defined by the user. 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 <u>varies significantly</u> 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 <u>only</u> be used when the curvature/gradient varies significantly between alternatives.

The user must define each alternative and decide whether project-specific values or defaults will be used. Rehabilitation costs must be entered for each alternative, taking the design period into account (e.g., 20 years for roadway pavements [rural] and intersection treatments, 40 years for pavements [urban, including roundabouts], and 75 years 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 the tables however, for further information, consult the user guide.

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

Vehicle Type	Occupancy (2009)	Work/Business $/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

The Occupancy rate is as reported in the “Natural Resources Canada” website [17]. The hourly Work/Business cost is from the “Alberta Learning Information Services” website [18]. A study prepared for Transport Canada estimated 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 the Other (e.g., leisure) travel time costs would be 50% of the rate used for Work/Business 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. The 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
Rural	$ 9,120,367	$ 66,744	$ 5,851
Urban	$ 9,464,015	$ 59,919	$ 8,520

Note: Costs are per collision rather than per fatality, or per injury, etc.

Collision costs have been provided by the Alberta Transportation 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 to 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 is often used. If one is predominant over the other, the cost associated with the majority setting may 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); and
- Benefit/Cost Ratio.

The Alberta Transportation discount rate is typically 4% and a project is considered economically viable once the IRR is greater than 4% (though the alternative with the highest IRR is preferred). A short time 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. Where two projects have a high NPV, the NPV/investment cost can be used to show which project is the most cost effective. 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.

Chapter G, 3R/4R Geometric Design Guidelines, contains examples of how the benefit cost model can be applied when considering various improvements such as grade-widening vs overlay, horizontal curve improvements, sideslope flattening, and paving a gravel road.

A.6 HIGHWAY CAPACITY AND LEVEL OF SERVICE

Level of Service (LOS) is a qualitative measure of the operational condition within a traffic stream and is generally described in terms of such factors as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort, convenience, and safety. Level of Service A represents the least congested conditions (free flow). Level of Service F represents the most congested conditions (forced or breakdown flow). The level of service concept is defined in the Transportation Research Board, “Highway Capacity Manual” (HCM) [19].

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

See the Glossary, included in the “Highway Geometric Design Guide” website, 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); and
- 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.

Two-lane undivided highway sections that pass through moderately developed areas often have a mix of local traffic and through traffic, 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, and signalized arterial roadways.

A.6.1 Guidelines for LOS Targets and Design Options

The LOS target is the minimum (worst) 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. Highways with a higher service classification require a higher LOS to minimize delays and maintain economic competitiveness and vitality in the province. Drivers generally tolerate a lower LOS on highways with a lower service classification, 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; and
- Signal timing optimization.

In densely populated areas, adding driving lanes on 6-lane or 8-lane highways can attract new traffic demand and minimize the LOS improvement. In addition to adding lanes, the designer should also consider techniques to manage traffic demand. 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 techniques to manage traffic demand:

- Managed lanes;
- Ramp metering;

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

LOS targets on Alberta highways are indicated in Table A-6-1a. The LOS targets vary by service classification 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 centres having a population greater than 500,000 and 50,000 respectively. Highway segments considered to be within the metropolitan areas are indicated in the "Provincial Highway Service Classification Map" [4]. Outside the metropolitan areas, there are separate targets for highways within a rural context and highways within an urban context (i.e., highway segments within communities).

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

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

	Outside Metropolitan Area		**Small Metropolitan Area (population > 50,000)**	**Large Metropolitan Area (population > 500,000)**
Service Classification	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

For a rural cross-section, roadway width typically consists of the travelled lanes and shoulders. Other cross-section elements include related drainage features, sideslopes and backslopes.

In urban and suburban areas, the roadway width typically consists of the travelled lanes, shoulders, sideslopes and/or curb and gutters. Other cross-section elements that may affect the roadway width include the provisions for pedestrians and cyclists (sidewalks, delineated bike lanes, separate bike paths, or shared multi-use paths), special purpose lanes (turning/storage lanes, parking lanes, bus lanes) and separators (medians, boulevards, outer separators). All are potential design considerations when selecting an interim or ultimate stage cross-section.

Nominal shoulder width varies depending if the roadway is divided or undivided. On divided roadways, nominal shoulder width (left and right side) is dependent on the number of travel lanes. On undivided rural roadways, nominal shoulder width is a function of the total surface width, which is dependent on service classification and traffic volume. 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 is used to determine the required roadway width. The width thresholds were developed considering level of service (using typical rural Alberta traffic and terrain conditions), benefit cost, safety, impact on the 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 used for new construction projects (i.e., where a project, or series of projects, are being designed or planned on an alignment where there is no salvageable existing paved roadway). These figures may also be used on existing paved highways where major upgrading work involving horizontal realignment is planned.

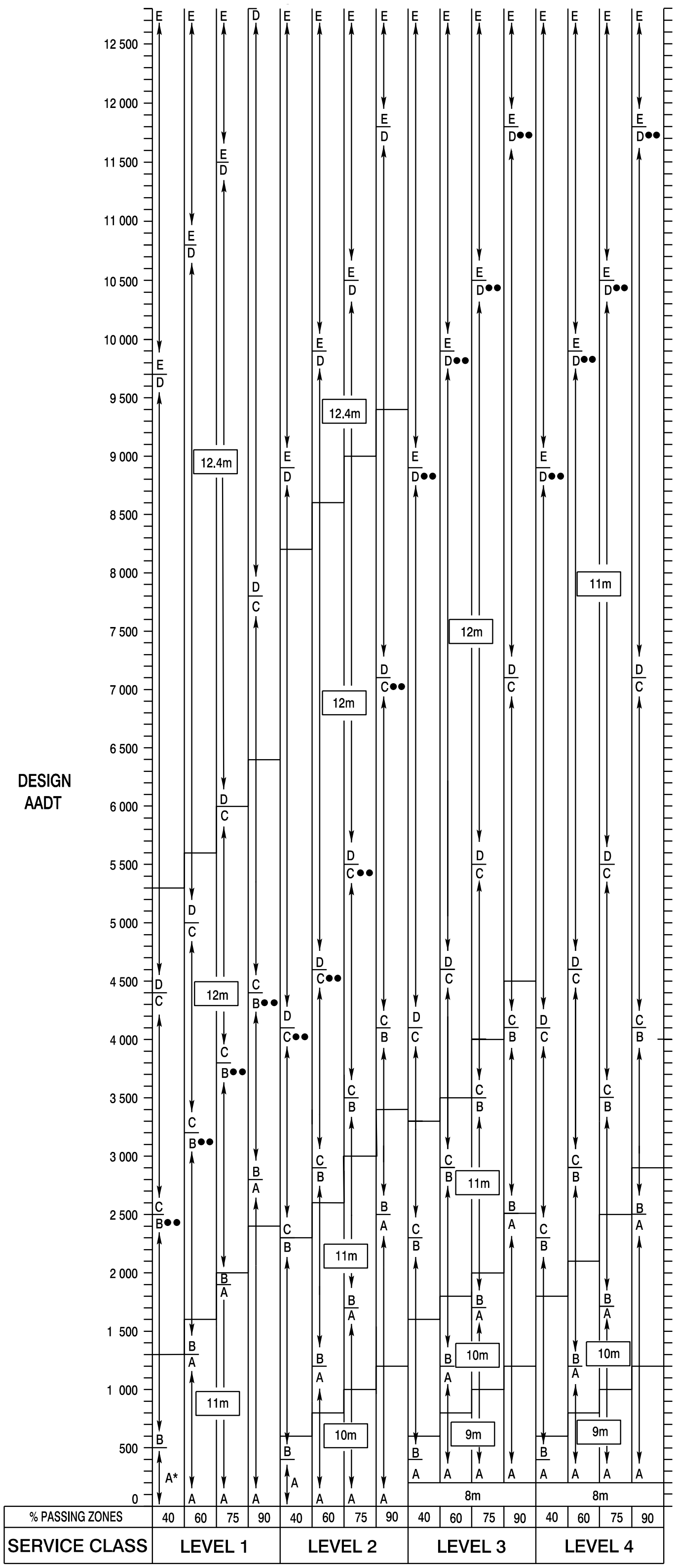
The width requirements shown in Figure A-7-1a only consider basic, two-lane, undivided cross-sections. Additional auxiliary lanes (i.e., climbing, passing, bypassing, turning, acceleration, and deceleration lanes) may be necessary in some areas to achieve the desired level of service. Refer to Chapter B, Alignment Elements; Chapter C, Cross-section Elements; and Chapter D, At-Grade Intersections, for information on auxiliary lanes, including lane warrants and typical lane and shoulder widths.

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

The suggested desirable widths shown in Figure A-7-1a are generally applicable. 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 environments; design speed; posted speed; safety; operations; right-of-way; and other site-specific constraints.

Figure A-7-1b shows the suggested desirable width for each service classification based on the existing traffic volume. The figure may be used to determine the desirable width on a new construction project 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 the traffic volume range for each designation has been adjusted based on a 20-year design life and an average annual traffic growth of 2.0 percent, not compounded.

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



NOTES

1. For planning and design purposes, projected AADT values should be used to ensure that the desirable road width selected is appropriate for the design life of the facility.

2. The traffic volume ranges shown here are intended to be used as a guideline in selection of desirable roadway width on new construction projects. New construction is generally defined as projects where there is no existing road or the existing road is unpaved. Desirable widths as shown here should also be applied to projects where major upgrading or grade-widening is deemed necessary on existing paved roads.

3. The ranges shown on the chart are generally applicable to the normal terrain and traffic conditions that exist in Alberta, that is, where the terrain is flat or rolling and the percentage of trucks in the traffic is 15. Where conditions vary from the above or other considerations dictate, exceptions to the suggested desirable roadway width may be warranted.

4. The levels of service (LOS) shown in this chart are based on Level Terrain because it has been found that this assumption yields the most accurate results in Alberta conditions even on roadways which are in rolling terrain.

•• The LOS targets shown on the chart are for rural cross sections, outside metropolitan areas. The Service Classification Levels and LOS targets are shown below. For further details refer to Section A.6.1 for service targets and Section A.6.1 for treatment options.
Level 1: LOS B Level 2: LOS C
Level 3: LOS D Level 4: LOS D

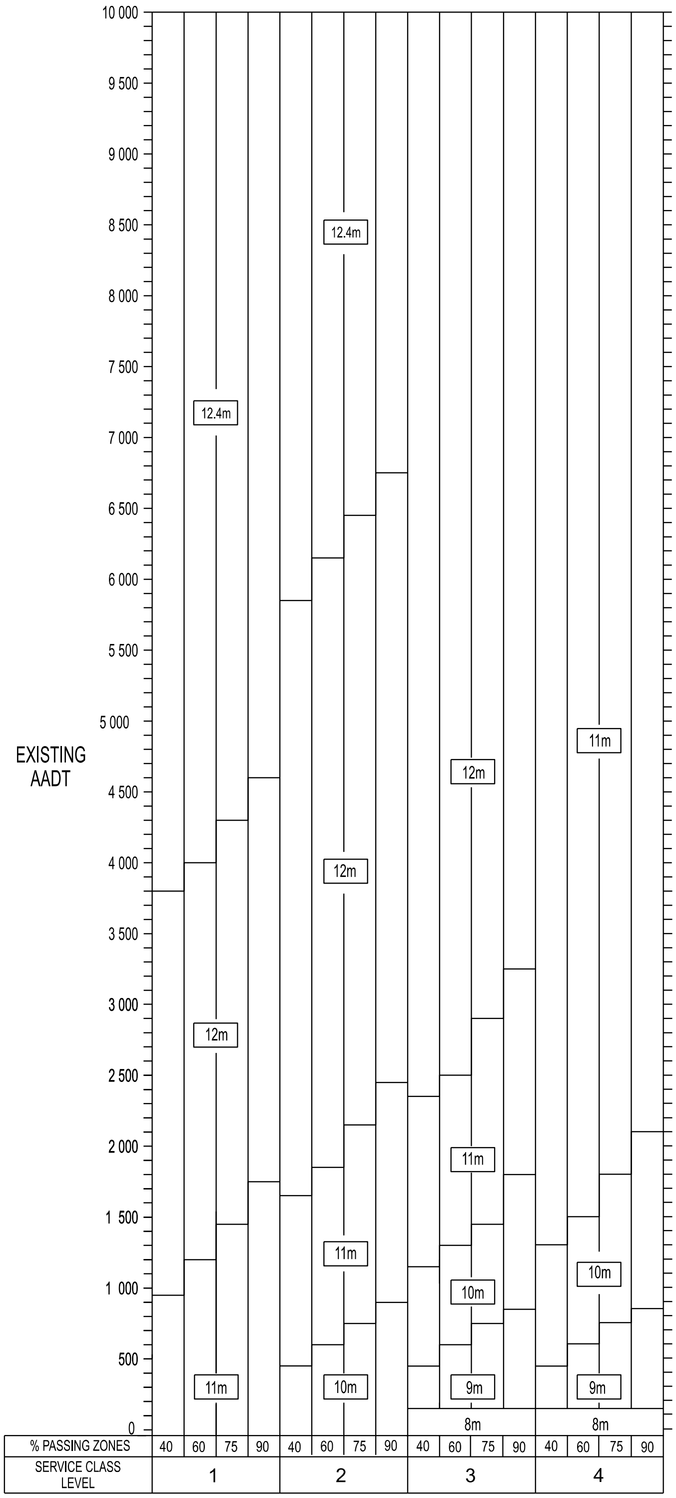
Levels of Service Assumptions

The following assumptions were in the Level of Service calculations.

1. Terrain: Level
2. % Trucks: 15
3. % Bus: 0
4. % R.V.: 4
5. Design Speed: 110km/h
6. Peak Hour Factor: 1.0
7. Directional Distribution: 60/40
8. Lane Width: 3.7m
9. Shoulder Width: Variable
10. % No Passing Zones: Variable
11. DHV=0.11 AADT on service class 1; DHV=0.12 AADT on all other roads
12. DHV (Design Hour Values) are based on typical 100th highest hour volumes

* This letter indicates the level of service expected in the 100th highest traffic volume in the year being considered.

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



NOTE: ON RURAL HIGHWAYS IN ALBERTA, THE TYPICAL PASSING ZONE AVAILABILITY IS 75%.

NOTES

1. The existing AADT values shown on this chart are based on the design AADT volume ranges that have been established and are shown in Figure A-7-1a entitled Desirable widths for two-lane undivided highways in Alberta. The existing AADT values have been obtained by dividing the design AADT values by 1.4. The growth factor of 1.4 has been assumed based on a 20-year design life and an average growth factor of 2.0 percent not compounded. Generally, this is considered to be a good ballpark growth rate to apply to Alberta's rural roads based on examination of traffic growth patterns for the past 15 to 20 years. Where a more accurate 20-year traffic volume projection is available for a specific roadway, a designer should use the more accurate projection in conjunction with the design AADT chart.

2. The traffic volume ranges shown here are intended to be used as a guideline in selection of desirable roadway widths on new construction projects. New construction is generally defined as projects where there is no existing road or the existing road is unpaved. Desirable widths as shown here should also be applied to projects where major upgrading is deemed necessary on existing paved roads.

3. The ranges shown on the chart are generally applicable to the normal terrain and traffic conditions that exist in Alberta, that is, where the terrain is flat or rolling and the percentage of trucks in the traffic is 15. Where conditions vary from the above or other considerations dictate, exceptions to the suggested desirable widths may be warranted.

4. For further details refer to Section A.6 for LOS targets and Section A.6.1 for treatment options.

A.7.2 Urban Highways

Urban and semi-urban cross-sections (including road width) vary depending on site-specific characteristics and/or constraints. Information regarding typical rural and urban design parameters and 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.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 roadway, as nearly all design elements relate directly or indirectly to design speed.

Some design elements are calculated using design speed as a variable in formulas that are based on the laws of physics (e.g., horizontal alignment, vertical alignment and superelevation). Other design elements (e.g., shy distance, lane width, shoulder width and 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. For example, 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 roadways with high mobility needs. Lower design speeds correspond to those roadways 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 may justify 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; and
- Physical and environmental constraints – it is not always practical or possible to accommodate design elements associated with higher design speeds. Lower design speeds may need to be considered and evaluated.

Table A-8-2a shows typical design speed ranges by functional classification for rural and urban roadways.

Table A-8-2a Typical Design Speeds Based on Functional Classification

<table>
<tr><th colspan="2">Rural</th><th colspan="2">Urban</th></tr>
<tr><th>Functional Classification</th><th>Design Speed Range (km/h)</th><th>Functional Classification</th><th>Design Speed Range (km/h)</th></tr>
<tr><td>Freeway (RFD)</td><td>110 – 130</td><td>Freeway (UFD)</td><td>90 – 110</td></tr>
<tr><td>–</td><td>–</td><td>Expressway (UED)</td><td>80 – 90</td></tr>
<tr><td>Arterial Divided (RAD)</td><td>120</td><td>Arterial Divided (UAD)</td><td>70 – 80</td></tr>
<tr><td>Arterial Undivided (RAU)
Flat and Rolling Terrain</td><td>110</td><td rowspan="2">Arterial Undivided (UAU)</td><td rowspan="2">70</td></tr>
<tr><td>Arterial Undivided (RAU)
Mountainous</td><td>Refer to Section 8.2.2.2</td></tr>
<tr><td>Collector Undivided (RCU)
Flat and Rolling Terrain</td><td>90 – 110</td><td rowspan="2">Collector Undivided (UCU)</td><td rowspan="2">70</td></tr>
<tr><td>Collector Undivided (RCU)
Mountainous</td><td>Refer to Section 8.2.2.2</td></tr>
<tr><td>Local Undivided (RLU)
Flat and Rolling Terrain</td><td>60 – 90</td><td rowspan="2">Local Undivided (ULU)</td><td rowspan="2">60</td></tr>
<tr><td>Local Undivided (RLU)
Mountainous</td><td>Refer to Section 8.2.2.2</td></tr>
</table>

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

For each functional classification within a jurisdiction, it is desirable to provide a reasonable degree of consistency in the selection of design speed. 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 as defined in the Alberta “Traffic Safety Act” [12].

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

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. In Alberta, data has been 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. The data indicated that the 85th percentile driver generally exceeded the posted speed limit (standard speed limit as per 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.

The 85th 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. 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

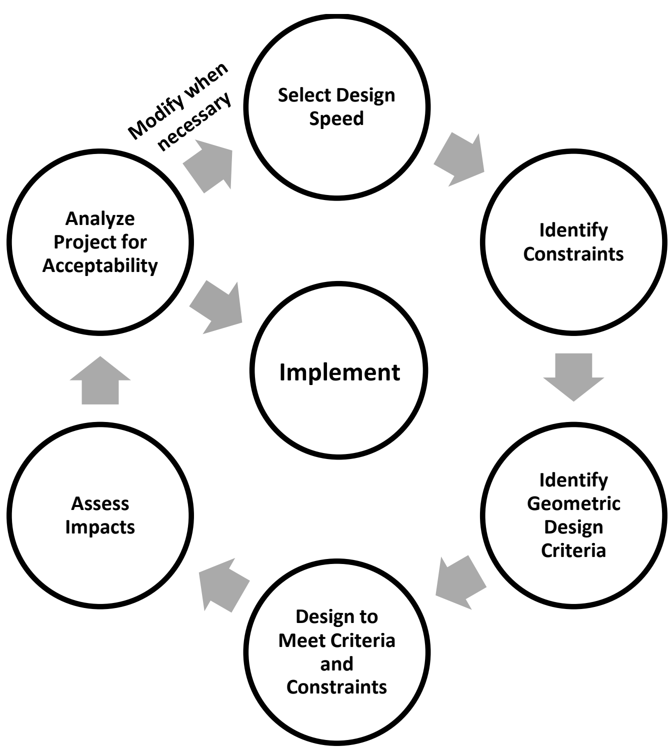
Special situations may arise in which engineering, economic, environmental or other considerations make it impractical to provide the minimum elements established by the design speed. Examples of these situations include sections of rough topography or tight curves where maintenance of full design speed 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 mitigate 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, in locations where property acquisition is difficult, or when entering a built-up area where conversion to an interrupted flow condition is required to provide access to adjacent land. Approaching drivers are more apt to accept a lower design speed where a difficult location is obvious than where there is no apparent reason. Reductions in design speed in response to a topographic or land-use constraint are to be evaluated on a case-by-case basis with documented justification indicating why the design speed reduction 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 (e.g., paving and road-user costs). This can be confirmed and quantified through an economic analysis using the Alberta Transportation, “Benefit Cost Model and User Guide” [16].

There may be an interactive aspect to the selection of an appropriate design speed. Additional information gleaned in the early design and planning phases may necessitate the adjustment of a chosen design speed. Some factors may be mitigated or adjusted, ppossibly 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



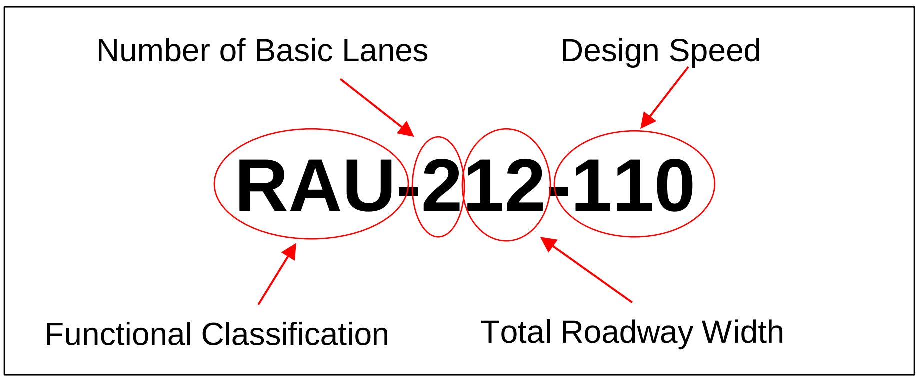
A.9 DESIGN DESIGNATION

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 three components of design designation are functional classification, 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 classification is indicated first, followed by the total number of basic lanes and the total roadway width (m), followed by the design speed (km/h). For divided highways, the total number of lanes for both directions is indicated, 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) other combinations are permitted.

If a road is designated to have a gravel surface, the design designation parameters will include a G after the total roadway width. For example, RLU-207G-60 is rural, local, undivided, 2-lane, 7m wide roadway with a gravel surface and 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 classification, 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, the design life of the roadway facility must be considered. Often, a design designation must be determined for two or more time horizons, depending on the expected staging of the facility. 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. The design elements that are specific to intersections (such as intersection sight distance, acceleration and deceleration lane lengths) 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 the intersections will be removed at the freeway stage. The horizontal and vertical geometry should be designed to achieve the typical Rural Freeway Divided (RFD) design speed of 130 km/h, in order to avoid the need for costly future re-alignment.

If applicable when selecting a current design designation, planners and designers should, at a minimum, evaluate and recommend the ultimate rural or urban design designation and future staging. For information regarding the existing and future functional classifications on the provincial network, refer to the "Functional Classification – Existing Conditions Map" [8] and the "Roadside Management Classification Map" [7], respectively, as well as 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	References in Chapter A Include
RAU	Functional Classification	A.2 – Roadway Classification A.3 – Design Life A.4 – Traffic Statistics for Planning and Design A.5 – Benefit Cost Analysis A.6 – Highway Capacity and Level of Service
212	Number of Basic Lanes and Roadway Width	A.2.5.1 – High Load Corridor A.2.5.2 – Long Combination Vehicle Routes A.3 – Design Life A.6 – Highway Capacity and Level of Service A.7 – Width Selection
110	Design Speed	A.8 – Design Speed A.10 – General Design Guidelines

A.10 GENERAL DESIGN GUIDELINES

A.10.1 Design Guidelines for Rural and Urban Highways

Table A-10-1a and Table A-10-1b provide a summary of the principal geometric design parameters that apply to each design designation for rural and urban roadways, respectively. Additional information is provided throughout the "Highway Geometric Design Guide".

The values shown in 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 or vertical alignment changes.

Some general notes regarding design guidelines are included in the tables. In addition to those general notes, planners and designers should consider general design controls identified in Section A.10.3, Other Considerations.

Table A-10-1a Design Guidelines for Rural Highways (page 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	Minimum Curve Radius (m)		950	750	600	600	600	600	440	340	340	130
	Spiral Parameter A		Refer to the superelevation tables in Chapter B.3.5 for the minimum and desirable "A" parameters for each curve radius and design speed.									
Vertical Alignment $K = \frac{L(m)}{A(\%)}$	Minimum Crest K	Passing Sight	780	675	580	580	580	580	490	405	405	190
		No Passing Zone Sight	250 (refer to Chapter B.2.5 regarding staged construction)			250	250	250	250	120	120	N/A
		Stopping Sight	124	95	74	74	74	74	52	39	39	11
	Minimum Sag K	Headlight Control	73	63	55	55	55	55	45	38	38	18
		Comfort Control (Illuminated Sections Only)	44	37	32	32	32	32	26	21	21	10
	Decision Sight Distance (m)		300 – 455	265 – 420	230 – 385	230 – 385	230 – 385	230 – 385	200 – 350	170 – 325	170 – 325	95 – 205
	Desirable Max. Gradient (%)		3	3	3	5	5	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	3.5	3.5
	Outside (Right) 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	0.5 0.0
	Inside (Left) Shoulder Width (m)		2.0 2.5 3.0	2.0 2.5	2.0 2.5 3.0	-	-	-	-	-	-	-
	Total Surface Width (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	8.0 7.0
	Median Width – from Inside Shoulder Line to Inside Shoulder Line (m)		32.6 (50.6 crown land) 32.6 (50.6 crown land) 25.2 (43.2 crown land)	37.6 (50.6 crown land)	32.6 (50.6 crown land) 32.6 (50.6 crown land) 25.2 (43.2 crown land)	-	-	-	-	-	-	-
	Centreline Spacing (m) (Refer to Chapter C.6.1)		40 (58 in Crown Land)	45 – 58 (58 in Crown Land)	40 (58 in Crown Land)	-	-	-	-	-	-	-
	Ditch Width (m)		4.0	4.0	4.0	4.0	3.5	3.5	3.5	3.5	3.0	3.0
	Subgrade Sideslope Ratio (See General Note 4)	Typical	6:1	6:1	6:1	6:1 5:1 5:1	4:1	4:1	4:1	4:1	4:1	4:1
		Maximum (in Fill)	4:1 Over 4.0 m	4:1 Over 4.0 m	4:1 Over 4.0 m	4:1 Over 4.0 m 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	3:1 Over 4m
	Backslope Ratio	Typical	5:1	5:1	5:1	5:1	3:1	3:1	3:1	3:1	3:1	3:1
		Maximum	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 (130 Crown Land) See General Note 5	120 (130 Crown Land) See General Note 5	110 (130 Crown Land) See General Note 5	60	50	50 50 40	50 50 40	50 50 40	50 40 40	40

Note: Table A-10-1a is continued on the next page.

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

GENERAL NOTES	
1. The following notes highlight certain key issues only. For more through explanations, refer to Chapter B of the "Highway Geometric Design Guide". 2. Minimum design values for horizontal and vertical curvature should be reserved for particular circumstances at critical locations. Effort should be made to use non-minimum values in the majority of cases. 3. Horizontal and vertical alignment elements should be designed to accommodate the ultimate design designation. They are among the most permanent design elements of a highway and once a facility is constructed, under-designed features will remain for many years. 4. For details on typical and maximum sideslope ratios, refer to Chapter C of the "Highway Geometric Design Guide" and the "Roadside Design Guide" [20]. 5. This right-of-way width does not include additional right-of-way for service road or C-D road accommodation.	
NOTES: HORIZONTAL ALIGNMENT DESIGN	**NOTES: VERTICAL ALIGNMENT DESIGN**
1. 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.	

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

Design Designation			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-412.4-90 UFD-616.6-90 UFD-820.8-90	UFD-617.1-90 UED-412.4-90 UED-617.1-90	UED-410.4-80 UED-614.1-80	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			110	100	90	90	80	80	70	70	70	60
Superelevation Table (%) (Refer to Chapter B.3.5)			6	6	6	6	6	6	6	4 or 6	4	Normal Crown
Horizontal Alignment	Minimum Curve Radius (m)		600	440	340	340	250	250	190	200 or 190	200	130
Horizontal Alignment	Spiral Parameter A		Refer to the superelevation tables in Chapter B.3.5 for the minimum and desirable “A” parameters for each curve radius and design speed.									
Vertical Alignment $K = \frac{L(m)}{A(\%)}$	Minimum Crest K	Passing Sight	Where passing sight distance is a consideration for staged construction of a divided highway, refer to Chapter B.							250	250	190
	Minimum Crest K	No Passing Zone Sight	For staged construction of a divided roadway, refer to Chapter B.2.5.							65	65	-
	Minimum Crest K	Stopping Sight	74	52	39	39	26	26	17	17	17	11
	Minimum Sag K	Headlight Control	55	45	38	38	30	30	23	23	23	18
	Minimum Sag K	Comfort Control (Illuminated Sections Only)	32	26	21	21	17	17	13	13	13	10
	Decision Sight Distance (m)		385 – 430	350 – 390	320 – 365	320 – 365	270 – 315	270 – 315	235 – 275	235 – 275	235 – 275	195 – 235
	Desirable Max. Gradient (%)		3	3	5	5	6	6	6	8	8	8
Cross-Section	Lane Width (m)		3.7	3.7	3.7	3.7	3.7	3.7	3.7, 4.3 3.7, 3.7, 4.3 (General Note 7)	4.5	3.5 4.5	4.5
	Outside (Right) Shoulder Width (m)		3.0	3.0	3.0	3.0	3.0	-	-	-	-	-
	Inside (Left) Shoulder Width (m)		2.0 2.5 3.0	2.0 2.5 3.0	2.0 2.5 3.0	3.0 2.0 3.0	0.0	-	-	-	-	-
	Total Surface Width (m) Excluding Gutter		12.4 16.6 20.8	12.4 16.6 20.8	11.4 16.1 20.8	17.1 12.4 17.1	10.4 14.1	7.4 11.1	8.0 11.7	9.0	14.0 9.0	9.0
	Median Width (m) and Type		22.8 Depressed 15.4 Depressed 8.0 Flush	22.8 Depressed 15.4 Depressed 8.0 Flush	22.8 Depressed 15.4 Depressed 8.0 Flush	8.0 Flush 15.4 Depressed 8.0 Flush	6.0 Raised	6.0 Raised	6.0 Raised	None	None	None
	Ditch Width (m)		4.0	4.0	4.0	4.0	3.5	Curb and 0.5 m wide Gutter. See General Note 6.				
	Subgrade Sideslope Ratio (See General Note 4)	Typical	6:1	6:1	5:1	5:1	4:1	Not Applicable				
	Subgrade Sideslope Ratio (See General Note 4)	Maximum (in Fill)	4:1 Over 4.0 m	4:1 Over 4.0 m	4:1 Over 4.0 m	4:1 Over 4.0 m	3:1 over 4m					
	Backslope Ratio	Typical	5:1	5:1	4:1	4:1	3:1					
	Backslope Ratio	Maximum	3:1	3:1	3:1	3:1	2.5:1					
Basic R/W Width – Typical (m)			90 (General Note 5)	90 (General Note 5)	90 (General Note 5)	80 (General Note 5)	70 (General Note 5)	40 50	40 50	30	30	20

Note: Table A-10-1b is continued on the next page.

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

GENERAL NOTES

1. The following notes highlight certain key issues only. For more through explanations, refer to Chapter B of the “Highway Geometric Design Guide”.
2. Minimum design values for horizontal and vertical curvature should be reserved only for critical locations, with better values being used in the majority of cases.
3. Horizontal and vertical alignment elements should be designed to accommodate the ultimate design designation. They are among the most permanent design elements of a highway and once a facility is constructed, under-designed features will remain for many years.
4. For details on typical and maximum sideslope ratios, refer to the “Roadside Design Guide” [20] and Chapter C of the “Highway Geometric Design Guide”.
5. This right-of-way width does not include additional right-of-way for service road or C-D road accommodation.
6. Refer to the Alberta Transportation “Roadside Design Guide” [20] for details regarding the selection of curb type related to design speed and acceptable combinations of curb and barrier systems.
7. A wider right-hand curb lane may be used to accommodate motor vehicles and cyclists operating side-by-side. The width of the shared lane is typically 4.3 m minimum. Refer to Chapter C.8.2.

NOTES: HORIZONTAL ALIGNMENT DESIGN	NOTES: VERTICAL ALIGNMENT DESIGN
1. 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.	

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 an urban section according to its functional classification described in Section A.2.3, Functional Classification. The rural and urban functional classifications 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 areas where the surrounding land use is transitioning from rural to urban or rural to 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/Tsuut’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 help 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 at the boundary between rural and urban sections. In these areas, special roadway design features are often implemented 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 Segment Characteristics

Various design techniques may be used to convey to drivers that the roadway is about to transition from rural to urban or vice versa. The following subsections outline key considerations and potential design techniques to help drivers adjust their driving to fit the changing setting.

Visual Cues
Visual cues along the roadway are added or removed to influence 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 areas and open land to mitigate distractions for higher travelling speeds. As more visual cues appear, drivers become more aware 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 indicated in the various documents located in the Alberta Transportation website “Methods of Reducing Collisions on Alberta Roads (MORCOAR)” [21], 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 connects to an urban street system that goes through an urban area (rather than around it). Gateway treatments are intended to reduce vehicle speeds and increase alertness at transition points in the road network. Two key features of gateway treatments used to affect driver behaviour are road narrowing (or the appearance of narrowing) to reduce vehicle speed without introducing new hazards or obstacles, and conspicuous roadside vertical elements (e.g. gateway treatments) to increase alertness and reduce speed.

Right-of-Way
From a rural to urban setting, a narrowing of, or the appearance of, the right-of-way boundary (often lined by bushes/trees) creates the illusion of a reduced 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 and frequency of illumination, drainage type (ditch vs curb and gutter), raised islands, lane width, pavement markings and access management.

Speed
A major factor in a transition segment is the change of speed limit. In a rural setting, the posted speed limit is typically 90km/h or higher. Most often, the roadway 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 70 km/h or lower. Within the transition zone, the speed limits may drop between 10 and 30 km/h, and gradually lower even more. Proper signage with an adequate transition distance is required to achieve gradual deceleration. As a driver approaches a suburban area on a divided highway, speed limit signs are typically posted on both sides of the road rather than only on the right.

Transit
In some areas where transitional highways exist, there may be a 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 where vehicles may pull over to board and let off passengers.

Active Modes
Roadways closer to an urban setting will often have increased active modes of transportation such as cyclists or pedestrians. Typically, the commuting distance between destinations is shorter and active modes may be more accessible in comparison to a rural location.

A.10.2.4 Examples of Existing Transitions and Hybrids

Below are some examples of existing transition zones in Alberta and the 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; and
- Drainage utilizing open ditches.

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 accesses and shorter intersection spacing; and
- 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 the 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;
- Open ditch drainage;
- Design speed of 110 km/h; and
- 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 that occurred as the municipality developed. Some features are:

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

Trans-Canada Highway 1, approaching the 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 an 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; and
- Continuous illumination in advance of the traffic signals.

Highway 11A, East of the Town of Sylvan Lake – Transition from rural highway into urban via roundabout
Highway 11A is the connecting highway between the 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;
- Open ditch drainage transitioning into raised curb and gutter when approaching the roundabout;
- Design speed of 110 km/h with a posted speed of 100 km/h, which lowers to 60 km/h approaching the roundabout;
- Increased illumination;
- Appearance of tighter right-of-way;
- Introduction of sidewalks for pedestrians; and
- 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; and
- 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 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 occupants of the vehicle. 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 Alberta Transportation currently 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 exist:

- 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); and
- end treatments are non-compliant.

Refer to the Alberta Transportation, "Roadside Design Guide" [20].

Pavement Markings
Designers are to consider the pavement markings that will be placed on the finished pavement of a highway. In particular, designers are to note the amount and location of barrier line indicating that passing is not allowed. Barrier lines may be required for the following:

- Insufficient sight distance for passing;
- Highway transitions;
- Climbing and passing lanes;
- At-grade intersections, including roundabouts; and
- Interchanges.

Planners and designers are to 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 and traffic conditions (i.e., probability of on-coming traffic eliminating passing opportunities). For information regarding pavement markings, refer to the Alberta Transportation website, "Traffic Control Standards" [22].

Traffic Control Guidelines
Highway signing requirements present a design constraint that is typically addressed at the design stage. For typical sign spacing and layout relative to junctions and other key geometric features, refer to the Alberta Transportation website, “Traffic Control Standards” [22].

Other guidelines and resources that are accessible through the “Traffic Control Standards” website include:

- Recommended Practices Guidelines;
- Manuals and Guidelines;
    - Guidelines for School and Playground Zones and Areas;
    - Highway Guide and Information Sign Manual;
    - Highway Lighting;
    - Special Events Guide;
    - Typical Signage Drawings; and
    - Standard Drawings for Traffic Signals;
- Traffic Sign Catalogue; and
- Traffic Sign Classifications.

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, HTCB generally has many advantages over other types of barrier systems, including reduced snow drifting.

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. For further information pertaining to bridge geometric design, refer to the Alberta Transportation, “Bridge Conceptual Design Guidelines” [23].

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. A DE can be initiated at any stage of a project, and may be initiated by the Consultant or by Alberta Transportation. A DE 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 a DE is to allow for deviations from normal design standards or practices, 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 appropriately considers roadway safety, risk and mitigation. By following a consistent documented process, Alberta Transportation is aware of common deviations from normal practice and is able to undertake timely reviews of any practices as warranted.

For more information, refer to the “Design Exceptions Guideline” at the Alberta Transportation website, “Design Exceptions” [24].

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 Manual” [25] and related documents such as the “Terms of Reference for Environmental Evaluation of Highway Infrastructure Projects” [26].

Chapter 3 of the “Environmental Management System Manual” [25] 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 activities. The required authorizations (e.g., 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 (Alberta) Act”, “Canadian Navigable Waters 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 Alberta Transportation, “Terms of Reference for Environmental Evaluation of Highway Infrastructure Projects” [26] 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. 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). Refer to the “Terms of Reference for Environmental Evaluation of Highway Infrastructure Projects” [26], 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); and
- 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 in the Alberta Transportation, “Noise Attenuation Guidelines for Provincial Highways Under Provincial Jurisdiction Within Cities and Urban Areas” [27]. It is critical that these guidelines be adhered to during the study as noise attenuation is expensive and, 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).

The user is to 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 the project schedule.

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. Refer to the “Terms of Reference for Environmental Evaluation of Highway Infrastructure Projects” [26].

Refer to the Alberta Transportation website, “Environmental Management of Transportation and Water Projects” [28] for access to all current environmental guidelines and standards.

A.13 OPTION SELECTION

Decision making is an integral part of the planning and design processes. Alberta Transportation 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.

Alberta Transportation 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 do not readily align with the tool, but the basic parameters (collision costs, discount rate, etc.) are 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). 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 Alberta Transportation, “Benefit Cost Model and User Guide” [16] is, all project costs considered 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. Alberta Transportation may choose to use an alternative analysis method known as Multiple Account Evaluation (MAE) [29] 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 Model and User Guide" [16] whenever practical. The MAE process is used by internal stakeholders, experts and others within the Alberta Transportation project team. Consultants 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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