Edmonton

COMPLETE STREETS DESIGN AND CONSTRUCTION STANDARDS 2-01: STANDARDS

City of Edmonton

Version 06
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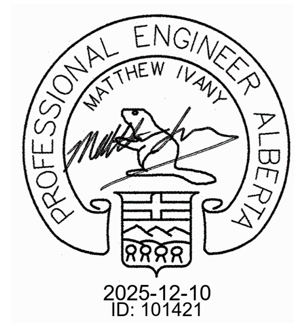
AUTHENTICATION TABLE

Complete Streets Design and Construction Standards Sections: 1 - 6 Appendices: A - F	Matthew Ivany, P.Eng. General Supervisor, Transportation Design	
Permit to Practice - Entire Document **Complete Streets Design and Construction Standards (All)** **Complete Streets Construction Specifications (All)** **Complete Streets Standard Drawings (All)**	Natalie Lazurko, P. Eng Director, Transportation Planning And Design	**PERMIT TO PRACTICE** **CITY OF EDMONTON** RM SIGNATURE: NLazurko RM APEGA ID #: 93519 DATE: 2025-12-10 **PERMIT NUMBER: P005038** The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

CHANGE HISTORY

Version	Change	Date
06	Revised “Transportation Network” to “Mobility System” throughout the document.	November 2025
06	Removed all references to "main street" and "main street guidelines". Replaced with "Nodes and Corridors" where applicable	November 2025
06	Removed reference to Mature Neighbourhood Overlay (MNO)	November 2025
06	Fixed typos and grammatical errors throughout the document.	November 2025
06	Removed reference to 2017 Fireseeds Report on Minimum Lane Widths for the City of Edmonton	November 2025
06	Changed "Shared Use Paths (SUP's)" to "Shared Pathways (SP's)"	November 2025
06	Changed "Manhole" to "Maintenance Hole" to align with EPCOR terminology.	November 2025
06	Added reference to City Access Design Guide and Access Management Guidelines where applicable	November 2025
06	Changed "Ancillary Zone" to "Curbside Zone" in Section 2.1.1 and throughout document	November 2025
06	Revised Section 1 to align with current City strategies and policies, including integration of City Plan, as well as consideration of Safe Mobility Strategy, Bike Plan, and others. Added reference to Big City Moves from City Plan and how they relate to design principles for complete streets	November 2025
06	Added new Section 1.8 on designing with a Climate Resilience Lens	November 2025
06	Added new road Functional Classifications, including Expressway, Principal Roadway, Enhanced Local, and Shared Street/Alley	November 2025
06	Revised modal priority section to clarify trade-offs and impacts on cross section selection	November 2025
06	Added new Section 2.4 on Designing Roads in Edmonton to provide guidance on how traffic calming should be applied in new and established neighbourhoods	November 2025
06	Adjusted dimensions for various design vehicles, including bikes, City of Edmonton buses, and City of Edmonton waste vehicles	November 2025
06	Revised posted and design speeds to align with 40 km/h posted speed	November 2025
06	Revised E-Bike section to encompass all Micromobility devices	November 2025
06	Substantially revised Section 3.2.3.1 - Selection of Suitable Bikeways	November 2025
06	Added design guidance for local street bikeways	November 2025
06	Added content related to dimensions and offset/buffers for shared pathways and bike paths	November 2025
06	Revised Section 3.2.3.3 on integration of cycling infrastructure with transit	November 2025
06	Removed all guidance related to cycling related pavement markings and signage and referenced Volume 8	November 2025
06	Added tables for minimum bike infrastructure horizontal radii	November 2025
06	Added bevelled curbs in text and standard details	November 2025

06	Added definition and figure for headers and verges	November 2025
06	Refined definition and added figure/standard for catch basins and utility covers	November 2025
06	Refined section on Road Structural Design to update existing content and add new subsection of road cross fall requirements, including a new table.	November 2025
06	Updated Curbside Zone section to incorporate more uses into definition, including patios, bike corrals, food trucks, etc. in accordance with the City's Curbside Management Strategy (referenced).	November 2025
06	Refined parking requirements for the Curbside Zone to add requirements for connector walks on streets with boulevard walks, include additional content in the subsection for disabled parking, and add reference to the City's Access Design Guide.	November 2025
06	Removed Section 3.3.1.7 - Boardwalks	November 2025
06	Added new Table 3.29 - Vehicle Turning Speeds and substantially revised list of design and control vehicle principles to be applied to swept path analysis in Section 3.2.2.2	November 2025
06	Changed Section 3.6.4.2 from "Crosswalk Enhancement Measures" to "Median Refuge Areas" with guidance on selection, dimensions, and materials and accessibility	November 2025
06	Added new Section 3.6.4.4 Two-Stage Crossings	November 2025
06	Added subsection "Horizontal Offset - Bend-out and Queuing Area" to define requirements for offset distance between protected bike lanes and adjacent travel lanes.	November 2025
06	Rewrote subsection on Protected Intersections, including adding content for design elements and design guidance.	November 2025
06	Removed most of Section 3.5.6.2 - "Painted Bike Lanes at Intersections" to prohibit use of painted bike lanes at intersections except for the approaches of Local Street Bikeways at intersections.	November 2025
06	Added additional content and figure for sight distances for mid-block crossings and bike crossings	November 2025
06	Added content on roundabout advantages and disadvantages (adapted from TAC Canadian Roundabout Design Guide)	November 2025
06	Updated definitions of roundabout categories (Mini, Single-Lane, Multi-Lane)	November 2025
06	Updated standard drawings for roundabouts to align with best practice	November 2025
06	Extensively updated Table 3.31 - Roundabout Category Comparison	November 2025
06	Rewrote subsection on Roundabout Design Methodology and Guidelines, including new content on roundabouts in new developments and retrofit roundabouts	November 2025
06	Added additional subsections on High Entry Angle and Low Entry Angle/Free Flow right turn lanes	November 2025
06	Removed Sections 3.6.9.1 (Pavement Markings), 3.6.9.2 (Signs), and 3.6.9.3 (Signals)	November 2025
06	Removed Tables 3.32, 3.33, and 3.34 - Design Domain: Offsets for Utilities, Poles, Cabinets, Trees, Sidewalks/shared pathway, and Face of Curb (in m), replacing with reference to Volume 1	November 2025
06	Extensively updated Section 3.8 Traffic Calming, including new benefit / disbenefit table	November 2025

06	Added new section "Road Staging" to Section 3.10.2 to clarify that collector and local roads (with adjacent sidewalks and shared pathways) cannot be staged (unlike arterials)	November 2025
06	Replaced content within Section 3.12 - Cul-De-Sac to align with updated City direction on restricting the use of cul-de-sacs, along with updated design criteria for these exceptions.	November 2025
05	Adding Chapter 2 (Construction Specifications) and Chapter 3 (Standard Drawings) to Front-Matter Table of Contents	August 2023
05	Correcting spelling errors and typos throughout all three chapters	August 2023
05	Changes instances of “Shared-Use Path” to “Shared Pathway”	August 2023
05	Changes “1.8.2.1 Modal Priority Areas” to “1.8.2.1 Establishing Modal Priority” and updates the modal priority areas based on most recent planning documents	August 2023
05	Adding guidance on designing for “interested but concerned” cyclists in Section 3.1.3.2	August 2023
05	Adding minimum width for active mode connections on bridges in Section 3.1.3.2	August 2023
05	Changes the bike facility categories in Table 3.4 to be consistent with The Bike Plan	August 2023
05	Adding “Curbside Activity and Access Management,” “Posted Speed and Traffic Volumes,” and “Pedestrian Volumes” to section 3.2.3.1 Selection of Suitable Bikeways	August 2023
05	Updates “Bicycle Boulevard” to “Local Street Bikeway”	August 2023
05	Adding design user impacts to Section 3.2.3.2 Bikeway Facility Design Domain	August 2023
05	Updates bike facility categories and design domains in Table 3.8 Design Domain: Protected Bike Lanes, as well as explanation associated with the table.	August 2023
05	Adding explanation of the bike lane buffer width in Section 3.2.3.2 Bikeway Facility Design Domain	August 2023
05	Updates bike facility categories and design domains in Table 3.9 Design Domain: Protected Bike Lanes	August 2023
05	Updates bike facility categories and design domains in Table 3.10 Design Domain: Shared-Use Paths and BIke Paths	August 2023
05	Adding target values to Table 3.14 Design Domain: Gradients	August 2023
05	Adding requirement for concrete header for curb extensions with landscaping in Section 3.3.1.5 Curb Extensions	August 2023
05	Updating “Figure 3.40A: Driveway crossing of a separated sidewalk” to be consistent with standard drawing 5320	August 2023
05	Updating the normal longitudinal grade of the walkways from 0.7% to 0.6% in Section 3.5.7 Vertical Alignment to be consistent with Appendix C	August 2023
05	Adding control vehicle columns to Tables 3.26 and 3.27	August 2023
05	Adding detail to Tactile Devices in Table 3.28 Curb Ramp Design Requirements	August 2023
05	Adding Section 3.6.4.2 Crosswalk Enhancement Measures and Section 3.6.4.3 Raised Crossings	August 2023
05	Adding Section 6.6.8.1.1 High Entry Angle	August 2023

05	Removes Type 3 backfill from Construction Specifications and clarified granular for use in Type 2 backfill	August 2023
05	Updates Table 3.1.2: Moisture Content Requirements	August 2023
05	Deleting Sections 1.2.8 - 1.2.18 in Construction Specifications	August 2023
05	Adds minor clarifications throughout Construction Specifications	August 2023
05	Updates to Section 3.2.3.1 on road and laneway restoration requirements in Construction Specifications	August 2023
05	Updates to air entrainment requirements in Table 7.11.1: Fillcrete Requirements and Addition of Table 7.11.2: Pumpable Fillcrete Requirements	August 2023
05	Updates to Section 7.1.1.4 Quality Assurance	August 2023
05	Updates to Section 7.11.1.3 Quality Assurance	August 2023
05	Updates to Section 7 - Concrete to allow use of Portland Limestone Cement in Construction Specifications	August 2023
05	Updates width/depth ratio in Section 6.9.3.3 of the Construction Specifications	August 2023
05	Table 2.1.1 and 2.1.3, changed application for Des 3 Class 63 from Granular Base to Granular Sub-base	August 2023
05	Update name from Engineering Services Section (ESS) to Technical Services Section (TSS) throughout Construction Specifications	August 2023
05	Adding standard drawings #3130, #3800, #3805, #3810, #3815, #3830, #3835, #3840, #3845, #3900, #5530, #5531, #6085, and #6525	August 2023
05	Updating standard drawings #2040, #2041	August 2023
04	Disclaimer and Authentication Table added	October 2021
04	Striking out of Sections 1.2.8 - 1.2.18 in 1. 'General' specification	October 2021
03	Adding 'Table of Offsets' note to Table 3.30 and Table 3.3.1	March 2021
03	Adding in temporary cross-section 2510	March 2021
02	Chapter 3 (Standard Drawings) Published	September 2018
01	Chapter 1 (Design Standards) and Chapter 2 (Construction Specifications) Published	June 2018

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CHAPTER 1: COMPLETE STREETS DESIGN

PURPOSE / INTENT OF THE DOCUMENT

The Complete Streets Design and Construction Standards (CSDCS) document provides a single point of reference that supports the planning, design, and construction of Complete Streets in Edmonton. It integrates the best practices in Complete Streets design philosophy and guidance introduced in the City's 2013 Complete Streets Guidelines with the City of Edmonton's former Roadway Design Standards and Construction Specifications in alignment with the CIty's Complete Streets Policy C573B.

The intent of these Complete Streets Design and Construction Standards is to encourage a holistic approach to street design that will develop a network of streets that are safe, attractive, comfortable, and welcoming to all users in all seasons, while considering operational and maintenance challenges. The document introduces the 'Design Domain' approach which allows flexibility in design through variance in street element design values based on the modal priorities and context of a specific corridor.

From a technical perspective, the document is intended primarily for design professionals and City builders both private and public. Though the document can be utilized by communities and the public, a less technical companion document will better serve those users.

The Complete Streets Design and Construction Standards are intended to be a living document, with regular updates to incorporate changes in best practice and their application in the Edmonton context.

THE COMPLETE STREETS APPROACH

Historically in Edmonton, transportation systems have been designed based on roadway functional classification with the primary focus on accommodating motor vehicle connections to destinations. Roadways designed in this fashion typically function as a link that primarily moves people in vehicles from Point A to Point B and are typically referred to as 'roads'.

When other modes of transportation, such as walking and cycling are considered, there are competing demands for limited space and several challenges arise when designing a 'street':

- How can the often-competing demands of people walking, riding bikes, taking transit, delivering goods, driving, and being driven be accommodated?
- How can the design reflect the varying land uses along a corridor today and in the future?
- How can cost-effective innovations, such as sustainable stormwater practices and improved urban design, be incorporated?
- How can the design accommodate essential infrastructure such as trees, hydrants, and street lights?
- How are placemaking elements provided and how might they vary to reflect unique community needs along a corridor?

Complete Streets attempts to address these challenges and represents a change from the past vehicle-focused roadway design philosophy.

The Complete Streets Design and Construction Standards provide context sensitive direction for the planning, design, and construction of streets for users of all modes. Over time, use of these standards will result in the creation of a mobility system that will accommodate the needs of all modes of travel in a safe, context sensitive manner. To accomplish this, some streets will prioritize certain modes over others. For example, a complete street in a shopping district may place priority on a person walking, cycling, and riding public transit, while a freeway will provide for high quality motor vehicle commuter traffic and goods movements. So, while each street in a network may not be designed to accommodate or prioritize every mode of transportation, the network of streets and off-street pathways will accommodate movements for users of all modes.

HOW TO USE THIS DOCUMENT

These Complete Streets Design and Construction Standards are comprised of three chapters as follows:

Chapter 1: Complete Streets Design Standards
contains higher level Complete Streets design philosophy and guidance. This Chapter draws upon existing content from Edmonton's original Complete Streets Guidelines and previous Design Standards and Construction Specifications, as well as the Transportation Association of Canada's (TAC) Geometric Design Guide for Canadian Roads (GDG) 2017. Chapter 1 is further broken down into three sections:

- ***Section 1.0:*** *Concepts and Philosophy for Complete Streets Design.*
- ***Section 2.0****: Design Process, Trade-offs and Evaluation.*
- ***Section 3.0:*** *Design Requirements for Complete Streets Design.*
    - Using Sections 1.0, 2.0, and 3.0, designers can produce context sensitive, functional, and sustainable street designs based on the design requirements for the street type based on its associated users.

Chapter 2: Construction Specifications contains detailed specifications that have been updated to align with best practices in construction methodology.

Chapter 3: Standard Drawings contains standard drawings that can be used in the design of streets in Edmonton including street cross sections, intersection elements, and other geometric design details.

SECTION 1.0: CONCEPTS AND PHILOSOPHY FOR COMPLETE STREETS DESIGN

1.0

Streets contribute to the quality of life in our city by providing choice in how people get around and providing essential public space for us to connect with one another. Streets are used by many different people in many ways and for many different reasons. Truck drivers use them to deliver goods, seniors to walk and get exercise, children to get to school and meet friends, families to drive for errands, workers to walk or ride their bicycles to work, and transit drivers to get their passengers where they need to go. In addition to connecting people to places, streets create public spaces for people to stop, linger, and enjoy the city. Streets also house essential infrastructure such as storm and sanitary sewers, water lines, gas service lines, and street lights.

1.1. DESIGN GOALS AND PRINCIPLES

The City of Edmonton (City) recognizes that a system of mobility networks serving multiple modes has the potential to increase the overall performance and efficiency of the mobility system and facilitate a shift from a primarily motor vehicle-focused system towards one that offers a wider range of viable transportation choices. ***The goal of the Complete Streets Design and Construction Standards (CSDCS) is to create a mobility system that is safe, welcoming, attractive, comfortable, and functional for all users in all seasons, and supports and enhances the unique characteristics of the neighbourhoods and districts they serve.***

A set of Principles have been developed for planning, designing, and operating streets in Edmonton to help shape the goals and objectives of any street design project, aid in the evaluation of possible designs, and reflect the direction of the City Plan. The Big City Moves of the City plan, and the related design principles are as follows:

A Community of Communities:

- A network of streets, transitways, and off-street pathways that together accommodate all users and allow for efficient and high quality travel experiences; and
- Streets are vibrant and attractive people places in all seasons to contribute to an improved quality of life.

Inclusive and Compassionate:

- The mobility system provides travel options for users of all ages and abilities that are safe, universally designed, context sensitive, and operable in all seasons (including winter); and
- Streets support Vision Zero by providing safe mobility for all users.

A Rebuildable City:

- Streets are adaptable by accommodating the needs of the present and future.

Greener as we Grow:

- Streets incorporate green infrastructure (such as trees, soil cells, and bioretention areas) and other design elements which contribute to the environmental sustainability and resiliency of the city.

Catalyze and Converge:

- Consider both direct and indirect total lifecycle costs, as well as the value of the public right of way and the adjacent land use; and
- Streets support the liveability and function of surrounding land uses.

Details on how implementation of these principles improves the completeness of streets is discussed in Appendix A.

1.2. STREETS AS BOTH LINK AND PLACE

Streets are a valuable public amenity, and take up significant space in Edmonton. Depending on the modal priority, a street might serve as a link for one or more modes including walking, cycling, transit, goods movement, or vehicle movement (see ***Section 1.9.2***) designed to move users between points quickly. As such, a street may feature one or more forms of transportation infrastructure including but not limited to vehicle lanes, transitways, cycling facilities, or walkways.

Concurrently, streets can function not just as a link between places, but as a social space which complements the surrounding areas where people live, work, and play. These streets can be designed to foster commercial activities and social interaction, allowing for a range of uses which are not confined to the surrounding properties. This approach can create a street character that transforms the street into a place and a destination in its own right.

Some streets in Edmonton may serve as both a link and a place. Because of the emphasis on creating space for social interaction and mixed use, these streets should be designed to discourage vehicle movement and instead prioritize more efficient and safer modes of transportation including walking, cycling, and transit. This allows the street to maintain its designation as a Link for one or more of these modes to move people efficiently while simultaneously permitting adaptive street use and minimizing potential conflicts between pedestrians and vehicles.

When one utilizes streets as both Links to get us around, and Places where we can spend time, this public space becomes more valuable to a city's residents and businesses. To reflect this value, the design philosophy adopted by the City of Edmonton is to use both Link and Place concepts in designing streets. The design and operational characteristics that support a street functioning as a link are often in tension with those characteristics that allow a street to function as a place. Trade-offs and prioritization between the different functions of a street are necessary to ensure that a street can successfully achieve its desired function. This philosophy, with visual representations of example streets, is shown in ***Figure 1.1*** on the following page.

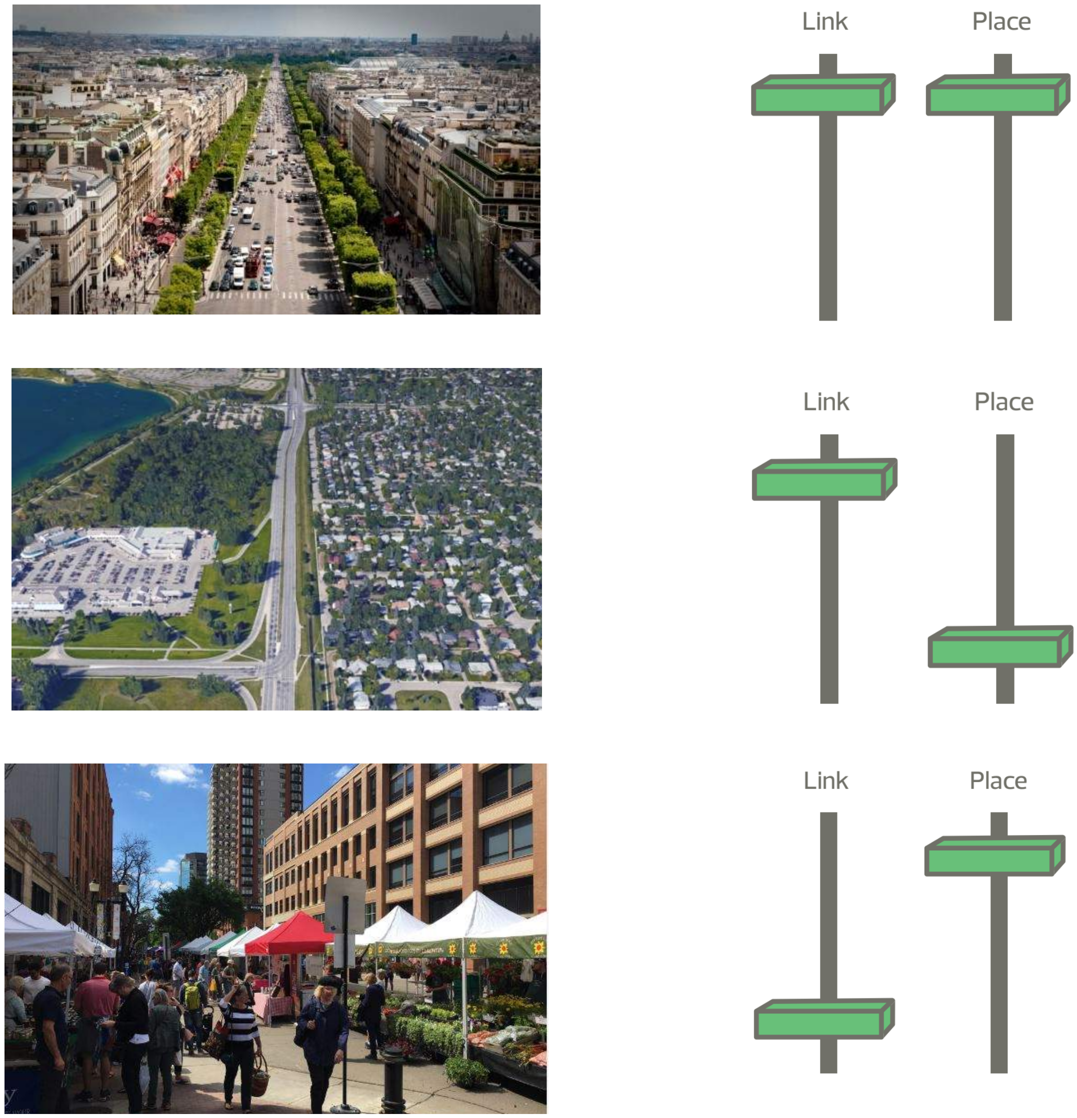


***Figure 1.1** Link & Place Concept*

1.3. DESIGNING WITH A SAFE SYSTEMS LENS

In general, the City of Edmonton has always strived to consider the safety of all users as the highest priority in the street design process. However, ongoing change to Edmonton's transportation system, including increased mode shift to public transportation and demand for multimodal options, has in recent years required a more holistic approach to designing and operating an increasingly complex transportation system. Furthermore, to increase safety, greater emphasis must be placed on a proactive and strategic process in the design and operation of Edmonton streets. To this end the City has adopted Vision Zero and the Safe Systems Approach.

In 2015, the City was the first Canadian city to officially adopt Vision Zero, a global initiative to eliminate fatalities and serious injuries from traffic collisions. In 2021, the City adopted the Safe Mobility Strategy, which identifies the key actions and pathways for implementing Vision Zero. A key component of this initiative is the adoption of the Safe Systems Approach. Central to this approach is a shared accountability between street users and those who design, maintain, and operate all parts of the transportation system.

The Safe Systems Approach views the transportation system holistically by addressing the interaction between the system users, the street and public realm/roadside, speed, and vehicles. The approach acknowledges that even responsible people sometimes make mistakes when travelling. This is a change from traditional approaches that tended to blame the user for causing a collision. Given that mistakes are inevitable, the approach recognizes the need to protect people from death or serious injury.

There is no such thing as "absolute safety", despite efforts to maintain, improve, and operate transportation facilities to the highest level that funding allows. There is risk in all transportation, regardless of the mode or combination of modes considered. That risk is inherent due to the variability of user behaviors, environmental conditions, and other factors over which no one has absolute control. Accordingly, the City recognizes that the transportation system should be designed such that "when collisions do happen, deaths can be avoided and injuries minimized."

The design approach adopted in Edmonton to address this inherent risk focuses on minimizing conflicts in time or space and minimizing the speed differential where conflicts remain. In doing so, the probability of death or serious injury, particularly for people walking, wheeling, and cycling, will be significantly reduced. This concept is illustrated in ***Figure 1.2***, which shows that below 50 km/h, the chance of a person walking surviving a collision rises significantly.

As part of the Safe Mobility Strategy, in August 2021 the City adopted a 40 km/h speed limit for residential streets, downtown, and high pedestrian areas which makes our streets safer, calmer, and quieter for everyone. Slowing down gives people more time to react to the unexpected to prevent crashes and reduce the severity of collisions that do happen. To achieve compliance with speed limits, physical features should be implemented as part of the design to ensure vehicles are slowing down. Some of these measures are discussed in ***Section 2.4***.

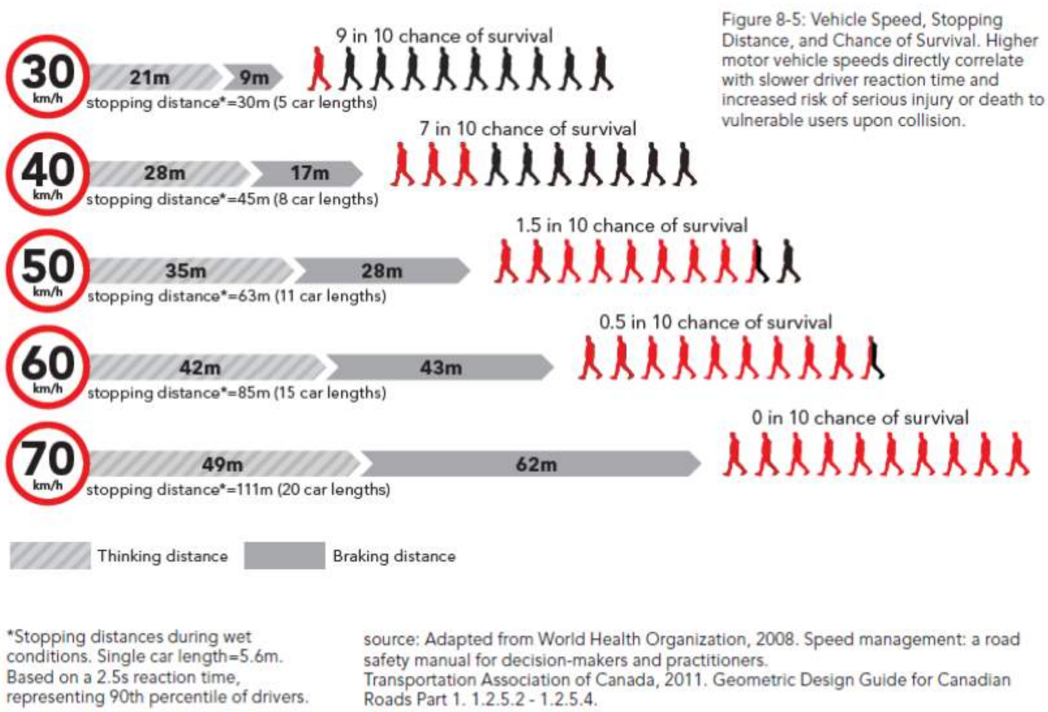


***Figure 1.2** Vehicle Speed, Stopping Distances, and Chance of Survival (Adapted from Figure 8.5, World Health Organization, 2008, Speed Management: a road and safety manual for decision-makers and practitioners*

Creating a Safe System that achieves Vision Zero and meets the Safe Mobility Strategy, requires one to:

- Design with Mistakes in Mind: Make the transportation system more accommodating of human error;
- Manage Force: Manage the forces that injure people in a collision to the level a human body can tolerate without serious injury;
- Consider Behaviour: Minimize the level of unsafe user behaviour; and
- Provide Equity: Make the transportation system safe for all travellers with consideration for local knowledge and identity.

The CSDCS supports the Accessibility Policy and Access Design Guide, Vision Zero, and Safe Mobility Strategy by providing design guidance that aligns with current best practice in designing streets for users of all ages and modes. This design guidance is adapted from the TAC GDG to reflect the needs of Edmonton's urban streets. The guidance is intended to result in streets that are self-explanatory and produce street user behaviour that is appropriate for the design/posted speed and human-scaled interactions.

Two examples of the type of adaptation that has been made is in design speed and lateral clearance (clear zone) from obstructions. The CSDCS requires design speed to equal posted speed for streets with posted speeds of 50 km/h or less. The CSDCS also require offsets to poles and trees that are much lower than in high speed environments (posted speed over 60 km/h) to reduce the width/scale of the street and encourage slower motor vehicle speeds while ensuring adequate sight lines are maintained at intersections, accesses, and mid-block crossings.

1.4. CONCEPT OF DESIGN DOMAIN

1.4.1.What is Design Domain?

The Design Domain concept was first introduced in the 1999 edition of the TAC GDG. While the concept is discussed in the following section, more information can be found in Chapter 1, Design Philosophy of the 2017 TAC GDG.

Design Domain can be thought of as a range of values that a design element, such as sidewalk width, lane width, design speed, or road curvature, might take. This range has a relationship with the fitness-for-purpose of the design element, as shown in ***Figure 1.3***. For example, utilizing values in the lower regions of the domain for a single design element may result in designs which may be less efficient or less safe although perhaps less costly to construct. Utilizing values in the upper regions of the domain may result in designs which may be considered to be safer in some aspects and more efficient in operation, but may cost more and may be less safe in other aspects. While all values within the range of Design Domain are acceptable, some may be better than others for a given situation. In all cases, care must be taken when selecting multiple lower bound values for elements along a corridor to ensure there are no compounding negative impacts.

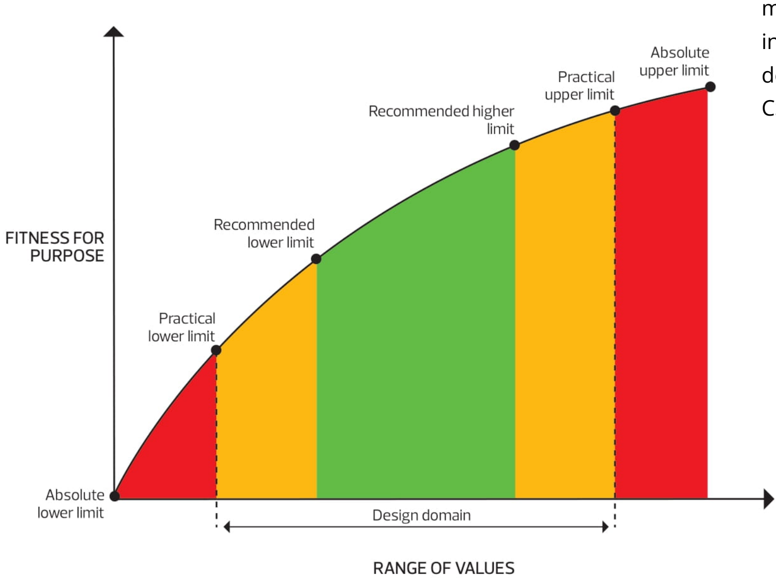


Figure 1.3 *The Design Domain Concept*[1]

[1] *TAC GDG Figure 1.4.1.s. 2017.*

The Design Domain concept provides several benefits to the designer including:

- It is more directly related to the true nature of the street design function and process, since it places a greater emphasis on developing appropriate and cost effective designs rather than those that simply meet guidelines or targets; and
- It directly reflects the continuous nature of the relationship between service, cost, and safety with changes in the values of design dimensions. It reinforces the need to consider the impacts of trade-offs throughout the Domain and not just when the threshold is crossed.

Wherever possible, data or information that provides estimates of changes in the quality of mobility, cost, or safety resulting from changes in the design, should be used to evaluate the impact of design decisions. Aesthetics, sustainability, and alignment with planning documents and land use context should also be considered. In keeping with Edmonton's multimodal approach to transportation, such evaluations should be carried out for all modes that the facility is designed to accommodate including walking, cycling, public transit, and motorized vehicles for personal mobility and goods movement. Where no such data or information is available, guidance is provided to the designer on the safety impacts of changes to criteria in the CSDCS as well as the TAC GDG.

1.4.2. Applying the Design Domain Concept

Applying the concept of Design Domain in practice may present challenges. While Design Domain is often presented as a continuous range of values bounded by an upper and lower limit, in some cases, it may only be relevant to consider a series of discrete values for the dimension in question. Lane widths, which typically are varied in increments of 0.1 m, provide a good example of such a case. In other instances, there may be no upper limit to a Design Domain other than practicality or economics (e.g. land costs for right of way). In these cases, the upper boundary of the Design Domain generally reflects typical upper level values found in practice, or the general threshold of cost-effective Design.

The designer must respect controls and constraints to a greater or lesser degree depending on their nature and significance. Some design requirements are inflexible, such as vertical clearance at structures, while others are less rigid. Often, the designer is faced with the dilemma of being unable to choose design dimensions that will satisfy all controls and constraints, with a trade-off being required. These are engineering decisions that call for experience, insight, and a good appreciation of community values.

Design requirements can be directed based on safety, service, capacity, comfort, and even aesthetic values. The designer must have a good understanding of their origin and purpose, and apply them with regard for community priorities. If a range of dimensions is given, the designer must select the appropriate value. In some cases, it may be necessary for the designer to choose values that fall outside the specified boundaries of the Design Domain for a given design element. Such cases are extraordinary and can have substantial impacts on various aspects of facility performance, including the safety of street users. Only in exceptional circumstances, where appropriate justification is provided, shall a variance below the minimum or above the maximum standard be accepted by the City. The Design Exception Process described in ***Section 2.2*** outlines how a variance can be obtained.

The consequences of reducing a value for a design requirement should be understood, particularly regarding safety performance and impacts, but also in terms of other costs and benefits. Mitigating measures, which could include a broad range of potential actions, need to be considered along with the geometric design. If a design involves trade-offs, it may be more appropriate to adjust several elements a small amount than to compromise one element excessively.

The Design Domain for Edmonton is based on the Recommended Range from the TAC GDG with adjustments made for local context.

1.5. DESIGNING WITH A UNIVERSAL LENS

Universal Design is an approach to design that increases the potential for developing a better quality of life for a wider range of individuals. The design process creates an environment that is usable to as many people as possible regardless of age, ability, or situation as summarized in ***Figure 1.4.***

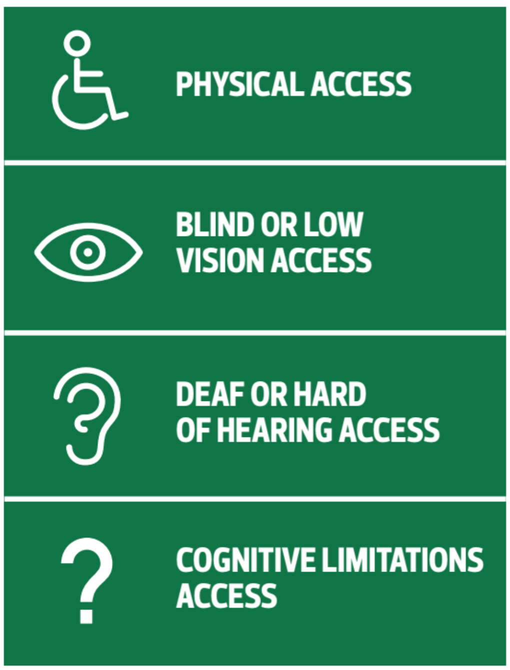


Figure 1.4 *Designing for All Users (Source: City of Edmonton Access Design Guide)*

Social inclusion underscores Universal Design, which addresses the barriers faced by people with disabilities, older people, children, and other populations that in the past may have been overlooked in the design process. In doing so, streets are designed for the movement of all people at various stages of life and regardless of ability.

Figure 1.5 summarizes the principles of Universal Design the designer should typically consider to support the broadest set of design users applicable to the context. For the purposes of this document, we ***define people walking*** to include the following:

- people running;
- people standing;
- people using manual/motorized wheelchairs or scooters;
- people using canes or walkers;
- people pushing strollers or carts;
- people pushing bicycles; and
- users of various other low-speed forms of human locomotion (e.g., skateboards).

Accordingly, wherever CSDCS refers to people walking or people walking and wheeling, it includes the aforementioned modes of travel.

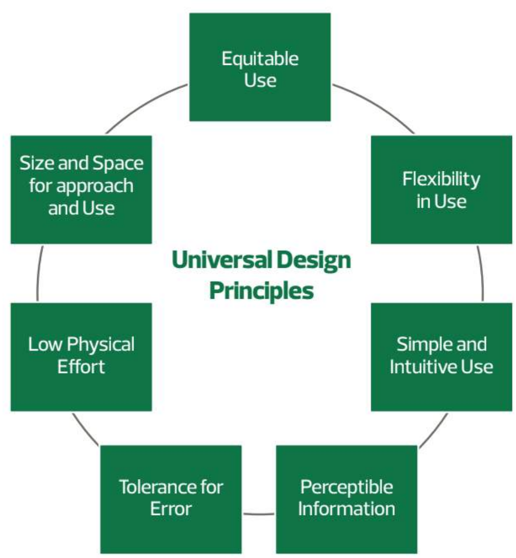


Figure 1.5 *Universal Design Principles (Source: Adapted from Center for Universal Design, 1997)*

1.6. DESIGNING WITH A WINTER LENS

Edmonton is a northern, winter city and the impact of winter needs to be considered in the design process. Experience shows that when a street is designed with winter in mind, it will be comfortable in all seasons.

Designing with a winter lens is not only designing from a winter perspective, but including this perspective at the beginning of the design process.

As outlined in the City of Edmonton's Winter Design Guidelines (WDG), there are five main principles that apply to designing for winter:

- Design and provide infrastructure that supports desired winter life and improves comfort in cold weather;
- Create visual interest with light;
- Incorporate design strategies to block wind;
- Maximize exposure to sunshine; and
- Use colour to enliven the winterscape.

A typical winter city cross section is illustrated in ***Figure 1.6.***

Winter city design also means designing facilities with consideration to the maintenance and operations that occur due to the impacts of snow accumulation and snow clearing to provide for efficient services. Winter city design should also consider planting survivability, including selection of plant species that are climate appropriate and salt tolerant, along with placement of plantings to reduce impacts of road salt.

For street design, the WDG impacts decisions around the design of:

- Sidewalks and Boulevards (Section 2.2.1 WDG);
- Street Crossings (Section 2.2.2 WDG);
- Bus Stops (Section 2.2.7 WDG); and
- Bicycle Routes and Storage (Section 2.2.9 WDG).

Other recommendations include guidance on street lighting, street furnishings, public art, wayfinding, light rail stops, bridges, and parking considerations.

Figure 1.6 *A Typical Winter City Streetscape (Source: City of Edmonton Winter Design Guidelines)*

1.7. DESIGNING WITH A RETROFIT LENS

The design of retrofit street infrastructure poses many challenges which are not encountered in growth or greenfield projects. In retrofit situations especially, designs must consider the location of existing buildings, mature trees, utility infrastructure, private landscaping within public right of way, and numerous other constraints, within an existing right of way. These constraints must be addressed while striving to balance the needs of all street users and incorporating input through public engagement. Strategic compromises and trade-offs through use of the Design Domain concept may need to be made by the designer to balance costs, technical feasibility, and other constraints.

There may be instances in retrofit situations where it is not feasible or possible to completely align with the requirements of these standards. In these instances, the designer should clearly identify where there is variation from the standards, and document the rationale for the deviation in a Design Exception. Documentation of the variation can be done at a neighbourhood level if the same variance is required throughout. For example, if lane or sidewalk widths must be varied due to tree and right of way conflicts on more than one street, the design exception can identify the area or range of streets to which the rationale applies for those with the same conditions and context.

Designs of new or renewed roadway infrastructure should consider future renewal requirements and recyclability of materials. This includes selecting pavement structures that meet the required service life, selecting materials that can be recycled in place or processed offsite for re-use, designating multi-party utility alignments and utility easements within and adjacent to the right of way to facilitate future utility and roadway infrastructure renewal, and providing sufficient right of way to allow for future reallocation of space as neighbourhoods grow and evolve.

1.8. DESIGNING WITH A CLIMATE RESILIENCE LENS

In 2016, the City of Edmonton completed an Edmonton-specific climate risk and vulnerability assessment and identified potential risks and opportunities these changes could present. The City's approach to managing these risks and opportunities are outlined in the Climate Resilient Edmonton: Adaptation Strategy and Action Plan. Combined with the Community Energy Transition Strategy and Greener as we Grow, these documents guide how infrastructure can be made more resilient and assist in reducing Greenhouse Gas (GHG) emissions.

As outlined in Climate Resilient Edmonton, given the long life span of transportation infrastructure assets, they are likely to be exposed to future climate conditions such as increasing temperatures and precipitation. The design of infrastructure systems therefore needs to take into account current and future climate conditions, vulnerabilities, risks, and opportunities, and use an evidence based decision making approach to increase the resilience of new and existing infrastructure. Furthermore, The City's asset level climate resilient assessments should be used to support design choices, as recommended in the Paved Roads Asset Management Plan.

For street design, this impacts decisions around:

- Incorporating elements into the cross section that reduce the impacts of the urban heat island effect and provide cooling amenities, including shade trees, street trees, shrubs, and perennial plantings, and specifying roadway materials that are resilient to increasing temperatures;
- Designing resilience to urban flooding events as part of transportation projects, including the use of innovative stormwater management systems, dry ponds, and Low Impact Development (LID); and
- Maintaining healthy ecosystems through ecological planning along transportation corridors.

As outlined in the Community Energy Transition Strategy, transportation accounts for 31% of Edmonton's total GHG emissions, and offers the greatest opportunity for reductions.

For street design, reductions in GHG emissions impacts decisions surrounding:

- Reallocation of space through road diets, closures, or initial designs, to non vehicle uses to promote multi-modal choices;
- Support zero emission vehicles via designated driving lanes, priority parking, or other measures;
- Identification of alternatives to existing mobility systems which are increasingly bottlenecked and increase GHG emissions;
- Addition of missing sidewalk and cycling connections and infrastructure to complete the active transportation network;
- Identify locations for potential build out of the zero emission charging network, as per the City's EV location guidelines;
- Use of low carbon materials where feasible; and,
- Quantify emissions reduction of new roadways and road widenings through multi-modal analysis, towards the City's carbon budget and GHG targets.

Low Impact Development (LID)

Resilience to future urban flooding events is an important consideration when designing street infrastructure, particularly in denser developments which lack proximity to large stormwater ponds or natural drainage features.

The use of Low Impact Development (LID) is a method of stormwater management which collects runoff from impermeable surfaces such as concrete and asphalt and temporarily stores it within a specially designed landscaping feature, often adjacent to the roadway. Examples of these features include bioretention basins, soil cells, box planters, pocket ponds, underground capture, or permeable or porous surfaces, among others.

The purpose of LID is to use natural features and processes to prevent runoff, slow runoff down, and capture and treat runoff as close to its source as possible.

Designs of new or renewed roadway infrastructure should consider the use of LID to offer greater flood resilience along transportation corridors and less land requirements in comparison to large stormwater ponds or complex retention systems. Additionally, LID acts as an additional opportunity to introduce ecological features along roadways by adding additional planting and supporting street beautification.

Additional guidance on the design of LID infrastructure can be found in Volume 3 of the City of Edmonton Design Standards.

1.9. STREET TYPES AND MODAL PRIORITY

1.9.1.Street Types

Street type is defined by the:

- Relationship of buildings to the street;
- Land use context; and
- Functional classification of the street.

The result is a three-dimensional matrix of potential street types (e.g., a street oriented residential collector), which should be further evaluated with how the adjacent land uses and buildings may change over time. The following sections summarize the factors that contribute to defining street type.

Relationship of the Building to the Street

Street Oriented:

Characterized by buildings that are built to minimum setbacks with building entrances directly on the street, prioritizing walking and wheeling activity over driving activity. Vehicular access is typically from side streets or alleys to create an uninterrupted Pedestrian Through Zone.

Non-Street Oriented:

Characterized by greater building setbacks from the street and building entrances that face areas internal to their sites (most often surface parking lots).

Land Use Context

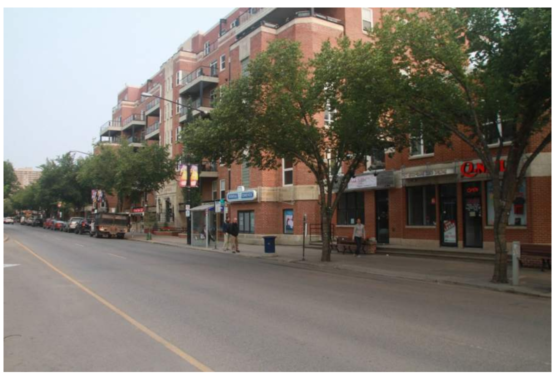
Residential:

Areas whose predominant character is defined as places where people live.

Community Destinations & Open Spaces:

Areas that are major activity generators that are visited by residents on a regular basis, like high schools, district parks, recreation centres, hospitals, universities and colleges, and other major public and institutional uses that drive their own distinct transportation behaviour.

Commercial/Mixed Use:



Areas with commercial uses and places of employment ranging from retail areas, downtown office towers, and shopping malls. Mixed use is achieved by co-locating these commercial and employment uses with residential, creating transportation behaviour that is different from exclusively residential areas. The nodes and corridors network, as designated in The City Plan, are anticipated to continue transitioning towards commercial/mixed use land uses, areas of focused density, and activity centres with both residential and employment opportunities.

Industrial:

Areas comprising Business Employment Zones (light industrial and small commercial businesses), Medium Industrial Zones (light and medium industrial development) and Heavy Industrial Zones (Heavy Industrial). Transportation behaviour is unique from other employment areas due to truck access requirements and the variety of uses. For instance, in some historically industrial areas, redevelopment and land use changes may result in a transition towards more commercial/mixed use land uses, requiring a consideration of transportation behaviour that is different from exclusively industrial areas.

Functional Classification

Information on design speeds for different street classifications, including design ranges and target values, is included in ***Table 3.4*** in ***Section 3.2.1.1***.

Highways and Freeways: defined and identified in the City Plan and District Plans, these streets are grade-separated high speed roadways with free-flow movement, providing regional and national connections. Typical volumes can often exceed 100,000 vehicles per day.

Expressway: defined and identified in the City Plan and District Policy and Plans (combined with Provincial Highways and Freeways), these streets are high capacity, relatively high-speed roadways with limited access points, and accommodation of transit and active modes mixed within the corridor. Expressway volumes may exceed 60,000 vehicles per day.

Principal Roadway: defined and identified in the City Plan, these streets provide cross–town auto and goods movement on a higher standard facility with strategic grade separations, often providing a link between highway and freeways and typically classified as Arterials in the Transportation Systems Bylaw. Some principal roadways form part of the nodes and corridors network and require special design and planning considerations. Typical volumes are similar to those of arterials.

Arterial: identified in the Transportation System Bylaw and District Policy and Plans, these streets have historically carried larger volumes of traffic (people driving as well as those riding transit, walking and wheeling, cycling, and delivering goods) between areas with relatively few and controlled access points. Many Arterial roadways form part of the nodes and corridors network and require special design and planning considerations, and may require trade-offs between the function of the roadway as a link and as a place to support current or planned land uses. Typical two lane arterials can carry volumes of up to 16,000 vehicles per day, while typical four lane arterials can carry volumes of up to 40,000 vehicles per day.

Collector: typically defined in District Policy and Plans or Neighbourhood Structure Plans, these streets provide neighbourhood travel between local roads and arterial streets with direct access to adjacent land. Public transit buses generally operate on collector streets within neighbourhoods. Some collector roadways form part of the nodes and corridors network and require special design and planning considerations. Typical two lane collectors carry volumes of up to 5,000 to 10,000 vehicles per day with appropriate access control.

Enhanced Local: these streets share variable design aspects of both local and collector streets, without accommodating transit, with formal design classification depending on the intended use. Some enhanced locals can carry volumes of up to 3,000 vehicles per day, others may include shared pathways to provide network connectivity, and may include street segments. The use of enhanced locals is context sensitive.

Local: provide direct access to adjacent lands and serve neighbourhood travel and include service roads. Typical locals carry volumes of up to 2,000 vehicles per day.

Alley: provide direct access to adjacent lands typically parallel to other classification of streets and are typically used for access, deliveries, and waste collection. In areas with supportive land uses, some alleys are evolving into shared alleys, with alley oriented development. Types of alleys can include residential alleys, commercial alleys, shared alleys and reverse alleys.

Shared Street/Alley: significantly limit motor vehicle traffic, and limit drivers to speeds that are no faster than a person can walk. Design elements like pavement material, entry features, greenery, and lighting define the space and make it clear that shared streets/alleys are primarily designed for people walking, wheeling, and cycling. Delineated pedestrian-only through zones are desired for shared streets, but are not required for shared alleys due to space constraints. Therefore, shared alleys require additional consideration of snow clearing operations and timelines to ensure that they are accessible for all users in the winter. Furthermore, shared alleys can be designed to support alley-oriented development.

Car Free Street: either prohibits motor vehicles and transit from using the street at all times, or at specific times. The street is designed primarily to support people walking and wheeling, but may also support people cycling.

Local Street Bikeway: employ design interventions such as traffic calming and diversion to reduce vehicle speeds and volumes and communicate the priority of people cycling within the travelled way. Unlike shared streets, local street bikeways still contain designated pedestrian spaces (sidewalks) separated from the motor vehicle and cycling space.

Bike Facility Classification

Cycling routes may share the same right of way space within or adjacent to roadways which accommodate vehicle traffic and are classified as above. However, designated bike corridors include their own functional classification as identified in the Edmonton Bike Plan.

District Connector: routes that serve as cycling arteries extending across multiple neighbourhoods, connecting districts. District connector routes generally prioritize directness. The type of infrastructure provided may vary, but because they are often located along corridors with higher vehicle volume and speeds, district connector routes are often separated from vehicle traffic (i.e., protected bike lanes or shared pathways). District connectors also provide access to major city-wide and regional destinations.

Neighbourhood Routes: provide local access, opportunities for recreational cycling and connections to destinations outside of the district connector network. These routes will be focused on local connections and are best planned and designed at a local neighbourhood level. Unlike district connector routes, neighbourhood routes may not be continuous across multiple neighbourhoods. The infrastructure for neighbourhood routes will vary depending on the local context.

1.9.2.Modal Priority

Modal Priority is a term that refers to the hierarchy of transportation modes (such as walking and wheeling, cycling, transit, driving, and goods movement) that a street is designed for depending on the street type. For example, a street prioritizing people walking and rolling would mean that the level of service of the street will be focused on maximizing the operation for people walking and wheeling, but still accommodating the flow of other modes of travel. Conversely, a major arterial street in an industrial area may focus on moving goods and motorized vehicles, while still accommodating the other modes.

The modal priority triangle in ***Figure 1.7.*** illustrates one potential example of the modal priority for a walking and wheeling priority street.

Within a corridor, the highest priority mode (see ***Section 1.9.2.1***) will take precedence in the design process and any trade-off assessment, while lower priority modes will be the first to be reviewed for potential trade-offs. Regardless, the Design Domain concept should be utilized to ensure minimum design requirements are met for all modes needing to be accommodated. Where this cannot occur, the designer may have to look to other adjacent routes in the network to properly provide for the requirements for lower priority modes. This may be an iterative process requiring an understanding of the trade-offs required for each mode, and resulting impacts on all mobility networks. For modes of travel not ranked as high priority on design corridors, there may still need to be a minimum level of accommodation that is safe and provides basic access. With respect to space within the streets that are provided for these modes of travel, the lower recommended range of the Design Domain tables can serve as a guide. In exceptional instances, values below the recommended range may have to be utilized and will require a Design Exception following the process outlined in ***Section 2.2***.

For all street types, access for emergency services vehicles is an essential consideration in the street design. All street types must be designed to accommodate emergency service vehicles when the route has been identified for primary access or staging.

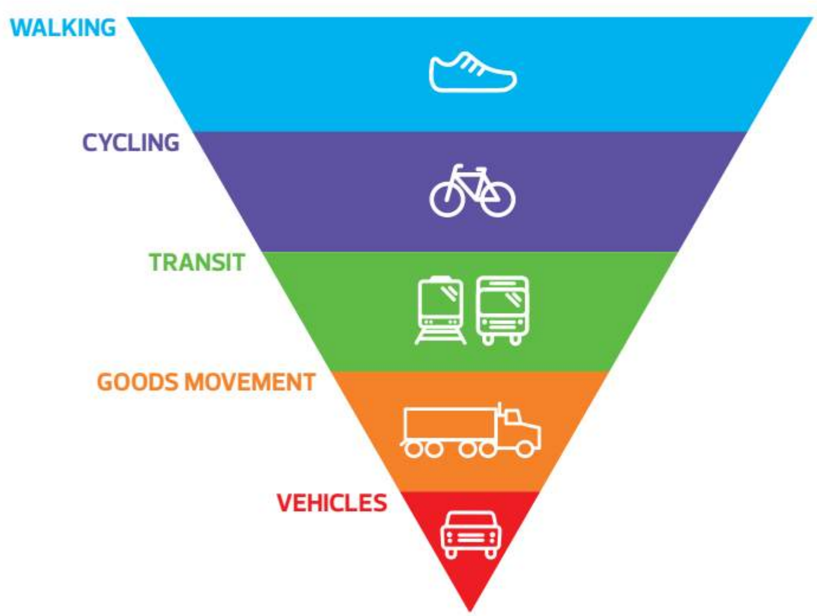


Figure 1.7 *Example modal priority triangle for a walking and wheeling priority street*

1.9.2.1. Establishing Modal Priority

Initial modal priority may be established through the direction of The City Plan, District Policy and Plans, and defined networks such as the Active Transportation network, Goods Movement (Edmonton Truck/Dangerous Goods Routes map), Mass Transit Network, Nodes and Corridors, and identified Pedestrian Priority Areas. Refinement of modal priority can also occur throughout later planning stages such as the development of Area Structure Plans (ASP's) and Neighbourhood Structure Plans (NSP's), Rezoning, Subdivision, and other planning documents or tools where a specific modal priority has been identified and approved by City Council. In some cases, multiple networks may overlap, requiring a more contextual understanding of the trade-offs and opportunities associated with balancing and prioritizing different travel modes.

Modal priority will influence the characteristics of the street in terms of cross section elements. For instance, a street with pedestrian priority may feature wider sidewalks and boulevard trees to slow down motor vehicle traffic and provide a buffer for pedestrians, while those along active transportation or mass transit routes may feature dedicated cycling or transit lanes, respectively.

Some existing direction has been identified below to aid in determining what travel modes should be considered higher priority and how these priorities can be reflected in the design features of the corridor.

Walking and Wheeling Priority

- Pedestrian Priority Areas as defined and identified in District Policy and Plans
- The Quarters Overlay
- Business Improvement Areas (BIAs)

Pedestrian Priority Areas are defined in District Policy as areas where the comfort and convenience of pedestrians should be prioritized over maximizing the movement of vehicles and transit. These areas will feature pedestrian-oriented urban design upgrades to crosswalks, street furniture, and wayfinding and lighting within the public realm.

Streets which prioritize people walking and wheeling should ensure a comfortable and safe space to travel, rest opportunities, and human-scale design elements (such as pedestrian scale lighting). Lower design speeds (to minimize speed differential between people walking and wheeling and motor vehicle traffic) and protection from weather also aid in establishing a high priority walking and wheeling corridor.

Cycling Priority

- Ongoing bicycle network planning in existing and future neighbourhoods
- Edmonton Bike Plan
- Edmonton Bike Area Network Plans
- Neighbourhood Structure Plans
- Existing Cycling Corridors

Bicycle facilities should prioritize health and comfort, connectivity, directness, attractiveness, and neighbourhood integration. People riding bikes desire a high degree of connectivity and a system that functions well for people of all skill levels, with minimal detour or delay. People cycling benefit from feeling safe and comfortable, particularly with respect to interactions with vehicular traffic. Bicycle routes that reduce and/or eliminate conflicts with people walking and people driving, can be maintained in all seasons, support social (side-by-side) riding, and consider design for higher cycling speeds form the basis of a high priority cycling corridor. Intersection design along these corridors is also critical to the function, comfort, and safety of these corridors for people who cycle.

Transit Priority

- Existing and future transit network
- Mass Transit Network Plans

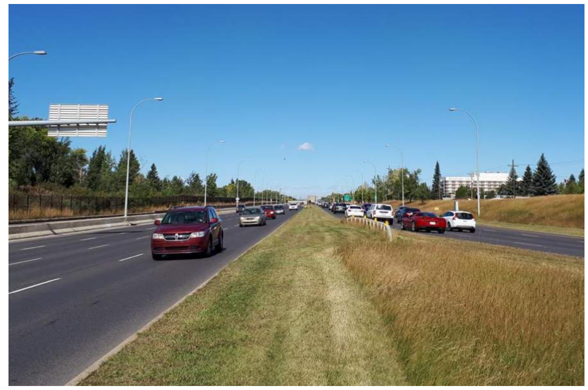
Transit corridors, including Light Rail Transit (LRT), future Bus Rapid Transit (BRT) and District Routes identified in The City Plan, and high volume transit routes promote economic development around high-quality transit service, while fostering a design scale in which walking, wheeling, and cycling actively complement public transit. As major generators of walking trips, high volume transit routes should be prioritized for walking / rolling safety improvements in both the immediate surrounding area and major access routes within a short walk of transit service. When redesigning streets to be high priority transit corridors, designers should assess how transit service is impacted not only by the geometry of the corridor, but also its existing signal timing, signal phasing, turning movements, and other operations that may jeopardize the quality and reliability of service.

Goods Movement Priority

- Edmonton Truck/Dangerous Goods Route Map
- Roadway and Goods Movement Network (as identified in the City Plan)

All truck routes should be designed to permit the safe and effective operation of trucks. To avoid competing demands on the same routes, designation of freight routes should be considered in coordination with mapping of primary walking and wheeling, cycling, and transit corridors, as well as analysis of key access routes, bridge hazards, and industrial or commercial land uses. Design vehicles for goods movement corridors are discussed in ***Section 3.1.3.3***. Considerations for accommodating goods corridors includes vertical clearance, adequate lane width, access, and corner radii.

Car Commuting Priority



People driving want to get to their destinations in a reliable and safe way with limited friction, interruption, or delay. Designs with these goals in mind tend towards limited-access, higher speed roads with limited chance of conflict or surprise. Due to their high speeds and vehicle mass, drivers feel safest when buffered from other moving vehicles, buses, trucks, and people walking, wheeling, and cycling. Adequate lighting and signage should be provided along these corridors to ensure drivers make safe and timely decisions.

SECTION 2.0: DESIGN PROCESS, TRADE-OFFS AND EVALUATION

2.0

This Section outlines the design process, including evaluation of design options and trade-off decision making.

2.1. DESIGNING STREETS: DESIGN ZONES AND DESIGN PROCESS

2.1.1.Design Zones

In Edmonton, right of way is publicly accessible land that accommodates and allows the movement of people between spaces. Typically, right of way consists of a series of zones that accommodate vehicle travel lanes (travelled way), paths for people and active transportation modes, trees, utilities, and other public realm functions. Not all streets will have all zones. The zones are illustrated in ***Figure 2.1A*** and ***Figure 2.1B*** and described on the following pages. Further information on managing zones can be found in the City of Edmonton's Curbside Management Strategy.

Figure 2.1A *Design Zones - Local Residential Street Context*

Figure 2.1B *Design Zones - Urban Commercial/Mixed Use Corridor Context*

Adjacent Land Uses: This space is the location of land uses that abut the street right of way.

Frontage Zone: Along Commercial and/or Mixed Use Corridors within an urban context, including pedestrian priority areas, the space adjacent to buildings and private property can be used as a support and/or extension of the land uses along the street. Uses can include ground floor retail displays, café seating, temporary signage, queuing areas, and other activities to support active use of the street by people and businesses. In the Local or Residential context, the Frontage Zone is typically the private front yard space.

Pedestrian Through Zone: This space provides an area for active transportation mobility for people of all ages and abilities to access the land uses along the street. Typically reserved for people walking and wheeling, in some cases this area can be shared with people cycling (shared pathways).

Furnishing Zone: Also sometimes called the “boulevard”, this space provides an area for signs, street light poles, street trees or landscaping, transit stops, benches, and seating for patios associated with adjacent businesses, in addition to underground and surface utilities and concrete curb. This is also the preferred location for snow storage and can be utilized for low impact development or overland drainage.

Curbside Zone: Located between the Travelled Way and the Furnishing Zone, this space provides the opportunity for various permanent and temporary street uses depending on the context and characteristics of the street. This space is typically considered “on-street”, but is not designed for through traffic. The use of this flexible space can vary along an individual block and between blocks. Uses can include vehicle parking, parklets, patios (public or associated with an adjacent business), bicycle parking, loading zones, universally designed parking, curb extensions, transit stops, and taxi stands. This space also includes the concrete gutter and, depending on the street design, may be used for snow storage. In cases where protected bike lanes are provided (i.e., part of the Travelled Way), the Curbside Zone may be located between two parts of the Travelled Way.

Travelled Way: This space provides an area for travelling through a street or to access land uses along a street for people travelling by motor vehicle, bicycle, and transit, and for the delivery of goods. The space can include exclusive or shared/general purpose lanes for transit, people cycling, motorized vehicles for people and goods movement, and may also include centre medians or islands, concrete gutters, refuge areas for people walking, and turning lanes. In non-peak hours, some of the Travelled Way may be used as an area for parking and loading and, in some cases, can also be closed at times to motor vehicle traffic to host events and festivals. The Travelled Way also includes space for people walking, wheeling, and cycling across the travel lanes, as well as deep utilities, including water, sanitary sewer and storm sewer lines.

Alleys: Not depicted in ***Figure 2.1***, Alleys provide a through zone for access to the Adjacent Land Uses for deliveries and parking, and can be a location for utilities. They can also provide opportunities for public art, walking, wheeling, and cycling connections, and place making.

2.1.2 Design Process

Designing streets should follow the process outlined in ***Figure 2.2***. Typically, since they are generally less constrained, the process for new streets will be less involved in terms of evaluating trade-offs than the retrofit of existing streets.

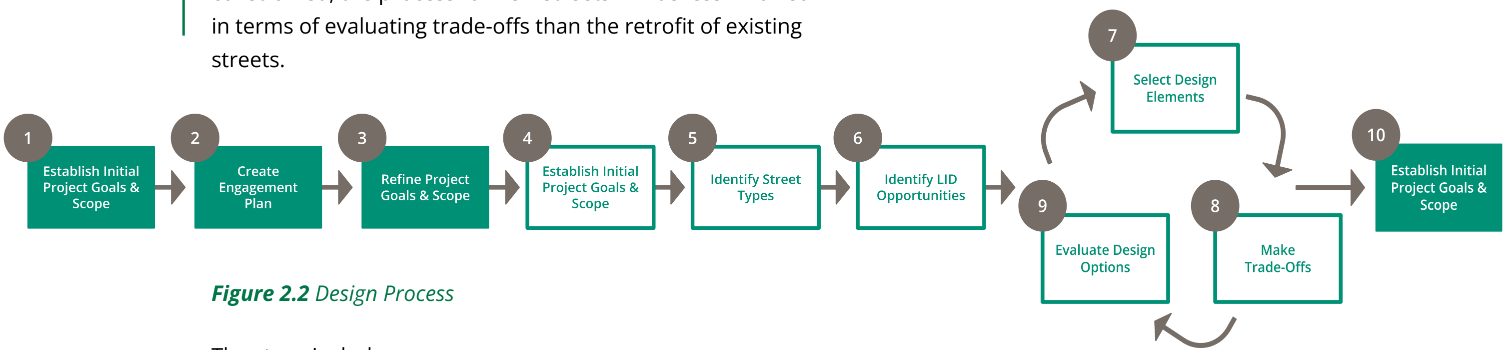


Figure 2.2 *Design Process*

The steps include:

1. Establish Initial Project Goals: Goals for the project initially established to align with the Design Principles and with the City's Strategic Goals described in The City Plan and Edmonton Community Energy Transition Strategy, and the goals outlined in higher order planning documents such as relevant District Plans, the Safe Mobility Strategy, relevant design documents, land use plans and policies, and mobility policies. Defining the scope for the project should consider both the street and adjacent lands both today and in the future.

2. Create Engagement Plan: Stakeholder and public participation occurs throughout the Design Process according to the City's 'Public Engagement Policy' C593 for each stage of the project. There is typically a greater level of engagement for projects in developed areas, including for renewal, reconstruction, and growth projects. The engagement plan will outline the activities that will be used for each of the subsequent steps in the Design Process.

3. Refine Project Goals and Scope: Goals for the project are refined from the initial project goals established at the scoping phase of the project to support creation of the project's Engagement Plan. Input from public and stakeholders is used to refine the project goals and scope of the project, incorporating local knowledge of the area and the issues and opportunities that may not have been known during initial project scoping.

4. Identify Street Type: Based on ***Section 1.9.1***, a street will be defined based on the relationship of the buildings to the street, land use context, and functional classification. These three factors are combined to form a composite street type (e.g., street oriented residential collector).

5. Identify LID Opportunities: Based on drainage patterns, project goals, and stormwater management requirements, identify where the street has potential for integrating LID into the cross section.

6. Identify the Modal Priorities: In this step, the modal priorities for a street will be determined by ranking the priority for walking and wheeling, cycling, transit, driving, and delivering goods/services. This ranking is based on the street's typology, the information in ***Section 1.9.2***, and information from the City's strategic plans, Winter Design Guidelines, concept plans, high level planning documents, and land use documents, as well as priorities expressed through engagement and the street's greater role in the overall network. Where required, emergency access must be accommodated regardless of the modal priorities of a corridor.

7. Select Street Design Elements: Section 3.0 provides information on the street design elements and the range of design values that can be used to create street cross sections and intersection designs for the identified street type, modal priorities and the results of the engagement process. Street design elements and their associated dimension will be dependent on the project's goals/scope, street type, and modal priority, and should consider access and maintenance for surface and subsurface utilities. For new neighbourhoods and in some retrofit situations, a designer may choose to select a standard drawing detail from Chapter 3.0. In so doing, the designer may still choose or need to alter the standard drawing based on the standards and guidance provided in Chapter 1.0, ***Section 3.0***. Design elements may also be required where a new street needs to tie-in or transition to an existing street design. Design elements should consider the placement and location of utilities to ensure current and planned infrastructure can be accommodated.

8. Make Trade-offs: Trade-off considerations (i.e., prioritizing competing demands for street space within limited right of way) should occur explicitly throughout the process. Considerations need to include modal priority and determination of appropriate street design elements and corresponding design values as well as impacts on winter operations. The operational impacts to all mobility networks should also be considered when making trade-offs to ensure consistency along a corridor and to understand any anticipated impacts on the adjacent mobility system. The process to evaluate trade-offs is outlined in ***Section 2.2***.

9. Evaluate Design Option(s): Evaluation of design options will be completed using the evaluation guidance outlined in ***Section 2.3***. The evaluation process is iterative and loops back to make trade-offs as options are created, evaluated, and revised to address deficiencies in the design.

10. Confirm Recommended Design: As a final step, the designer should re-examine whether the project design meets the goals and objectives established at the beginning of the Design Process and if the intent of the Design Principles as outlined in ***Section 1.1*** has been achieved. Through discussion with stakeholders, consideration of trade-offs and possible further design changes, stakeholders will then reach agreement that the recommended design meets the established goals and objectives, and the detailed design can proceed.

2.2. TRADE-OFFS AND DESIGN EXCEPTION PROCESS

Modes identified as high priority must be accommodated and should be designed using the values in the higher end of the recommended range of the Design Domain, whenever possible. Lower priority modes should be provided at least basic access using design values at the lower end of the recommended range of the Design Domain.

Trade-offs may be required in constrained situations (e.g., limited right of way, utility requirements, and street trees) when determining how to fit multiple modes into the cross section. These trade-offs could, depending on context and project type, include consideration of the following:

- Reduce the design speed
- Remove the parking lane on one or both sides of the street
- Remove medians and turning lanes
- Remove motor vehicle lanes
- In exceptional circumstances, place the sidewalk facility next to the curb, and remove or reduce the Furnishing Zone (if traffic volumes, speeds, and winter operations allow this to be suitable).
- Acquire additional right of way
- Remove trees
- Relocate utilities
- Add shared pathways instead of separate sidewalks and bike lanes
- Convert to one-way traffic where applicable

Where constraints dictate that a mode cannot be accommodated on a street within the recommended Design Domain values, the broader network should be reviewed to determine if a mode can be accommodated on a parallel street.

Designers will need to justify the use of values outside the recommended Design Domain values through development of a Design Exception.

According to the TAC GDG, "[a] Design Exception is a case where one or more design elements for one or more modes of transportation falls outside normal boundaries of the Design Domain for that design element. It is an extraordinary situation and one where the design needs to be tailored to its context through sound professional judgement. Design Exceptions can be initiated at any stage of a project; how they are addressed needs to reflect the range of relevant legal, policy, and organizational practices."

A Design Exception may be required to provide a design that is implementable (e.g., constrained right of way locations) or may be required to provide a non-traditional or alternative design that will result in significantly improved performance while providing significantly improved total lifecycle cost. Examples for when Design Exceptions may be required include the following:

- Constraints, such as right of way, buildings, utilities, or heritage designations that may not be able to be changed or moved.
- Multimodal safety audit findings that clearly show critical risks that require mitigation.
- Emerging best practices or a trial installation that will be used to test a new design or operational approach.

Design Exceptions need to be evaluated to determine performance, risks, and mitigation strategies and documented to communicate design decisions. Reasons to justify a Design Exception could include improved safety performance or mitigating community impacts. In all cases, Design Exceptions require the development of alternatives, identification of risks/mitigations, analysis of total lifecycle costs, and rationale for the decisions made and should follow a thorough, repeatable, and well-documented process. Design exceptions shall be authenticated in accordance with the latest APEGA Authenticating Professional Work Products practice standard.

Figure 2.3 illustrates the steps of a typical Design Exception process. More information on assessment and documentation of Design Exceptions can be found in the TAC GDG, Section 1.5. The latest City of Edmonton design exception form is available in ***Volume 1*** of the design standards.

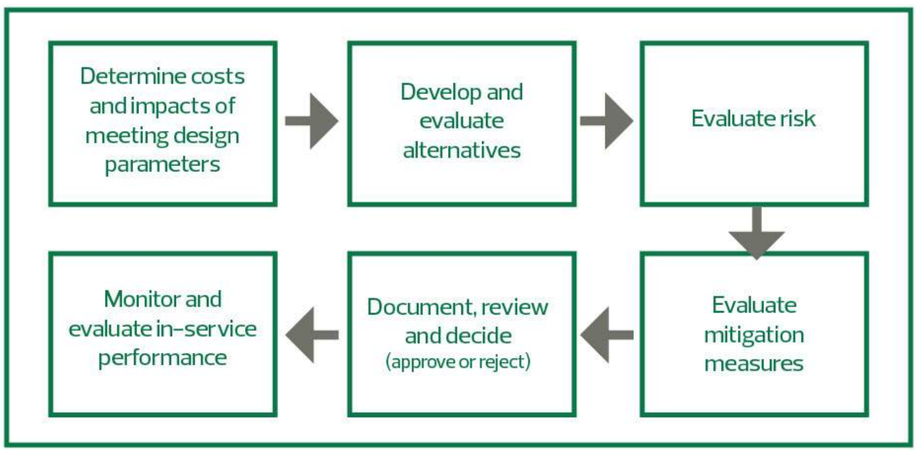


Figure 2.3 *Design Exception Process*

Deviations from the specified recommended range of the Design Domain may be the premise for claims that the geometric design of the street is not "safe." Proven effective strategies against these types of claims include compliance with policies related to flexible design, use of appropriate engineering judgement supported by quantitative analysis, and good, consistent documentation of the reason for the decision including a summary of mitigating strategies considered and implemented.

2.3. ANALYSIS PROCESS TO EVALUATE STREET DESIGN

An analysis process for evaluation of street designs should be used to determine a preferred option from various alternatives and an analysis process is also needed for the evaluation of the performance of a street design that has been implemented. In both cases, evaluation criteria should cover the following areas:

- Policy Alignment - does the design align with municipal goals, objectives, and principles surrounding safety and accessibility, healthy and active living, economic and aesthetic vibrancy, environmental sustainability, enhanced social equity, and cost effectiveness?
- Street Function - does the design meet the approved/required mode priorities of the street?
- Operations & Maintenance - does the design allow for the intended operations and cost-effective long term maintenance, including consideration of utilities and drainage?
- Lifecycle Costs - does the material selection of the design provide adequate longevity that minimizes repair and replacement costs?
- Future Planning - does the design work in the future and can it be easily adapted?
- Constructability - is the design implementable?
- Sustainability - can the amount of throw-away construction be reduced and are trees able to survive?

Specific data to inform these evaluation criteria should include, at a minimum:

- Volume of current and projected future users
- Collision data and observational data
- Speeds of motor vehicle traffic
- Travel times for all modes
- Potential impacts on surrounding public space and land use
- Environmental and health benefits
- Safety performance
- Drainage and winter maintenance

The evaluation of street designs should be completed by a multidisciplinary team drawn from affected City of Edmonton departments to reflect the multidimensional impact the design of streets has on residents, businesses, and City operations. Where possible, the team should include City staff responsible for policy, planning, design, operations, construction, and maintenance.

The evaluation process should be considered whenever a design deviates from the target values contained in this document, or wherever Design Exceptions are utilized. The decision to undertake evaluation of a design rests with the designer, and is meant to provide valuable information regarding performance of certain designs for influencing future projects.

2.4. DESIGNING STREETS IN EDMONTON

Neighbourhood streets in Edmonton shall be designed in a way which encourages motorists to drive slower and exercise caution to create liveable safe streets that align with their intended use while limiting the negative effects on emergency response agencies and operational costs. To encourage operating speeds of no more than 40 km/h in residential neighbourhoods, traffic calming measures shall be engineered into the design of local and collector roadways to create a “naturally calm” street. New neighbourhoods shall be designed using a “modified grid” layout wherever feasible, while maintaining grid-like permeability for people walking and wheeling through the use of breezeways and walkway connections.

Furthermore, to promote safety of vulnerable users, intersections and crossings shall be designed to enhance intervisibility of vulnerable users and vehicles and to shorten crossing distances to the greatest extent possible based on site specific circumstances.

Incorporating traffic calming elements into street design not only benefits safety for all users, and contributes to the goal of Vision Zero, it also reduces lifecycle costs as incorporation of these elements at the greenfield stage reduces the need for expensive retrofit installations. To avoid the retroactive deployment of adaptable and retrofit measures along neighbourhood streets, new neighbourhoods and neighbourhood renewal shall be designed and constructed to incorporate these measures from the onset.

The design of neighbourhood streets, both in greenfield and redevelopment, shall utilize a variety of traffic calming measures as described in ***Section 3.8***, adapted based on the roadway network, local context and land use. Protected bike infrastructure and bike boulevards can also be utilized as a traffic calming approach by narrowing the road carriageway along an entire corridor. Bike facility design guidance can be found in ***Section 3.2.3***.

The implementation will vary depending on whether a neighbourhood has a true grid system, modified grid, or curvilinear street network (examples shown in ***Figure 2.4***), with additional care required in true grid neighbourhoods to discourage shortcutting.

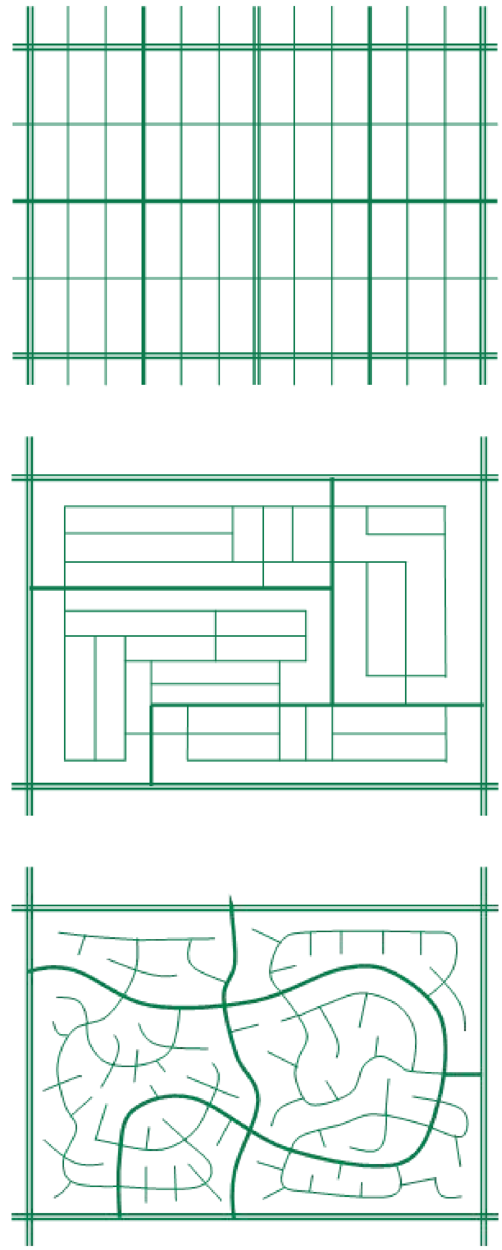


Figure 2.4 *True Grid (top), Modified Grid (centre) and Curvilinear (Bottom) Street Networks*

Figure 2.5 shows the potential toolkit of traffic calming measures which could be utilized. ***Figure 2.6*** shows the toolkit of traffic calming measures as applied to intersections and crossings in neighbourhoods.

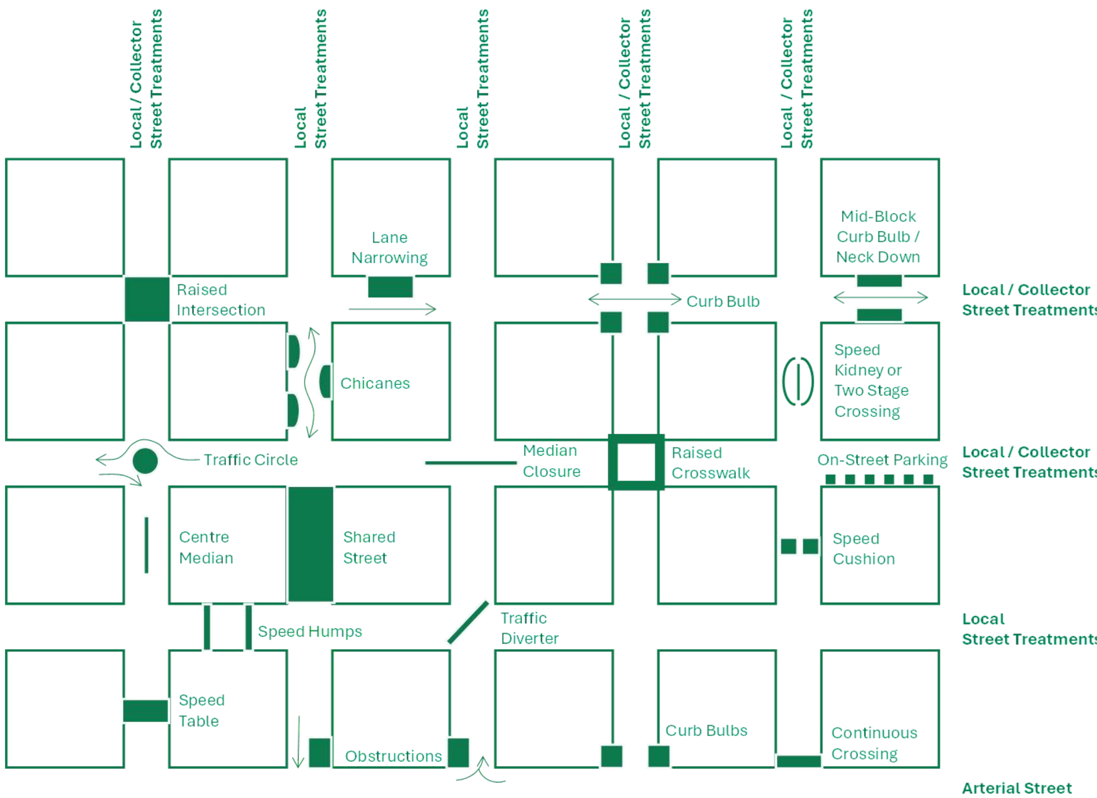


Figure 2.5 *Toolkit of Traffic Calming Types (adapted from City of Mississauga Traffic Calming Guidelines)*

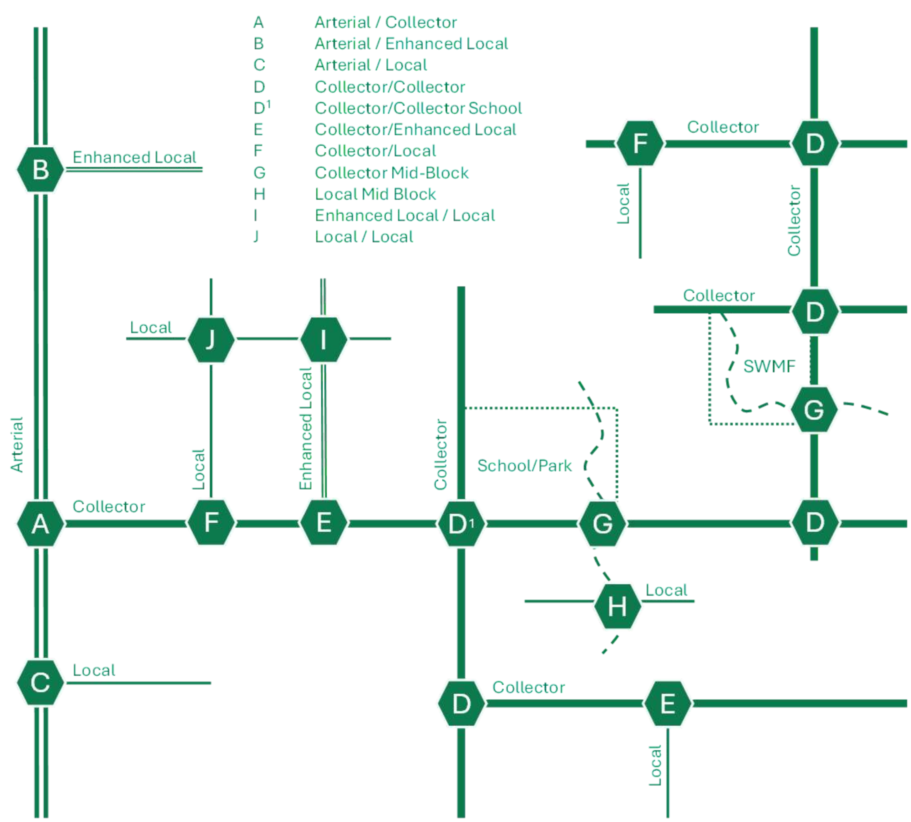


Figure 2.6 *Toolkit of Traffic Calming by Intersection Type*

[A] Arterial/collector intersections

- Roundabouts are preferred wherever feasible based on long term operations, local context and land use. For new developments, analysis of roundabout feasibility shall be undertaken as part of the Transportation Impact Assessment. Roundabout design guidance can be found in ***Section 3.6.7***.
- Where signalized intersections cannot be avoided, gateway traffic calming features should be installed at the first intersection adjacent to the signal, as per the internal gateway intersection requirements.
- Where arterial/collector intersections are not required to be fully signalized (i.e., stop controlled approach; pedestrian half signals, overhead amber flashers, or rectangular rapid flashing beacons (RRFBs) are not considered full signalization), and no right turn bay on the arterial is provided, a bend-out raised crosswalk should be installed on the side street as per Standard Drawing 3880.
- Where arterial/collector intersections are not fully signalized (i.e., stop controlled approach; pedestrian half signals, overhead amber flashers, or RRFBs are not considered full signalization), and a right turn bay on the arterial is provided, a raised crosswalk should be installed on the side street as per Standard Drawing 3881.

[B] Arterial/enhanced local intersections

- Arterial/enhanced local intersections are only permitted where identified in a Neighbourhood Structure Plan.
- Where stop control is insufficient for operations of the side street, roundabouts are preferred wherever feasible based on long term operations and right of way constraints.
- Where signalized intersections cannot be avoided, gateway traffic calming features should be installed at the first intersection adjacent to the signal.
- Where arterial/local intersections are not required to be fully signalized (i.e., stop controlled approach; pedestrian half signals, overhead amber flashers, or rectangular rapid flashing beacons (RRFBs) are not considered full signalization), and no right turn bay is provided, a bend-out raised crosswalk should be installed on the side street as per Standard Drawing 3880.
- Where arterial/local intersections are not fully signalized (i.e., stop controlled approach; pedestrian half signals, overhead amber flashers, or RRFBs are not considered full signalization), and a right turn bay is provided, a continuous crosswalk should be installed on the side street as per Standard Drawing 3881.

[C] Arterial/local intersections

- Arterial/local intersections are generally not permitted in new neighbourhoods unless warranted based on the Neighbourhood Structure Plan and approved by the City.
- Where arterial/local intersections are already present in existing neighbourhoods, the operational requirement for full signalization shall be reviewed. Where it is concluded that full signalization is necessary, gateway traffic calming features should be installed at the first intersection adjacent to the signal.
- A bend-out raised crosswalk as per Standard Drawing 3880 should be provided where:
  - The arterial/local intersections are not fully unsignalized (i.e., stop controlled approach; pedestrian half signals, overhead amber flashers, or RRFBs are not considered full signalization);
  - Posted speeds are 60 km/h; and,
  - No right turn bay is provided.

- A straight raised crosswalk as per Standard Drawing 3881 should be provided where:
  - The arterial/local intersections are not fully signalized (i.e., stop controlled approach; pedestrian half signals, overhead amber flashers, or RRFBs are not considered full signalization);
  - Posted speeds are 50 km/h or 60 km/h; and,
  - A right turn bay is provided.
- A continuous crossing as per Standard Drawing 3840 should be provided where:
  - The arterial/local intersections are not fully signalized (i.e., stop controlled approach; pedestrian half signals, overhead amber flashers, or RRFBs are not considered full signalization);
  - Posted speeds are 50 km/h; and,
  - No right turn bay is provided.

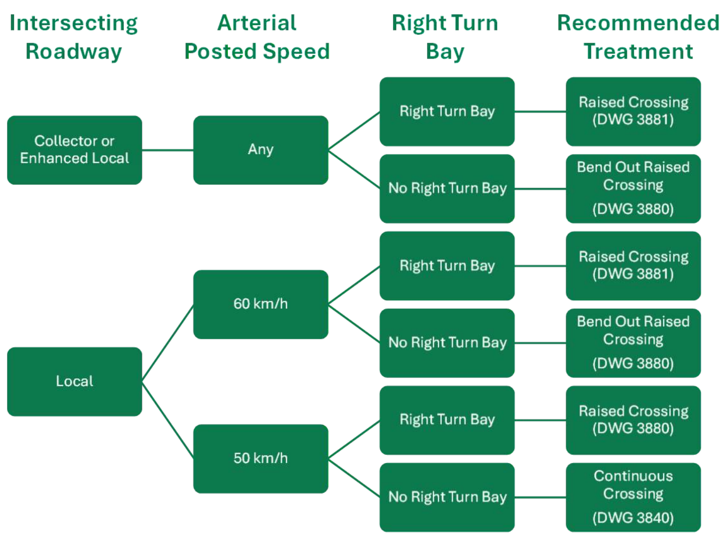


***Figure 2.7** Arterial Intersection Treatment Selection Flowchart*

Internal gateway intersections

- Where the arterial roadway intersection is signalized, the first intersection within 150 m of the entry to the neighbourhood should include traffic calming to provide a transition into the neighbourhood from the adjacent roadway consisting of either:
  - A combination of raised features and narrowing, such as a combination of curb extensions along the main roadway (where on-street parking is provided) and a raised intersection; or
  - A neighbourhood traffic circle or mini roundabout.
- Where no intersection exists within 150 m of the cross street, a mid block curb extension (where on-street parking is provided), centre median, or speed table shall be installed.

[D] Collector/collector intersections

- Where a collector/collector intersection does not require signalization based on traffic volumes and signal warrants, curb extensions shall be installed on all approaches where there is on-street parking. However, the design of curb extensions along transit routes must accommodate bus turning movements as required without encroachment into opposing traffic lanes.
- A raised intersection can also be considered, particularly at two-way stop controlled intersections.
- Where additional traffic controls are deemed to be required beyond all-way stop control based on traffic volumes and operational warrants, a roundabout shall be considered first before the provision of signalization.

[E] Collector/enhanced local intersections

- At two-way stop controlled intersections, continuous crossings on the stop controlled legs should be installed where a shared pathway crosses the street.
- A raised intersection can also be considered, particularly at two-way stop controlled intersections.
- A roundabout can also be considered.

- Where additional traffic controls are deemed to be required beyond all-way stop control based on traffic volumes and operational warrants, a roundabout shall be considered first before the provision of signalization.
- Where a roundabout is not feasible, curb extensions shall be installed, and a raised intersection should be considered.

[F / I] Collector/local and enhanced local/local intersections

- Curb extensions shall be installed on the collector and enhanced local approaches to the intersection where on-street parking is provided.
- Where higher pedestrian volumes are expected (i.e., adjacent to bus stops, or commercial developments), a raised crosswalk shall be provided across the higher volume road.
- A continuous crossing can be considered for the minor leg, and should be provided where a shared pathway crosses the street.
- Mini roundabouts and raised intersections can also be considered.

[J] Local/local intersections

- Typical local street intersections do not require any special treatment.
- Where local streets experience higher volumes, traffic calming may be desirable at intersections, with treatments like those for collector/local intersections.
- Neighbourhood traffic circles may also be considered, particularly where additional traffic control is needed.
- Where local street volumes are expected to exceed 2,000 vehicles per day, an enhanced local cross section or alternate road network that reduces traffic volumes shall be considered.

[G / H] Mid-block crossing treatments

- Where mid-block crossings (either shared pathways or sidewalks) are proposed on collector streets, either:
  - A raised crosswalk and curb extensions shall be provided on both sides of the roadway; or
  - A two-staged crossing shall be provided.
- Where mid-block crossings (shared pathways) are proposed on collector streets, curb extensions on both sides of the roadway in combination with a raised crossing or a two-staged crossing shall be provided when the shared pathway extends as part of a network on each side of the collector street.
- Curb extensions shall be combined with a raised crossing where a mid-block crossing is adjacent to or connecting to a school or park site.
- Raised crossings may also be provided in combination with curb extensions and/or two-staged crossings in other locations.
- Where mid-block crossings are situated adjacent to planned or existing bus stops, curb extensions shall be lengthened accordingly to accommodate transit vehicles, with the stop being relocated a short distance away from the crossing as required.
- Mid-block crossing placement on collector roadway curves should be avoided wherever possible. Where these crossings on curves cannot be avoided, adequate sightlines which consider the placement of trees, fences, utilities, and other appurtenances, shall be provided for intervisibility of all users.
- Where mid-block crossings (either shared pathways or sidewalks) are proposed on local streets, a raised crosswalk shall be provided. A curb extension on one or both sides of the street may also be provided.

[D[1]] School sites (planned and existing)

- All intersections immediately adjacent to a school site, playground, or sports field shall include curb extensions and should include either raised intersections (for collector/collector intersections) or raised crosswalks (for collector/local or local/local intersections). Where bus stops are planned or present, the curb extensions should be lengthened accordingly to accommodate transit vehicles.
- At least one Rectangular Rapid Flashing Beacon (RRFB) is required at all school sites at the main crossing location for students, complete with appropriate pavement markings and signage.
- As shown in ***Figure 2.8***, roundabouts shall not be provided at intersections immediately adjacent to school buildings; roundabouts may be provided at intersections adjacent to the school site to facilitate safe and legal U-turn manoeuvres.
- Any mid-block crossings adjacent to or leading to school or park sites shall include treatments as detailed in the mid-block crossings above.
- Two-stage crossings should be avoided in the school pick-up and drop-off areas due to impacts on parking.
- In the absence of roundabouts, raised features such as speed tables, raised intersections, or raised crossings, shall be provided along collector roads at the boundary of any school or park site.

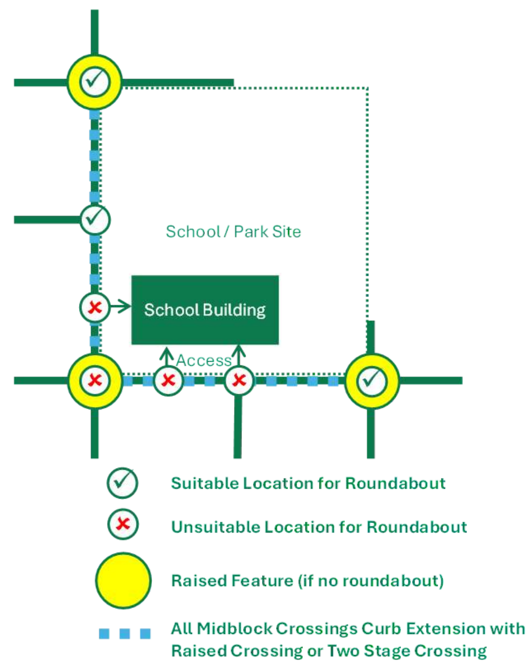


Figure 2.8 *Traffic Calming Locations Near Schools and Parks*

[G] Collector and enhanced local street mid-block features

- Where collector street block lengths exceed 200 m, mid-block treatments should be considered. This can include:
  - Mid-block crossings (as described above)
  - Centre medians (i.e., kidneys or splitters)
  - Curb extensions
  - Speed tables
  - Chicanes (where collector streets are not used for bus routing)

[H] Local street mid-block features

- Where higher traffic volumes (i.e,. in excess of 1,000 vehicles per day) are expected along local roads, and where block lengths exceed 100 m, mid block treatments should be considered, including:
  - Curb extensions
  - Speed humps
  - Chicanes

Bus Stops and Traffic Calming

- Collector roadways should be designed for buses to stop in-lane, through the use of elongated curb extensions that contain bus stops or centre medians that bring the travel lane curbside in advance of the stop. Designs should be reviewed by ETS to identify select timing points.

- Where present near school sites, playgrounds or sports fields, curb extensions shall be lengthened accordingly to accommodate transit vehicles, with the stop being relocated a short distance away from the crossing as required.

Spacing

- Traffic calming on collector streets in general should be spaced at no more than 100 to 150 m and shall include a combination of vertical and horizontal measures selected with the goal of meeting the desired operating speed of the roadway.

- When intended to address speeding, vertical deflection should be placed in succession with one another, with a maximum spacing of 150 m apart in order to be effective at slowing traffic.

- There is no minimum spacing requirement for horizontal treatments along collector streets; for example, roadway narrowing can be completed along an entire block length if desired.

- Access and intersection spacing shall meet the City of Edmonton Access Management Guidelines.

Grid Neighbourhood Traffic Diversion

- In addition to the speed reduction measures described above, grid neighbourhoods should be designed to discourage through traffic by including:
  - Curb extensions
  - Medians
  - Diverters

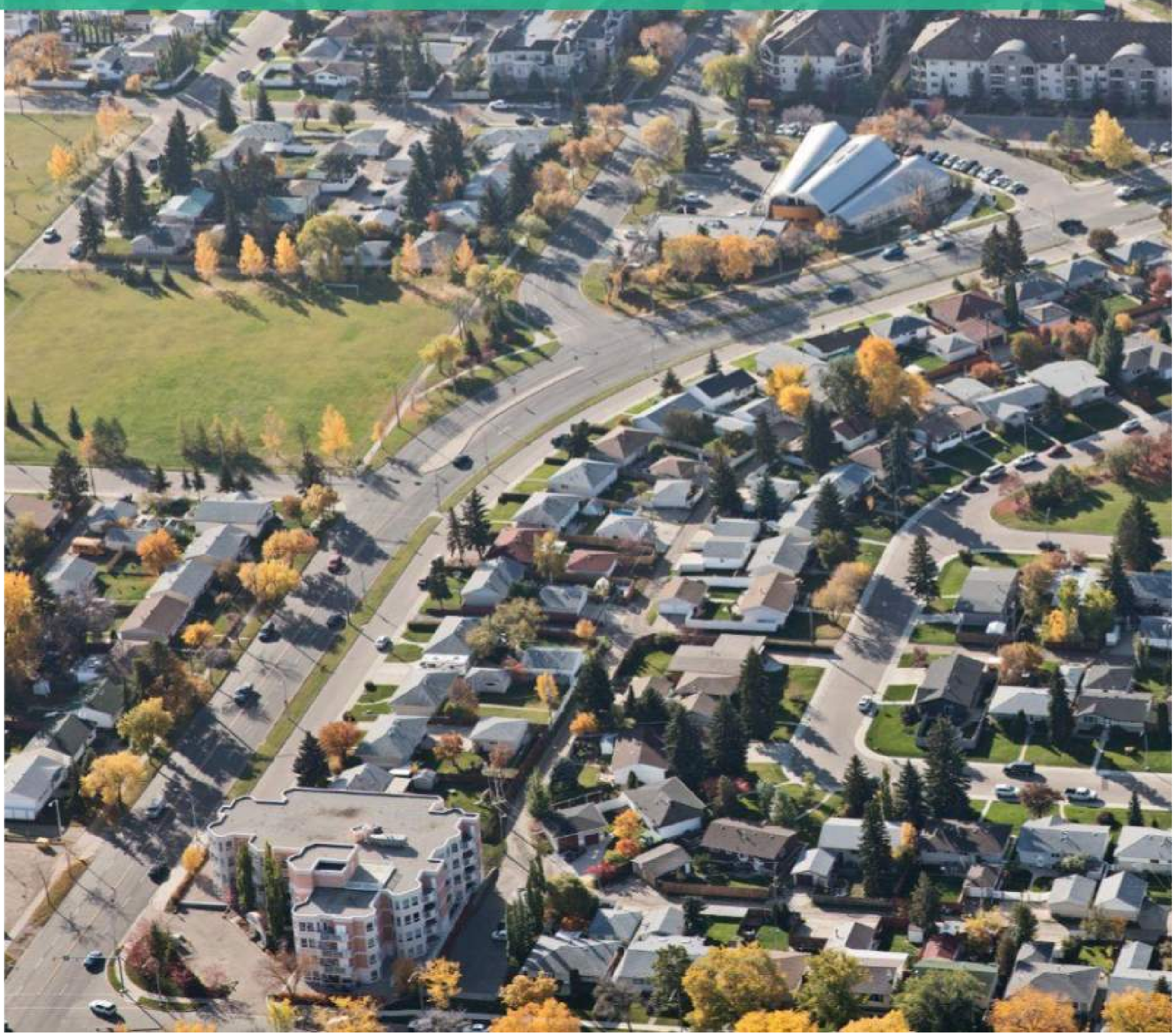
Local Street Bikeways

- See **Section 3.2.3.2** for guidance on traffic calming treatments for local street bikeways.

SECTION 3.0: DESIGN REQUIREMENTS FOR COMPLETE STREETS DESIGN

3.0

This Section includes the guidance and design requirements for street and off-street path/trail design in Edmonton.



3.1. GENERAL

3.1.1.Guiding Documents

The Standards presented in this document are to be used in the design of Edmonton streets. They are based on the latest edition of the following municipal, provincial, national, and international guidance:

- Geometric Design Guide for Canadian Roads (GDG), Transportation Association of Canada (TAC);
- Canadian Roundabout Design Guide, TAC;
- Manual of Uniform Traffic Control Devices for Canada (MUTCD-C), TAC;
- Canadian Guide to Traffic Calming (CGTC), TAC;
- Winter Design Guidelines (WDG), City of Edmonton;
- Alberta Transportation Highway Geometric Design Guide, Alberta Transportation;
- Design Manual for Bicycle Traffic (CROW Manual), CROW, 2016;
- Accessible Design for the Built Environment, Canadian Standards Association (CSA);
- Pedestrian Crossing Control Guide, TAC;
- Access Management Guidelines (AMG), City of Edmonton; and
- Access Design Guide, City of Edmonton.

3.1.2.Human Factors

Streets are built for use by people whether they are walking and wheeling, cycling, driving, delivering goods, or using transit. Human abilities determine how far we can see, the limits of our peripheral vision, how quickly we react, the extent of our mobility, and how we perceive and process information.

Figure 3.1 illustrates how a variety of physical, intellectual, and psychological influences relate to a person's ability to react to a given situation.

These human abilities impact design decisions and design element values by impacting human actions. Consequently, human traits need to be considered in design. Human factors are of significant interest in the street design process as there is a close link between how streets are built and how people use them. If perceptual clues are clear and consistent, the task of adaptation is made easier and the response of people driving, walking and wheeling, and cycling will be more appropriate and uniform. For street design this translates into two foundational principles:

- It is important to design a street so that it generally conforms to what users expect from that type of street based on previous experience and user expectation; and
- It is important to provide street users with sufficient time to detect, identify, and react to hazards in the street (e.g., user perception and reaction).

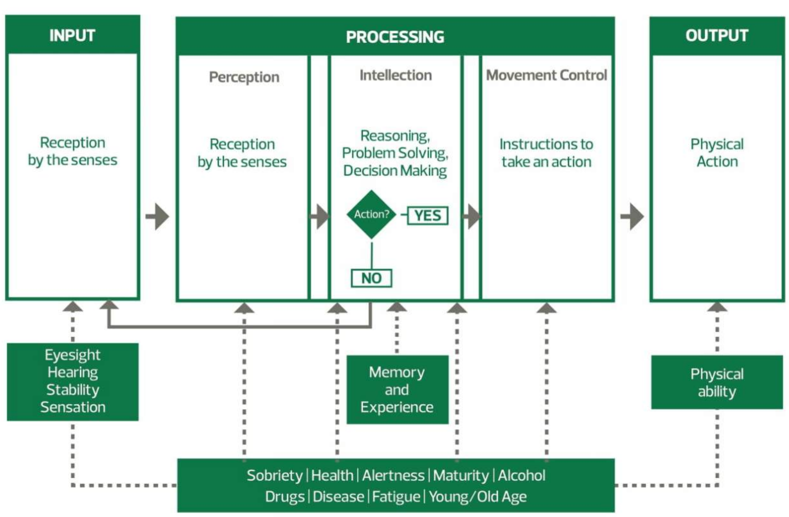


Figure 3.1 *Human Factors (Source: Human Factors Lecture Outline. W.S Homburger)*

> Different street users have different performance capabilities and design needs, which can be categorized in terms of the "type" of user being considered for design purposes. When contemplating design challenges, designers consider different "design users" in the same way they consider different "design vehicles."

Design users will include a wide range of modes including designing for people of all ages and abilities consistent with Universal Design principles. They will also represent a range of people, from those who are young and inexperienced, to those who are older, and those with challenges resulting from failing sensory and cognitive faculties and physical disabilities. Trip purposes may also differ from those who are travelling for pleasure to those who are commuting, and from those who are in a hurry to those who are not. Perhaps most importantly, design users will include those who are familiar and those who are unfamiliar with the street.

In considering human abilities and traits, it is important to remember that they vary from person to person and from situation to situation. For example, a numerical value for reaction time should not be thought of as fixed, even though a fixed numerical value may be assumed for design purposes. Older adults will often have slower walking speeds, reduced perceptions, and increased stopping distances. Those with mobility impairments may require additional time to start a movement, especially when using mobility aids. Street users of all ages and abilities also adapt to perceived and anticipated conditions.

More information on Human Factors and the related topic of Design Consistency can be found in Sections 2.2 and 2.7 of the TAC GDG.

3.1.3.Design Users & Design Vehicles

Designing streets requires an understanding of the dynamics and functional requirements of people and their various modes of transportation. This section defines Design Users and Design Vehicles to be used in the design of Edmonton streets.

3.1.3.1.Design Users & Vehicles for Walking and Wheeling

Walking and wheeling are the most universal and equitable forms of travel. Most trips, regardless of mode used, start or end with walking or wheeling. People walking and wheeling are also among the most vulnerable of street users.

For street design, people walking and wheeling also includes those running, or standing; people using manual/motorized wheelchairs or scooters; people using canes or walkers; people pushing strollers or carts; people pulling sleds; people pushing bicycles; and users of various other low-speed forms of human locomotion (e.g., skateboards, cross-country skiing). Applying the Universal Design Principles (see ***Section 1.5***) is critical in achieving an accessible journey for all people that are walking or wheeling.

The typical width of a person is 0.5 m, measured at the shoulders, with a corresponding operating envelope of 0.75 m. When walking with a child, a service animal, with crutches, a cane or a walker, walking side by side, or moving in a wheelchair or power mobility device, the person has a wider horizontal operating dimension. ***Figure 3.2*** illustrates the varying horizontal operating dimensions for people walking and using a mobility aid. Other important dimensions include the length and turning radius of manual wheelchairs, powered wheelchairs, and mobility scooters. The lengths of these devices are up to 1.4 m with a turning diameter of up to 3.15 m.

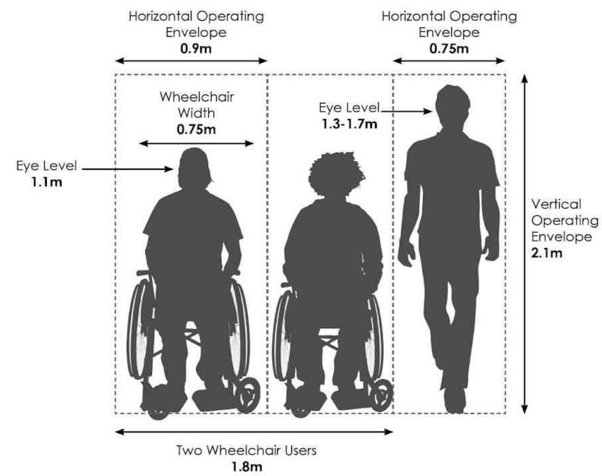


Figure 3.2 *Walking/Wheeling Operating Space*

The dimensions provided in ***Table 3.1*** summarize the recommended Design Domain values for horizontal and vertical operating envelopes for people walking and wheeling and are consistent with CSA's Accessible Design for the Built Environment.

Table 3.1 *Design Domain for People Walking and Wheeling (in m)*

Parameter: Operating Envelope	*Recommended Values*	
	Horizontal Operating Envelope	*Vertical Operating Envelope*
Person Walking	0.75	2.10
Manual Wheelchair or Scooter	0.90	2.10
Person Walking with Child / Person Walking with Service Animal / Two People Walking / Two Wheelchair Users Passing	1.80	2.10

All sidewalks in Edmonton should be designed at minimum to accommodate two passing wheelchair users, with a minimum clear width of 1.8 m. Design Domain values for other sidewalk users have been included for consideration when in a constrained situation.

When selecting the width of sidewalks, consideration must be given to the impacts of snow accumulation and clearing. For example, some sidewalks may need to be widened to accommodate the windrows from snow clearing of the Pedestrian Through Zone or adjacent travel lane. Recommended sidewalk widths in the Edmonton context can be found in ***Section 3.3.4.2*** and ***Table 3.19***.

Wherever possible, the use of monolithic sidewalks along collector and arterial streets should be avoided. Where this is not possible, additional sidewalk width should be provided to enhance safety and comfort for people walking and wheeling and to accommodate snow clearing windrows from the adjacent street in winter. At minimum, an additional 0.5 metres of sidewalk width must be provided for monolithic sidewalks adjacent to arterial and collector streets.

Where there is a barrier or vertical obstruction adjacent to a sidewalk or walkway, an additional horizontal clearance of 0.2 m should be provided in addition to the horizontal operating envelope. If the walking and wheeling facility is shared with people cycling, see ***Section 3.1.3.2*** for horizontal clearance requirements.

For Universal Design, the grade of walking and wheeling infrastructure is also an important consideration. Guidance on grades is provided in ***Section 3.5.7***.

3.1.3.2.Design Users & Vehicles for Cycling

Complete Streets principles recognize the need to design for the full range of user ages and abilities of people who may ride a bicycle. Consistent with TAC's GDG, this broad group could be defined as the "Interested but Concerned" segment or AASHTO's "Casual and Less Confident" segment, and embodies the widest practical range of ages and abilities. Based on surveys in Edmonton, this group makes up about 45% of the population.

Many existing bicycle facilities do not feel safe for people who might otherwise ride. Designing cycling facilities for people of all ages and abilities must consider the unique circumstances and needs of a broad range of potential users. This includes children; seniors; women; people with disabilities; racialized people; people with low incomes; people moving people, cargo and goods; people riding bike share and e-scooter share; and confident cyclists. Refer to the Edmonton Bike Plan for more information on these potential users.

Unless otherwise indicated, the design requirements included in this document, especially for facility types and facility selection, are based on the "Interested but Concerned" group of users and incorporate principles of supporting people cycling of all ages and abilities.

The Bike Plan sets forth Aspiration, Values, and Network principles to set direction for the improvement of cycling in Edmonton. The following direction from The Bike Plan should be considered in the design of bicycle facilities:

Network Principle: Directness

- **The bike network should be efficient and direct** - stopping and starting is very energy intensive and should be kept to a minimum. Routes should be direct and minimize out of direction travel.

Network Principle: Health and Comfort

- **The bike network should be accessible and safe for all users** - at low speeds bicycles are unstable. Tight turns, unevenness, and narrow facilities are difficult to navigate and are barriers to less confident cyclists and people using non-standard bikes such as trailers and handcycles.

Aspiration: Inviting in All Seasons

- **The bike network should be comfortable in all-seasons** - design to provide shelter from sun, wind and rain, and allow for efficient snow and ice control to accommodate year-round riding.

Value: Fun and Functional

- **The bike network should be social** - people on bikes should be able to ride side-by-side. This allows people to ride together, parents to supervise children, and passing.

Refer to the Edmonton Bike Plan for more information about the aspiration, values, and network principles used to guide set direction for cycling in Edmonton.

Figure 3.3 illustrates dimensions for different types of bicycles as well as the horizontal and vertical operating envelopes. Bicycles range in size based on the type of bicycle and physical size of the rider. Adult bicycles are approximately 1.8 m long and can be 2.4 m long for cargo bicycles. An adult bicycle pulling a trailer, including those for children, is approximately 3.0 m in length. The widths of cargo bicycles and bicycle trailers are approximately 0.75 m. Electric versions of these bicycles have consistent length and width dimensions, but are heavier and may travel at higher speeds, particularly when travelling uphill.

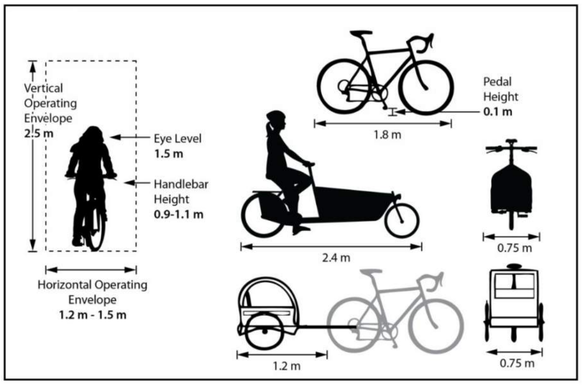


Figure 5.2.1 Bicycle Operating Space

Figure 3.3 *Cycling Operating Envelope and Bicycle Dimensions*

The dimensions provided in ***Table 3.2*** summarize the recommended Design Domain values for the horizontal, lengthwise, and vertical operating envelopes for people cycling.

Table 3.2 *Design Domain for People Cycling (in m)*

Parameter: Operating Envelope	*Recommended Values*		
	Recommended Lower Limit	*Recommended Upper Limit*	*Target Value*
Horizontal Operating Envelope	1.2	1.5	1.5
Lengthwise Operating Envelope	2.5	4.1	2.5
Vertical Operating Envelope	2.5	N/A	2.5

The higher ends of the horizontal operating envelope are most appropriate for steep grades. The higher values noted in the lengthwise operating envelope represent requirements to accommodate bicycles with attached trailers and for cargo bikes. This dimension is important when designing medians intended for refuge, when considering horizontal alignments and horizontal shifts in alignment, including horizontal curves, and the design of intersections, including protected intersections.

The following Design Vehicles for bicycle facilities should be used based on cycling route type:

- Neighbourhood Route:
  - Cargo bicycle (i.e., 2.4 m bicycle length)
  - Unidirectional facility should be wide enough to allow passing and snow clearing equipment (i.e., 2.1 m)
  - Bidirectional facility should allow two cargo bicycles to pass (i.e., 3.0 m)
- District Connector Route:
  - Bicycle with trailer (i.e., 3.0 m bicycle length)
  - Unidirectional facility should be wide enough for social cycling (i.e., 2.5 m)
  - Bidirectional facility should allow two people cycling side-by-side and one person to pass in the opposite direction (i.e., 4.0 m)

The vertical operating envelope is used in consideration of vertical clearances which is discussed in ***Section 3.2.7.2***.

The following horizontal clearances should be provided for cycling facilities:

- The minimum clearance from the face of curb should be 0.25 m for a 250 mm gutter pan or 0.50 m where there is a 500 mm gutter pan. The width of the gutter pan is not considered part of the horizontal operating envelope.
- Minimum horizontal clearance of 0.2 m is required from vertical obstructions of 100 mm to 750 mm in height;
- Minimum horizontal clearance of 0.5 m is required for vertical obstructions greater than 750 mm in height,
- Horizontal clearance of 0.2 m should be provided to accommodate passing manoeuvres between people cycling, either for oncoming or overtaking movements;
- Where the facility width is narrower than 1.8 m, additional horizontal clearance may be required to support snow and ice control operations, and should be discussed with the City of Edmonton; and,
- On bridges with active mode connections additional horizontal offsets should be provided as follows:
  - Shared Pathway width including 0.6 m offset: 4.2 m
  - Sidewalk width including 0.5 m offset: 2.8 m

More information on vertical alignment for bicycle facilities can be found in ***Sections 3.2.7.2*** and ***3.5.7***, while information on horizontal alignment can be found in ***Section 3.2.6.3***.

3.1.3.3. Design Vehicles for Driving, Transit, and Goods / Services

The physical characteristics of the vehicles using a street define many geometric design elements including, amongst others, intersections, site access configurations, and vertical clearance. As part of the design process, it is necessary to identify all vehicle types using a street and then to select a representative design vehicle whose turning dimensions (i.e., dimensions affecting tracking or turning behaviour) and other characteristics (e.g., height of eye, overall length, and performance characteristics) are then used to establish the relevant design vehicle parameters for geometric design.

Design vehicle categories are established by examining all vehicle types, selecting general class groups on the basis of use and turning behaviour, and defining a representative size of vehicle within each classification. Three general classes of vehicles have been established based on research commissioned by TAC:

- Passenger cars - includes compacts and subcompacts, SUVs, all light vehicles, and all light delivery trucks (e.g., vans and pickups);
- Trucks - includes single-unit trucks, truck tractor-semitrailer combinations, and trucks or truck tractors with semi trailers in combination with full trailers; and,
- Buses - includes single unit buses, articulated buses, and intercity buses.

The ***Design Vehicle*** is typically the vehicle with the largest turning radius frequently required to manoeuvre a turn at the intersection and, as such, turns should be made with relative ease. The Design Vehicle also assists in establishing the width of elements within the Travelled Way and Curbside Zone.

Control Vehicles, on the other hand, are typically the largest vehicle occasionally required to manoeuvre a turn at an intersection corner, but are relatively low in frequency and may have less available space to manoeuvre. The space needed for manoeuvring by Control Vehicles may occur by turning into non-curbside travel lanes or encroaching into opposing lanes (provided measures are taken to manage the conflicts).

Table 3.3 defines Design Vehicles and Control Vehicles to be used for street design in Edmonton based on street type. For turning movements, the largest vehicle permitted on the lower order roadway should be used as the design and control vehicle. However, adjacent land use should also be considered in the selection of design and control vehicles as accommodation of larger vehicles may be required.

Though not specified as the Design Vehicle for each street type, the transit bus (COE Bus, based on the New Flyer Xcelsior model) should be used as an additional design vehicle at intersection corners that are part of a bus route. ***Figures 3.4*** through ***3.10*** provide dimensional details for the Design Vehicles. Typical vertical heights of trucks range from 4.15 m to 4.25 m which can be used in the assessment of vertical clearance (see ***Section 3.2.7.1***). Refer to the City's Design Drawing Standards for City of Edmonton specific design vehicle templates. Where differences exist, the design vehicle templates shall govern.

Information on turning movements and swept path requirements for Design and Control Vehicles can be found in ***Section 3.6.2.2***.

Should a designer select a Design or Control Vehicle that is different from those listed in ***Table 3.3***, a Design Exception is required.

Table 3.3 *Design Vehicles by Context*

Street Classification	Design Vehicle	Control Vehicle [2]	Control Vehicle Allowable Encroachments
Car Free Streets & Shared Streets	Bicycle	FT	FT must manoeuvre within hard surfaced areas with 0.3 m clearance to hard surface edge and any obstacles.
Reverse Housing Lane	P	WT, FT	WT, FT must manoeuvre within hard surfaced areas with 0.5 m clearance to any property line.
Alley	P	WT	WT must manoeuvre within hard surfaced areas with 0.3 m clearance to pavement edge and any obstacles.
Local (Non-Industrial)	P	WT, FT, MSU	Manoeuvre within hard surfaced areas with 0.3 m clearance to pavement edge and any obstacles.
Collector (Non-Industrial)	COE Bus	WT, FT	Manoeuvre within hard surfaced areas with 0.3 m clearance to pavement edge and any obstacles.
Arterial[1] (Non-Truck Route[3] or Downtown[1] Truck Route[3])	COE Bus	WB-21	Encroachment into adjacent lanes in same direction at major intersections (opposing lanes at minor intersections)
Industrial Local	WB-21	WB-36	Encroachment into opposing lanes permitted at intersections (local/collector)
Industrial Collector	WB-21	WB-36	Encroachment into opposing lanes permitted at intersections (local/collector)
Arterial (Truck Route[3])	WB-21	WB-36	Encroachment into adjacent lanes in same direction permitted at major intersections (opposing lanes at minor intersections)
Freeways/Expressways	WB-21	WB-36	Encroachment into adjacent lanes in the same direction at ramp intersections only.

Legend (Design, Control Vehicles):

P = Passenger Car;
MSU = Medium Single Unit Truck;
FT = City of Edmonton Fire Truck;
WT = City of Edmonton Waste Collection Truck;
COE Bus = City of Edmonton Modified Standard Single Unit Bus (Xcelsior Model);
WB-21 = Semi-Trailer (Alberta Transportation); and
WB-36 = Turnpike Double (Alberta Transportation).

For further information and details on the above Design Vehicles and other potential Design Vehicles, refer to TAC GDG Section 2.4 (e.g., articulated buses).

Notes:

1. As defined in the Centre City - Downtown, Centre City - North Edge, Centre City - Wihkwentowin, 124 Street, and Centre City - Quarters areas of the Central District Plan.

2. A minimum 6.0 m clear width and 5.0 m clear height is required to accommodate FT operations. This must be provided where FT is a control vehicle and can be accommodated by including the width of opposing lanes, as well as parking lanes on local streets.

3. For Truck Routes refer to the latest City of Edmonton Truck Route Map.

4. For detailed information on swept path analysis requirements, refer to ***Section 3.6.2.2***.

5. Straight Face (SF) curbs are considered obstacles for all vehicle types. Semi-mountable (SM) and Rolled Face (RF) curbs may be mounted by FT vehicles for short distances. However, this does not apply to WT vehicles.

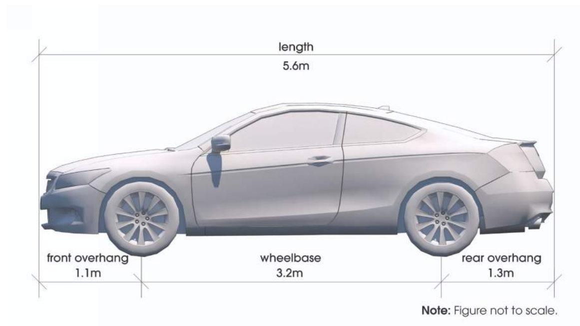


Figure 3.4 *Passenger Car Dimensions*
Width = 2.0 m
Turning Radius = 6.3 m

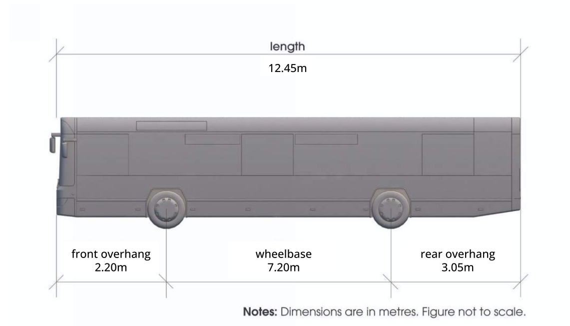


Figure 3.6A *COE Bus: City of Edmonton Modified Standard Single Unit Bus Dimensions*
Width (w/o mirrors) = 2.6 m
Width (w/mirrors) = 3.2 m
Turning radius = 10.8 m

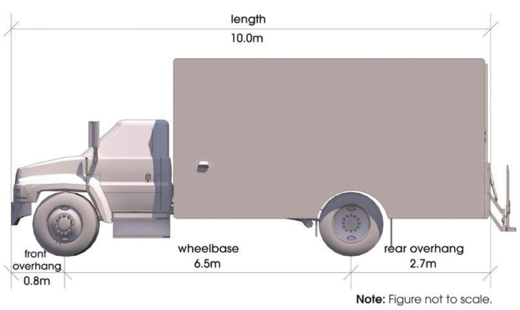


Figure 3.5 *Medium Single Unit Truck Dimensions*
Width = 2.6 m
Turning Radius = 11.1 m

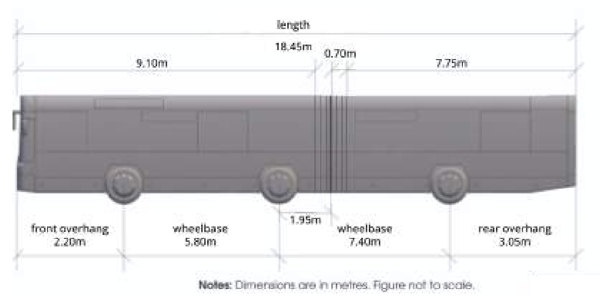


Figure 3.6B *Articulated Bus Dimensions*
Width (w/o mirrors) = 2.6 m
Width (w/mirrors) = 3.2 m
Turning radius = 12.45 m

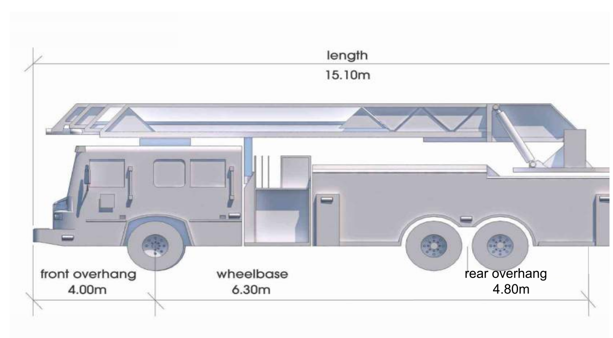


Figure 3.7 *City of Edmonton Fire Truck Dimensions*
Width (w/o mirrors) = 2.6 m
Turning radius = 12.8 m

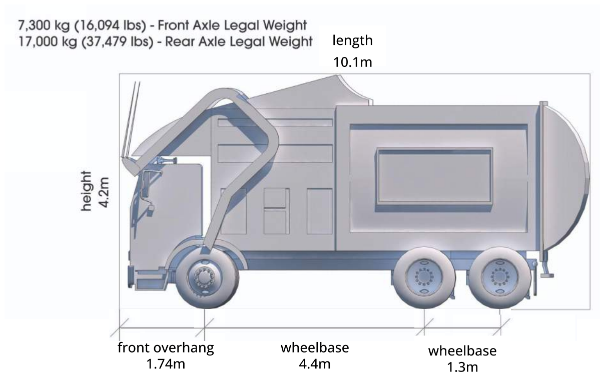


Figure 3.8A *City of Edmonton Waste Collection Truck (Front-Loading)*
Width (w/o mirrors) = 2.6 m Width (w/mirrors) = 3.15 m
Turning radius = 13.8 m

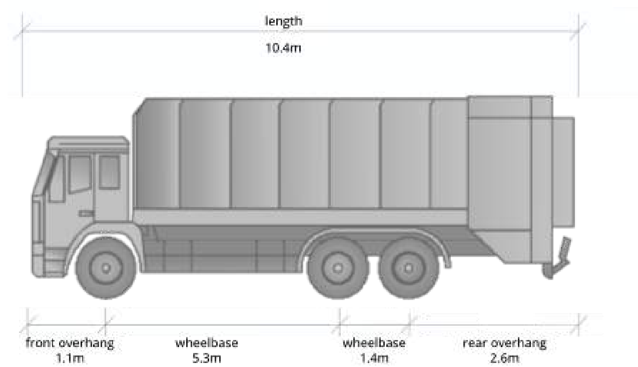


Figure 3.8B *City of Edmonton Waste Collection Truck (Side -Loading)*
Width (w/o mirrors) = 2.6 m Width (w/mirrors) = 3.15 m
Turning radius = 14.4 m

Figure 3.9 *WB-21 Tractor Semi-Trailer Dimensions*
Width = 2.6 m
Turning radius = 12.8 m

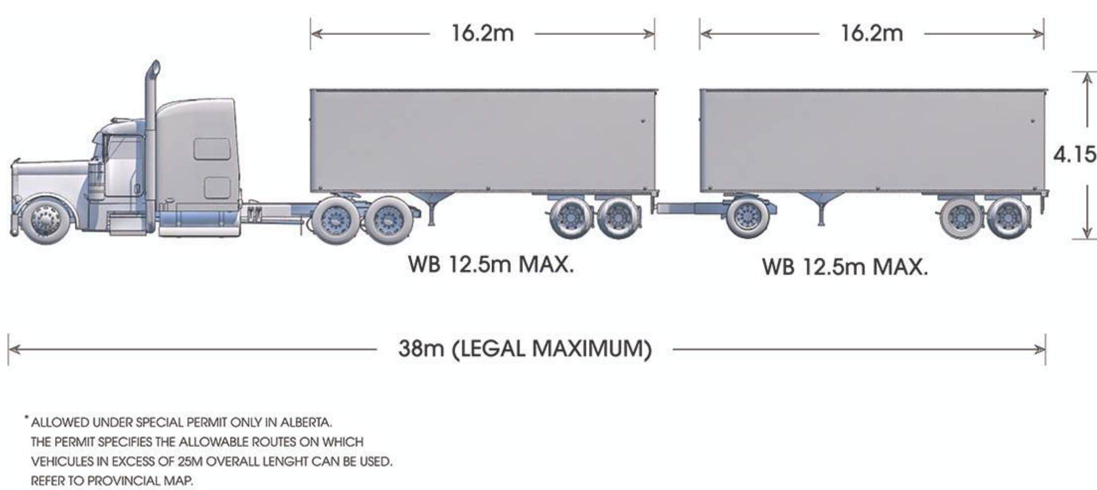


Figure 3.10 *WB-36 Tractor Semi-Trailer Dimensions*
Width = 2.6 m
Turning radius = 12.8 m

3.2. TRAVELLED WAY

The Travelled Way is the space provided for travelling through a street or to access land uses along a street for people travelling by motor vehicle, bicycle, transit, and for the delivery of goods. The space can include exclusive or shared/general purpose lanes for transit, motorized people and goods movement and may also include centre medians or islands, concrete gutters, refuge areas for people walking, and turning lanes. In non-peak hours, some of the Travelled Way may be used as an area for parking and loading and, in some cases, can also be closed at times to motor vehicle traffic to host events and festivals. The Travelled Way also includes space for people walking, wheeling, and cycling across the travel lanes.

The following sections describe the various design elements that contribute to the overall design of the Travelled Way.

Information on Offsets for design elements with respect to the Travelled Way can be found in ***Section 3.7***. This includes horizontal offsets and clearances to utilities, poles, and trees. Requirements for Sight Distances and Clear Sight Triangles at intersections can be found in ***Section 3.6.1.4***.

3.2.1.Design Speed

Travel speeds have a significant impact on the safety and efficiency of the transportation system. Inconsistencies between the Operating Speed, Design Speed, and the Posted Speed can create unsafe conditions.

Operating Speed refers to the actual travel speed of vehicles at a time when traffic volumes are low and drivers are free to choose the speed at which they travel without reductions due to congested conditions. The 85th Percentile Speed, or the speed at which 85% of drivers travel at or under, is a common metric used to define Operating Speed as it reflects the speed that most vehicles are comfortable travelling at.

In general, the intended Operating Speed should be equal to or less than the Design Speed. There is evidence that design treatments such as narrow lanes, traffic calming measures, on-street parking, street oriented buildings, and trees located closer to the street result in drivers travelling at lower Operating Speeds. This suggests that drivers behave less aggressively and more cautiously on narrower streets and is the basis for “self-explaining roads” in which the road is designed for a specific purpose or function as well as the approach taken to Safe Systems and Vision Zero in these CSDCS (see ***Section 1.3***).

Research has shown the probability of fatalities increases significantly when impact speeds are above 40 km/h (see ***Section 1.3***). To mitigate these negative impacts, streets in areas with buildings oriented to the street should be designed for slower, walking-compatible motor vehicle travel speeds as a response to higher levels of people walking. These speeds should be kept at or below 40 km/h wherever possible.

In 2021, the City adopted a 40 km/h default speed limit on most residential streets and high pedestrian areas, including downtown. Reducing residential speeds make our streets calmer, quieter, and safer for people walking, biking, driving and enjoying their neighbourhood. Slowing down gives us more time to react to the unexpected, reduces unnecessary tragedies on our roads, and has very little impact on travel times.

The choice of Posted and Operating Speed of a street also has significant impacts on the placement and location of furnishings in walkable environments, as well as the comfort and safety of pedestrians and cyclists. Where lower speeds cannot be achieved, the negative impacts should be mitigated through increased sidewalk buffers for people walking, increased physical separation from motor vehicle traffic for people cycling, and safe and convenient crossing opportunities for all vulnerable users.

3.2.1.1.Design Speed for Streets

Design Speed for Edmonton streets will be applied as follows:

- Design Speed = Posted Speed for:
  - Local Streets
  - Collector Streets
  - Other Non-Arterial streets with Posted Speeds of 50 km/h or less
- Design Speed = Posted Speed + 10 km/h for:
  - Arterial Streets with Posted Speed of 60 km/h or greater
  - Freeways/Expressways (Design Speed may equal Posted Speed + more than 10 km/h depending on Posted Speed); and
- Arterial Streets with Posted Speed = 50 km/h or less:
  - Use Design speed = Posted Speed for the following elements:
    - lane widths, tapers, and horizontal offsets
  - Use Design Speed = Posted Speed + 10 km/h for the following elements:
    - horizontal alignment, vertical alignment, and intersection sightlines.

Table 3.4 outlines the recommended Design Domain and City of Edmonton target value for motor vehicle design speed for through movements as well as turn movements (see ***Section 3.6.2*** for more information on motor vehicle turning speeds).

Design Speed ranges are based on aspects such as land use context, building orientation in relationship to the street, functional classification of the street, types of interactions that can occur between street users, and mobility goals of the street section. Faster vehicle travel speeds negatively impact the mobility experience of others, whether they are walking, biking, rolling, using transit or driving. Safety is the priority for every street in Edmonton. A design speed must carefully consider the safety and comfort levels of people walking, biking and rolling, and potential collision severity. The table allows the designer to establish the design speed for a street through the engagement process, review of historic safety performance, and consideration of the above noted factors at the early stages of design.

Table 3.4 *Design Domain for Design Speeds & Posted Speeds (in km/h)*

Contextual Street Classification (building relationship to the street, land use, and functional classification)	*Design Domain Recommended Range*		*City of Edmonton Target Value*	
	Recommended Lower Limit	*Recommended Upper Limit*	*Design Speed*	*Posted Speed*
Alleys, Reverse Housing Lanes, Shared Streets, Shared Alleys, and Car Free Street (all contexts)	5	20	20	20
Local Streets (all contexts except Industrial)	30	40	40	40
Local Industrial Streets	30	50	50	50
Collector Streets (except Industrial Areas) 40 km/h posted speed	30	50	40	40
Collector Streets (except Industrial Areas) 50 km/h posted speed[3]	40	50	50	50
Industrial Collector Streets	50	50	50	50
Downtown Core Roadways (all classifications)	40	40	40	40
Street Oriented Arterial Streets (all land use Contexts, except downtown)	40	50	50[1]	50
Non-Street Oriented Arterial Streets (all land use contexts, except downtown)	50	70	70	60
Freeways/Expressways	70	120	90+	80+

Notes:

1. Use 60 km/h Design Speed for horizontal alignment, vertical alignment, and intersection sightlines for street oriented arterial streets.

2. Where a road falls into more than one classification, the lowest recommended design and posted speed shall apply.

3. 50 km/h Collectors only apply to legacy collector roads and shall not be used in greenfield development.

3.2.1.2.Design Speed for Pathways & Bikeways

Bike lanes and bike paths should have a Design Speed that is at least as high as the preferred speed of the faster cyclists who will use the facility. Shared pathways must also take into account the expectations of the other users of a facility, including those with mobility issues. Similar to the design of arterial streets, a higher design speed (30 km/h) for horizontal and vertical alignments for pathways and bikeways should be used to improve comfort and safety for curves and approaches to crossings. The range of design speeds for pathways and bikeways is shown below in ***Table 3.5***.

The Design Domain ranges for bicycle travel are based on aspects such as land use context, building orientation in relationship to the street, types of interactions that can occur between street users, and mobility goals of the bicycle infrastructure.

Facilities with higher design speeds must account for slower-moving users by providing elements that facilitate safe passing, such as additional facility width, refuge pullouts, and separation of travellers by mode and/or direction of travel.

Table 3.5 *Design Domain for Design Speed of Pathways & Bikeways (in km/h)*

Parameter: Design Speed	*Design Domain Recommended Range*		City of Edmonton Target Value
	Recommended Lower Limit	*Recommended Upper Limit*	
Where: ✚ ***Pathways are shared with people walking, wheeling, and cycling*** ✚ ***Uneven pathways*** ✚ ***Pathways with low coefficients of friction or not concrete or asphalt surfaces*** ✚ ***Protected bike lanes or pathways with multiple conflict points and insufficient sightlines*** ✚ ***High usage by vulnerable users (e.g. schools, parks etc.)*** ✚ ***Geometric constraints***	10	30	20
Neighbourhood Route	20	40	20
District Connector Route	20	40	30[1]
Approaching Intersections	20	50	20[2]

Notes:

1. Where the downgrade exceeds 5% for more than 60 m, or strong tailwinds are likely due to prevailing wind conditions, design speed should be increased to ≥ 40 km/h. See ***Section 3.2.7.2*** and TAC GDG Chapter 5 for additional direction.
2. Careful consideration needs to be given to continuous crossings to provide safe crossings at a higher speeds for cyclists given limitations on sightlines. Where possible, a 30 km/h design speed should be targeted to support increased sight distances.

Micromobility

Micromobility, consisting of electric bikes and electric scooters (also called e-bikes and e-scooters, respectively) is growing in popularity. E-bikes use a small electric motor to aid with pedalling, which can support cycling in a city by eliminating barriers posed by long distances and hills, as well as for those with reduced physical fitness.

Studies have found that electric bike users have similar behaviours as those of users of regular bicycles. Studies on travel speeds for e-bikes indicate average and 85th percentile speeds are 2 to 9 km/h higher than conventional bicycles, while speeds are typically slower when e-bike riders are operating in mixed conditions with people walking. In Canada, pedal-supported e-bike speeds are limited to up to 32 km/h.

Because travel speeds for people cycling with e-bikes are higher and their market share is increasing, the design conditions to permit these users on cycling facilities have been updated from previous versions of these Standards for the Design Domain of Design Speed identified in this section. In addition, e-bike speeds uphill can be much faster than speeds of conventional bicycle riders, and consideration should be given to wider bicycle facilities to accommodate passing. Acceleration rates for e-bikes are also higher than conventional bicycles, but the slower acceleration rates and travel speeds of conventional bicycles will govern clearance times at intersections.

3.2.2.Lane Widths

3.2.2.1.Functions of Lane Widths

Lane width has an impact on driver behaviour, sidewalk animation, and safety of users of all transportation modes. Lane widths must balance the safety, access, and comfort for all users, including people walking and wheeling, cycling, riding transit, driving, and delivering goods.

Vehicle lanes are intended to perform the following functions:

- Delineate space within the Travelled Way that is primarily used by motor vehicle traffic including transit and goods (although bicycle traffic can also use these lanes); and
- Reduce traffic conflicts between vehicles travelling in the same or opposite direction.

3.2.2.2.Design Considerations

The TAC GDG discusses the design considerations for lane widths in Section 4.2. Topics described include safety, Design Speed (and desirable Operating Speed), vehicle type, multimodal traffic volumes, climatic conditions, utility and streetscaping elements, and land use context.

TAC GDG Section 4.2.2 identifies three links between safety and lane width:

- The wider the lanes, the larger the average separation between vehicles operating in adjacent lanes. This may provide a larger buffer to absorb the small random deviations of vehicles from their intended path. On streets that are identical except for lane widths, drivers may tend to drive faster and follow the preceding vehicle more closely on a street that has wider lanes.[2] Slower speed limits, when coupled with wider lanes, can also result in poor compliance with the posted speed;
- A wider lane may provide more room for correction in near-collision circumstances. For example, a moment’s inattention may lead a vehicle to drift into an adjacent lane. In the same situation, if the driving lane was wider, the driver’s moment of inattention may have less serious consequences; and
- However, wider lane widths typically induce higher operating speeds by creating an open environment with little “side friction”. In urban areas, this can be linked to reduced safety performance for people walking, wheeling, and cycling. Higher speeds increase stopping distances and increase the severity of collisions.

Research and analysis completed for the City of Edmonton reviewed the relationship between travel lane width, operating speeds, and safety. Key findings of this local review include:

- The relationship between lane width and safety is complex and difficult to isolate as there are many factors which contribute to safety performance;
- Use of the Design Domain concept for lane width decisions is appropriate; and

2. Hauer, E. 1998. “Literature Review and Analysis on Lane Widths”. University of Toronto

- Speed should be a primary factor in setting context sensitive design guidelines for lane width. For high speed streets (i.e., over 60 km/h posted speed), lane widths towards the lower end of the design domain lanes should be avoided. For low speed streets, lane widths towards the lower end of the design domain should be used to encourage Operating Speeds consistent with the Design and Posted Speeds.

3.2.2.3.Lane Width Design Domain

Design Domain and design target values for lane widths in Edmonton, are shown in ***Tables 3.6A*** and ***3.6B*** based on the Design Speed. The designer should begin with the target value and adjust as necessary within the recommended Design Domain when considering factors discussed in TAC GDG Section 4.2 and those listed below:

- Deviating towards narrower lane widths in the Design Domain may increase the need for more frequent snow clearing and increased off-site snow storage. Designers should consider snow storage when selecting lane widths and designing the street as whole;
- Higher motor vehicle volumes will not generally justify installing wider lanes, but could justify installing additional lanes. Higher volumes of truck traffic, transit vehicles, and people cycling and walking and wheeling may justify increasing widths of their respective lanes/facilities to minimize conflicts and improve comfort for all users.

Comprehensive evaluation and caution should be exercised when deviating toward lower bounds of the lane width Design Domain on high speed streets (i.e., over 60 km/h posted speed) or where deviating towards the upper bounds on low speed streets; and Wider parking lanes may be justified on facilities with high parking utilization and turnover, or frequent large truck parking, to reduce sideswipe, rear end, and dooring conflicts with people cycling.

Before selecting lane widths, the designer should review the design considerations described above and the following detailed considerations:

- Speed;
- Available right of way;
- Land use;
- Street classification;
- Travel mode prioritization, volumes and level of service;
- Cross section (number, type, and width of all cross section elements in each travel direction, including median);
- Collision history;
- Parking utilization and turnover;
- Curbside deliveries and loading;
- Emergency Services;
- Utility installations;
- Snow clearing and storage requirements; and
- Topography and curvature.

***Table 3.6A** Design Domain for Lane Widths (in m): Design Speed 50 km/h or Less*

Parameter: Lane Widths [1,2]	*Design Domain Recommended Range*		*City of Edmonton Target Value*
	Recommended Lower Limit	*Recommended Upper Limit*	
Standard Travel Curbside Lane (non-transit, non-truck route) [3]	3.25	3.75	3.25
Standard Travel Lane (non-transit, non-truck route) [3]	3.00	3.50	3.00
Transit Route Curbside Lane	3.55	3.75	3.55
Transit Route Lane	3.30	3.50	3.30
Truck Route Curbside Lane	3.55	3.95	3.65
Truck Route Lane	3.30	3.70	3.40
Parking Lane	2.35	2.65	2.45[4]

Notes:

1. Dimensions are for through and turning lanes. Turning lanes are typically at the lower end of the recommended ranges as these movements are completed at lower Operating Speeds.

2. Dimensions are measured to face of curb for curbside lanes.

3. For local streets, local street bikeways, alleys, shared streets, and car free streets, a combined single drive lane with yield operation for both directions can be provided. This shared lane must be a minimum of 4.1 metres wide. For local streets, the minimum Travelled Way width shall be 8.0 m to accommodate required offsets for underground utilities and emergency response access, which may require parking restrictions. Where they already exist, service roads have a minimum Travelled Way width of 6.0 m due to the presence of an adjacent street. The designer must also consider the impacts of underground utilities, as well as winter design and operations when selecting Travelled Way widths.

4. Parking lanes for large trucks in industrial areas shall be 3.10 m to face of curb for collector and local roadways.

5. For local streets, local street bikeways, alleys, shared streets, and car free streets, a combined single drive lane with yield operation for both directions can be provided. For streets designated as local street bikeways, the shared lane must be a minimum of 4.1 metres wide. For local streets and shared streets, the desired shared lane should be 4.1 metres wide, which may be reduced to a minimum of 3.3 metres wide through an approved design exception. For local streets, the minimum Travelled Way width shall be 8.0 m to accommodate required offsets for underground utilities and emergency response access, which may require parking restrictions. Where they already exist, service roads have a minimum Travelled Way width of 6.0 m due to the presence of an adjacent street. The designer must also consider the impacts of underground utilities, as well as winter design and operations when selecting Travelled Way widths.

Table 3.6B Design Domain for Lane Widths (in m): Design Speed Over 50 km/h

Parameter: Lane Widths [1,2]	Design Domain Recommended Range		City of Edmonton Target Value
	Recommended Lower Limit	Recommended Upper Limit	
Standard Travel Curbside Lane (non-transit, non-truck route)[3]	3.55	3.95	3.75
Standard Travel Lane (non-transit, non-truck route)	3.30	3.70	3.50
Transit Route Curbside Lane	3.65	3.95	3.75
Transit Route Lane	3.40	3.70	3.50
Truck Route Curbside Lane	3.65	3.95	3.95
Truck Route Lane	3.40	3.70	3.70

Notes:

1. Dimensions are for through and turning lanes. Turning lanes are typically at the lower end of the recommended ranges as these movements are completed at lower Operating Speeds.

2. Dimensions are measured to face of curb for curbside lanes.

3.2.3.Bicycle Facilities

Bikeway facilities range in types based on the degree to which people riding bicycles are separated from motor vehicle traffic and people walking and wheeling. The Bike Plan provides information on bicycle network route type for District Connector Routes and Neighbourhood Routes. Refer to the Bike Plan to determine the type of bicycle route. Depending on the bicycle route, there are different types of bicycle facilities that could be used. The types of facilities and their level of separation are as follows:

- Protected Bike Lanes – are on-street facilities designed for the exclusive use of people cycling that are separated from travel lanes for motor vehicle traffic and from facilities for people walking. Protected bike lanes are sometimes referred to as separated bike lanes or cycle tracks;

- Off-Street Paths – are roadside facilities (i.e., off-street in the public realm) for the exclusive use of people cycling (i.e., bike paths) or for shared-use by people cycling, walking and wheeling, and other active transportation modes (i.e., shared pathway);

- Local Street Bikeways – (sometimes referred to as a bicycle boulevard or neighbourhood greenway), are shared roadways located on the street in space shared with motor vehicle traffic within the Travelled Way. The application of motor vehicle speed and volume management techniques is an important and necessary design component to create an operating environment that meets the needs of the design user group (i.e., "Interested but Concerned"); and

- Painted Bike Lanes – are on-street facilities which are delineated from travel lanes for motor vehicles using pavement markings. These facilities should only be used in limited situations along short segments of roadway to connect to existing painted bike lanes or when designing contraflow cycling operations on one-way streets. Painted bike lanes may be buffered or unbuffered depending on the degree of horizontal separation required along a particular road.

These facility types are further described in ***Section 3.2.3.2*** along with the recommended Design Domain for each facility type. More information and details can be found in Section 5.3 of the TAC GDG.

For all bicycle facilities, the design of intersections, driveways and alley crossings, and mid-block crossings must consider the safe operation of people cycling. The design can include bend-out elements, continuous or raised crossings, two-stage crossings with refuge median areas, protected intersections, and other elements. Refer to ***Section 3.6*** for design guidance on intersections.

3.2.3.1.Selection of Suitable Bikeways

It should be anticipated that people on bikes may ride on any street and that motor vehicle speed and volume are key considerations in identifying a suitable bikeway facility to support safe and comfortable travel by people on bicycles.[3]

Comfort and safety on bicycle infrastructure is impacted by the volume and speed of the various types of traffic using a corridor. As the volume and speed of motor vehicles increases, separation between bicycles and motor vehicles must also increase to ensure the route is safe and comfortable. Interactions with larger vehicles, including buses, also contributes to the need to separate bicycles from vehicle traffic.

The following Bikeway Selection Framework is based on Canadian and international guidance.[4] Details of the design requirements for each bicycle facility is included in ***Section 3.2.3.2***.

The selection framework can be used in numerous ways to select and evaluate bikeway facility types in the design process as follows:

- If a street has been selected for a bikeway, the framework can help identify candidate bikeway facilities for that street;
- If a bikeway facility (e.g., protected bike lane) has been selected, the framework can help identify candidate streets with suitable conditions for that facility type;
- If a bikeway facility has been selected for a street, the framework can help identify what the target motor vehicle speed should be on that street. This can also be used to allocate traffic calming measures and enforcement resources; and
- For an existing bikeway facility, the framework can be used to identify if it remains suitable for prevailing conditions based on motor vehicle traffic speeds, motor vehicle volumes, and other street context considerations.

Motor Vehicle Speed and Volumes

The primary variables to determine bicycle facility suitability are based on the Safe System Approach and consideration of motor vehicle speeds and exposure risk posed by motor vehicle volumes. Motor vehicle speeds and volumes also significantly impact the level of comfort for people cycling.

As the relative speed between people driving and cycling increases, the comfort and safety of people on bikes decreases. At lower speeds, it is generally acceptable for people cycling and driving to share the same space, but as speeds increase, higher levels of protection and separation are required.

At motor vehicle speeds higher than 30 km/h, the risk of serious or fatal injury increases significantly for people cycling if they are involved in a crash. With higher speeds and volumes of motor vehicles, the number of passing events and interactions between people cycling and motor vehicles increases. This increases stress and decreases safety as the exposure to potential conflict rises. ***Figure 3.11*** shows how the number of passing events increases with both speed and volume of motor vehicles.

[3] Winters, M., Davidson, G., Kao, D., & Teschke, K. 2011. “Motivators and Deterrents of Bicycling: Comparing influences on Decisions to Ride”. Transportation, 38, pp. 153-168.

[4] In addition to Figure 5.4.1 from the TAC GDG, for other examples, see: Ministry of Transportation Ontario (MTO). 2021. Ontario Traffic Manual. Book 18: Cycling Facilities. MTO.; de Groot, R. editor (CROW). 2016. Design Manual for Bicycle Traffic. CROW.; Austroads. 2014. Cycling Aspects of Austroads Guides. Publication AP-G88-14. Austroads.; Troels Andersen, et al. 2012. Collection of Cycling Concepts 2012. Cycling Embassy of Denmark.; National Association of City Transportation Officials (NACTO). 2017. Designing for All Ages & Abilities - Contextual Guidance for High-Comfort Bicycle Facilities. NACTO.; Dufour, D. 2010. PRESTO Cycling Policy Guide: Cycling Infrastructure. European Commission.; City of Vancouver. 2017. Transportation Design Guidelines: All Ages and Abilities Cycling Routes. City of Vancouver.; Federal Highway Administration (FHWA). 2019. Bicycle Selection Guide. FHWA.; Transportation Association of Canada (TAC). 2020. Safety Performance of Bicycle Infrastructure in Canada. TAC.

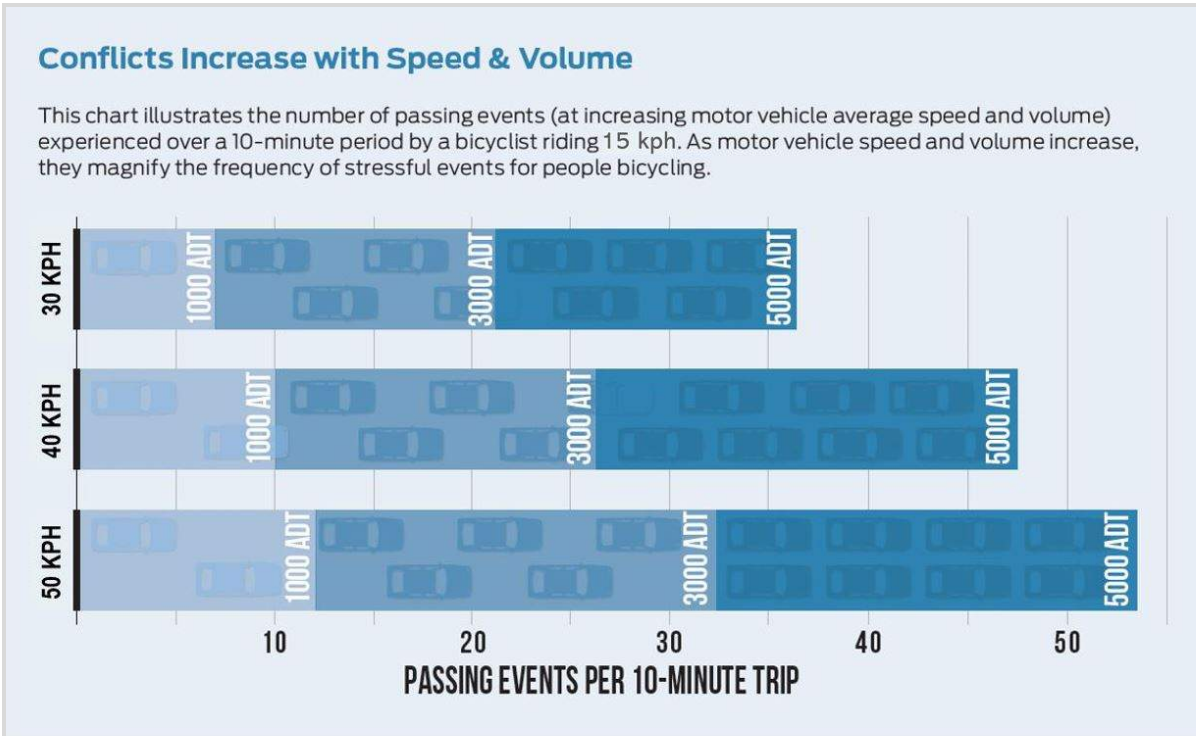


Figure 3.11 *Passing events between people cycling and motor vehicles (Source: NACTO)*

Providing traffic calming to reinforce slower speeds and manage motor vehicle volumes is important when designing and operating Local Street Bikeways. At speeds of 50 km/h and higher or at higher motor vehicle volumes, separation and protection is required.

Operational Considerations

There are a number of operational considerations that can influence the suitable bicycle facility for a street or off-street location, which include:

- Locations with high curbside activity due to high turnover motor vehicle parking or loading zones;
- Locations with high volumes of people walking and sidewalk activity;
- Locations with frequent transit;
- Locations with higher volumes of trucks and heavy vehicles; and,
- Locations with high number of turning conflicts (e.g., high number of intersections and/or driveways/accesses).

Streets with high curbside activity, higher sidewalk activity, and potential turning conflicts have higher risk of potential conflicts between users. In these locations, bicycle facilities that are unidirectional and separated from motor vehicle traffic and sidewalks are more appropriate to remove the potential for conflicts and to make the remaining conflicts more predictable.

In all locations, access management and operational practices to remove and limit the number of conflict points should be considered and incorporated as part of the design process. Access management techniques include turn restrictions, centre medians, and access closures. Operational practices include protected bicycle signal phases, protected left turn signal phases, no right turn on red, and leading bicycle intervals.

Along corridors with frequent transit and higher percentage of motor vehicles that are trucks (i.e., heavy vehicles of 5%), separation of people cycling from motor vehicle traffic is recommended to reduce exposure to vehicles that have greater kinetic energy in the event of a crash and have poorer sight lines and more blindspots for the driver of the truck or transit vehicle.

Pedestrian Volumes for Shared Pathways

Where higher pedestrian volumes are present, separation between people walking and people cycling should be considered, particularly for those with limited mobility or low vision. Separated pathways can include a Bike Path with Sidewalk or a Raised Protected Bike Lane. Separation is warranted at pathway locations where:

- A high percentage of people walking (more than 20% of users) and total peak user volumes are greater than 33 persons/hr/m of path width; or
- A low percentage of people walking (less than 20% of users) and total peak user volumes are greater than 50 persons/hr/m of path width; or
- There are greater than 1500 combined users/day.

Where walking counts or forecasted volumes are not available, land use plans and street classifications can be used to identify areas with higher anticipated activity levels of people walking, which may result in increased conflicts between people walking and people cycling. These may include pedestrian priority areas and areas with a high concentration of destinations and/or commercial frontage.

Bicycle Facility Selection Framework

Table 3.7 summarizes the range of speeds and volumes at which each ***bikeway facility is most likely to be suitable*** for the "Interested but Concerned" user group (see ***Section 3.1.3.2***). The table includes other considerations related to street context which can also influence the suitable bicycle facility type. Once motor vehicle speeds exceed 40 km/h, protected bike lanes, bike paths, or shared pathways are required.

The table is meant to be a starting point in selecting bikeway facilities for design. The street's Posted Speed is used in this framework since it is generally known, but should not limit the designer from using engineering judgement to select a facility for a street in consideration for safety and accessibility.

If a Protected Bike Lane or Shared Pathway (including the Bike Path with Sidewalk) is the suitable bikeway facility type, the following ***Separated Bikeway Selection Factors*** should be considered to determine if the facility should be a Protected Bike Lane or Shared Pathway:

- Where there is high curbside activity or in areas with higher volumes of people walking, Protected Bike Lanes are preferred (including Raised Protected Bike Lanes)
- Refer to ***Pedestrian Volumes for Shared Pathways*** for guidance on determining if a Shared Pathway should include separate facilities for people walking and cycling (i.e., Bike Path with Sidewalk)
- Where the number of commercial accesses or intersections are closely spaced (less than 100 m) and high turning conflicts exist, Raised Protected Bike Lanes are preferred because the access frequency would create too many breaks in the street buffer for non-raised protected bike lanes

Unidirectional versus Bidirectional Bikeways

Separated Bikeways—Protected Bike Lanes, Shared Pathways, and Bike Paths—can be unidirectional or bidirectional. Bidirectional facilities have a higher degree of risk, particularly at intersection, access, and driveway locations. The following should be considered when determining when a unidirectional or bidirectional facility may be suitable.

Why are unidirectional bikeway facilities preferred?

- Intersections, accesses, and driveways are safer for unidirectional bicycle facilities than bidirectional facilities because people cycle in both directions on bidirectional facilities. Drivers may not be expecting this "out of direction" travel.
- The risk of people cycling from the "unexpected direction" can be compounded by inadequate sightlines and clear sight triangles from the side street. Research shows most drivers are more focused on motorized traffic flow at side street intersections rather than on people walking or cycling and more than 25% of drivers making a right turn will only look left and not right prior to proceeding (see CROW for more details).
- Unidirectional bikeways are safer for people cycling and using micromobility devices due to removing the potential for head-on crashes between users of the separated bikeway.

When might a bidirectional bicycle facility be suitable?

- When there are destinations on only one side of a street or where the facility is in an exclusive area for active transportation (e.g., parks, utility corridors, pathways outside the clear zone along a freeway), a bidirectional bikeway on the side of the street with the destinations can decrease travel distances and travel time for people cycling.
- When there are destinations on only one side of a street or block lengths are very long, bidirectional facilities can decrease the number of crossings people cycling have to make of the main street, which can reduce exposure to crash risk. People cycling may ride in both directions even in a unidirectional bikeway in these contexts due to their ability to reduce their travel distances and travel time delays from intersections, which supports designing for bidirectional bikeway travel.
- In retrofit situations where width for two unidirectional lanes may not be available.
- When connecting to existing bidirectional facilities, including shared pathways. This helps to maintain consistent operating patterns for cyclists throughout a corridor and can reduce the need for unintuitive transitions between facility types.
- Where there are no or very few accesses or driveways and the distance between intersections is larger (e.g., arterial streets and the situations described above), bidirectional facilities may be suitable due to limited number of conflict points.

If suitable, the following measures should be used to improve the safety of bidirectional bikeways at side streets:

- Build a raised crossing;
- Create queuing space between the crossride and the major street prior to the crossing (i.e., bend-out crossing configuration) for turns off the major street and movements from the minor street (6 m queuing space);
- Provide turn lanes along the major street coupled with protected traffic signal phasing or leading bicycle intervals to reduce turn conflicts from the major street across the bidirectional facility;
- Provide adequate sight distance for traffic approaching from the side street to see bikeway users travelling in both directions; and,
- Use pavement markings and signs to communicate right of way and priority at the crossing.

Table 3.7 *Framework for Consideration of Bike Facilities*

Posted Speed[1]	Motor Vehicle Volumes or Functional Classification	Considerations	Suitable Facility	Notes
N/A	Off-Street (open space, River Valley, ravine, utility corridor, etc.)	Volume of people walking and cycling	Shared Pathway OR Bike Path with Sidewalk	Refer to ***Pedestrian Volumes for Shared Pathways*** section for guidance
	Car Free Street	Volume of people walking and cycling	Local Street Bikeway – Shared Roadway OR Parallel Route if pedestrian volumes are very high	
30 km/h or less	Shared Street	People walking, wheeling, and cycling share the Travelled Way	Local Street Bikeway – Shared Roadway	Design treatments are required to reinforce shared Travelled Way pedestrian priority operation
	Alley	People walking, wheeling, and cycling share the Travelled Way	Local Street Bikeway – Shared Roadway	
	500 vehicles per day or less	N/A	Local Street Bikeway	Traffic Calming may be used to reinforce low speed and volume environment
	500 to 1,000 vehicles per day OR Local Street	N/A	Local Street Bikeway with Traffic Calming to reinforce low speed and volume environment	Traffic Calming to reinforce speeds of 30 km/h and volumes under 1,000 vehicles per day
	1,000 to 2,000 vehicles per day OR Enhanced Local Street	N/A	Local Street Bikeway with Traffic Calming	Traffic Calming to reduce volumes to 1,000 vehicles per day or less
		If Traffic Calming is unlikely to reduce volumes	Protected Bike Lane OR Shared Pathway	Refer to ***Motor Vehicle Speed and Volumes*** section for guidance See ***Separated Bikeway Selection Factors*** below
	Over 2,000 vehicles per day OR Collector Street	N/A	Protected Bike Lane OR Shared Pathway	

Posted Speed[1]	Motor Vehicle Volumes or Functional Classification	Considerations	Suitable Facility	Notes
40 km/h	Less than 1,000 vehicles per day OR Local Street	Less than 50 motor vehicles per hour in the peak direction at peak hour	Local Street Bikeway	Refer to ***Motor Vehicle Speed and Volumes*** section for guidance
		More than 50 motor vehicles per hour in the peak direction at peak hour	Local Street Bikeway with Traffic Calming to reduce peak hour volumes	
		If peak hour volumes cannot be reduced	Protected Bike Lane OR Shared Pathway	See ***Separated Bikeway Selection Factors*** below
	1,000 to 3,000 vehicles per day	Less than 50 motor vehicles per hour in the peak direction at peak hour	Local Street Bikeway with Traffic Calming to reduce speeds to 30 km/h and volumes to under 1,000 vpd	Refer to ***Motor Vehicle Speed and Volumes*** section for guidance
		More than 50 motor vehicles per hour in the peak direction at peak hour OR If Traffic Calming is unlikely to reduce volumes and speeds OR Heavy vehicle volumes are more than 5%	Protected Bike Lane OR Shared Pathway	Refer to ***Motor Vehicle Speed and Volumes*** section for guidance See ***Separated Bikeway Selection Factors*** below
	More than 3,000 vehicles per day OR Collector or Arterial Street	Including streets designated as Truck Route, or City-Wide or District Mass Transit Route, or Frequent or Express Transit Route	Protected Bike Lane OR Shared Pathway	
50 km/h	Any volume OR Arterial Street	N/A	Shared Pathway OR Bike Path with Sidewalk OR Protected Bike Lane	Refer to ***Pedestrian Volumes for Shared Pathways*** section for guidance See ***Separated Bikeway Selection Factors*** below
60 or 70 km/h	Any volume OR Arterial Street	N/A	Shared Pathway OR Bike Path with Sidewalk OR Protected Bike Lane with rigid barrier	Refer to ***Pedestrian Volumes for Shared Pathways*** section for guidance
Over 70 km/h	Any Volume OR Arterial Street or Freeway	Typical pathway volumes	Shared Pathway located outside the Clear Zone	Refer to ***Pedestrian Volumes for Shared Pathways*** section for guidance
		High pathway volumes	Bike Path with Sidewalk located outside the Clear Zone	

Notes: *Designers should also check motor vehicle operating speeds during the design process.*

3.2.3.2.Bikeway Facility Design Domain

The following presents the recommended Design Domain for each bikeway facility type. More information and details can be found in Section 5.3 of the TAC GDG.

When selecting widths, the designer should consider impacts to the design user:

- Whenever possible, design widths that allow side-by-side riding should be selected. This allows for social riding and passing. Where passing is not possible, it may encourage people on bikes to use the driving lane or sidewalk to make passing manoeuvres or avoid hazards; and,
- When using narrower widths, shorter, bevelled, or mountable curbs should be used to reduce the hazard of pedal strike and provide a place to exit the lane.

Protected Bike Lane

Protected Bike Lanes are illustrated in ***Figures 3.12*** and ***3.13***. They are typically positioned directly next to a curb or on the curb side of a parking lane, and are separated from motor vehicle travel lanes by a vertical delineator appropriate to the speed and volume of the adjacent motor vehicle traffic. The defining element of this facility type is the horizontal and/or vertical protected bike lane delineator, which is designed to minimize or prevent encroachment on the bike lane by motor vehicles. A parking lane, where provided, may also function as a further buffer between people cycling and motor vehicle traffic as a complementary element beyond the protected bike lane delineator. Protected bike lanes may also be separated from motor vehicle travel lanes by grade separation at an elevation between the Travelled Way and sidewalk.

Other important considerations for protected bike lanes are traffic controls and markings to manage conflicts with other street users at intersections and driveway locations, queuing space for people riding bikes at intersections, and managing access to vehicle parking spaces, loading zones, and bus stops.

Figure 3.12 Unidirectional (Raised) Protected Bike Lane

Figure 3.13 Bidirectional Protected Bike Lane

In general, unidirectional protected bike lanes on each side of the street are preferred on two-way streets due to the design challenges with bidirectional protected bike lanes in this context. Bidirectional protected bike lanes on two-way streets require access management, turn restrictions (turn prohibitions and separate traffic signal phasing), pavement markings, and signs to remove, mitigate, and manage conflict points at driveways, accesses, and intersections.

On one-way streets, bidirectional protected bike lanes should be placed on the left side of the street for two reasons. First, bicycle and motor vehicle traffic move in the same direction where they are adjacent, reducing their relative travel speed. Second, users remain on the normally-anticipated side of the street, so that drivers making right turns do not face oncoming bicycle traffic, which is contrary to drivers' expectations. It should be noted that in this situation, drivers making left turns will need to be aware of cyclists travelling in the same direction on their left.

Protected bike lanes may also be raised above the Travelled Way to sidewalk level or an intermediate level between the sidewalk and the Travelled Way. For ***Raised Protected Bike Lanes***, or raised cycle tracks, there is a buffer between the bike lane and the Travelled Way or Curbside Zone consistent with street level protected bike lanes which is typically hard surfaced. The curb between the street buffer and the Travelled Way or Curbside Zone can be straight face, which is preferred adjacent to on-street parking or a travel lane to minimize the potential for entering the protected bike lane by motor vehicle traffic. If the street buffer is landscaped and the raised cycling facility is offset significantly from the Travelled Way, this in-boulevard cycling facility is considered a ***Bike Path***.

For intermediate level raised protected bike lanes, a bevelled curb (1V:3H) is used on either side of the bike lane to transition to the Furnishing Zone and may be used toward the Travelled Way or Curbside Zone if the bike lane drains toward the Furnishing Zone. The use of a bike-friendly frame and cover is required if draining toward the sidewalk.

The bevelled curb between the intermediate level raised protected bike lane and sidewalk is detectable for people with vision loss if the difference in elevation is at minimum 50 to 60 mm. Tactile walking surface indicators may be required for a sidewalk level raised protected bike lane unless the protected bike lane is separated from the sidewalk by a landscaped Furnishing Zone, which are detectable by people with vision loss due to the difference in surface material, colour, and texture. Tactile direction indicators and tactile attention indicators are important for crossings of raised protected bike lanes to access accessible parking or loading spaces and bus boarding islands.

Sidewalk level protected bike lanes may offer maintenance benefits, particularly for snow clearing and ice control, while intermediate level protected bike lanes will require the same considerations as street level protected bike lanes.

Table 3.8 defines the Design Domain for protected bike lanes.

The recommended width of a protected bike lane is based on:

- Accommodating passing and side-by-side riding, where possible, to accommodate social riding and to accommodate people cycling at different speeds;
- Accommodating single-file bicycle traffic plus separation between people travelling in opposite directions on bidirectional facilities;
- Accommodating higher volumes and speeds at the higher end of the recommended range and for District Connector Routes (>1500 bicycles/day); and,
- Accommodating the width of equipment required to maintain the lanes, including snow and ice control.

When selecting widths on the lower end, the designer should consider the use of low or rolled curbs to provide a safe run out zone for cyclists. Lower limits should only be used in retrofit or constrained urban situations.

Table 3.8 *Design Domain: Protected Bike Lanes (in m)*

Parameter	Design Domain Recommended Range		Target
	Lower Limit	Upper Limit	
Bike Lane Component[1]			
Unidirectional Bike Lane (District Connector)	2.1[2]	3.0	2.5
Unidirectional Bike Lane (Neighbourhood Route)	2.1[2]	2.5	2.1
Bidirectional Bike Lane (District Connector)	3.0	4.5	4.0
Bidirectional Bike Lane (Neighbourhood Route)	3.0	4.0	3.0
Buffer Component[3,4]			
Unidirectional Bike Lane Buffer Width, Bike to Street	0.6	5.0	1.5[5]
Bidirectional Bike Lane Buffer Width, Bike to Street	0.6	5.0	1.5[5]
Buffer Width, Bike to Walk	0.6[6]	N/A	1.0

Notes:

1. The width of the bike lane component is measured to/from the face of the curb and accommodates the horizontal operating envelope, horizontal offset to curbs, 0.25 m gutters, and considerations for all seasons maintenance. For gutters wider than 0.25 m, additional width is required due to the longitudinal hazard caused by the joint between the gutter and pavement.

2. The recommended minimum width of unidirectional protected bike lanes is based on the bike lane being located between two vertical curbs. If the bike lane is raised to sidewalk level, the minimum width can be 1.8 m for Neighbourhood Routes. In this situation, concrete must be used.

3. Where the posted speed exceeds 60 km/h, a separated bike path or shared pathway is preferred and the path should be located outside of the clear zone. If a bike lane is used, an appropriate roadside barrier is required.

4. Wider buffers are preferred when practical within available right of way.

5. The width of the street buffer for protected bike lanes should also consider the intersection and driveway crossing offset requirements from the parallel traffic lane. The recommended crossing offsets from the parallel travel lane for unidirectional protected bike lanes are 2 to 5 m. The recommended offset for a bidirectional protected bike lane is 5 m. The protected bike lane should bend-out prior to intersections and crossings. See ***Section 3.6.5.1*** for additional guidance on intersection design for protected bike lanes.

6. The minimum width of the sidewalk buffer at 0.6 m accommodates installation of signage.

In addition to the design requirements based on user needs and directionality, the width of protected bike lanes should also consider the width of maintenance equipment such as sweepers and snow plows.

The purpose of the protected bike lane buffer between the bike lane and the street is to provide physical separation with vertical objects between people cycling and parked or moving motor vehicles. The recommended minimum width of the protected bike lane buffer ranges from 0.6 m to 1.0 m based on the following, but could be wider if motor vehicle speeds are high:

- Typical dimensions of delineators;
- Accommodating the opening of motor vehicle doors on the passenger side (minimum of 0.6 m width);
- Accommodating the grade difference between a bike lane and a motor vehicle lane if the bike lane is raised (minimum of 1.0 m width);
- Possibility to use the delineator for temporary snow storage for snow cleared from the bike lane; and
- Accommodating typical widths of signs.

As part of protective delineator selection and design, the designer should consider the horizontal clearances as per ***Section 3.1.3.2*** and incorporate additional width as required. Larger buffers can also be used to accommodate a Curbside Zone or Furnishing Zone for furnishings or landscaping as long as the horizontal clearances are maintained.

Protected bike lane delineators, as illustrated in ***Figure 3.14***, include green flexible bollards, parking stops, planter boxes, concrete barriers, raised or landscaped medians, and raised bike lanes. Protected bike lane delineators must use contrasting colours for high visibility, especially at night. Motor vehicle parking and other Curbside Zone uses can also be used to increase the horizontal offset of the bicycle lane to the traffic lane. For more information on these measures and the additional factors to consider for selection, refer to TAC GDG Section 5.7.5.

Flexible Bollard

Typically used in lower-speed environments. May not be appropriate, without additional curbing, for streets with posted speed limits that exceed 50 km/h. Typically spaced between 3 and 6 m apart.

Parking Stop

Typically used for lower-speed environments adjacent to vehicle parking and can be combined with flexible bollards to make curbs more visible in all seasons. May be placed continuously with gaps between or under for drainage or can be spaced between 2.5 and 3.5 m apart.

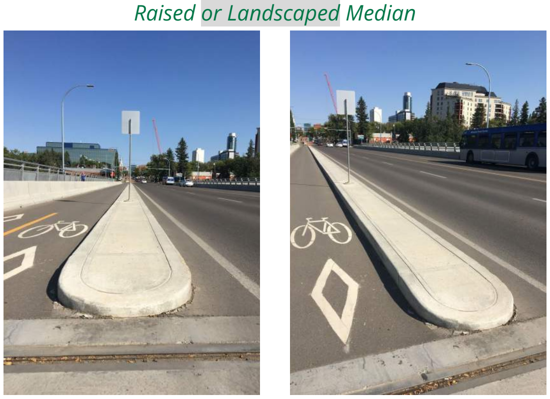
Planter Box

Typically used in lower-speed environments. Planter boxes with periodic or intermittent spacing are not appropriate on streets with posted speed limits greater than 50 km/h. Planter boxes may also be placed on top of a concrete median.

Concrete Barrier

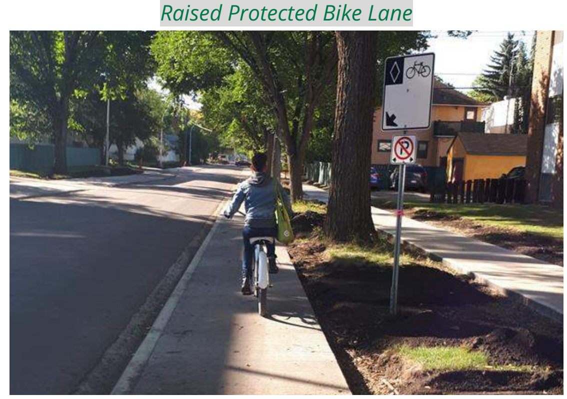
Typically used for locations where more physical protection from motor vehicle traffic is required, such as on bridges and higher-speed streets. Should not be used where there is on-street parking.

Raised or Landscaped Median



Typically used for locations where more physical separation between people cycling and motor vehicle traffic is needed, such as on bridges and higher-volume streets. Median curbs can also be bevelled to reduce the risk of pedal strikes. Can be used in locations where there is on-street parking, with hardscaped medians preferred in locations with high curbside activity.

Raised Protected Bike Lane



Typically used in locations where there are physical constraints limiting the ability to accommodate recommended horizontal buffer space, or where preferable for snow and ice control procedures. Can be combined with raised or landscaped medians between the bicycle lane and parking lane or traffic lane. If located adjacent to a parking lane, a horizontal buffer should be provided between the raised protected bike lane and the parking lane to support vehicle loading/unloading.

Figure 3.14 *Protected Bike Lane Delineators*

Shared Pathways & Bike Paths

Bike Paths and ***Shared Pathways*** are designations used to describe bike facilities that are not located directly on the Travelled Way, but separated from the vehicle traffic by a boulevard/Furnishing Zone, median, or buffer, or located within park space, open space, or a utility corridor. Shared pathways should not be located immediately adjacent to a vehicle travel lane without a buffer.

A shared pathway is an off-street facility that allows for two-way shared-use by people cycling and walking and wheeling as illustrated in ***Figure 3.15A***. If a shared pathway is configured to separate people walking and cycling on separate path sections, as illustrated in ***Figure 3.15B***, it is treated and designed as two facilities: a bike path and an adjacent sidewalk.

Figure 3.15B shows the sidewalk facility separated from the bike path using physical separation. An alternative arrangement could include a tactile delineator between the bike path and the sidewalk or placing the sidewalk slightly above the shared pathway. The configuration with the sidewalk above the bike path is preferable, for people with sight loss.

Separation of shared pathway users should be considered as outlined under *Pedestrian Volumes for Shared Pathways* in ***Section 3.2.3.1***.

Shared pathways shall not be provided along residential local streets except as identified in the cross sections. Providing a shared pathway on an enhanced local is only acceptable in areas of high vehicular volumes or no yield conditions.

Bike Paths are commonly located alongside a parallel sidewalk and are designated for the use of people cycling and may also be used by people operating micromobility devices. As such, the bike path and sidewalk, as a pair, are similar to a shared pathway, but segregates the users by type.

Within the road right of way, if the cycling facility is significantly offset from the Travelled Way by a landscaped Furnishing Zone, the in-boulevard bicycle facility is considered a bike path. If the offset to the Travelled Way or Curbside Zone is narrower, the raised bicycle facility is considered a raised protected bike lane.

(A) Shared Pathway

(B) Bike Path with Sidewalk

Figure 3.15 *Shared Pathways*

The recommended lower limit width of a shared pathway provides comfortable width for one person cycling in each direction and accommodates a scenario based on the operating envelope of a single person cycling plus comfortable space for two people walking abreast. This dimension also accommodates the operating envelope of one coasting inline skater in each direction. The recommended upper limit width is appropriate in areas with higher volumes of walking and cycling traffic where there is a need to accommodate passing manoeuvres for cyclists and pedestrians simultaneously in both directions of travel. Shared pathways that are District Connector routes are wider to account for anticipated higher volumes of pathway users.

The recommended width of a bike path depends on whether it is unidirectional or bidirectional and whether it is a District Connector or Neighbourhood Route. Wider facilities are required for higher order facilities and those with higher anticipated volumes.

Table 3.9 defines the Design Domain for shared pathways and bike paths.

Table 3.9 *Design Domain: Shared Pathways and Bike Paths (in m)*

Parameter	*Design Domain Recommended Range[1]*		*Target*
	Lower Limit	*Upper Limit*	
Path Component[1]			
Unidirectional Bike Path (District Connector)	2.1	3.0	2.5
Unidirectional Bike Path (Neighbourhood Route)	1.8	2.5	2.1
Bidirectional Bike Path (District Connector)	3.0	4.5	4.0
Bidirectional Bike Path (Neighbourhood Route)	3.0	4.0	3.0
Shared Pathway (District Connector)	3.0[2]	6.0	3.0
Shared Pathway (Neighbourhood Route)	3.0[2]	4.0	3.0
Buffer Component[3,4]			
Buffer Width, Bike to Street	0.6	N/A	1.5[4]
Buffer Width, Bike to Walk	0.3	N/A	1.0

Notes:

1. Widths measured from edge of path to edge of path. If paths are located adjacent to a curb (i.e., curbline or monolithic path), an additional minimum 0.6 m width is required.

2. The Design Domain for shared pathway recommended lower limit along an Industrial Local Street can be 2.5 m if the path is not a District Connector Route within the larger bicycle network at the discretion of the City.

3. Wider buffers are preferred when practical within available right of way and, when parallel to higher speed streets where posted speeds exceed 60 km/h, the pathways should be located outside the clear zone.

4. The width of the street buffer for bike paths and shared pathways should consider intersection and driveway crossing offset requirements from the parallel traffic lane. The recommended offsets from the parallel travel lane for unidirectional bike paths are 2 to 5 m, while the offset for shared pathways and bidirectional bike paths is 5 m. This dimension can be used continuously along the corridor, or a bend-out design can be used at intersections and crossings. See ***Section 3.6.6*** for additional guidance on intersection design for pathways.

Local Street Bikeway

A ***Local Street Bikeway***, is a street with low motor vehicle traffic volumes and speeds, where all ages and abilities of people cycling will feel comfortable riding their bicycles on-street with motor vehicle traffic.

A ***Local Street Bikeway***, as illustrated in ***Figure 3.16***, also referred to as a Shared Roadway, is a street where the Travelled Way is shared by people cycling and driving and provides a continuous corridor of suitable operating conditions for the design user group (i.e., "Interested but Concerned"), including limiting exposure to motor vehicle traffic and designing for low motor vehicle speeds. Often located on local streets, Local Street Bikeways incorporate traffic calming measures to facilitate through access by bicycle traffic while inhibiting through access by motor vehicle traffic.

A Local Street Bikeway incorporates traffic calming and other design elements as needed to ensure motor vehicle operating speeds are 30 km/h or less, volumes are low (under 1,000 vpd and 50 in the peak hour), and the design of the facility clearly indicates that people cycling are prioritized. To meet the intent of this facility, traffic calming measures should be provided every 100 meters, alternating between horizontal deflection, vertical deflections, and roadway narrowing.

At major intersections, such traffic calming measures can include diagonal diverters and bicycle-crossable medians. Between intersections, traffic calming measures can include bicycle-crossable chicanes and speed humps. Design guidance for traffic calming measures is provided in ***Section 3.8***. When designing traffic calming, designers should consider and mitigate impacts to existing accessible parking. Additional traffic diverters should be provided at collector - local intersections or at intervals no greater than 600 meters to limit traffic shortcutting and achieve lower traffic volumes.

To reduce travel time for people cycling and facilitate maintenance of speed and momentum at minor street intersections, stop signs should be oriented to control the cross street rather than the local street bikeway. At major street intersections, bicycle signals with bicycle actuation should be provided. To mitigate potential concerns with speeding and shortcutting that may occur as a result, additional traffic calming or diversion may be required.

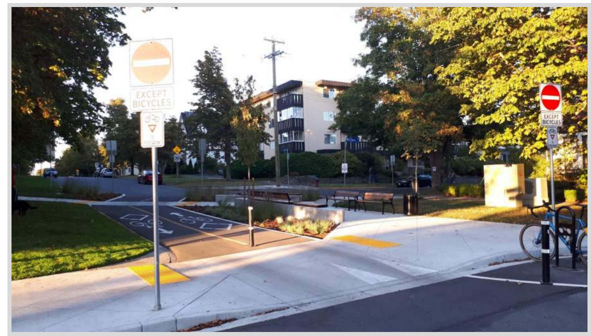


Figure 3.16 *Local Street Bikeway*

Signage and pavement markings should be used to identify the Local Street Bikeway and prepare people driving to encounter traffic calming treatments. Shared-use lane markings ("sharrows") may be used in accordance with the TAC Bikeway Traffic Control Guidelines for Canada. Care should be taken to not rely solely on pavement markings as they may not be visible in winter conditions and may not support the conditions required to ensure a suitable facility for users of all ages and abilities.

Existing examples of "Shared Roadway" treatments relying primarily on shared-use lane markings ("sharrows") and signage without traffic calming measures may not be suitable for users of all ages and abilities.

The Design Domain for the width for Shared Roadway Local Street Bikeways are based on the Design Domain dimensions for general purpose travel lanes and parking lanes in ***Section 3.2.2***.

Painted Bike Lanes

Painted Bike Lanes are reserved travel lanes for people cycling. They are only used in limited situations to allow contraflow operation one-way streets or to connect to existing painted bike lanes.

A ***Painted Bike Lane*** is illustrated in ***Figure 3.17***. A Painted Buffered Bike Lane is defined by additional longitudinal pavement markings running parallel to the Travelled Way that act as a buffer to increase the separation between people cycling and adjacent motor vehicles. The buffer space may also be marked with transverse pavement markings such as hatched striping, and can decrease ambiguity as to the purpose of the bike lane and bike lane buffer (i.e., it is less likely to encourage inappropriate motor vehicle use as a travel lane).

A ***Contraflow Painted Bike Lane*** is a bike lane that allows bicycle travel in the opposite direction on a one-way street as illustrated in ***Figure 3.18***.

Traffic calming is required to reinforce 40 km/h posted speed limits on streets with painted bike lanes. When designing traffic calming, designers should consider and mitigate impacts to existing accessible parking.

Figure 3.17 *Painted Bike Lane*

Figure 3.18 *Contraflow Painted Bike Lane*

Table 3.10 defines the Design Domain for the width of painted bike lanes and any buffers that are provided, with the rationale discussed following the table.

Table 3.10 *Design Domain: Painted Unidirectional Bike Lanes (in m)*

Parameter	*Design Domain Recommended Range*		
	Lower Limit	*Upper Limit*	*Target*
Bike Lane Component[1]			
Unidirectional Bike Lane (District Connector)	1.8	2.5	2.1
Unidirectional Bike Lane (Neighbourhood Route)	1.8	2.1	1.8
Buffer Component[2]			
Buffer Width, Bike/Street	0.3	N/A	0.9

Notes:

1. The width of the bike lane component is measured from face of curb and accommodates the horizontal operating envelope, horizontal offset to curbs, 0.25 m gutters, and considerations for all seasons maintenance. For gutters wider than 0.25 m, additional width is required due to the longitudinal hazard caused by the joint between the gutter and pavement.

2. Wider buffers are preferred when practical within available right of way.

The recommended width of a painted bike lane of between 1.8 m and 2.1 m is based on:

- Reasonable width for single-file movements;
- Accommodation of basic passing movements; and
- Accommodating higher volumes of bicycle traffic (>1,500 bicycles/day) at the higher end of the recommended range.

Where a total painted bike lane width is greater than 2.1 m, it is recommended that a buffered bike lane be used instead.

If the total lane including the buffer is wider than 3.0 m, it may encourage motor vehicle traffic to use it inappropriately as a parking or travel lane. Where a total width greater than 2.5 m is available, it is recommended that a protected bike lane be considered.

Where there is high curbside activity, protected bike lanes should be used and flexible delineators or other physical delineators should be added to the painted bike lane buffer or along the painted bike lane line marking.

3.2.3.3. Additional Bicycle Design Considerations / Guidance

Lighting

Lighting is an essential component of bicycle transportation infrastructure. The most important areas for lighting are intersections, which need to be illuminated to allow a person cycling enough time to see the intersection and take appropriate action in advance of the crossing. Intersection lighting also allows the people cycling to be seen, and to see others, while crossing the intersection. Additional locations where lighting is important are bridges, under and over passes, crossings, tunnels, and viaducts. Where the bikeway facility is separated from the Travelled Way by more than 5 m, lighting design should follow the Volume 6 of the City of Edmonton's Design and Construction Standards. Lighting may also be needed wherever there is bikeway facility signage, particularly warning signs.

The effects of incidental lighting on a shared pathway need to be considered. The most common example of incidental lighting is where a path parallels a street. Headlights of oncoming vehicles can shine directly into the eyes of people cycling causing momentary blindness. Similarly, people cycling on-street could be hidden by the headlights of vehicles from behind. This could be hazardous to people cycling on a curving path or in the face of oncoming bicycle traffic. In these cases, low level path lighting is recommended. Refer to Volume 6 of the City of Edmonton's Design and Construction Standards for appropriate lighting levels.

Integration with Transit

Where bikeways are located along streets with transit service, there may be potential conflicts with passengers embarking or disembarking from transit vehicles and people riding bicycles. There are two basic approaches to integrate cycling with transit at transit stops: Transit Stop Boarding Platform or Transit Stop Mixing Zone. The preferred and recommended approach is the Transit Stop Boarding Platform. In constrained locations where a Transit Stop Boarding Platform can not be provided, a Transit Stop Mixing Zone may be an alternative. A custom design will be required with an approved design exception from the City of Edmonton (including Edmonton Transit Service).

At a Transit Stop Boarding Platform a bicycle bypass is provided that allows people cycling to pass stopped buses on the right side of the bus, between the transit stop boarding platform and the sidewalk, and prevents conflicts with buses pulling to the curb. The Transit Stop Boarding Platform can be used with painted bike lanes, buffered bike lanes, and protected bike lanes. The bikeway can be at street-level, sidewalk-level, or an intermediate-level. If the bikeway is located at street-level or an intermediate-level, curb ramps will be required to provide an accessible connection to the transit stop boarding platform for people walking / transit passengers.

Although protected bike lanes create safer conditions for people cycling by physically separating people cycling from motor vehicle traffic, their location next to the curb has two major impacts:

- It eliminates direct access to the curb for people accessing transit vehicles that are picking or dropping them off; and,
- It results in people walking having to cross an active bikeway to access bus service that uses bus stops located on a transit stop boarding platform.

There is also an issue with protected bike lanes and access to transit stops for people with vision loss. People with vision loss can have difficulty detecting the delineation treatment between the walking path and bicycle path with a cane, under foot, or with guide dogs. In addition, detecting approaching bicycle users can also be difficult.

Conflicts between people cycling and people walking and wheeling may increase around transit stop boarding platforms compared to conventional bus stop designs; however, this can be mitigated by providing generous transit stop boarding platforms, clearly marking the bikeway crossing with pavement treatments and signage, including design elements to slow approaching bicycle traffic, and improving sightlines near the transit stop.

Integrating bikeways with transit stops should include elements that consider and accommodate the following movements and interactions:

1. Walking along the accessible walking route
2. Riding along the bikeway
3. Finding the bus stop
4. Orienting and navigating to and from the transit stop boarding platform

5. Interactions between people walking and people cycling:

   + People walking detecting approaching bicycle traffic and having confidence that they have the right of way

   + Managing speeds of people cycling at the bus stop location and yielding right of way to people walking across the bikeway

6. Bus boarding and alighting

For more information and background on bikeway integration with transit and transit stop boarding platforms, refer to the *Design Guide for Bus Stops Adjacent to Cycling Infrastructure* published by the British Columbia Ministry of Transportation and Infrastructure available here. This guide also includes information for Transit Stop Mixing Zone. See also TAC GDG Section 5.7.4 for more guidance on bike infrastructure integration with transit stops.

The following should be incorporated into the design of Transit Stop Boarding Platforms based on the components identified in ***Figure 3.19*** within the Bus Stop Area. Due to the width requirements for Transit Stop Boarding Platforms and its components, the Frontage Zone may need to be removed or narrowed to provide accessible width for the Pedestrian Through Zone.

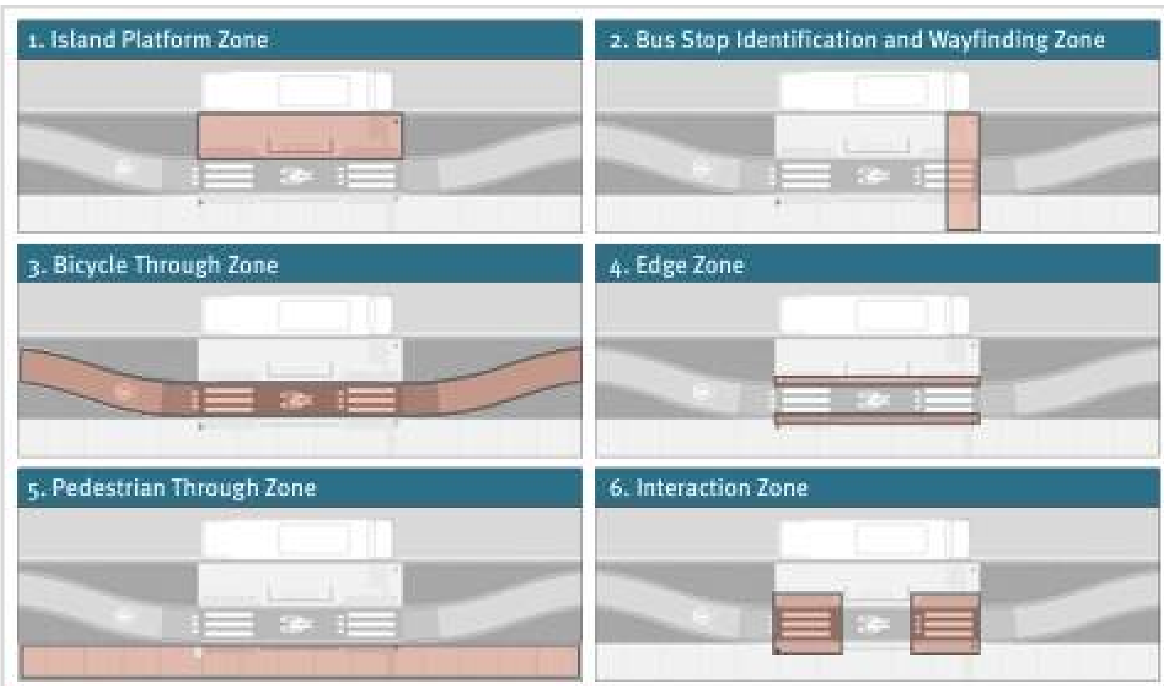


Figure 3.19 *Transit Stop Boarding Platform Components within the Bus Stop Area (Source: MOTI Design Guide for Bus Stops Adjacent to Cycling Infrastructure)*

Island Platform Zone

The Island Platform Zone is the Transit Stop Boarding Platform where public transit passengers embark, disembark, and wait for transit service.

- The size of the Transit Stop Boarding Platform can range in size (length and width) based on the available right of way/space, passenger volumes, transit headways, and other transit operational factors. The sizes typically range from 9 m by 4 m to 12 m by 2.25 m. Refer to Standard Detail 4110.
- Transit Stop Boarding Platforms should be at a different elevation from the protected bike lane (50 to 150 mm) to allow people with vision loss to differentiate between the bikeway and platform. If the bikeway is at the same elevation as the Transit Stop Boarding Platform, railings may be used.

Bus Stop Identification and Wayfinding Zone

The Bus Stop Identification and Wayfinding Zone are located across the Bus Stop Area to assist transit passengers in identifying the crossings to/from the Transit Stop Boarding Platform, including for people with vision loss, and orienting themselves to the Accessible Boarding Area.

- A bus stop ID pole should be placed at the head of the Transit Stop Boarding Platform. The bus stop ID pole should be directly adjacent to the Accessible Boarding Area and placed near the vehicular route edge.
- Tactile Attention Indicators can be located at the Accessible Boarding Area at the head of the Transit Stop Boarding Platform (optional).
- Tactile Direction Indicators can be used between the Tactile Attention Indicators for the crosswalk and the Tactile Attention Indicators for the Accessible Boarding Area across the Transit Stop Boarding Platform (optional). If used, the Tactile Direction Indicators should be 300 mm wide.

Bicycle Through Zone

The Bicycle Through Zone is the location of the bikeway through the Bus Stop Area and is located between the Furnishing Zone and the Transit Stop Boarding Platform. The Bicycle Through Zone includes elements to manage bicycle speeds and encourage yielding to people walking to/from the Island Platform Zone.

  - The width of the bikeway can be narrowed within the Bus Stop Area to reduce the likelihood of passing and manage bicycle speeds.

- A horizontal lateral shift should be included on the bikeway approach prior to the Interaction Zones at the beginning of the Bus Stop Area for the Transit Stop Boarding Platform to reduce speeds of people cycling. The lateral shift should be at a rate of 5:1 (longitudinal to horizontal). ***Figure 3.20*** provides an example of a lateral shift of a bidirectional bike lane.

Figure 3.20 Bidirectional Bike Lane Lateral Shift

- The bikeway can be raised at crossings to further reduce bicycle speeds. The grade of the ramp should be between 5% and 8.33%.

Edge Zone

The Edge Zone includes the Furnishing Zone and the buffer between the bikeway/Bicycle Through Zone and the Transit Stop Boarding Platform.

- To accommodate the Transit Stop Boarding Platform and horizontal lateral shift of the bikeway, the Furnishing Zone may need to be narrowed or shifted laterally toward the property line. The preferred minimum width of the Furnishing Zone is 0.5 m, and the absolute minimum is 0.3 m within the Bus Stop Area.

- Signs, lighting, and trees should be located within the Furnishing Zone.
- Landscaping within the Bus Stop Area should be no higher than 0.6 m in height to ensure visibility of children.
- For an intermediate-level bikeway, a bevelled curb should be used as part of the Edge Zone to decrease the risk of pedal strikes.
- For a street-level bikeway, a straight face curb can be used or a bevelled curb.
- For sidewalk-level bikeways, a railing may be installed 0.5 m from the edge of the bikeway/Bicycle Through Zone on the Transit Stop Boarding Island to restrict access across the bikeway to the Interaction Zones (i.e., marked crossings). The railing will require a larger Island Platform Zone.

Pedestrian Through Zone

The Pedestrian Through Zone includes the accessible walking route for people walking and wheeling along the street, including those travelling to/from the transit stop.

- To accommodate the Transit Stop Boarding Platform and horizontal lateral shifts of the bikeway, the Pedestrian Through Zone may need to be narrowed or shifted laterally toward the property line.

Narrowing the Pedestrian Through Zone should be the last trade-off used by designers due to the higher walking activity that may occur to/from the transit stop.

Interaction Zone

Interaction Zones are the locations of the crossing for transit passengers to access/egress the Transit Stop Boarding Platform across the bikeway.

- The minimum width of the crosswalk and approach to the crossing should be 2.0 m.
- Each crosswalk should be at sidewalk- or an intermediate-level to provide a speed management feature for bicycle traffic.
- Tactile Attention Indicators should be placed on either side of the crossing of the bikeway and 300 mm from the edge of the crossing.
    - Tactile Directional Indicators can be used across the Pedestrian Through Zone up to the Tactile Attention Indicators (optional). If used, the Tactile Direction Indicators should not be used across the bikeway and the width of the Tactile Direction Indicators should be 600 mm across the Pedestrian Through Zone.
- A "Cyclists Yield to Pedestrians" regulatory sign should be placed on the approach to the Bus Stop Area and the first Interaction Zone.
- The crosswalks should be marked with a Zebra Crosswalk pavement marking and associated crosswalk sign.
- Unobstructed sightlines for people cycling on the approach to the Interaction Zone should be provided for a distance of 20 m from the crossing to see people walking 1 m from the back of the Tactile Attention Indicators.

Example Transit Stop Boarding Platforms

Figure 3.21A and ***3.21B*** illustrate example Transit Stop Boarding Platforms applying the design requirements noted above. When providing a Transit Stop Boarding Platform, the bus stop pad size should be at minimum as detailed in the Section 4000 drawings. Bus stop design may be context-dependent based on the location and stops along cycling routes may be configured differently than typical stops, but the space required for accessibility, furniture placement, etc. cannot be less than typically required and noted in the standard details. Additional bus stop pad space may be required to provide adequate setback/clearance between people cycling and bus shelters or to accommodate other elements that may reduce pad space, including railings or landscaping.

Figure 3.21A *Transit Stop Boarding Platform (Unconstrained Location)*

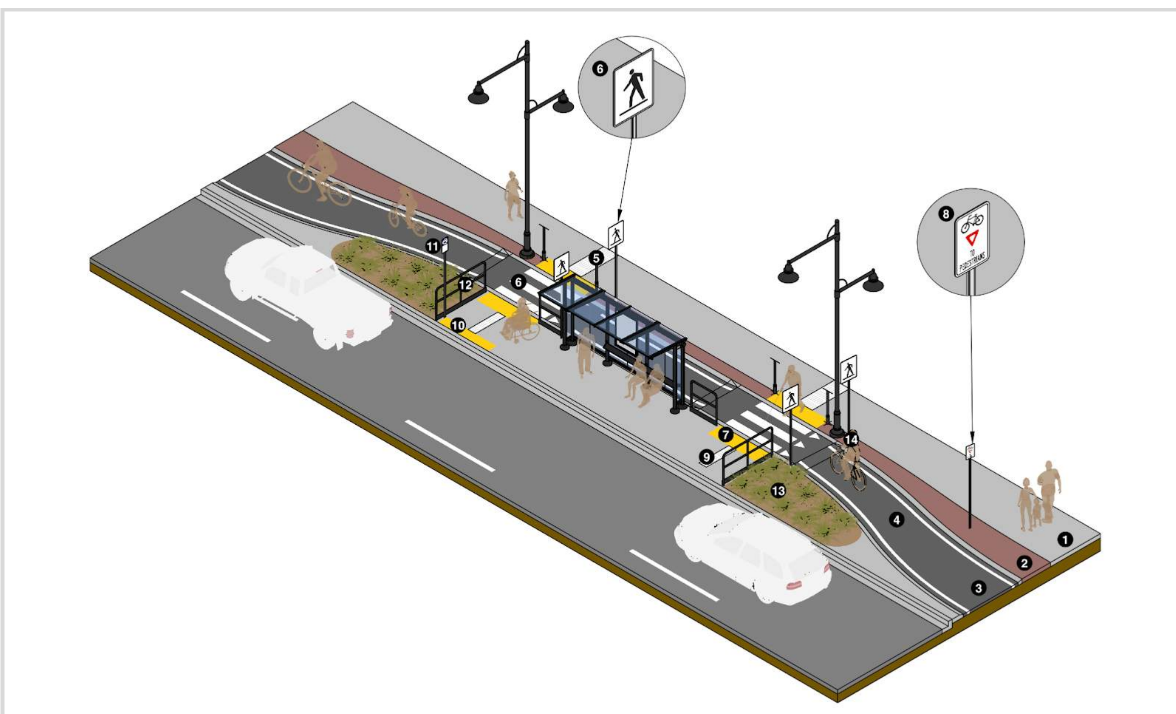


Figure 3.21B *Transit Stop Boarding Platform (Constrained Location)*

Transit Boarding Platform Components:

1. Unobstructed sidewalk provided of 1.8 m minimum to allow two wheelchairs to pass (see ***Table 3.19***).
2. Furnishing Zone provided with a width of 1.7 m or greater (see ***Table 3.18***). Boulevard for trees, streetlights, and signs.
3. Protected bike lane (width varies based on context, see ***Table 3.8***). Bevelled curb used on either side of raised protected bike lane if intermediate-level.
4. Protected bike lane is raised and shifted horizontally (5 longitudinal:1 horizontal).
5. Tactile directional indicators (600 mm in width) direct people walking to crossing (Optional).
6. Marked crosswalk with crosswalk signs and pavement markings.
7. Tactile Attention Indicators (600 mm deep; 300 mm from edge of crossing) on either side of the raised protected bike lane.
8. “Bikes Yield to Pedestrians” sign installed in advance of first crossing.
9. Tactile Direction Indicators (300 to 600 mm in width) on transit stop boarding platform to find crossings (Optional).
10. Tactile Attention Indicator (600 mm deep) at accessible boarding area located at the head of the bus stop (Optional).
11. Bus Stop ID Pole located at the accessible boarding area location.
12. Railings provided between bus stop and protected bike lane and at ends of transit stop boarding platform to direct people to crosswalk locations (Optional).
13. Landscaping should be a maximum height of 0.6 m.
14. Clear approach sight lines for 20 m prior to crosswalk for approaching bicycle riders to see people 1.0 m away from Tactile Attention Indicators at the crossings.

3.2.4. Pavement Markings & Signs for Bicycles at Mid-Block Locations

The latest pavement marking guidelines for the City of Edmonton can be found in the City’s Design and Construction Standards Volume 8: Pavement Marking. This document should be referenced for all standard longitudinal markings (lane lines, pavement edge lines, guidelines, etc.), lateral markings (crosswalks, stop bars), merging/diverging markings, and pavement symbols.

For signage and pavement markings, refer to the latest edition of the MUTCD-C.

For additional information on the application of MUTCD-C bicycle-specific pavement markings and signage, see the TAC Bikeway Traffic Control Guidelines for Canada.

Some general principles associated with these guidelines are:

- An emphasis on uniformity of design and application to avoid confusion;
- Clear identification for all street users making it particularly useful to visitors and those using a facility for the first time; and
- In all cases, proposed sign and pavement marking designs for bicycle routes or paths must be confirmed as enforceable under the relevant traffic regulations.

3.2.5.Centre Treatments

This section provides guidance on elements of the Travelled Way that are located in the centre of the Travelled Way with a focus on medians and two-way left turn lanes for urban streets.

A median is the portion of the road which physically separates the travel lanes of traffic travelling in opposing directions. Median width is the lateral dimension measured between the face of curbs on either side of the median (or edge of shoulder for expressway/freeway medians).

Types of medians and two-way left turn lanes are illustrated in ***Figure 3.22****. Medians range from raised concrete/landscaped to barriers to depressed landscaped areas to painted medians. Streets with higher speeds or volumes typically use barrier-style or depressed medians. Medians along streets in urban areas are typically raised concrete or landscaped medians and, in some cases, are a textured surface. Textured surfaces may require additional life cycle maintenance and repair. Medians can also be used for LID. Refer to Volume 3 of the City's Design and Construction Standards for more information on LID.*

Where medians are intended for use as a refuge area for walking, wheeling, or cycling across wide streets (over 3 lanes), the median can be raised with curb ramps for Universal Design and should be sized to accommodate bicycles with trailers and mobility aids. If pedestrian actuated push buttons are used for the signals, additional push buttons mounted to poles within the median will be required. Additional details on median refuge areas can be found in ***Section 3.6.4.2***.

Raised medians are also used as a delineator for protected bike lanes and more information can be found in ***Section 3.2.3.2***.

Figure 3.22: *Median Types*

Figure 3.22A: *Rural freeway/expressway median*

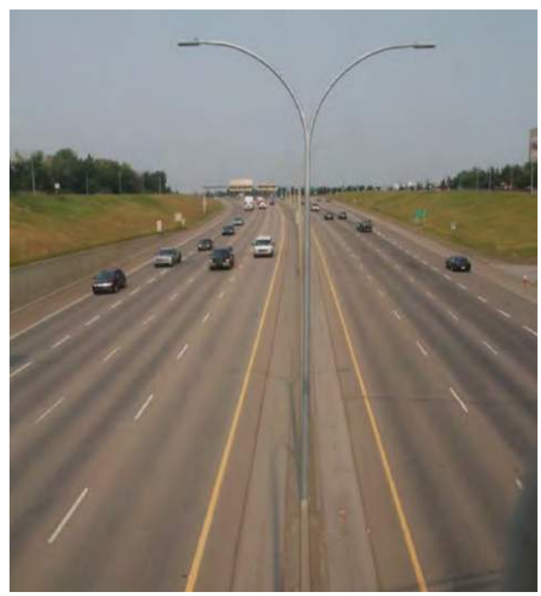


Figure 3.22B: *Urban freeway/expressway narrow median*

Figure 3.22: *Median Types (cont.)*

Figure 3.22C: Two-way or shared left-turn centre lane (Typically used in industrial area arterial streets)

Figure 3.22F: Painted/Flush median

Figure 3.22D: Textured (and flush) median

Figure 3.22G: *Raised median*

Figure 3.22E: Refuge median

3.2.5.1.Freeway Medians

Median widths for non-urban freeways range from 13 m to 50 m. For consistency with Provincial standards for freeways, a median width of 43.2 m (measured between the edges of the innermost ultimate travel lane in each direction) is recommended for depressed medians in non-urban settings, while a median width of 15.4 m is recommended for depressed medians in urban settings. For additional information regarding rural freeway design, refer to the Alberta Transportation Highway Geometric Design Guide.

Urban freeways generally have medians that are flush or a raised island with a median barrier. Median dimensions depend on shoulder widths, barrier type, and the need for provision of structure piers.

Medians are much narrower in constrained urban corridors. Minimum median width should be 3.0 m, plus the width of the selected barrier, plus allowances for such factors such as barrier deflection on impact, and provision for barrier mounted illumination poles, overhead sign footings, and bridge piers. Design Domain values for freeway medians are provided in ***Table 3.11***.

3.2.5.2.Arterial Medians

Medians on a divided urban street serve a variety of important purposes related to safety, traffic operations, access control, and aesthetics including:

- Physical separation of opposing traffic flows;
- Storage area for left-turning vehicles out of the path of the through traffic stream;
- Provision of pedestrian and bicycle refuge space;
- Control of access by restricting left-turns and U-turns to specific median openings;
- Provision of physical space for the effective placement of signage, traffic control devices and bridge piers;
- Provision of human scale and visual character to the street; and
- Provision of space for landscaping and streetscaping treatments to enhance street aesthetics, designed in accordance with Volume 5: Landscape Design and Construction Standards.

While medians in urban areas may be either raised or flush, they are normally raised using straight face curbs. They can include median tips that protect the refuge area and slow left turning motor vehicle traffic, decreasing the speed of left turns across the path of people walking, wheeling, and cycling. Recommended median dimensions are provided in ***Table 3.11*** for different types of medians based on street classification.

Additional median width may be required to accommodate left turn bays, auxiliary left turn lanes, higher volumes of turning truck or transit traffic, illumination poles, bridge piers, landscaping concrete verges, or traffic control devices. Refer to Appendix C and Chapter 3 of this document, as well as TAC GDG Section 4.5.3 for guidance on these specific accommodations.

In general, medians should be included on streets:

- With Posted Speeds of 60 km/h or more; or
- With more than 3 lanes in order to provide a refuge area for people walking, wheeling, and cycling to complete two-stage crossings at intersections and/or mid-block locations, particularly where the crossings are unsignalized.

***Table 3.11** Design Domain: Median Widths (in m)*

Parameter: Median Width	Design Domain Recommended Range[1]	
	Recommended Lower Limit	Recommended Upper Limit
Freeway Median, Depressed	13.0	30.0
Freeway Median, Raised	5.5	N/A
Non-Freeway, No Left Turn Bay [1]	1.2[2,3]	N/A
Non-Freeway, With Left Turn Bay [1]	4.5	N/A
Non-Freeway, Walking/ Cycling Refuge [1]	3.6[3]	N/A

Notes:

1. Non-freeway median widths are measured from face of curb to face of curb.
2. Minimum median width of 1.8 m is required for a raised landscaped median. Median widths under 1.8 m (measured from back of curb to back of curb) shall be hard surfaced.
3. Walking/Wheeling/Cycling Refuge areas should have a target width of 4.1 m and an absolute minimum width of 2.5 m. The minimum area of the refuge shall be 10 m^2 to provide sufficient room for all users. Median refuge areas should include a median tip when a street crossing of more than 2 lanes per direction is required and the crosswalk/crossride passes through the median at street level.

3.2.6.Horizontal Alignment

Horizontal alignment is the configuration of the street as seen in plan view (e.g., aerial) and generally consists of tangent sections and circular curves. In developing the alignment, the designer must establish the proper relationship between the curvature of the street and a set of horizontal alignment controls with the objective of providing for safe continuous operation at the desired Operating Speed under the general conditions for that street.

3.2.6.1.Design Domain Controls

The horizontal alignment is a relatively permanent feature of a street and is generally difficult and expensive to modify after its construction. It is thus critical that the designer be aware of and account for a number of key factors which can have a significant influence in defining the boundaries of the Design Domain for the various elements of horizontal alignment. The following items have specific relevance to horizontal alignment design:

- User expectation;
- Design Speed;
- Topography, available property, and environmental features;
- Climatic conditions;
- Adjacent land use;
- Traffic volume and vehicle mix; and
- Major utility location.

For more context on these Design Domain controls, refer to Appendix C and TAC GDG Section 3.2.1.2.

3.2.6.2.Design Elements

The following horizontal alignment design elements are discussed in this section:

- Circular curves;
- Spiral curves; and
- Superelevation.

Circular Curves

A circular curve, or simple curve, is one with a constant radius. For more information on the inter-relationship between human factors considerations, speed, maximum superelevation, lateral friction, minimum radius, and stopping sight distance, refer to TAC GDG Section 3.2.2. Minimum curve radii in the Edmonton context can be found below and in Appendix C.

Spiral Curves

A spiral curve is a curve with a constantly varying radius. The purpose of a spiral curve is to provide smooth transition and a natural driving path between a tangent and a circular curve. Spiral curves are typically only applied to streets with Design Speeds of 70 km/h and higher, and where superelevation of the circular curves is desirable. For information on how to design spiral curves, refer to TAC GDG Section 3.2.3.

Superelevation

As a vehicle travels around a circular curve at a constant speed it experiences radial acceleration which acts towards the centre of the circle. The centripetal force providing this radial acceleration is the lateral friction between the vehicle tires and the Travelled Way surface. If the Travelled Way is superelevated, the lateral friction is supplemented by a component of the force of gravity, due to the weight of the vehicle. For technical information on how to properly design/ develop superelevation, refer to TAC GDG Sections 3.2.2 and 3.2.4.

For local and collector streets in Edmonton, superelevation is not used. The minimum horizontal curves are:

- Local streets: 90 m
- Residential Collector streets: 120 m to 130 m
- Arterials: 190 m (absolute minimum), 500 m (preferred)

More details are provided in Appendix C.

For arterial streets, a maximum superelevation of 0.06 m/m can be used. See TAC GDG Section 3.2.4 for more information regarding the design of horizontal curves on arterial streets, freeways, and expressways.

3.2.6.3.Horizontal Alignment: Bicycle Facilities

Minimum Radii & Lateral Shifts

The minimum radius for a circular curve is a function of bicycle speed, superelevation, and coefficient of friction. For many on-street bicycle facilities, the horizontal alignment will match the horizontal alignment of motor vehicle travel lanes within the Travelled Way.

The absolute minimum radius for bicycle facilities and snow maintenance equipment is 6.0 m, below which the operating speed reduces to less than 12 km/h which is the speed where stability is significantly impacted. An exception to the absolute minimum radius is on the approach to a stop control or signal controlled intersection to align with curb ramps where bicycle users will be slowing and a radius of 3.5 m is allowed.

Table 3.12A shows the minimum design radius for superelevations at 0.02 m/m and 0.05 m/m. Where curve radii are less than those in the table, or superelevation is unavailable, warning signs should be placed in advance of the curve. Superelevation is typically used for off-street paths or trails (shared pathways or bike paths). The use of curve radii lower than those in this table should be avoided on major bike routes.

Table 3.12B shows the recommended Design Domain minimum for the centreline radius of bikeways based on the Design Speed outlines in ***Table 3.5***.

Where there is a need for a lateral shift in the alignment of a bikeway horizontally, it is often preferred to use a taper rather than back-to-back horizontal curves. Tapers can be easier to navigate for people riding cargo bicycles and those pulling trailers. A taper is also preferred to accommodate operational characteristics of snow and ice control equipment. Where the lateral shift of the bikeway is less than 2 times the path width, a taper should be used to develop the lateral shift as noted in ***Table 3.12C***. When the shift exceeds the threshold, the shift may be simply connected by a straight segment or back-to-back curves using the radii that meet the Minimum Bikeway Radii identified in ***Table 3.12B***.

Table 3.12A *Minimum Radii for Paved Bikeways (Source: TAC GDG Table 5.5.2)*

Design Speed (km/h)	Coefficient of Lateral Friction	Minimum Radius for Design (m)	
		e = 0.02 m/m	e = 0.05 m/m
20	0.30	10	9
25	0.30	15	14
30	0.28	24	21
35	0.27	33	30
40	0.25	47	42
45	0.23	64	57
50	0.22	82	73

Table 3.12B *Design Domain: Recommended Minimum Radii for Paved Bikeways (in m)*

Network Context	Minimum Centreline Radius (m)
Protected Bike Lane	20
Shared Pathway	15
Major Intersection Approach	10
Minor Intersection Approach or Driveway	6

Table 3.12C *Design Domain: Bikeway Tapers*

Parameter: Bikeway Tapers	Design Domain Recommended Range		Target
	Recommended Lower Limit	Recommended Upper Limit	
Taper[1]	5:1	12:1	10:1-12:1
Degrees[2]	11.31°	4.76°	5.71°-4.76°

Notes:

1. The absolute minimum taper is 3:1 and should only be used where slowing people cycling is required for traffic calming or in very constrained situations.

2. The absolute minimum is 18.43°.

Lateral Clearance

Lateral clearance to obstructions on the inside of horizontal curves is based on the need to provide sufficient sight distance to riders who notice an obstacle on their intended path of travel and need to stop. The line of sight to the object is taken to be the corner of the visual obstruction, and the stopping distance is measured along the intended path, which is taken to be the inside edge of the inner lane. Refer to TAC GDG Table 5.5.3 for the lateral clearance for a range of radii and stopping sight distances.

3.2.7.Vertical Alignment

Vertical alignment consists of straight line grades (tangents or gradients) and the vertical curves used to connect them. There are two types of vertical curves, crest curves which occur on hills, and sag curves which occur in valleys. In general, the design of these curves is based on visibility to provide a safe stopping sight distance or comfort criteria and a parabolic function is used to define them.

3.2.7.1.Design Elements

The following sections discuss, at a high level, the basic design elements of vertical alignment: grades, maximum gradients, and vertical curves.

Grades

The grade along a street is expressed as a percentage; that is the rise or fall in metres over a horizontal length of 100 m. Grades are positive if rising in the direction of increasing chainage and negative if falling in the direction of increasing chainage.

It is generally accepted that passenger cars readily negotiate grades as steep as 4 to 5% without appreciable loss of speed. On level grades, truck speeds approximate passenger car speeds. On down grades, truck speeds are about 5% higher than on level terrain. In some cases, on long downhill grades, trucking companies mandate slower speeds, to help prevent runaway trucks. On up-grades, there is a large variance in truck speeds depending on the severity and the length of grade as well as the mass/power ratio of the vehicle. For more information, refer to TAC GDG Section 3.3.2.

Gradients

Although the relationship between Design Speeds and maximum grade is relatively subjective, ***Table 3.13*** provides the generally accepted gradient ranges in Edmonton. The minimum longitudinal gradient must be provided on all streets to ensure adequate drainage.

***Table 3.13** Design Domain: Gradients (in %)*

Parameter: Gradient	Design Domain Recommended Range		
	Lower Limit	Upper Limit	Target Value [3]
Local & Collector	0.6%	8.0%[1]	6.0%
Arterial	0.6%	6.0%[1]	4.0%
Freeway / Expressway	0.6%	5.0%[2]	4.0%

Notes:

1. Maximum grades of up to 12% may be utilized in exceptional circumstances where necessary due to Topography.

2. Higher maximum grades may be necessary in exceptional circumstances due to topography. Design consideration should be given to truck deceleration/ acceleration where grades in excess of 5.0% are used on high speed roads.

3. Maximum grades of 4.0% are recommended for Arterials and other major transportation facilities that are planned to include significant transit and/or goods movement, wherever feasible.

Vertical Curves

The function of a vertical curve is to provide a smooth transition between adjacent grades. The form of curve used for vertical curves is a skewed parabola, positioned so that basic measurements can be made horizontally and vertically. Curves are described as crest or sag depending on their orientation.

Crest Vertical Curves

Crest vertical curves have to be flat enough to provide the required sight distances. The most common sight distances that are considered in the design of vertical curves are:

- Stopping sight distance;
- Passing sight distance;
- Decision sight distance; and
- Non-striping sight distance.[5]

For design guidance on crest vertical curves, refer to TAC Section 3.3.3.2.

Sag Vertical Curves

To provide adequate stopping sight distance on a sag vertical curve, where good street lighting does not prevail, the sag curve must be sufficiently flat for a vehicle's headlight beams to illuminate the road ahead at least for the minimum stopping sight distance. Where good street lighting does prevail, comfort becomes the criterion that limits values. For design guidance on sag vertical curves, refer to TAC GDG Section 3.3.3.4

Within Edmonton, vertical curves are required for all street profiles demonstrating an algebraic grade difference greater than:

- Arterial: 1.0%
- Collector: 1.5%
- Local: 1.5%
- Alleys: 2.0%

Successive short tangent lengths of various grades are not an acceptable design to eliminate vertical curves.

For additional vertical curve Design Domain application guidance and other design considerations, including drainage, snow, and intersections and driveways, refer to TAC GDG Section 3.3.5.

Vertical Clearance

A minimum vertical clearance of 5.4 m is required, measured from the highest point of the Travelled Way on the cross section to lowest point of the underside of the structure above.

[5] *TAC. 2014. Manual of Uniform Traffic Control Devices for Canada . Ottawa: Transportation Association of Canada.*

3.2.7.2.Vertical AlignmentI Bicycle & Walking and Wheeling Facilities

Grade

The recommended range of gradients for cycling and walking and wheeling facilities is provided in ***Table 3.14***. When setting grades, the designer should be cognizant that long, steep grades are a deterrent to cycling and walking. Where sidewalks and shared pathways parallel, the travelled grades should match those of the adjacent roadway, however, landings may be required where grades exceed 8.0%. The target grade for cycling facilities is 3.0% or less.

The impacts of different grades on the operation of various facilities are shown in ***Table 3.15***. Recommended grades for people walking and wheeling are provided in ***Section 3.5.7***.

Table 3.14 *Design Domain: Cycle and Walking Gradients (in %)*

Parameter: Gradient	Design Domain Recommended Range	
	Recommended Lower Limit	Recommended Upper Limit
Dedicated Cycle Facility	0.6%[1]	6.0%
Walking and Wheeling Facility (Sidewalk, Walking Trail)	0.6%[1]	5.0%[2]
Shared Pathway	0.6%[1]	5.0%[2]

Notes:

1. Minimum gradient may be reduced to 0.0% provided adequate cross fall and lateral slope is provided. Care should be given in designs where slopes are reduced. The recommended lower limit is also the target value for the City of Edmonton.

2. Maximum 8% slope is permissible for walkways located adjacent to Storm Water Management Facilities (SWMF).

Table 3.15 *Grade Impacts for People Cycling*

Grade	Impacts
< 4%	✚ Ideal grade for cycling ✚ Uphill speed is 10 km/h ✚ Downhill coasting speeds can reach 25 km/h
4% - 6%	✚ Downhill coasting speeds can reach 40 km/h ✚ Desirable to have a relatively flat area (3% or less) every 100 m to allow people cycling to rest for uphill
6% - 8%	✚ Not recommended ✚ Considered steep ✚ Should be paved ✚ Will reduce uphill speeds ✚ Downhill coasting speeds can reach 60 km/h ✚ Higher design speeds should be used ✚ Warning signs should be posted

Grades and length of slope for in-line skaters are found in Section 3.3.1 of the TAC In-line Skating Review.

Crest Curves, Sag Curves & Grade Breaks

Abrupt grade transitions along cycling facilities can reduce rider comfort and may lead to a loss of control at higher speeds. The target range for grade breaks along cycling facilities is 1.5 to 2.0%. However, higher values are acceptable for transitions within the facility, including curb ramps, slip ramps, and entrances to protected facilities. The target maximum grade break value for transitions is 6%, with an absolute maximum of 11% permitted in constrained conditions.

The maximum algebraic difference in grade for vertical curves of shared pathways is 6%. The desirable crest curve K value is 6.0 and the minimum is 1.5. The desirable sag curve K value is 6.0 and the minimum is 2.5. Refer to TAC GDG Section 5.5.4.

Vertical Clearance

The recommended minimum vertical clearance for a bikeway is 3.6 m, measured from the highest point on the bikeway riding surface to the lowest point on the underside of the structure/foliage above the bikeway. This accommodates most small service vehicles and provides a comfortable buffer in addition to the 2.5 m vertical operating envelope.

Cross Fall: Bicycle,Walking and Wheeling facilities

Bike paths / shared pathways may be crowned or have a constant cross fall while on-street bicycle facilities typically use a constant cross fall. Where the off-street path operation is two-way, a crowned section may be preferable for drainage and to maintain the cross fall to the right for people cycling, walking, and wheeling in both directions.

Cross fall for a concrete-surfaced bicycle facility is recommended to be 2.0%. For asphalt-surfaced bicycle facilities, a cross fall of 2% to 3% is recommended.

3.2.8.Curb & Gutter, Catch Basin & Utility Covers

3.2.8.1.Curb & Gutter

Curbs are raised or vertical elements, located adjacent to a travel lane, parking lane, painted bike lane, or protected bike lane. They may be employed with all types of streets for any or all of the following reasons:

- Drainage control;
- Delineation of the pavement edge, cycling facilities, or walking facilities to improve safety;
- Right of way reduction with the elimination of open ditch drainage;
- Reduction in maintenance operations;
- Access control or provision; and
- Aesthetics.

Concrete gutters are typically used to facilitate longitudinal drainage along urban streets. They are often cast integrally with curbs. The width of a gutter should be excluded from the width needed for bicycle facilities.

There are four general types of curb: straight face, mountable, rolled face, and bevelled.

Straight Face Curb

Straight face curb is near vertical, with a typical height of 150 mm, and is intended primarily to control drainage and access. Straight face curb is generally not used on urban freeways and is considered undesirable on expressways and arterials with Design Speeds in excess of 70 km/h.

For raised protected bike lanes, a 50 to 60 mm straight face curb with or without a gutter may be used. This curb height is detectable for people with vision loss. See also bevelled curb for this application, which limits pedal strike risk for people cycling and is accessible for people using mobility aids.

Mountable Curb

Mountable curb is considered to be mountable under emergency conditions or very slow moving conditions. Its face slope ranges from short (100 mm or less) and nearly vertical to a slope of 0.250 m/m to 0.625 m/m with a maximum vertical height of 125 mm. Mountable curbs are often used on urban freeways, expressways, and on high speed arterials (Design Speed over 70 km/h). Mountable curbs are also used for mountable aprons on roundabouts or corner radii in street oriented contexts where corner radius is minimized but truck access is still required, or along bike routes where emergency access is necessary. Mountable curbs used for truck aprons will require multiple curb ramps to provide Universal Design access.

***Figure 3.23** Straight Face Curb*

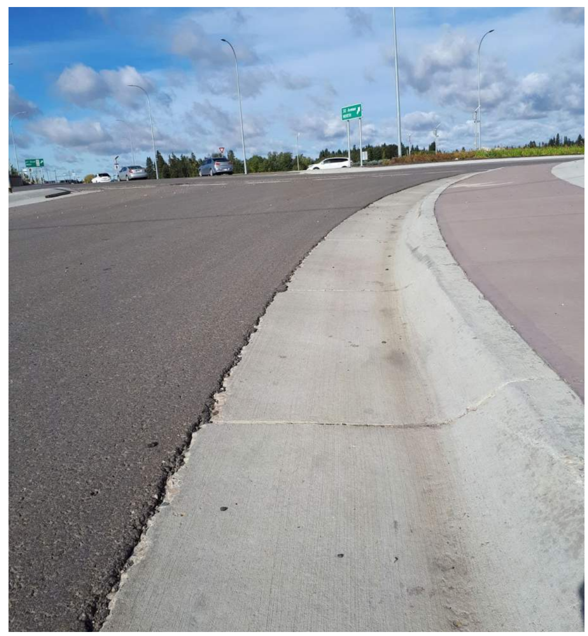


***Figure 3.24** Mountable Curb*

Rolled Face Curb

A rolled face curb contains a relatively flat sloping face (0.10 m/m to 0.25 m/m) to permit vehicles to cross over it easily. Rolled face curbs are typically used in residential neighbourhoods on local roads to facilitate access to driveways, or in constrained turning movement locations to accommodate large vehicles. Designers should consider additional improvements and design within the Furnishing Zone and/or Curbside Zone to ensure the transition from the Furnishing Zone/Curbside Zone/Pedestrian Through Zone to the Travelled Way is clear for people with visual impairments.

Figure 3.25 *Rolled Face Curb*

Bevelled Curb

Bevelled curbs are angled to reduce pedal strike hazards for people cycling and to ease access to the sidewalk for people who have dismounted their bicycles. Bevelled curbs can be up to 150 mm in height.

While a bevelled curb can have a 1 vertical:1 horizontal for a full height curb (i.e., 150 mm), a 1 vertical:3 horizontal (1V:3H) bevelled curb can be used for raised protected bike lanes. A minimum vertical dimension of 50 to 60 mm has been found to be detectable by people with vision loss, while also being navigable/mountable by people using mobility aids. For intermediate level protected bike lanes, the recommended bevelled curb is 50 mm high by 150 mm in width.

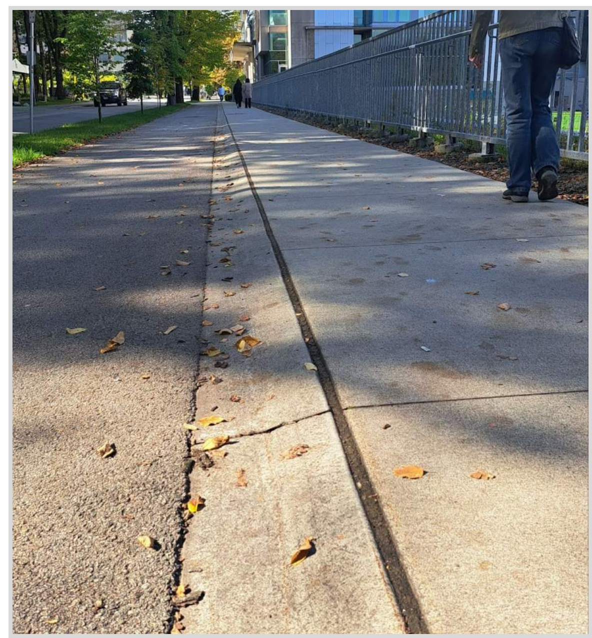


Figure 3.26 *Example Bevelled Curb between raised protected bike lane and sidewalk/boulevard*

For more design guidance on these three curb types, refer to TAC GDG Section 4.7.2.

Headers and Verges

Headers and verges shall be provided as per Volume 5: Landscape Design and Construction Standards.

3.2.8.2.Catch Basin & Utility Covers

Drainage grates, catch basins, and utility covers are potential hazards for people cycling because they tend to be slippery when wet, not flush with the Travelled Way or bikeway surface, a prime location for the formation of potholes, and a potential trap for bicycle wheels. While this can be mitigated to some extent through the use of appropriate frames and covers including the City of Edmonton's design (see ***Figure 3.27A***, below), wherever possible, catch basins and utility covers should not be located within a bikeway. For raised protected bike lanes, if the cross fall requires a catch basin to be located within the bike lane, a narrow catch basin should be used similar to that depicted in ***Figure 3.27B***.

Maintenance holes and utility covers should not be placed within sidewalks as they pose a slip and trip hazard.

For best practices on urban storm drainage, LID treatments, and LID best management practices (BMP), refer to TAC GDG Section 4.8.3. Edmonton Design and Construction Standards for drainage infrastructure are provided in Volume 3.

Figure 3.27A *- Example of bicycle-friendly catch basin design*

Catch basins should never be located within a curb ramp, curb ramp flare, on corners with a radius less than 6.0 m, or other locations that are pedestrian crossings. This supports Universal Design principles for walking and limits pooling of rain or snowmelt in the crosswalk, thereby improving safety and accessibility.

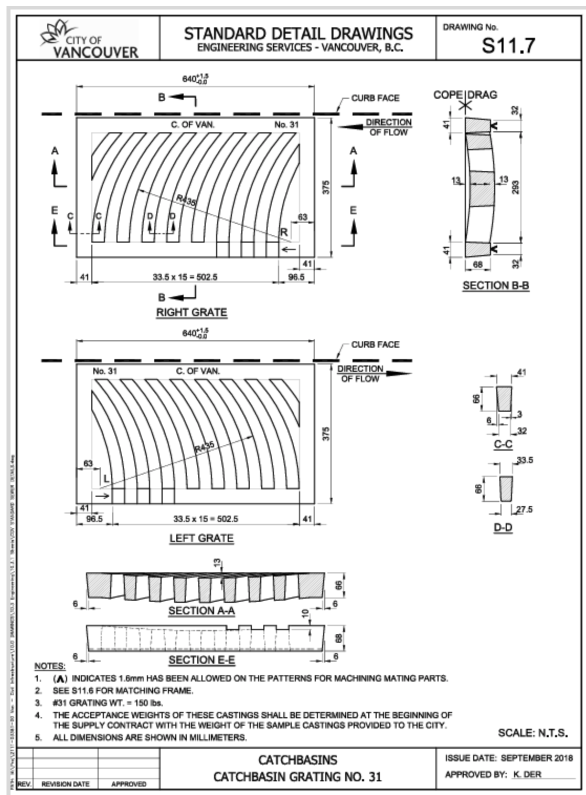


Figure 3.27B *- Example of bicycle-friendly catch basin design for a raised protected bike lane*

3.2.9. Road Structural Design

3.2.9.1.Submission Requirements

For greenfield design, the first submission of engineering drawings shall be accompanied by a geotechnical report complete with borehole logs. The report shall specify the structures of the street required and all assumptions used in the structure design, including California Bearing Ratio (CBR) values, design traffic loading, and the pavement design life. Similarly, consideration should be provided by the geotechnical report to the pavement structure associated with the construction of Shared Pathways or Top-of-Bank Trails.

For rehabilitation projects, geotechnical investigations necessary to inform pavement design shall form part of the preliminary design.

3.2.9.2.Construction Specifications

Chapter 2 (Construction Specifications) provides the construction specifications associated with road structural design and construction.

3.2.10. Road Cross Fall

For undivided local and collector roadways, a parabolic crown shall be utilized. For all other roadways, a straight cross fall shall be used with a crown at the centre or median of the roadway. Typical cross fall rates and formulas are summarized in ***Table 3.16***.

Table 3.16 *Design Domain: Roadway Cross Falls*

Roadway	Crown Height	Effective Cross Fall	Equation
8.0m Local	110mm*	3.0%	$y = 0.007822x^2$
9.0m Local	130mm*	3.0%	$y = 0.007197x^2$
11.5m Collector	150mm*	2.5%	$y = 0.004959x^2$
14.5m Collector	180mm*	2.5%	$y = 0.003673x^2$
All Other Urban		2.5%	n/a
Hard Surfaced Rural		2.5%	n/a
Gravel Surfaced Rural		3.0%	

Notes:
* Measured from lip of gutter

“x” is measured relative to the centreline of the roadway crown

“y” is the corresponding drop relative to roadway crown

3.3. PUBLIC REALM

In urban areas, the roadside is referred to as the public realm, or the public space along a street where people conduct their business and interact with each other. The public realm comprises the Furnishing Zone, Pedestrian Through Zone (or Clear Sidewalk or Accessible Pedestrian Route), and Frontage Zone. In instances where the Curbside Zone is utilized for patios or parklets, this zone too could be considered part of the public realm. Design requirements and illustrations for these zones are provided in the sections that follow.

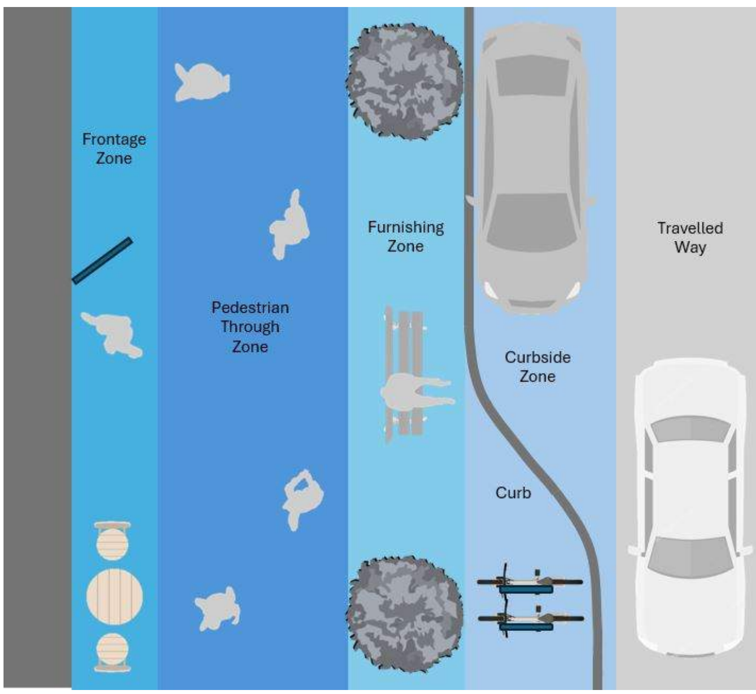


Figure 3.28 *Sample of Public Realm Zones in an Urban Context*

3.3.1.Curbside Zone

3.3.1.1.Locational Requirements

Located between the Travelled Way and the Furnishing Zone, the Curbside Zone provides a flexible space that can accommodate a number of different uses along a street in an urban area to reflect the unique requirements of the street users and adjacent lands. Curbside Zones provide an enhanced buffer for people walking and wheeling from moving motor vehicles. They also allow for the flexible allocation of this space to active uses (e.g., parklets, patios, bike corrals, food trucks, etc.) that are critical to streets being places for people. Curbside Zones are different from shoulders, in that they provide a specific role in supporting the public realm. Traditionally used for on-street parking, Curbside Zones are transforming into valuable space for people and businesses under many different uses identified in the City's Curbside Management Strategy. In redeveloping areas, Curbside Zones may be repurposed into permanent commercial or pedestrian infrastructure that complement the surrounding land uses. Curbside Zones may also be used for snow storage provided that the path of people walking and wheeling or accessing parked vehicles is not obstructed.

Curbside Zones are typically provided in street oriented contexts and can be provided along streets of all functional classifications. The Curbside Zone is not typically provided on streets with Design Speeds of 60 km/h or more and are typically not provided in non-street oriented contexts.

When on-street protected bike lanes are provided on a street, the Curbside Zone uses are located between the bike lane and the rest of the Travelled Way. This, in effect, splits the Travelled Way on either side of the Curbside Zone with general purpose motor vehicle travel lanes on one side and bicycle lanes on the other. For guidance on protected bike lanes and the delineator requirements associated with separating the lanes from the Curbside Zone, see ***Section 3.2.3.2***.

3.3.1.2.Possible Curbside Zone Design Elements & Design Requirements

Elements and uses of the Curbside Zone include parking for motor vehicles and bicycles, loading zones for deliveries, curb extensions, parklets or patios, and transit platforms. The width of the Curbside Zone may need to be increased, by extending into the Furnishing Zone, to accommodate accessible parking for those specific stalls, where there are transit timing points, or where large vehicle loading activities regularly occur. The Curbside Zone may also be used for snow storage.

Based on the possible design elements presented in the remainder of this section, ***Table 3.17*** summarizes the Design Domain for the Curbside Zone. Selecting a value closer to the recommended lower limit is more suitable for lower speed environments such as local streets or in highly constrained locations. On local streets where the Travelled Way is narrow, a Curbside Zone wider than the recommended lower limit may overly constrain the Travelled Way. Where possible, the Curbside Zone should be delineated through the use of surface materials which differ from the adjacent travelled way. These materials may include concrete, brick pavers, or stamped asphalt.

Table 3.17 *Design Domain: Curbside Zone (in m)*

Parameter	Recommended Lower Limit	Recommended Upper Limit
Width[1], Curbside Zone	2.1	2.5[2]

1. Measured from face of curb.
2. Curbside zone upper limit to be increased to 3.0m where the curbside zone is to be used to accommodate a bus bay or timing point.

3.3.1.3.Parking, Loading & Deliveries

On-street parking is an important part of streets adjacent to street oriented land uses (e.g., commercial, public institutions). In this context, curbside space dedicated to loading/unloading can also accommodate deliveries of goods required by businesses. On-street parking, loading, and delivery spaces can also reduce motor vehicle travel speeds and can act as a buffer from moving traffic for people walking and wheeling and people cycling (if protected bike lanes are present). See ***Section 3.2.2.3*** for Design Domain widths for parking, loading, and delivery lanes.

Parking should be restricted near two-way stop control intersections and mid-block crosswalks (marked or unmarked) so that visibility between people walking and wheeling, cycling, and driving from the right and the left is not obstructed.

Parking is legally prohibited within 5 m of the near side of a marked crosswalk, 5 m of a stop or yield sign, or 5 m of the projection of the curb or edge of the street. This may be controlled through a combination of signage and geometric elements, including curb extensions. Parking prohibition should also be based on sight triangles and stopping distances as per ***Section 3.6.1.4***.

Where parking is provided on residential streets with rear drive access and boulevard walks, connector walkways between the curb and sidewalk should be provided to increase accessibility of on-street parking. The location of these connector walks should align with the private walk connections to the building front door wherever feasible, as shown in ***Figure 3.29***.

Figure 3.29 *Connector Walks*

3.3.1.4.Accessible Parking

Accessible parking is motor vehicle parking that is dedicated for the use of persons with disabilities or reduced mobility. To support these needs, accessible parking spaces should be located near curb ramps, demarcated using appropriate signage, and accessible during all seasons. The Curbside Zone provides the opportunity for dedicated 24-hour accessible parking, increasing the accessibility of destinations along the street to a broader range of people.

Accessible parking in an urban context is illustrated in ***Figure 3.30***. More information on accessible parking policy can be found in the City of Edmonton's Curbside Management Strategy.

The width requirements for accessible parking are generally consistent with motor vehicle parking but may require additional width to accommodate wheelchair access. Refer to the City of Edmonton's Access Design Guide for detailed design information regarding on-street accessible parking.

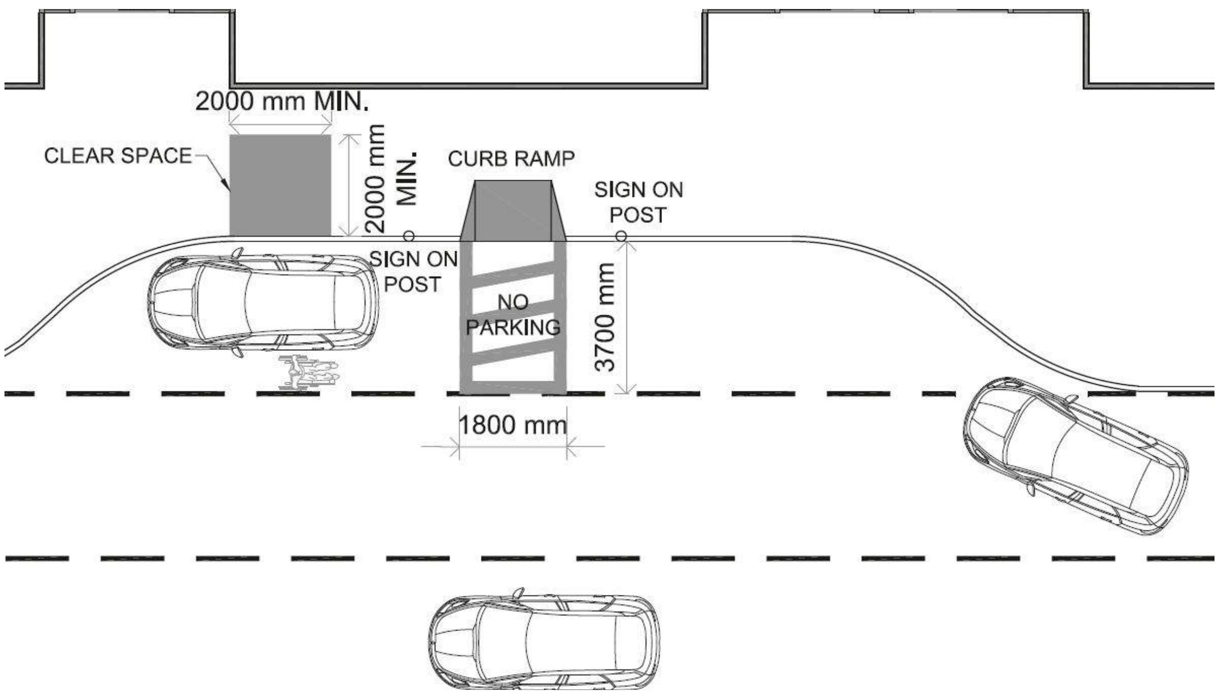


Figure 3.30 *Accessible Parking Design*

3.3.1.5.Curb Extensions

Curb extensions or bulb-outs extend the curb into or toward the Travelled Way at intersections and mid-block crossings. In doing so, curb extensions increase comfort and safety of streets by reducing crossing distances for people walking and wheeling, increasing the intervisibility between people walking and wheeling and passing drivers, increasing the visibility for people driving that are turning onto or off of streets, reducing motor vehicle operating speeds, increasing the available pedestrian queuing area, and facilitating buses to stop in the travel lane when passengers are boarding and alighting. Their design is influenced by the swept path of relevant Design Vehicles on a street. A curb extension is illustrated in ***Figure 3.31***.

Curb extensions can also be spaces to locate traffic signal poles, bicycle parking, newspaper boxes, benches, on-street pay parking stations, landscaping, fire hydrants, and other uses such as bioretention areas. The selection and placement of these types of street furniture or landscaping must consider intersection sightlines and underground utilities.

Figure 3.31 *Curb Extensions*

Curb extensions are best located where there is existing or proposed on-street parking, corners with marked crosswalks in high activity areas, locations with demonstrated safety issues for people walking and wheeling, wide streets, school crosswalks, or mid-block crossings.

Curb extensions are typically 2.0 m to 2.5 m in width (measured from face of curb of the street prior to the curb extension to the face of curb of the curb extension; depending on parking lane width) and the tangent should be at least 6.0 m long. A minimum radius of 4.5 m allows street sweeping and snow removal equipment to navigate the inside curves of the curb extension. Curb extensions have the potential to impact longitudinal drainage. This should be addressed by providing either a drainage line along the edge of lane line or providing additional catch basins.

3.3.1.6.Transit Stops on Curb Extensions

Transit stops on curb extensions (also known as transit platforms) are enhanced transit stops that are incorporated into a longer curb extension. They provide additional space for passenger waiting, loading, and unloading; provide space for additional or expanded amenities; and improve transit service reliability by removing the need for buses to merge back into traffic after picking up/dropping off passengers. For these reasons, transit stops on curb extensions are preferred for transit routes along collector roadways.

If provided, streets can accommodate a transit platform width of up to 3.95 m by using space from the Curbside Zone and the Furnishing Zone. This width allows various enhanced transit stop amenities to be incorporated (e.g., benches, information kiosks, bicycle parking, larger shelters, etc.). The length of the curb extension should be determined by the length requirement of the bus stop.

3.3.1.7.Parklets & Patios

Parklets are small scale public parks and seating areas while Patios (as illustrated in ***Figure 3.32***) are typically associated with an adjacent business. When provided, parklets or patios can be located in the Curbside Zone and provide additional public congregating space along streets to support them as destinations and places for people.

Parklets and patios can be temporary or permanent structures and should include a flush transition from the curb to avoid tripping hazards or, in the case of parklets, may include ramps to transition from the sidewalk to the street. Parklets and patios shall include a non-slip walking surface and railing around their edge (i.e., along the edge between the Curbside Zone and Travelled Way) and shall also include curb stops and flex posts with reflective tape at each end. For some temporary installations, the surface may be the asphalt or paving material of the Curbside Zone. Seating and tables or other street furniture (e.g., flower pots) can be added to parklets and patios.

Parklets and patios are typically 2.20 m wide (measured from face of curb) while their length varies by location. The design of a parklet or patio structure should not impede surface stormwater drainage from flowing along the street underneath the parklet or patio and should not obstruct access to catch basins or maintenance holes. Parklets should be positioned to avoid existing hydrants while maintaining adequate separation distance and accessibility. Parklets should be placed and designed to avoid tree wells and minimize negative impacts on existing street trees. For year-round installations, further considerations related to snow clearing and street sweeping need to be incorporated into the design including the material selection. The design of each parklet or patio can be distinct to reflect the unique character of the street and, in the case of patios, the adjacent businesses associated with the patio.

Figure 3.32 *Parklet in Curbside Zone*

3.3.1.8.Bicycle Parking Corrals

Bicycle parking corrals are arrangements of bicycle parking located in the Curbside Zone, as illustrated in ***Figure 3.33.*** Bicycle parking corrals support access to businesses by more people while increasing safety for pedestrians by removing parked bicycles from the Furnishing Zone, decreasing encroachment of parked bicycles into the Pedestrian Through Zone, and improving sightlines at intersections. Bicycle corrals are typically used in street oriented contexts.

Bicycle parking corrals can be temporary or permanent and typically replace one or more motor vehicle parking stalls with bicycle parking. The lengthwise dimension of a bicycle is 1.8 to 3.0 m as outlined in ***Table 3.2***. Bicycle corrals are typically located near intersections to increase their access to multiple bicycle routes. Bicycle corrals shall include areas allowing people to pull into and dismount from their bicycles within the corral. The location of the bicycle rack shall ensure that the rear of parked bicycles does not extend more than 2.25 m from the curb, which requires an angled orientation to the bike racks to support parking for cargo bicycles. Bike parking corrals shall be positioned to avoid existing hydrants while maintaining adequate separation distance and accessibility. Bikes shall not be placed overtop of drainage infrastructure, including catch basins and maintenance holes. Bike corrals shall be offset from the intersection and outside of desired intersection sightlines. For more information on the design of bicycle parking corrals, including rack placement and offsets, refer to the City of Edmonton's City Owned and Maintained On-Street Bike Rack Installation Guidelines.

Figure 3.33 *Bicycle Parking Corral in Curbside Zone*

3.3.2.Transit Stop & Shelters

Transit stops are the fundamental interface for people accessing, loading, and unloading from buses or other transit vehicles. Street oriented contexts are destinations that strongly benefit from frequent transit service along the street and transit stops that are safe, accessible, and comfortable for transit passengers.

While not a design zone, transit stops and shelters have been included as a separate sub-section because they can be located in either the Curbside Zone or Furnishing Zone and, in some cases, the transit stop area can encroach into the Pedestrian Through Zone and bicycle facilities. However, encroachment by fixed objects such as transit shelters and benches must be minimized to allow sufficient clear space for the horizontal operating envelope of a person walking and wheeling or cycling. An example of a transit stop and shelter is shown in ***Figure 3.34***.

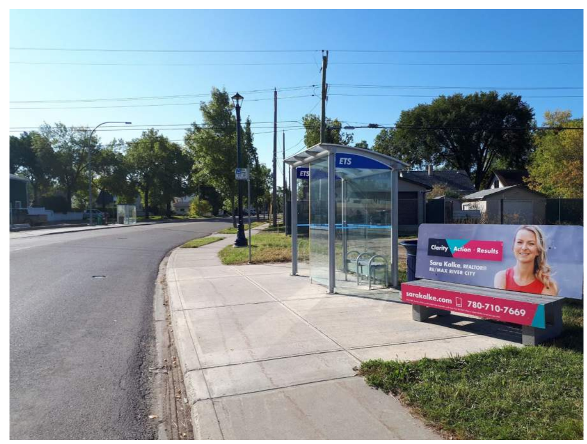


Figure 3.34 *Transit Shelter (with sidewalk access and shelter oriented to protect waiting passengers from prevailing winds)*

3.3.2.1.Locational Requirements

The placement of a transit stop before or after an intersection is referred to as a near-side or far-side transit stop, respectively. The placement of a bus stop on one side of an intersection or another is based on a number of factors including visibility, safety, transit operation, bus signal priority, intersection operations, parking restrictions, passenger demand, pedestrian access, or roadside constraints, as well as the City's Transit Service Standards. Far-side bus stops are preferable as they allow the bus to depart immediately after stopping, with near-side locations acceptable in some very limited conditions. Potential reasons for near-side configuration include:

- Locations with clear single direction transfer activity;
- Locations adjacent to signalized intersections;
- Locations where the head of the bus stop can be set 35 m from the intersection; and
- Locations where a bus stop curb extension (i.e., transit platform) is desirable on single lane streets.

Bus stops, particularly mid-block stops, shall not be placed in profile sag locations, where catch basins are installed, to prevent splashing of waiting passengers during rainfall events.

3.3.2.2.Bus Pad Design Requirements

All bus stop pads must be concrete, including when adjacent to asphalt pathways. Boarding and alighting onto monowalk stops on asphalt facilities is strongly discouraged and bus shelters cannot be fastened to asphalt.

Refer to the standard detail drawings in Chapter 3 (Standard Drawings) for guidance on transit pad design for monolithic sidewalks and separated sidewalks.

3.3.2.3.Transit Shelter Design Requirements

Providing comfortable space for transit users to wait is an important aspect of quality services which helps retain riders and grow ridership. The waiting areas should be designed to accommodate all user groups, including those with impairments, parents with strollers, older adults, and people with bicycles.

3.3.2.4.Universal Design

From a universal design perspective, access to and from the shelter shall not be blocked by street furniture, signs, landscaping or tree planting and the shelter design must be wheelchair accessible.

3.3.2.5.Detailed Drawings & References

Required transit stops or shelters are to be designed as shown on the standard detail drawing in Chapter 3 (Standard Drawings).

3.3.3.Furnishing Zone

3.3.3.1.Locational Requirements

On streets with separated sidewalks, the Furnishing Zone (sometimes referred to as the boulevard) is located between the curb or pavement edge and the Pedestrian Through Zone, as shown in ***Figure 3.35***. On streets where the sidewalk is monolithic (adjacent to the curb), the grass space behind the sidewalk can serve as the Furnishing Zone.

Figure 3.35A *Furnishing Zone (Local)*

Figure 3.35B *Furnishing Zone (Urban)*

On streets with separated sidewalks, the Furnishing Zone serves as a safety separation, as well as a location for surface and shallow underground utilities, traffic signs, traffic signals, street light poles, other control devices, street trees, landscaping, transit shelters, benches, patios and seating associated with adjacent businesses, bicycle parking, hardware and street furniture, snow storage, and low impact development. The design of the Furnishing Zone shall consider the impact of snow clearing equipment and possible snow removal.

The recommended width of the Furnishing Zone is 1.7 m to 5.0 m. The lower end of this range provides basic functionality, while the upper end allows for additional street oriented uses of the right of way. The Design Domain of the Furnishing Zone is shown in ***Table 3.18***.

Table 3.18 *Design Domain: Furnishing Zone (in m)*

Parameter	*Recommended Lower Limit*	*Recommended Upper Limit*
Width*, Furnishing Zone	1.7	5.0

* Measured from face of curb.

The recommended minimum width of 1.7 m accommodates the width of the curb and sufficient soil volume to support the growth and health of mature street trees. Furnishing Zone widths below 1.7 m may not accommodate street trees and may limit the ability to have other plants that are healthy. When warranted by mitigating circumstances at the discretion of the City, Furnishing Zone widths less than the recommended lower limit may be utilized, but will require alternative landscape treatments such as hardscaping.

Situations where a wider Furnishing Zone approaching the recommended upper limit of 5.0 m may be suitable include:

- On high-speed, high volume streets (i.e., where adjacent traffic speeds are 60 km/h or higher and volumes are 10,000 vehicles per day or higher) for the increased comfort of people walking and wheeling;
- On streets with transit service (typically collectors and arterials) for potential transit facilities such as transit stop pads and bus shelters;
- On streets with larger corner radii, to increase offset of the sidewalk and better align with the location of the curb ramp and crosswalk;
- On commercial/mixed use streets for street furniture, sidewalk patios, or display space;
- On streets where significant amounts of vegetation and street trees are desired; and,
- On wide, non-street oriented arterial streets to accommodate more space for snow storage.

Where fire hydrants are proposed in the Furnishing Zone, additional width may be required to ensure adequate offsets are maintained as per the City's Design and Construction Standards Volume 4.

The absolute minimum width of the Furnishing Zone is 0.5 m to support detectability by people with vision loss and accommodate signs and poles.

3.3.3.2.Street Trees & Landscaping / Hardscaping

Street trees and landscaping are critical elements of Edmonton's urban streets and should be prioritized accordingly due to their contributions to an urban space; providing climate control (micro-climates) from heat, wind, and rain; reducing traffic speeds; improving pedestrian safety; and adding value to adjacent properties.

Street trees and landscaping can include a variety of species. Adequate tree spacing and soil volume is required for healthy tree growth and is dependent on tree species. The soil volume can be located under a combination of the Furnishing Zone, Pedestrian Through Zone, and Curbside Zone or Travelled Way through the use of soil cells. Information pertaining to tree selection, soil volume, spacing, and landscaping requirements for all street functional classifications (arterial, collector, local) can be found in Volume 3 and Volume 5 of the Design and Construction Standards.

In street oriented commercial contexts, due to the level of activity within the Curbside Zone with people accessing and exiting parked vehicles and/or protected bike lanes, a hardscaped Furnishing Zone is preferred. It can be in the form of concrete, paver stones, brick, or other hard surface. Furnishing Zones that are hard-surfaced should consist of a different texture and colour than the Pedestrian Through Zone.

Street trees may obscure sightlines and visibility at intersections and mid-block crosswalks. As such, plant selection (i.e. smaller calliper deciduous trees free of low branches) and placement shall strive to maintain sightlines. See ***Section 3.6.1.4*** for sightline requirements.

Constrained Conditions

If Furnishing or Frontage Zones are too narrow, if sidewalks are adjacent to curbs, or if ordinances and setback requirements eliminate trees from the Furnishing or Frontage Zones, low-maintenance plantings/shrubs can be utilized as an alternative to street trees. Areas can also be hardscaped with paving stones or other materials.

3.3.3.3.Street Lighting

Street lighting is used to illuminate the public right of way and its various users. Lighting can be more person-friendly if designed and spaced at a human scale commonly referred to as “pedestrian-oriented lighting”. Human-scaled lighting contributes to safety for people walking and wheeling, and supports urban streets as places.

Pedestrian-oriented lighting should be considered where street oriented commercial or mixed use development exists or is planned, or where high volumes of pedestrian traffic are anticipated. Special consideration should also be given to school zones, playgrounds, and crosswalks to ensure adequate levels of lighting. Placement of pedestrian-oriented lighting should also consider the City’s dark skies initiatives to minimize light pollution where possible

Pedestrian-oriented lighting should be placed with a spacing of 30 m and height above the sidewalk surface of approximately 5 m to provide sufficient illumination of the Pedestrian Through Zone. This spacing also works well for street tree locations, however, spacing should be modified as needed to accommodate street tree locations. Pedestrian-oriented lighting fixtures can be affixed to the same pole as street lighting or on separate poles.

Light fixtures for the Travelled Way spaced every 60 m complements the 30 m pedestrian lighting spacing. Street lighting shall also be added to traffic signal poles to increase the illumination and safety of intersections. Street lighting is illustrated in ***Figure 3.36***. In all cases, appropriate lighting shall be provided at all pedestrian crossings, including mid-block, to ensure adequate inter-visibility between street users.

More information on street lighting can be found in Volume 6 of the Design and Construction Standards and the TAC Guide for the Design of Roadway Lighting.

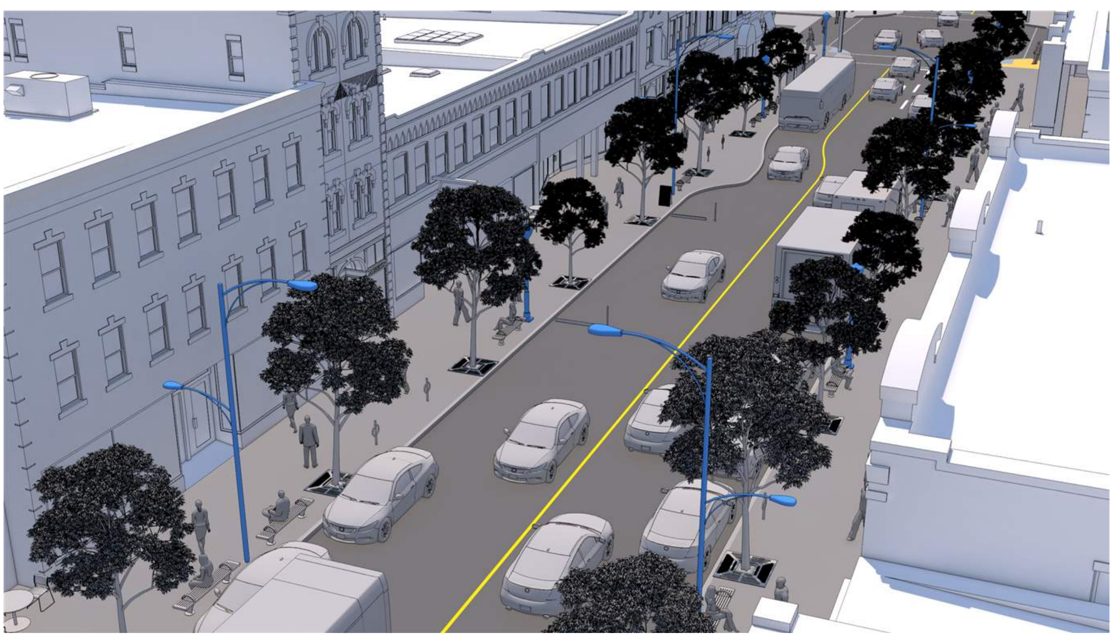


Figure 3.36 *Street & Pedestrian Lighting Spacing*

3.3.3.4. Street Furniture

Street furniture includes functional and decorative elements that support the function and use of the street and the creation of a people place. Street furniture can include elements such as poles for traffic signals and lighting, benches, bicycle parking, flower pots, waste receptacles, bollards, banners, tables and chairs, advertising boards, signal boxes/traffic controllers, fire hydrants, pay parking stations, newspaper boxes, wayfinding, sign poles, and public art. Placement of street furniture shall be consistent to make the street more predictable for people with vision loss.

The amount and type of street furniture will vary depending on the adjacent building locations and orientation, the number of people using an area, the width available for the Furnishing Zone, the presence of a Curbside Zone and/or Frontage Zone, and the characteristics and design of the Travelled Way. In general, all streets shall provide waste receptacles and bicycle parking as well as necessary functional items (e.g. traffic signal poles, street lights, traffic controllers/signal boxes, fire hydrants, etc). Street furniture should be aligned, clustered, and integrated with utilities and other appearances wherever possible. Street furniture should not be placed within the Pedestrian Through Zone.

For more information on the design of bicycle parking, including rack type, placement and offsets, refer to the City of Edmonton’s City Owned and Maintained On-Street Bike Rack Installation Guidelines.

The design of the street furniture can be used to achieve more than one purpose (e.g. seating and art, planter and seating). The Furnishing Zone surface material (e.g. pavers, concrete, etc), needs to allow for installation of street furniture. When designing street furniture, consideration must be given to their long-term maintenance, snow clearing, snow storage, and the need to replace damaged pieces. Snow clearing operations may need to be adjusted to ensure that damage to Furnished Zone is minimized, and to allow on-street parking access to the sidewalk year-round.

3.3.4.Pedestrian Through Zone

3.3.4.1.Locational Requirements

The Pedestrian Through Zone is the area where people walk, interact with one another, and access adjacent buildings and destinations. Sidewalks, walkways, paths, and trails shall form a comprehensive and integrated pedestrian circulation system within a neighbourhood and between neighbourhoods. This may mean sidewalks on both sides, shared pathways on both sides, or a sidewalk on one side and a shared pathway on the other. Vehicle driveways across the Pedestrian Through Zone shall be limited where rear alley access is available, and existing accesses should be reviewed during infrastructure renewal activities.

To ensure that the design of the pedestrian environment accommodates the greatest possible number of people, it is desirable to adhere to the following:

- Allow a clear path of travel, free of obstructions;
- Provide a firm, stable, smooth, non-slip, and glare-free surface;
- Ensure that gradients along the path of travel are gradual to allow access by all and that landings are added (See ***Section 1.5*** on Universal Design & Accessibility, ***Section 3.2.7.2***, ***Section 3.3.4.3***, and ***Section 3.5.7***);
- Limit vehicle driveways across the Pedestrian Through Zone to minimize disruption and improve safety (and review existing accesses during street renewal activities).
- Materiality and typology of the sidewalk should carry across accesses.

Figure 3.37 *Pedestrian Through Zone*

For facilities within street rights of way, a sidewalk, walkway, or pathway shall be provided in order of preference as described below:

- Arterial Streets
  - Shared Pathway on both sides
  - Sidewalk on both sides if protected bike lanes are provided; on one side where a Shared Pathway is provided on one side only
  - All facilities must be separated from the Travelled Way or Curbside Zone by a Furnishing Zone
- Collector Streets
  - Active Modes Infrastructure on at least one side as per the Bike Plan. Where separation of parallel facilities meets the criteria within the Bike Plan, elimination of active modes infrastructure may be considered via a design exception.
  - Sidewalk on both sides if protected bike lanes are provided; on one side where a Shared Pathway is provided
  - Preference is for all facilities to be separated from the Travelled Way or Curbside Zone by a Furnishing Zone
- Industrial Collector Streets
  - Shared pathway one side
  - Sidewalk minimum on one side, with connections to side streets
  - Preference is for all facilities to be separated from the Travelled Way or Curbside Zone by a Furnishing Zone
- Local Streets
  - Sidewalk on both sides of the street
  - Sidewalks are preferred as separate walks (i.e., separated from the Travelled Way or Curbside Zone by a Furnishing Zone). However, monolithic sidewalks may be acceptable in constrained situations.
- Industrial Local Streets
  - Boulevard sidewalk minimum on one side
  - Preference is for all facilities to be separated from the Travelled Way or Curbside Zone by a Furnishing Zone
- School Sites
  - Wide monolithic sidewalk adjacent to all school sites
  - Shared Pathway or bike facility preferred on one side
- Transit Stops
  - Sidewalk connections required to all bus stops and must connect to crosswalk to provide access to facility if it is on the other side of the street
- Other Locations
  - Shared pathways shall be constructed where necessary for connectivity of the cycling and walking and wheeling network at the discretion of the City
  - Sidewalks shall be constructed in all locations that, in the opinion of the City, generate significant pedestrian traffic

3.3.4.2. Pedestrian Through Zone Width

Pedestrian Through Zone width is a function related to the horizontal operating envelope of people walking and wheeling and the volumes of these activities. The preferred Pedestrian Through Zone width for a high activity area is 3.0 m to accommodate the higher walking and wheeling volumes and to allow people to walk in groups. In areas with lower volumes, the minimum through zone width is 1.8 m. This width will allow a person holding a child’s hand to pass another person, as well as a person using a wheelchair to pass a person walking or complete manoeuvring movements, or two passing wheelchair users.

Where two Pedestrian Through Zones intersect, a 1.5 m fillet should be provided to accommodate the desired path of people walking around the corner.

Table 3.19 summarizes the Design Domain dimensions for the Pedestrian Through Zone (i.e., clear sidewalk or accessible pedestrian route) based on street classification and adjacent land uses of people walking and wheeling. The Pedestrian Through Zone should not include obstructions within the recommended lower limit widths; obstructions should be located in the adjacent zones (i.e., Furnishing Zone and/or Frontage Zone). The Design Domain for shared pathways is provided in ***Section 3.2.3***. Recommended offsets to landscaping, poles, and street furniture are provided in ***Section 3.7***. There is no upper limit to Pedestrian Through Zone widths.

Universal Design related to intersections can be found in ***Section 3.6.3*** including the use of tactile walking surface indicators.

Table 3.19: *Design Domain: Pedestrian Through Zone (in m)*

Parameter: Width, Pedestrian Through Zone		*Recommended Lower Limit*
Local Street	Monolithic or separated sidewalk	1.8[1]
Industrial Local Street	Monolithic sidewalk	2.3
	Separated sidewalk	1.8
School Zone	Monolithic sidewalk	2.5
Collector Street	Monolithic sidewalk	2.3[4]
	Separated sidewalk	1.8[1]
	Sidewalks with or anticipated higher use	2.25[5]
Industrial Collector Street	Monolithic sidewalk	2.3[4]
	Separated sidewalk	1.8
Street Oriented Arterial Street[3]	Separated sidewalk[2]	2.5
Non-Street Oriented Arterial Street[3]	Separated sidewalk	1.8
	Sidewalks with higher use	2.25[5]
Primary or Secondary Corridor/High Activity Area[3]	Separated sidewalk	3.0

Notes:

1. In constrained retrofit locations, the minimum width of the Pedestrian Through Zone can be reduced to 1.6 m measured from face of curb to back of sidewalk for monolithic sidewalk or edge to edge for separated sidewalks.

2. Monolithic sidewalks are not recommended along arterial streets. Where monolithic sidewalks cannot be avoided due to site constraints at the discretion of the City, the sidewalk width must be increased by a minimum of 0.5 metres.

3. The use of sidewalks along arterial streets will require alternate bicycle accommodation where shared pathways are not currently being provided.

4. Monolithic sidewalks along Collector or Industrial Collector Streets are not recommended; however, in retrofit locations, reconstruction or replacement of existing monolithic sidewalks may be required and the dimension noted should be used as the minimum width of the Pedestrian Through Zone.

5. Areas with more walking and wheeling activity require wider minimum sidewalk widths to provide sufficient space for users of all ages and abilities to comfortably use the space. Areas that are or will be along recreational running or walking routes and locations with street oriented commercial uses are examples of locations requiring sidewalks with larger minimum widths. See ***Section 3.2.3.2*** for user volume considerations when separating shared pathways into a separate sidewalk and bicycle facility.

3.3.4.3.Universal Design

Edmonton's streets must be designed to accommodate travel by the full spectrum of people walking and wheeling including those that use mobility aids.

An accessible Pedestrian Through Zone allows people of all ages and abilities to travel to, travel through, and access buildings along all streets. The Design Domain dimensions for the Pedestrian Through Zone are based on providing a universally accessible Pedestrian Through Zone as a primary principle. In addition, the horizontal clearances (***Section 3.1.3.1***) and requirement for an obstruction-free clear space for the sidewalk allows for continuity and ease of navigation for people with mobility challenges and/or vision loss. Vertical grades that support Universal Design of the Pedestrian Through Zone are provided in ***Sections 3.2.7.2*** and ***3.5.7***.

Universal Design related to intersections can be found in ***Section 3.6.3*** including the use of tactile walking surface indicators.

3.3.4.4.Surface Materials

While sidewalk surfaces shall be smooth and free of debris and obstacles, the choice of sidewalk construction materials provides an opportunity to enhance the visual aesthetics and experience for people walking and wheeling.

Always consider the impacts of decorative paving on the mobility challenged and people with vision loss. Slippery materials or uneven surfaces such as pavers and stamped concrete should never be used in the Pedestrian Through Zone or a sidewalk. For most sidewalks, concrete offers the most effective travel surface. Decorative scoring patterns or colour may be laid into concrete as a simple way to add visual interest to the walkway.

3.3.4.5.Pedestrian Through Zone at Driveways

Any ramps for motor vehicle access at driveways to transition from the Travelled Way or Curbside Zone elevation to the elevation of the Pedestrian Through Zone shall occur entirely within the Furnishing and/or Curbside Zone. This allows the Pedestrian Through Zone to remain flat or essentially flat. This is illustrated in ***Figure 3.38A***.

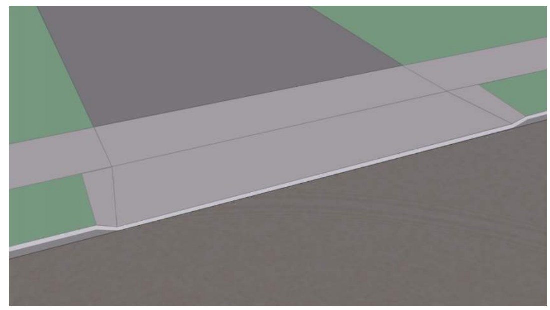


Figure 3.38A: *Driveway crossing of a separated sidewalk*

In locations with monolithic sidewalks, the driveway ramp may have to be located within the Pedestrian Through Zone. In these instances, a minimum flat segment of Pedestrian Through Zone of 1.0 m wide should be provided, as illustrated in ***Figure 3.38B***. This flat segment should be provided whenever a straight face curb is utilized and the sidewalk is a minimum 2.3 m in width. Where a straight face curb exists, but sidewalk widths are less than 2.3 m, this may require a widening of the Pedestrian Through Zone and use of space in the Frontage Zone where it is available.

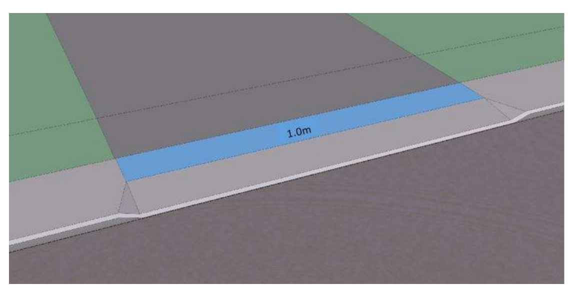


Figure 3.38B: *Driveway crossing of monolithic walk*

3.3.5.Frontage Zone

3.3.5.1.Locational Requirements

Located adjacent to the building and/or property line, the Frontage Zone provides people walking and wheeling with an offset distance from adjacent lands, and provides clearance from building fronts, doors opening outwards, utilities, and architectural features, and can be utilized for patios and street displays. The Frontage Zone is illustrated in ***Figure 3.39.***

Figure 3.39 *Frontage Zone*

3.3.5.2.Design Requirements

The Design Domain recommended width of the Frontage Zone is 0.3 m to 4.5 m. The lower end of this range provides basic functionality and accommodation of some underground utilities to be located outside the Pedestrian Through Zone. The upper end allows for additional uses to support a walkable environment. Wider zones may be considered based on adjacent land use.

The recommended width of the Frontage Zone is influenced by physical conditions at the property line. Generally, a greater width is more appropriate from building edges than from lawns or pavement. The latter may require no Frontage Zone at all. Involvement of the adjacent landowners and business operators often contributes significantly to the design and use of the Frontage Zone. The width of the Frontage Zone should also consider building setbacks, and opportunities may exist to develop frontage zones in collaboration with adjacent property owners. ***Table 3.20*** summarizes the Design Domain for the Frontage Zone. In some cases, a Frontage Zone may not be possible where right of way is constrained.

Table 3.20 *Design Domain: Frontage Zone (in m)*

Parameter	Recommended Lower Limit	Recommended Upper Limit
Width, Frontage Zone	0.3[1]	4.5

Note:

1. *Frontage Zone may be reduced to 0.0 metres where there is constrained right of way, at the discretion of the City.*

To accommodate different activities, the following may assist with selection of a Frontage Zone width based on the context of the street:

- 0.9 m width accommodates advertising boards, or other small signage, and lineup areas
- 1.2 m width accommodates display and sales tables plus standing space for browsing shoppers. This width also accommodates small restaurant tables with seating for two people plus circulation space for service staff
- 1.75 m accommodates restaurant tables with seating for four people plus circulation for service staff

In all cases, the Frontage Zone shall be designed in a way which enables navigation for people with vision loss or mobility challenges. Frontage Zones that are hard-surfaced should consist of a different texture and colour than the Pedestrian Through Zone.

3.3.6.Berms and Noise Attenuation

Berms are embankments which slope down away from the property line/edge of road right of way and establish a natural barrier between private property and the street. Typically used along higher volume roadways, berms may be accompanied by a fence to provide additional screening from the noise of passing traffic.

Berms shall only be developed at those locations where, in the opinion of the City, their construction will not interfere with the normal lot drainage of abutting properties. Where lot drainage problems could occur, the berm shall be constructed to provide a positive drainage swale on the property side of the berm that has been developed in accordance with the approved lot grading plan. The berm slopes shall not be steeper than 3:1 where there is naturalized sideslope or 3.5:1 where the slope is to be maintained and/or mowed . The edge of the berm shall not be closer than 1 m from the edge of the walkway. Lot drainage problems affecting lots that conform to the lot grading plan and resulting directly from the development of the berm shall be the exclusive responsibility of the Developer.

The City requires necessary noise attenuation for roads classified as arterials or above (including TUC, highways, freeways, expressways, principal road, and typical arterials) to a minimum height as determined through a submitted noise study or the City's minimum requirements, whichever is greater. For truck routes, the minimum requirements are a 1 m berm and 1.8 m noise fence. For non-truck routes, the minimum requirements are a 1.8 m noise fence. All heights shall be measured on the roadway side, from the toe of the berm or ground at the base of the fence.

Berms shall be designed in accordance with the Landscaping Standards found in Volume 5 of the City’s Design and Construction Standards. The grades shall conform to the gradient of the sidewalk/walkway/shared pathway to avoid conflicts with the drainage pattern within the right of way. For walkway grading requirements, see ***Section 3.5.7***.

3.4. ROADSIDE

In the context of non-urban areas, the roadside refers to the area between the pavement edge and the adjacent property line. Non-urban areas in Edmonton are typically industrial or with agricultural land uses where street designs do not include an urban cross section. Drainage in these contexts uses overland drainage via ditches instead of curb and gutter.

Due to land use context and associated street types/user demands, streets in non-urban areas typically include a roadside that accommodates different functional zones than in urban areas: side slope, drainage channel, and backslope (with accommodation for people walking, wheeling, and cycling). Within the non-urban areas, these roadside functional zones are typically included in the Clear Zone.

The design of a non-urban roadside shall take into consideration the potential future use of the area; non-urban streets can become urbanized as boundaries expand.

Non-Urban Roadside Areas are illustrated in ***Figure 3.40***.

Information on offsets for design elements within the Non-Urban Roadside Areas, including with respect to the Travelled Way, can be found in ***Section 3.7***. This includes horizontal offsets and clearances to utilities, poles, and trees. Requirements for Sight Distances and Clear Sight Triangles at intersections can be found in ***Section 3.6.1.4***.

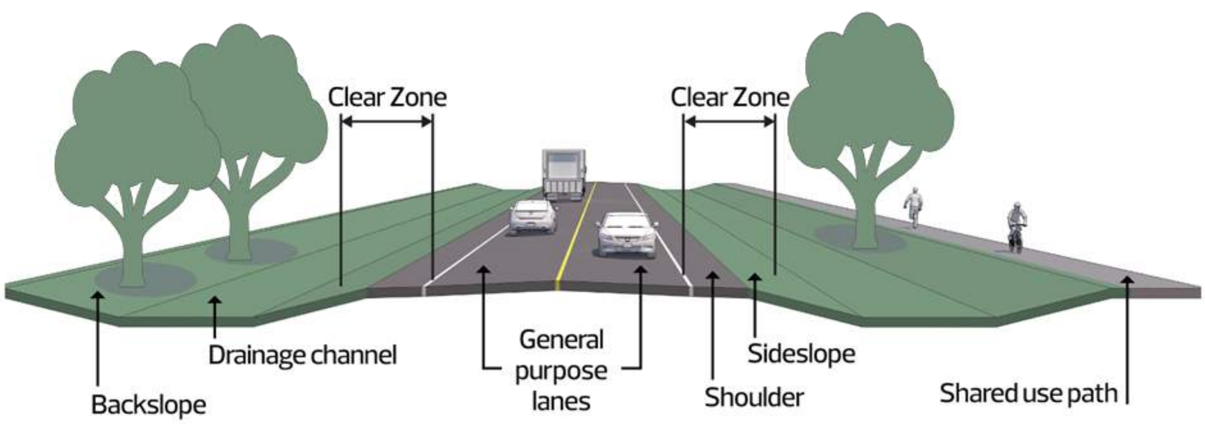


Figure 3.40 *Non-Urban Roadside Areas*

3.4.1.Clear Zone

Much of the non-urban roadside falls into the Clear Zone, which is part of the Recovery Zone (see ***Figure 3.41***). The Recovery Zone is the total unobstructed traversable area available along the edge of the street and, by convention, it is measured from the edge of the closest through travel lane. Clear Zones support the Safe Systems Approach by making the road forgiving of driver error along the higher speed streets that typically have non-urban roadsides (e.g., freeways, arterial streets with a posted speed of 60 km/h or higher).

The Recovery Zone may have recoverable slopes, non-recoverable slopes, and a clear run-out area. The elements of the Clear Zone are described below and illustrated in ***Figure 3.41***.

- Recoverable slopes are those on which a driver may, to a greater or lesser extent, retain or regain control of a vehicle (generally 4:1 or flatter);
- A non-recoverable slope may be traversable, but a vehicle will continue to the bottom (generally steeper than 4:1); and
- A clear run-out area is located at the toe of a non-recoverable slope, and is available for safe use by an errant vehicle

The wider the Clear Zone in non-urban areas, the lower the frequency and severity of collisions with fixed objects. However, there is a point beyond which any further expenditure to move or protect the fixed objects is not warranted because the marginal risk reduction is too small.

The Clear Zone Design Domain for non-urban areas reflects the influence of:

- Design speed;
- Traffic volumes;
- The presence of cut or fill slopes;
- The steepness of slopes; and,
- Horizontal curve adjustments

Design Domain guidance for the Clear Zone is presented in two parts: a quantitative guide to generally accepted values used for the clear zone under varying circumstances and a set of heuristics and/or practices which should be considered by designers in applying these values. The former must not be used without the latter. Details on calculating non-urban area Clear Zones and design decisions around it can be found in TAC GDG Section 7.3; the decisions around elements and size of Clear Zone are not exact, and require analysis of the various options to make final decisions.

Design Domain of specific elements within the non-urban roadside should follow the Design Domains identified in ***Section 3.3*** (e.g., Design Domain width of shared pathways).

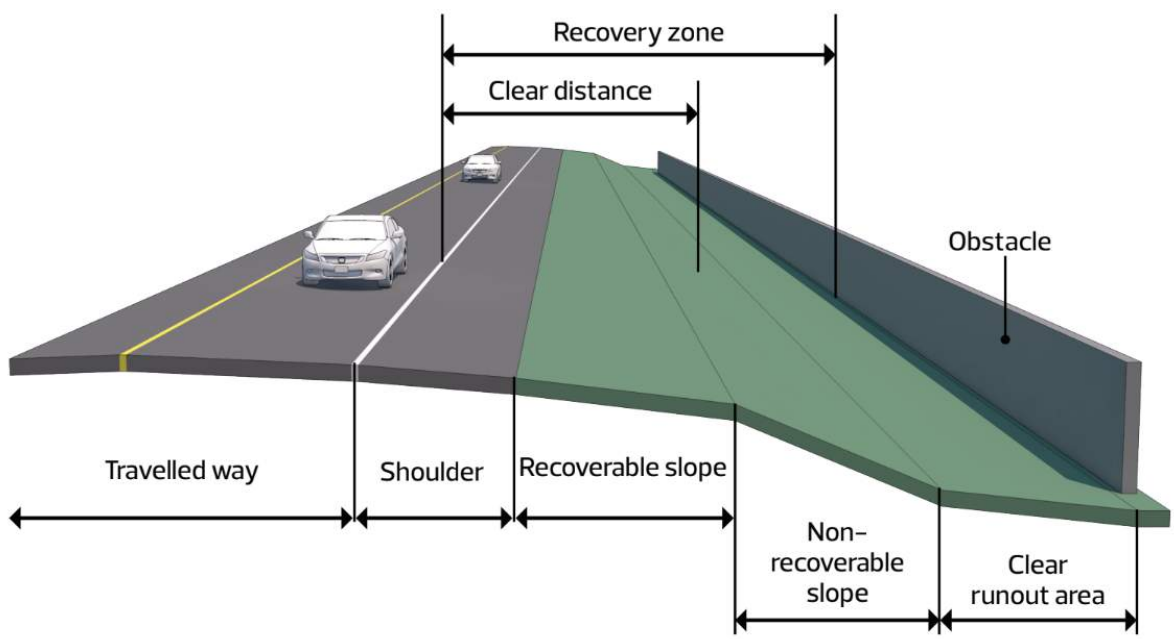


Figure 3.41 *Non-Urban Roadside Recovery Zone*

3.4.2. Non-Urban Active Transportation Requirements

For people walking and wheeling, non-urban area streets involve different risks than urban streets, such as unlit night-time conditions and high motor vehicle speeds. To facilitate safe and comfortable access, non-urban area street design should mitigate these risks through lighting, signage, and the provision of shared pathways or sidewalks. **Table 3.21** summarizes the requirements for people walking, wheeling, and cycling on non-urban area streets.

Table 3.21 *Roadside Accommodation for People Walking, Wheeling, and Cycling on Streets in Cross Sections (i.e., Non-Urban Areas)*

Speed Limit	Walking/Wheeling & Cycling Facilities
≥ 60 km/h	Off-street bicycle facilities such as shared pathways or bike lanes located outside the clear zone and on the backslope side of the drainage channel
40 km/h to < 60 km/h	Off-street bicycle facilities such as shared pathways or bike lanes located off the Travelled Way
< 40 km/h	Sidewalks off the Travelled Way and on-street bicycle facilities.

Night conditions are particularly hazardous for people walking, wheeling, and cycling along non-urban streets because street lighting is often absent. Where warranted by the methodology outlined in the Volume 6 of the City of Edmonton's Design and Construction Standards, the roadside design of new streets in non-urban areas shall incorporate street lighting that effectively illuminates the entire Travelled Way and roadside.

3.4.3. Non-Urban Transit Stops & Shelters

The City requires an appropriate transit stop and amenity pad be constructed as part of new transit stop pad construction. The unconstrained accessible pad dimensions for a transit stop along a non-urban street are 2.25 m by 12.0 m, with a 0.3 m minimum clearance to the property line.

The amenity pad shall be constructed with an adjacent curb and gutter section. A hard surfaced connection from the sidewalk/shared pathway located on the backslope of the ditch to the bus stop amenity pad is required. The connection will include a ditch crossing with appropriately sized culverts and must include a sidewalk or shared pathway constructed with concrete. See the standard detail drawings in Chapter 3 for bus stops and pads in non-urban areas

3.4.4. Drainage in Non-Urban Areas

TAC GDG Section 7.4 covers roadside safety issues related to proper ditch, culvert and related drainage structure design. Incorporating good drainage practice within a safe roadside design can be a difficult challenge. In addressing this challenge, designers should explore the following options, in order of preference:

- Eliminate non-essential drainage structures;
- Design drainage structures so they present a minimal hazard to errant vehicles, including providing traversable structures; and
- Provide shielding with a suitable barrier for any structures that cannot be redesigned or relocated to eliminate their potential threat to errant vehicles.

TAC GDG Section 7.4 addresses these options in the context of Design Domain guidelines that are primarily feature-oriented and framed around the primary types of drainage structures. In applying them, designers must consider their interaction with both the Clear Zone principles, as well as those outlined in discussions regarding traffic barriers (see TAC GDG Section 7.6).

3.5. OFF-STREET PATHS/TRAILS

Places for people walking and wheeling and riding bikes include off-street paths and trails that can be located through parks, utility corridors/rights of way, and stormwater facilities. The environments in these public places shall be designed to allow safe and convenient access by all active transportation traffic, and should accommodate appropriate maintenance vehicles as necessary.

3.5.1. Locational Requirements

Three types of active transportation facilities are used for off-street locations: asphalt paths (i.e., shared pathways), concrete pathways (i.e., walkways), and granular paths (i.e., trails). In general,

- Shared Pathways shall be constructed adjacent to or within:
  - Stormwater Management Facilities (SWMF), utility corridors, and utility rights of way wider than 6.0 metres as defined by the City;
  - Top of Bank Walkways designated for developments abutting the North Saskatchewan River Valley and Ravine System Protection Overlay as identified in the Edmonton Zoning Bylaw;
  - Ravines and the River Valley at the discretion of the City, and in accordance with applicable environmental assessments and management plans; and
  - Park sites (urban village parks, district parks, school/park sites, etc).
- Granular Pathways shall be considered adjacent to or within the following areas, but the surface materials must consider accessibility for people using mobility aids:
  - Trails intended for use as mountain bike trails; and,
  - Trails in naturalized areas, as identified in the Neighbourhood Plan, subdivision plan, or around a SWMF to support a Natural Area Management Plan where permeable surfaces would be preferred.
- Concrete Pathways shall be constructed adjacent to:
  - Walkway lots and PULs as necessary to provide neighbourhood connectivity and accessibility to transit;
  - Locations where slopes require additional structural reinforcement (e.g., Top of Bank); and
  - All land uses that, in the opinion of the City, generate significant pedestrian traffic.

Figure 3.42 *Off-Street Path & Trail*

3.5.2. Path/Trail Width

Off-street paths are the same in design concept as shared pathways. Design Domain dimensions for the width of shared pathways are discussed in ***Section 3.2.3.2*** and can be used for granular trails as well. Further design requirements are provided in ***Section 3.6.11***, if an off-street path/trail is to be used for emergency access.

3.5.3. Drainage

A cross fall of 2% to 3% is recommended for proper drainage of off-street paths, walkways, and trails. Surface drainage from the path/walkway/trail will dissipate as it flows down gently sloping terrain. However, if a path/walkway/trail is constructed on the side of a hill, a drainage ditch or swale may be necessary on the uphill side to intercept the slope drainage.

A culvert or bridge shall be used where a path/walkway/trail crosses a drainage channel. Sizing of the required culvert opening should be determined by a hydraulics engineer and see the City's Design and Construction Standards Volume 3.

For off-street paths, walkways, and trails in flatter environments, ditches may be required to accommodate rain and snow melt to ensure the path/walkway/trail is not flooded and that ice is not formed in colder months.

3.5.4. Landscaping and Amenities

Landscaping elements shall be specified on the landscaping plans in accordance with the requirements of the City's Design and Construction Standards Volume 5. The placement of any plants must consider the "as-planted" sightlines, and "as-matured" sightlines. Benches shall be provided and placed at strategic locations along the off-street path/trail. The benches shall be located a minimum of 1 m from the edge of the path/trail.

Waste receptacles shall be provided where major off-street paths/trails intersect with streets. The waste receptacles shall be of the standard type defined for off-street paths/trails use by the City and shall be located within the off-street path/trail right of way and no more than 3 m from the street right of way. Additional waste receptacles shall be provided along off-street paths/trails as per the City's Design and Construction Standards Volume 5.

The lighting design and other utilities must be shown on the construction plan submitted for City approval.

3.5.5. Pipelines, Railways & Stormwater Facilities

Where off-street paths/trails cross or are located within an existing major utility or pipeline right of way, the designer will be responsible to obtain proper written permission/agreement with the appropriate authority prior to construction. The designer will be asked to produce a copy of a plan approved by the appropriate authority permitting construction of the off-street path/trail within the utility or pipeline corridor.

A crossing agreement or proximity agreement may be required if the path/trail or required work area is adjacent to the pipeline right of way. Agreement will be necessary where work occurs within 30 metres of a Pipeline.

Railway crossings require approvals, and as part of these approvals rail companies often require upgrades to their crossing lighting systems for the new off-street path/trail, which could add costs to the project.

When the alignment of a pedestrian facility is planned within the footprint of a stormwater management facility (SWMF), the designer should provide due consideration to how the operation of the SWMF will impact operation of the off-street path/trail. This may include making provisions to locate the facility above the 1:25 year flood line to ensure minimal disruption or conflict, or revising the alignment to ensure proper longitudinal drainage is maintained.

3.5.6.Horizontal Alignment

The alignment of off-street paths, walkways, and trails intended to accommodate multimodal transportation and recreational uses should use a Design Speed outlined in ***Section 3.2.1.2*** when laying out the alignment and determining sightlines and vertical profiles. Refer to ***Section 3.2.6.3*** for more details on horizontal alignment for bicycle facilities. Larger radii may be preferred for granular pathways to provide a more comfortable surface for people cycling.

3.5.7. Vertical Alignment

The vertical alignment of off-street paths/walkways/trails should be integrated with the horizontal alignment, drainage, and berm design. Since off-street paths are used as self-contained drainage corridors, the off-street path/trail should be designed to facilitate positive drainage flow. The normal longitudinal grade of the walkways is 0.6% and the minimum permitted grade is 0.5%. The cross fall should be designed at 2% to 3% with a landscape swale offset from the walkway. See also ***Section 3.5.3***.

In addition to the above, ***Table 3.22*** provides guidance on the provision of landings for sidewalks, shared pathways, and walkways to create rest areas for people with disabilities traversing extended slopes. The provision of landings supports Universal Design of both on-street and off-street walking and wheeling infrastructure. Additional information on vertical geometry for pedestrian and active modes infrastructure can be found in the TAC Geometric Design Guidelines.

Table 3.22 *Sidewalk/Walkway/Shared Pathway/Trail Grading Requirements*

Maximum Slope	Maximum Length	Maximum Height	Landings
≤2%	None	None	Not required
>2% to ≤5%	None	None	Note 1
>5% to ≤6.25%	12 m	750 mm	Every 12 m
>6.25% to ≤8.30%	9 m	750 mm	Every 9 m
>8.30% to ≤10%	1.5 m	150 mm	Note 2

Notes:

1. Landings at 750 mm elevation difference are desirable.
2. It is recognized that the gradient and building layout on some streets may make the provision of landings impractical.
3. Maximum 8% slope is permissible for walkways located adjacent to Storm Water Management Facilities (SWMF).

3.6. INTERSECTIONS

This section provides guidance to street designers in the design of and preparation of drawings for intersections and crossings for all modes based on the Safe Systems Approach.

An intersection is defined as the location where two or more streets join or cross at-grade, including on-street and off-street for all modes of travel. An entrance or exit from an adjacent property (i.e., driveway) is considered an access and not an intersection.

Intersection design is based on geometric elements including horizontal alignment, vertical alignment, and cross section components. The design of an intersection requires integration of these elements with the physical constraints, multimodal traffic characteristics, and environmental requirements of the intersection, along with the functional classification of the intersecting streets. Intersections should be designed to prioritize safety and comfort for vulnerable road users of all ages and abilities (including those with disabilities) whilst walking, wheeling, driving, or riding transit.

Intersections must be designed to be universally accessible and follow Universal Design principles. Universal Design principles for intersections are:

- Make approaching, entering, and using an intersection easy for people walking and wheeling of all ages and abilities;
- Provide streets and intersections that are both convenient and safe for all users, particularly those with mobility issues;
- Emphasize dignity and independence, providing those features that will allow all people to function in their day-to-day activities;
- Consider accessibility in all seasons and conditions; and
- Be successfully integrated with an intersection’s function and form.

3.6.1.Functional Requirements

3.6.1.1.Design Process

Intersection planning and design involves consideration of current and future transportation needs, as well as zoning and planning context to determine the function and requirements of the intersection. Other considerations in the planning process include how intersection design can be influenced by the physical environment, human factors, policy, economic factors, and local issues. Intersection design is an iterative process where, like cross section design, options are refined to ensure consideration of all factors and achieve the most appropriate design.

When designing an intersection, it is also important to consider the needs and specific limitations of all street users (e.g., people walking and wheeling, cycling, and driving) and their vehicles, as well as the safety of all street users. Applying this requirement should result in designs that satisfy the following principles:

- A street user's expectations of the design are not violated (i.e., strangers to an area are not surprised by the location of the intersection, or its layout, and there is consistency in design from one location to the next along a corridor); and
- The design provides a level of forgiveness for street user errors by:
    - Minimizing exposure to conflicts;
    - Reducing speeds at conflict points;
    - Communicating right of way priority; and
    - Providing adequate sight distance.

Specific considerations for various street users are summarized in TAC GDG Section 9.3.2.

The process of intersection design involves identifying operational and geometric requirements that are interrelated, and determining the information that needs to be presented on design plans. ***Figure 3.43*** highlights the intersection design process.

Figure 3.43 *Intersection Design Process Flow Chart*

3.6.1.2.Intersection Types

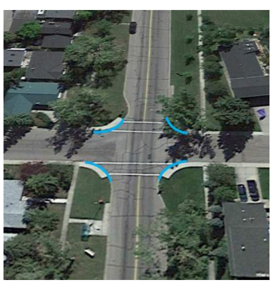
Basic Intersection

There are four basic intersection types as follows:

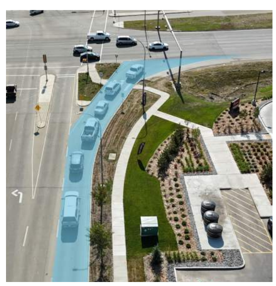
- ***Simple Intersection*** – where the normal lane width of the major street is maintained through the intersection and minimum corner radii are provided (typically single radius curves). Such intersections may have auxiliary lanes (i.e., right or left turn lanes);
- ***Channelized Intersection*** – channelization of an at-grade intersection separates and directs driving, walking and wheeling, and cycling movements and crossings into defined paths. To do so, it uses geometric features, pavement markings, traffic control devices, and other positive guidance elements, as needed;
- ***Protected Intersection*** – separation of turning vehicles from those walking and wheeling using physical barriers, including corner islands. This design provides a setback and a protected path which prevents users wheeling from merging into mixed traffic while turning or proceeding through the intersection.
- ***Roundabout*** – a type of circular intersection in which vehicles travel counter-clockwise where vehicles entering the roundabout must yield to circulating traffic, with those walking and wheeling circulating around the outside of vehicular traffic.

Basic intersection configurations are discussed in more detail in TAC GDG Section 9.2.4 while ***Figure 3.44*** illustrates the typical right turn lane and left turn lane configurations.

Simple Intersection

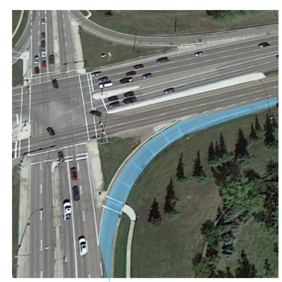


High Entry Angle (Right Turn Channelization Yield)



Low Exit Angle (Right Turn Channelization Merge)

Low Exit Angle (Right Turn Channelization Free-Flow)



Left Turn Lane (Single Parallel)

Left Turn Lane (Single Slotted)

Left Turn Lane (Dual Slotted)

Protected Intersection

***Figure 3.44** Basic Intersection Configurations*

Retrofit Intersection

An intersection retrofit is an improvement or change to an existing intersection. Retrofitting urban intersections is often needed to meet changing traffic demands or to implement operational improvements that increase safety, accessibility, and efficiency. An intersection retrofit may involve many alterations to geometric elements such as introducing or modifying channelization, improving undesirable geometric conditions that affect driving, transit, cycling, and walking and wheeling safety, incorporating curb ramps and refuge areas, and implementing traffic calming measures, or may include conversion to a roundabout (See ***Section 3.6.7*** for Roundabouts).

3.6.1.3.Horizontal and Vertical Alignment Considerations

Like mid-block segments, intersection design is influenced by functional classification, land use context, and building orientation of the intersecting streets. These elements define the purpose of the streets and intersections and how they should function. Every intersection layout is also defined by specific multimodal traffic operational requirements and site conditions that must be considered to identify and address safety concerns. After the intersection location, general alignment, and traffic control measures have been determined, the detailed alignment of each leg of the intersection must be established.

Horizontal Alignment

General considerations for the horizontal alignment of intersections (such as streets, curb ramps, and sidewalks) include:

- Location of intersections on curves is not desirable due to decreased visibility (and inter-visibility), increased conflict potential for people crossing the major street, and complications with street superelevation on higher speed streets; and
- Intersecting streets should meet at, or within 10 degrees of a right angle (90 degrees). This reduces the size of the conflict area, improves visibility/inter-visibility, and decreases the severity of collisions relative to those occurring at greater angles. In locations where angles are between 10 to 20 degrees of 90 degrees, depending on collision history and/or performance concerns, realignment of the intersecting streets should be considered. In some cases, realignment of the intersecting streets to achieve an angle within 10 degrees of 90 degrees may not be cost effective. Detailed discussions on acceptable solutions are provided in TAC GDG Section 9.7.2.

Vertical Alignment

General considerations for the vertical alignment of intersections (such as grades) include:

- Profiles of the minor streets are typically adjusted to match those on the major streets. In some situations, adjusting the major street slightly may assist in smoothing out the profile of the minor street as it intersects;
- Cross fall can be adjusted between 1.0% to 3.0% without affecting the efficient operation of traffic along the major street and the universal accessibility of people traversing the cross fall. Cross falls less than 1.0% should be avoided due to potential drainage problems. Figures on cross fall concepts and transitions are provided in TAC GDG Section 9.7.3;
- Grade breaks between 0.5% to 2% are desirable for Design Speeds of 70 km/h or higher. For Design Speeds of less than 70 km/h, the maximum recommended grade break is 4% (and 6% for 30 km/h) to avoid impacts to people driving. Stopping sight distance must be achieved when using maximum grade breaks; and
- Grades of intersecting streets should be as flat as possible, while still achieving minimum grades for drainage.

3.6.1.4.Sight Distance & Clear Sight Triangles

The avoidance of collisions and the efficiency of operation depends on the judgement, capabilities, and responses of each user. Thus, it is important to provide the appropriate reaction and decision time for street users to clearly see the intersection, identify any potential conflict approaching and passing through the intersection, and make the appropriate decision to stop or otherwise avoid the conflict. Intersection design must provide adequate sight distance for the control type present to all users of the intersection. Restricting obstructions in areas along the intersection approaches and across corners gives users more time to complete their visual search and ensure that they have sufficient time to react.

Sight Distance

The minimum sight distance requirement for people driving vehicles approaching an intersection is the stopping sight distance (SSD), which is based on Design Speed and the stopping distance of the Design Vehicle/User. Due to the complex situations that people driving may encounter at intersections, it is desirable to provide more than the minimum stopping sight distance to enhance safety wherever possible.

To this end, providing decision sight distance (DSD) is desirable in advance of the critical intersection decision points. These decision points include locations where people driving must make prompt choices regarding lane selection, where information and potential conflicts are difficult to perceive, and where unexpected manoeuvres may be required. Values for SSD and for DSD over a range of Design Speeds are provided in TAC GDG Section 2.5.3 and 2.5.5 respectively. ***Table 3.23A*** provides example SSDs for the operation of passenger cars at varying grades for varying Design Speeds.

Bicycle Sight Distance

Sight distances are also important for people riding bicycles for both on-street and off-street bicycle facilities. The minimum sight distance that must be provided for people riding bicycles is the minimum stopping distance, which is the distance required to bring a bicycle to a controlled full stop. This distance is a function of a person's perception-reaction time, the initial speed, the coefficient of friction between the tires and the bikeway surface, the braking capability of the bicycle, and the grade of the bikeway.

Based on a design speed of 30 km/h for bicycle traffic, the stopping sight distance is 32 to 42 m for paved surface and wet conditions depending on approach grade. ***Table 3.23B*** summarizes stopping sight distances for people riding bicycles.

Table 3.23A *Stopping Sight Distance for Passenger Cars*

Design Speed (km/h)	*Stopping Sight Distance by Grade (m)*						
	-9%	*-6%*	*-3%*	*0*	*3%*	*6%*	*9%*
20	20	20	20	20	19	18	18
30	35	35	32	32	31	30	29
40	53	50	50	50	45	44	43
50	74	70	66	65	61	59	58
60	97	92	87	85	80	77	75
70	124	116	110	105	100	97	93
80	154	144	136	130	123	118	114

(Adapted from TAC GDG Tables 2.5.2 and 2.5.3, for brake reaction time of 2.5 s, deceleration rate of 3.4 m/s2, and a passenger car. NOTE: SSD for trucks are longer than those provided below and should be calculated based on guidance from TAC GDG Section 2.5.3.)

Table 3.23B *Stopping Sight Distance for Bicycles*

Design Speed (km/h)	*Stopping Sight Distance by Grade (m)*						
	-8%	*-6%*	*-4%*	*0*	*4%*	*6%*	*8%*
20	23	22	21	20	19	19	19
30	42	39	38	35	33	32	32

(Adapted from TAC GDG Tables 5.5.1 for a bicycle with paved surface, wet conditions, coefficient of friction of 0.25, and perception-reaction time of 2.5 s.)

Clear Sight Triangles

Sight distance at intersections is defined by the clear sight triangles. The dimensions of the legs of the sight triangles depend on the Design Speeds of the intersecting streets and the type of traffic control used at the intersection. These dimensions are based on observed behaviour of people driving and are documented by space-time profiles and speed choices. In intersection design, there are two types of clear sight triangles: approach sight triangles and departure sight triangles.

Each quadrant of an intersection should contain a triangular area free of obstructions that might block an approaching person's view of potentially conflicting movements. The length of the legs of this triangular area should be such that people driving, walking and wheeling, or cycling can see any potential conflicts with other street users with sufficient time to slow or stop before colliding. Obstructions include parked vehicles, landscaping, buildings, monuments, utility boxes, and any objects with vertical presence that restrict people's line of sight.

The following section highlights the key sight triangles for consideration at intersections. Refer to TAC GDG Section 9.9.2 for details on determining the appropriate sight distances and sight triangles to provide. Appropriate sight distances need to consider several factors including but not limited to Design Speed, intersection control type, eye height of people travelling, object height, type of manoeuvre, Travelled Way widths, median treatment, intersection skew, and street right of way.

Approach Sight Triangles

Figure 3.45 shows typical clear sight triangles to the left and to the right for a person approaching a yield-controlled intersection (i.e., travelling along the "minor street" approaching the intersection with the "major street").

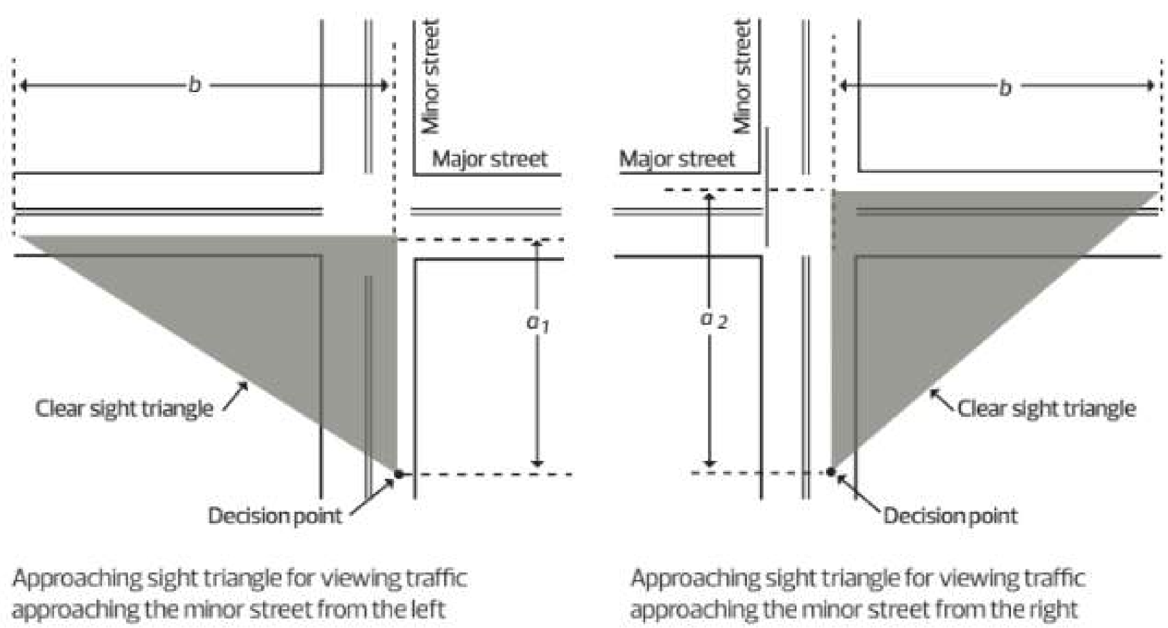


Figure 3.45 *Approach Sight Triangle (Yield-Controlled) (Adapted from TAC GDG Figure 9.9.1)*

Table 3.24 provides the minimum sight distance (or clear approach space, ***b*** in ***Figure 3.45***) required at various posted speeds between a person in a vehicle travelling on a minor street approaching an intersection and vehicles or bicycles travelling on the major street. The Design Speed noted in ***Table 3.24*** is for the design speed of the users along the major street. The clear approach space provides the person travelling on the minor street adequate time to make a decision on whether or not to brake to a stop or proceed through the intersection. Obstructions should be restricted within the clear approach sight triangle to ensure adequate sightlines.

The distance a_1 represents the distance from the person in a vehicle approaching on a minor street to the middle of the curbside travel lane along the major street at which point a decision to brake must be made. The a_1 and the resulting ***b*** can also be calculated to the near-side bikeway facility, if present. If there is a bikeway along the major street and the minor street approach is yield-controlled, clear approach sight triangles for both the general purpose travel lanes and bikeway should be checked.

The distance a_2 represents the distance a_1 plus the width of the lane(s) departing from the intersection on the major street to the right of the approaching driver. Distance a_2 should also include the width of any median present on the major street unless the median is wide enough to permit a vehicle to stop before entering or crossing the Travelled Way beyond the median. Providing a clear sight triangle also allows the user on the major approach with the right of way to react appropriately should users on the minor approach not stop.

In circumstances where approach sight distance cannot be met due to existing conditions or site-specific constraints, additional safety and operational analysis and mitigations should be evaluated.

Table 3.24 *Minimum Sightline Distance for Approach Clear Sight Triangle*

Design Speed (km/h)	Minimum Sightline Distance, b (m)	Minimum Stopping Sight Distance, a1 (m)
≤ 20	45	20
30	70	35
40	90	50
50	115	65
60	135	85
70	160	105
80	180	130

(Adapted from TAC GDG Table 9.9.10, for intersection approach grades ≤ 3% based on passenger car making a left or right turn at a yield-controlled intersection)

Approach sight triangles, like those shown above, are not used for intersection approaches controlled by stop signs or traffic signals as the approaching person's need to stop is determined by the traffic control devices and not by the presence or absence of people travelling on the intersection approaches. For stop- and signal-controlled intersections, the clear sight triangle is based on the departure sight triangle.

Yield-controlled approaches generally need greater sight distance than stop-controlled approaches. If sight distance sufficient for yield control is not available, use of a stop sign instead of a yield sign should be considered.

Departure Sight Triangles

The departure sight triangle provides sight distance sufficient for a person driving, walking and wheeling, and cycling that is stopped on a minor street approach to depart from the intersection and enter or cross the major street.

Figure 3.46 shows typical departure sight triangles to the left and to the right of the location of a person stopped in a vehicle or bicycle on the minor street. Departure sight triangles should be provided in each quadrant of each intersection approach controlled by stop or yield signs, and for all uncontrolled approaches (although approach sight triangles will likely control the clear sight triangle for yield-controlled intersections). For signalized intersections, a departure sight triangle to the left should be provided at intersections where right turns on a red signal are permitted. While departure sight triangles are generally not required at signalized intersections which restrict this movement, they are beneficial as they allow the users with the right of way adequate time to slow, stop, or avoid users travelling without the right of way on the minor approach, or when traffic signals are not operational.

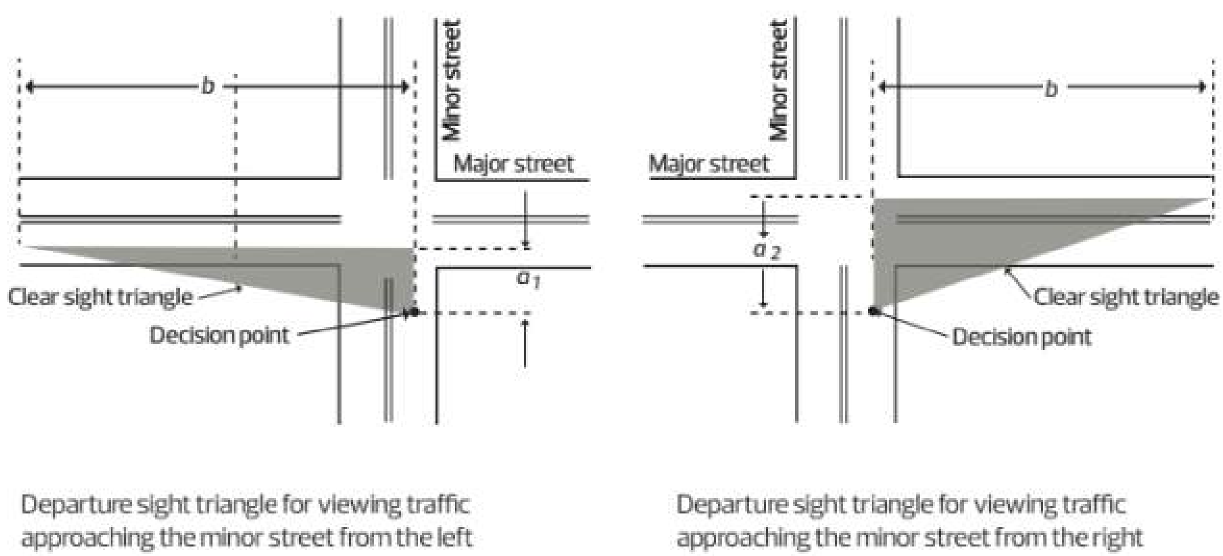


Figure 3.46 *Departure Sight Triangles (Stop-Controlled) (Adapted from TAC GDG Figure 9.9.2)*

Table 3.25 provides the minimum sight distance (or clear approach space, ***b*** in ***Figure 3.46***) required at various Design Speeds between a person stopped in a vehicle on a minor street approach and drivers travelling on the major street, such that the person stopped is safely able to depart from the intersection and enter or cross the major street. The Design Speed noted in ***Table 3.25*** is for the design speed of the users along the major street.

The distance a_1 represents the distance from where the person is stopped in a vehicle on the minor approach to the middle of the curbside travel lane. The a_1 and the resulting ***b*** can also be calculated to the near-side bikeway facility, if present. If there is a bikeway along the major street and the minor street approach is stop-controlled, clear departure sight triangles for both the general purpose travel lanes and bikeway should be checked in both directions.

The distance a_2 represents distance a_1 plus the width of the lane(s) departing from the intersection on the major street to the right. Distance a_2 should also include the width of any median present on the major street unless the median is wide enough to permit a vehicle to stop before entering or crossing the Travelled Way beyond the median.

Table 3.25 *Minimum Sightline Distance for Departure Clear Sight Triangle*

Design Speed (km/h)	Minimum Sightline Distance, b (m)
20	45
30	65
40	85
50	105
60	130
70	150
80	170

(Adapted from TAC GDG Table 9.9.4, for intersection approach grades ≤ 3% and based on passenger car)

Clear Sight Triangle Size

The size of the clear sight triangles is based on the sight distances for the approach and departure sightlines and selecting the value based on intersection control type (e.g., stop control). While sight distances can be calculated for all modes of transportation, most street designs are controlled by the sight distance of users operating vehicles due to their higher speed of travel, and thus greater required stopping and decision sight distances.

Refer to TAC GDG Section 9.9.2.3 for guidelines on determining the clear sight triangle area based on the intersection traffic control type. Sight triangles for oblique (less than 60 degrees) angled intersections are described in TAC GDG Section 9.9.2.4.

Clear Sight Triangles for Bikeways

For roadway crossings at intersections of shared pathways, bike paths, or protected bike lanes, and for the intersection of off-street paths with each other, clear sight triangles should be provided. Sight distances and clear sight triangles should be checked in both directions for two-way bikeways.

In addition to the below, refer to TAC GDG Section 5.6.3.2 for more information on sight distance of mid-block crossings of off-street paths across streets.

Intersection of Two Off-Street Facilities

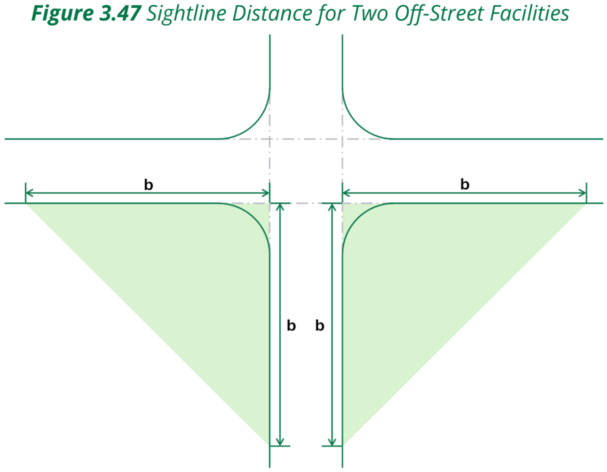
The design of the intersection of two pathways should be based on stopping sight distance of bicycle users along each leg of the approach as shown in ***Table 3.26***, where the sightline distance noted makes up each side of an approach clear sight triangle. Distances should be measured as shown in ***FIgure 3.47***.

Where sight lines cannot be met, mini-yield signs for one or more of the facilities should be added, with sightlines provided as per a yield condition.

Table 3.26 *Sightline Distance for Two Off-Street Facilities*

Facility Design Speed (km/h)	Minimum Sightline Distance, b (m)
20	20
30	35

Figure 3.47 *Sightline Distance for Two Off-Street Facilities*



Intersection with Roadways with Vehicle Priority

For bicycle crossing locations where approaching motor vehicle traffic on the intersecting street have right of way or where a stop- or yield-sign is not controlling approaching motor vehicle traffic, the clear sight triangle is dependent on motor vehicle speed of the intersecting street and the distance to be crossed (i.e. roadway width) as outlined in the TAC GDG and the CROW *Design Manual for Bicycle Traffic*.

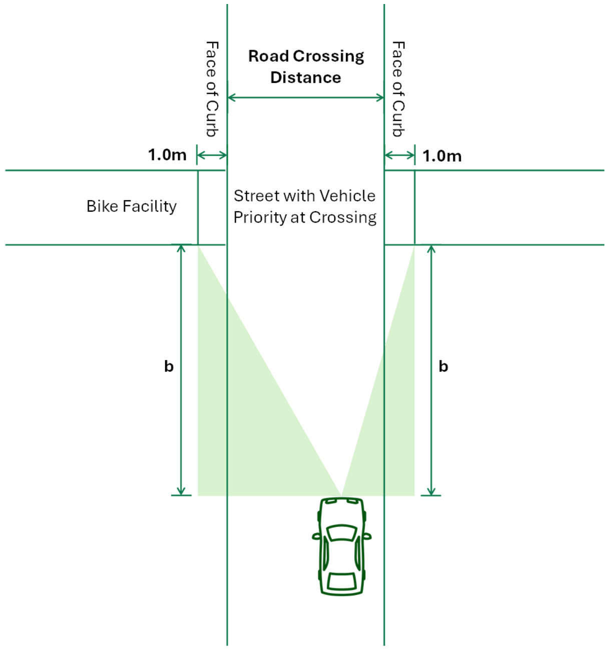
The clear sight triangle is dependent on motor vehicle speed of the intersecting street and the distance to be crossed (i.e. roadway width). The location of where the clear sight triangle along the major road must be achieved is based on the stopping location of the bicycle rider prior to making the crossing, and should be considered to be 1 m from the edge of the street crossing. Sight distance along the street should be provided as per ***Table 3.27***, and measured as shown in ***Figure 3.48***.

Where bike facilities cross higher speed roadways (with a posted speed over 50 km/h) or multi lane roadways (more than one travel lane in each direction, including turning lanes), traffic controls should be installed to provide safe crossings for cyclists.

Table 3.27 *Sightline Distance for Vehicle Priority Crossings*

Roadway Design Speed (km/h)	Road Crossing (approximate distance)	Minimum Sightline Distance, b (m)
30	Single Lane (3-4 m) Two Lanes (6-8 m) Local Street (9.0 m) Collector with Parking (10-14 m)	45 55 60 70
40	Single Lane (3-4 m) Two Lanes (6-8 m) Local Street (9.0 m) Collector with Parking (10-14 m)	75 90 95 105
50	Single Lane (3-4 m) Two Lanes (6-8 m) Local Street (9.0 m) Collector with Parking (10-14 m)	105 120 130 140

Figure 3.48 *Sightline Distance for Vehicle Priority Crossings*



Intersection with Roadways with Cyclist Priority

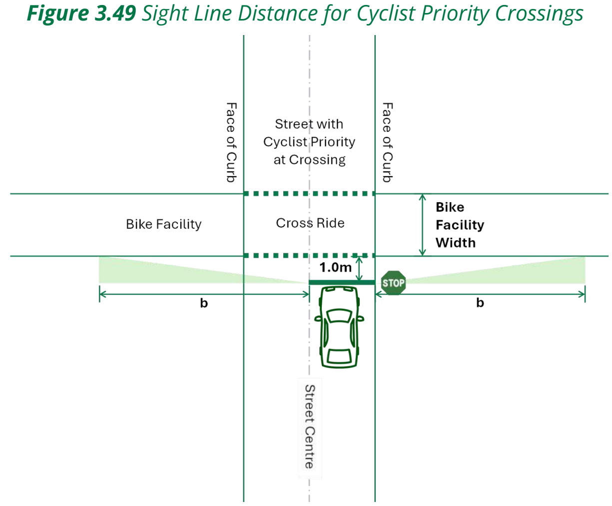
For bicycle crossings of a street where approaching motor vehicle traffic on the intersecting street do not have right of way and must yield or stop prior to crossing the bicycle facility (e.g., continuous crossings, local street intersections of collector streets), **the clear sight triangle will be determined on a project-by-project basis through review from the City of Edmonton.** Additional traffic calming features should be considered in conjunction with the cyclist priority crossing such as a raised crossing or other vertical deflection to promote slower vehicular speeds approaching this type of crossing.

Table 3.28 and ***Figure 3.49***.provide high level guidance as a starting position based on Intersection Sight Distance for a departure clear sight triangle as outlined in TAC GDG Chapter 9 for a motor vehicle to cross a bicycle facility from stopped, with assumed motor vehicle acceleration rate of 1.75 m/s^2, a 1.0 m offset from stop/yield line to the cross ride, a 2.5 second perception-reaction time, and a 15 km/h motor vehicle speed of the bicycle crossing.

Table 3.28 *Sightline Distance for Cyclist Priority Crossings*

Width of Cycling Facility to be Crossed (m)	*Intersection Sight Distance, b (m) At Bicycle Approach Speed*	
	20 km/h	*30 km/h*
2	*25*	37
3	*26*	39
4	*28*	41

Figure 3.49 *Sight Line Distance for Cyclist Priority Crossings*



Approach Clear Space for Protected Bike Lanes and Shared Paths at Intersections

Unlike clear sight triangles, the approach clear space for protected bike lanes at intersections is based on the design speed of the bikeway and the motorist turning speed. The approach clear space outlines the recognition, decision, and yielding/stopping actions that are required of people driving and cycling as they approach an intersection and the driver will be turning across the protected bike lane. ***Figure 3.50*** illustrates two conditions. On the left side of the Figure is when a person driving approaches a person cycling from the rear and will yield due to their relative position and travel speed on the intersection approach. On the right side of the Figure, the person cycling will yield to the person driving as they are approaching the intersection behind the person driving and potentially in the driver's blindspot. In both scenarios, the Approach Clear Space prior to the intersection conflict point applies.

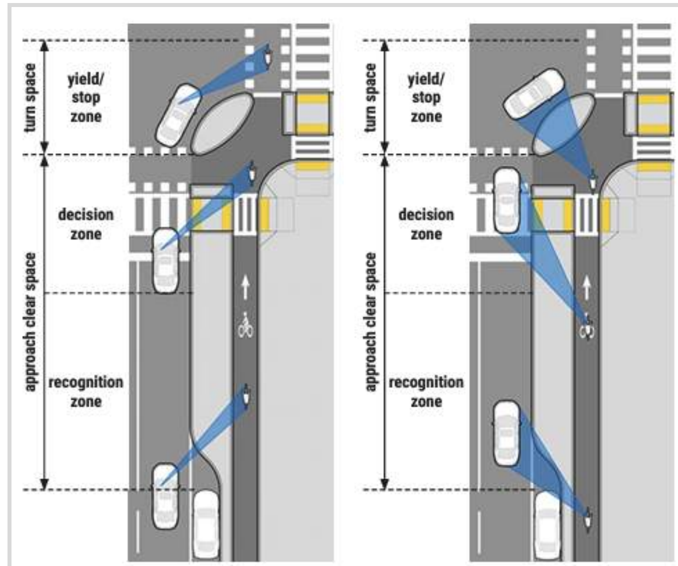


Figure 3.50 *Protected Bike Lane Approach Clear Space (Source: ITE Protected Bikeways Practitioners Guide)*

Based on the vehicle turning speeds noted in ***Table 3.29***, providing a minimum Approach Clear Space of 6 m is required at driveways, alleys, and intersections. However, an increased Approach Clear Space of 15.0 m should be used at intersections where the curb radius is between 5.0 and 10.0 m.

The Approach Clear Space should not include elements that would obstruct the line of sight or visibility of children. This means objects including planting should be less than 0.6 m. All parking, loading, and stopping zones must be restricted within the Approach Clear Space.

For more information on the Approach Clear Space, see the ITE Protected Bikeways Practitioners Guide and the City of Ottawa's Protected Intersection Design Guide.

3.6.2.Corner Radius

3.6.2.1.Introduction

The corner radius is constructed to connect the curbs of two intersecting streets. The design of corner radii is influenced by the following elements:

- Design Vehicle(s) (and Control Vehicle in some cases);
- Turning traffic volumes;
- Street type;
- Lane widths;
- Parking lane widths;
- Total pavement (Travelled Way) widths;
- Angle of intersection;
- Turning condition (stop or yield);
- Turning speed;
- Existing and proposed drainage facilities;
- Degree of activities and volume of people in the Pedestrian Through Zone and public realm areas;
- Bicycle facility types and widths;
- Right of way restrictions; and
- Street Function.

Corner radii also impact people walking and wheeling by influencing:

- Available queuing space at intersections;
- Crossing distance;
- Crossing directness;
- Location, number, and type of curb ramps;
- Sightlines and visibility of and for people walking and wheeling in the non-Travelled Way; and
- Speed of turning motor vehicles.

Corner radii should be designed using the minimum vehicle turning path of the Design Vehicles to reduce the speed of vehicle turns. Smaller corner radii provide more queuing space for people walking and wheeling, facilitate a shorter crossing distance, enable straight and direct connections, and increase the visibility of pedestrians. When selecting smaller curb radii, consideration must be given to ensure adequate drainage can be provided around the corner and snow clearing operations are accommodated. Catch basins shall be located without interfering with curb ramps, and desired crossings can be accommodated. The design of corner radii may differ for each situation, with vehicle turning path software used to assist in, and verify, the design.

There are typically three types of curves used in intersection design: circular (simple) curves, two-centred compound curves, and three-centred compound curves, as detailed in TAC GDG Sections 9.13.2.2, 9.13.2.3, and 9.13.2.4

In general, compound curves are more appropriate for intersections which are frequently used by larger vehicles, such as the WB-21 and WB-36, such as in Industrial Areas. Circular curves are more common for non-Industrial Area intersections, in street oriented contexts, and where there are constrained rights of way.

3.6.2.2. Design Principles & Requirements

Design Vehicles are used in determining the appropriate corner radius, as discussed in ***Section 3.1.3.3***. An intersection is typically designed to accommodate the Design Vehicle, and the Design Vehicle should be able to manoeuvre the intersection without encroaching into opposing lanes; however, in constrained locations, encroachment into opposing lanes may be required and an advanced stop bar should be used. A Control Vehicle is the largest vehicle type required to manoeuvre the intersection, but occurs at relatively low frequency, and may encroach into adjacent and opposing lanes.

The following Design Vehicle and Control Vehicle principles should be applied when developing corner radii utilizing the swept path analysis method. Unless stated otherwise, offset distances identified in this section refer to the wheel paths of vehicles. For more information related to swept paths, refer to TAC GDG Section 2.4.5.

Turning Speeds

Vehicle turning speeds should be based on vehicle type as per ***Table 3.29***.

Table 3.29 *Vehicle Turning Speeds*

Vehicle Type	Turning Speed (km/h)
Passenger Vehicle	5 - 10
Large Trucks (WB-21, WB-36)	5
Fire Truck	10 - 15
Transit Bus	10 - 15
All Other Design Vehicles	5 - 10

Note:

1. Lower vehicle speeds may be used for constrained conditions at the discretion of the City.

Encroachment

- Encroachment into opposing traffic on arterial roadways by any portion of the vehicle (wheel path or body) is not permissible.
- Design Vehicles shall not cross the centreline of the intersection approach, except on local streets.
- Encroachment into an approach lane where there is one receiving lane will not be permitted on conventional ETS bus routes.
- Control Vehicle encroachment into opposing traffic may be permitted for low volume occasional turning movements at the discretion of the City, subject to the following.
  - Large truck control vehicle encroachments may be permitted to utilize the entire width of the roadway, maintaining a 0.3 m offset from the face of curb or edge of roadway as per ***Table 3.30***.
  - Other Control Vehicle encroachments should be limited to 3.0 m beyond the centre of the roadway as per ***Table 3.30***.
  - All Control Vehicles should recover from oversteering movements into the opposing side of the road in the shortest distance possible.
- All vehicles shall be able to manoeuvre turns without coming into conflict with legally parked vehicles.
- Permissible encroachments are summarized in ***Table 3.30***.

Table 3.30 Permissible Encroachments by Approach and Receiving Street Type

Approach Street / Receiving Street	*Design Vehicle*	*Allowable Encroachment*		*Control Vehicle*	*Allowable Encroachment*	
		Approach	*Receiving*[1]		*Approach*	*Receiving*[1]
Arterial Truck Route / Arterial Truck Route	WB-21	None	Two receiving lanes	WB-36	Adjacent lane	All receiving lanes in same direction, mountable aprons
Arterial Truck Route / Arterial Non-Truck Route	COE Bus	None	Two receiving lanes	WB-21	Adjacent lane	All receiving lanes in same direction, mountable aprons
Arterial Truck Route / Collector	COE Bus	None	Two receiving lanes	WT, FT	Adjacent lane	All receiving lanes in same direction, mountable aprons
Arterial Non-Truck Route / Arterial Truck Route	COE Bus	None	Two receiving lanes	WB-21	Adjacent lane	All receiving lanes in same direction, mountable aprons
Arterial Non-Truck Route / Arterial Non-Truck Route	COE Bus	None	Two receiving lanes	WB-21	Adjacent lane	All receiving lanes in same direction, mountable aprons
Arterial Non-Truck Route / Collector	COE Bus	None	Up to two receiving lanes	WT, FT	None	All receiving lanes in same direction, mountable aprons
Collector / Arterial Truck Route	COE Bus	None	Up to two receiving lanes	WT, FT	None	All receiving lanes in same direction, mountable aprons
Collector / Arterial Non-Truck Route	COE Bus	None	Up to two receiving lanes	WT, FT	None	All receiving lanes in same direction, mountable aprons
Collector / Collector	COE Bus	None	Up to two receiving lanes	WT, FT	None	All receiving lanes in same direction, mountable aprons
Arterial / Local	P	None	N/A[2]	WT, FT, MSU	None	Full width of roadway, mountable aprons
Local / Arterial	P	N/A[2]	None	WT, FT, MSU	Full width of roadway	All receiving lanes in same direction, mountable aprons
Collector / Local	P	None	N/A[2]	WT, FT, MSU	All departing lanes in same direction	Full width of roadway, mountable aprons
Local / Collector	P	N/A[2]	None	WT, FT, MSU	Full width of roadway	Up to 3m beyond centreline
Local / Local	P	N/A[2]	N/A[2]	WT, FT, MSU	Full width of roadway	Full width of roadway

Note:

1. Encroachment into receiving lanes is permitted for the same direction of travel only.

2. N/A identifies local streets where shared two- way operations are expected and permitted.

Starting and Ending Positions

- Passenger Vehicle starting positions should have a minimum 0.6 m offset from the face of curb or centre of the lane marking on the right side of the vehicle.
- For Non-Passenger Vehicles, vehicle starting positions should have a minimum 0.3 m offset from the face of curb or centre of the lane marking on the right side of the vehicle and the centre of the roadway on the left side of the vehicle. On intersection approaches less than 6.6 m in width, a 3.3 m offset should be maintained from the face of curb on the left side of the vehicle.
- Large Truck Control Vehicles shall be permitted to initiate a right turn from the lane adjacent to the curbside turning lane. Control vehicles should not initiate a right turn while encroaching into an opposing lane.
- The end position of vehicle turning envelopes shall maintain a minimum 0.3 m offset from the centre of the lane marking or face of median / island curb on the left side of the vehicle.
- Vehicle turning movements must maintain a minimum 0.3 m offset from any face of curb or edge of pavement at the start and end positions of the turning manoeuvre. This may be reduced at the discretion of the City where there are no pedestrian facilities immediately adjacent to the curbline. However, in situations where offsets on both sides of the vehicle cannot be maintained in the starting position, the offset on the left side of the vehicle should be reduced first.
- On roads with no painted centreline, the Control Vehicle may initiate a turn while maintaining a minimum offset of 3.3 m from the face of curb on the left side of the vehicle where a road is less than 6.6 m wide.
- Passenger Vehicles shall turn into the designated receiving lane while maintaining offsets of 0.3 m from all curblines and paint lines.
- Non-Passenger Vehicle Design Vehicles may use multiple receiving travel lanes with the same travel direction, depending on the type of vehicle. Large Trucks may use up to three (3) receiving lanes. All other Design and Control Vehicles (including Transit Buses) may use up to two (2) receiving lanes where available.

Turning Movements

- A vehicle turning envelope clearance of 0.3 m should be maintained from the face of curb around the curb radii during the turning manoeuvre for all Design and Control Vehicles. A tracking apron may be required to accommodate larger vehicle turning movements.
- Dual left and right turn lanes must be designed to accommodate side by side manoeuvres by the Design Vehicle in the inside lane and an MSU in the outside lane, as a minimum.

Stop Bar / Line Placement

- If intersections are stop-controlled, and adequate sightlines can be provided, vehicles on the receiving approach must have adequate setback for the stop line to minimize conflicts with turning vehicles. The placement of an advanced stop line shall consider the vehicle body of the turning vehicle.
- An advanced stop line should be installed where the Design Vehicle encroaches into opposing lanes of traffic at a signalized intersection. This is more likely to occur in constrained rights of way.

Emergency Vehicles

- Emergency vehicles must be able to physically manoeuvre between fixed objects and parked vehicles on all corners, but are allowed to use the entire pavement width on any roadway type. However, the wheel paths of these vehicles must maintain a minimum 0.3 m offset from any face of curb or edge of pavement during the turning manoeuvre.

Other Considerations

- Where possible, symmetrical designs should be used in the same intersection for consistent user expectations and to allow manoeuvring of the Design Vehicle in all directions.

- Intersection corners with full time 'no right turn' restrictions do not need to accommodate right turning vehicles.

- When a right turning lane is not adjacent to the curb, the effective turning radius can be greater than the physical radius. This can occur where there are painted bike lanes or on-street parking at an intersecting street. The effective turning radius shall be used for manoeuvring, and a smaller physical corner radius should be constructed, as shown in ***Figure 3.51***.

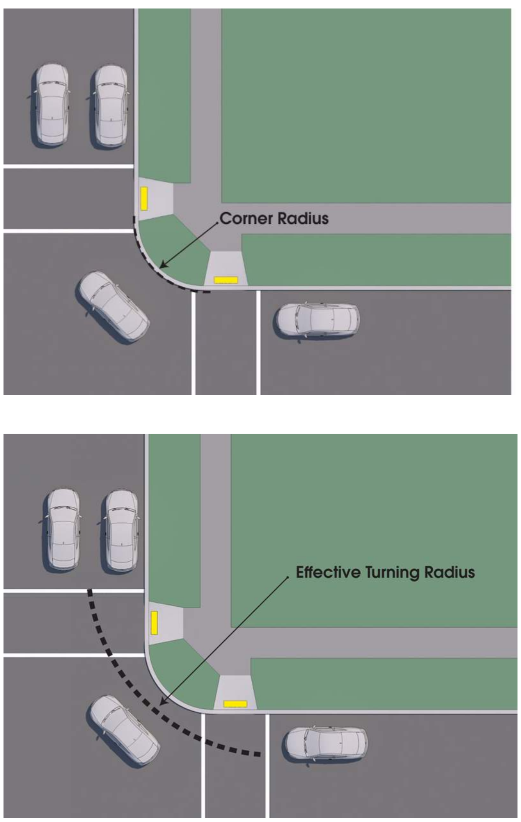


Figure 3.51A *Corner Radii and Effective Turn Radius*

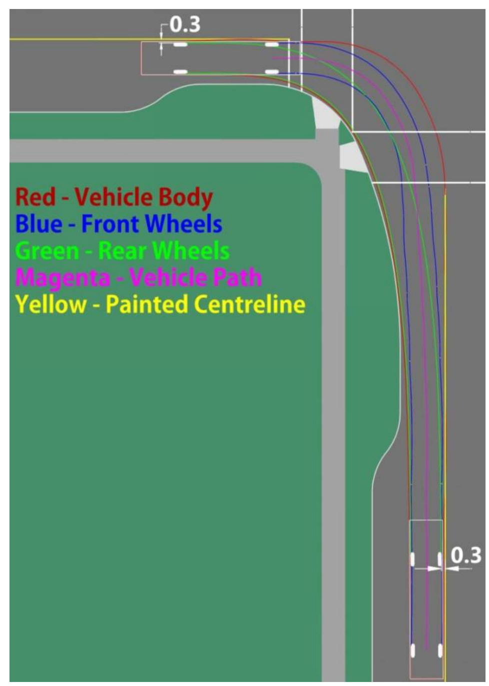


Figure 3.51B *Example Turning Movement Analysis*

Design Domain dimensions for corner radii are included in ***Tables 3.31*** and ***3.32*** for varying intersection types based on the Design Vehicle for intersections in non-Industrial and Industrial Areas, respectively. Corner radii shall be confirmed through the use of swept path analysis to ensure the Design Vehicle can navigate the proposed design. All radii are navigable by snow clearing equipment.

Refer to ***Table 3.3*** (***Section 3.1.3.3***) for a complete summary of the Design and Control Vehicles by street classification. For arterial streets with Design Speeds over 50 km/h that intersect with arterial or collector streets, two-centred, three-centred, and channelized right turns may be more appropriate. See ***Section 3.6.8.1*** for factors and design considerations for channelized right turns.

Table 3.31 *Design Domain: Intersection Corner Radii (in m)*

Parameter: Intersection Corner Radii (Departing Street/Receiving Street)	*Design Vehicle*	*Control Vehicle*	*Design Domain Recommended Range[1]*		*Design Target Value[2,4]*
			Recommended Lower Limit	*Recommended Upper Limit*	
Arterial Truck Route/Arterial Truck Route[3]	WB-21	WB-36	Use High Entry Angle channelized right turn design		
Arterial Truck Route/Arterial Non-Truck Route[3,5]	COE Bus	WB-21	7.5	15.0	12.0
Arterial Truck Route/Collector	COE Bus	WT, FT	10.0	15.0	10.0
Arterial Non-Truck Route/Arterial Truck Route[3,5]	COE Bus	WB-21	7.5	15.0	12.0
Arterial Non-Truck Route/Arterial Non-Truck Route[3,5]	COE Bus	WB-21	7.5	15.0	8.0
Arterial Non-Truck Route/Collector	COE Bus	WT, FT	10.0	15.0	10.0
Collector/Arterial Truck Route[3]	COE Bus	WT, FT	7.5	12.5	8.0
Collector/Arterial Non-Truck Route[3]	COE Bus	WT, FT	6.5	12.5	7.0
Collector/Collector	COE Bus	WT, FT	7.5	12.5	8.0
Primary or Secondary Corridor/Any Street,[6, 7] OR Any Street/Primary or Secondary Corridor	MSU	COE Bus	4.5	12.5	6.0
Local/Any Street OR Any Street/Local	P	WT, FT, MSU	4.0	9.0	5.0

Notes:

1. Designers should use corner radii toward the lower end of the Design Domain if the design target value is not used, however, turning manoeuvres must be confirmed using swept path analysis for the Design and Control Vehicle

2. Target value is based on typical street cross sections as shown in the Standard Details. Swept path analysis is required to confirm corner radius based on the Design Principles. Where a corner is utilized by a bus, and the total width of the receiving lanes is less than 6.0 m (in the same direction), a two centred R9 + R70 curve shall be used.

3. All arterial street receiving lane scenarios are based on two receiving lanes along the arterial street and a median. If more than two lanes are provided, a corner radius lower than the Design Domain recommended lower limit is possible, but must be confirmed using swept path analysis. For first stage arterials where only a single receiving lane is provided, the simple radius may not be applicable, a compound curve radius, channelization, stop box, or additional receiving lanes may be required to accommodate turning movements.

4. When along a Primary or Secondary Corridor, or inside a Major or District Node or Pedestrian Priority Area, review simple or multi-centred radius curves with the objective to minimize crossing distances for people walking.

5. Where there is a raised or depressed centre median, a simple radius may not accommodate the Control Vehicle. Complete swept path analysis to confirm vehicle turning movements. The use of a High Entry Angle channelized right turn may be required.

6. A COE Bus design vehicle should be utilized where bus movements are expected and may require adjustment to curb radii depending on the number of receiving lanes.

7. Where the receiving street has a single lane and encroachment into oncoming lanes is not desirable for the MSU design vehicle, a R7.5 + R50 two-centred curve may be used.

Table 3.32 *Design Domain: Intersection Corner Radii – Industrial Areas (in m)*

Parameter: Intersection Corner Radii (Departing Street/Receiving Street)[1]	*Design Vehicle*	*Control Vehicle*	*Design Domain Recommended Range[2]*		*Design Target Value[3]*
			Recommended Lower Limit	*Recommended Upper Limit*	
Arterial Truck Route/Industrial Area Collector	WB-21	WB-36	Use High Entry Angle channelized right turn design		
Arterial Truck Route/Industrial Area Local	WB-21	WB-36	Use High Entry Angle channelized right turn design		
Industrial Area Collector/Arterial Truck Route[4]	WB-21	WB-36	Use High Entry Angle channelized right turn design		
Industrial Area Collector/Industrial Area Collector	WB-21	WB-36	11.5	15.0	13.0
Industrial Area Collector/Industrial Area Local	WB-21	WB-36	14.0	15.0	15.0
Industrial Area Local/Arterial Truck Route[4]	WB-21	WB-36	Use High Entry Angle channelized right turn design		
Industrial Area Local/Industrial Area Collector	WB-21	WB-36	12.5	15.0	13.0
Industrial Area Local/Industrial Area Local	WB-21	WB-36	15.0	15.0	15.0

Notes:

1. Arterial street/arterial street intersection Design Domain is provided in ***Table 3.27***.

2. Designers should use corner radii toward the lower end of the Design Domain if the design target value is not used, however, turning manoeuvres must be confirmed using swept path analysis for the Design and Control Vehicle.

3. Target value is based on typical street cross sections as shown in the Standard Details. Swept path analysis is required to confirm corner radius based on the Design Principles.

4. All arterial street receiving lane scenarios based on two receiving lanes along the arterial street and a median. If more than two lanes are provided, a corner radius lower than the Design Domain recommended lower limit is possible, but must be confirmed using swept path analysis.

Mountable Curbs

As discussed in ***Section 3.2***, mountable curbs can be used in areas where there is a need to accommodate infrequent large trucks. The inside curb radius is designed to accommodate the larger Control Vehicle turning template (or Design Vehicle that is less frequent), while the outside curb radius is designed to accommodate the Design Vehicle. The area between the two curb radii can be constructed as a mountable curb apron.

Figure 3.52 shows examples of using mountable curbs for extension of corner areas, and how to transition the curb ramps (see ***Section 3.6.3***) across the curb extension. The design requires two curb ramps to transition down to street level, but the curb ramp transitions would be more gradual than regular curb ramps. The curb side ramp would transition from full curb height (e.g., 150 mm) down to the back of the mountable apron area. The height would vary depending on the width of the curb extension. A minimum cross fall of the apron area is 0.02 m/m towards the street, with the mountable rolled curb height of 80 mm. The second lower curb ramp would transition from the back of the apron area down to the Travelled Way. Additional measures should be installed for Universal Design. A Tactile Walking Surface Indicator should be installed on the first ramp. Crosswalk markings should be painted, or a different surface treatment used through the lower curb ramps, to ensure people do not use the mountable apron as a waiting area.

The City of Edmonton has been piloting coloured concrete aprons using egyptian red and a pinwheel brick pattern to delineate the raised apron. A detail is provided for reference on drawing #3130. Other jurisdictions within Alberta have been using similar colours in between dark red and brown earth tones.

(Source: Central Seattle Greenways)

(Source: Google Maps)

(Source: Google Maps)

Figure 3.52 *Mountable Curb Treatment Examples*

3.6.3. Curb Ramps & Tactile Walking Surface Indicators

A curb ramp is a graded transition between the Pedestrian Through Zone (e.g., sidewalk) and the Travelled Way, linking the Pedestrian Through Zone with the crosswalk and ensuring a smooth transition for all users. A curb ramp consists of several parts that provide smooth transitions, places of refuge, and tactile guidance for people walking and wheeling who may have a visual impairment or are using mobility aids. The shape and positioning of these elements varies according to curb ramp type and geometric constraints. The parts are illustrated in ***Figure 3.53*** and include:

- Ramp – the transitional grade between two surfaces (typically a sidewalk and a street crosswalk);
- Landing – a flat surface at the top of a curb ramp that provides a space for refuge and manoeuvring;
- Flare – the sloped edge between the ramp and the adjacent sidewalk. A flare is not an ideal travel surface for a wheelchair user, but provides a flexible and detectable means for people walking and wheeling to access the ramp from the side, rather than the landing;
- Approach – the sidewalk panel(s) adjacent to the curb ramp. The approach area should be designed as flat as possible so that grades entering the curb ramp are minimized;
- Tactile Walking Surface Indicator (TWSI) – a warning treatment that alerts people walking and wheeling to the presence of a street crossing through a tactile surface (Tactile Attention Indicator) and/or contrasting colour. Tactile Direction Indicators can also be used that extend from the Tactile Attention Indicator across the approach sidewalk to alert people with vision loss of the crossing perpendicular to their path of travel. If used, these devices should be of contrasting colour, but should not be yellow; and
- Hard surfaced – All the above described parts of the curb ramp should be hard surfaced and comply with requirements described in the CSA's Accessible Design for the Built Environment.

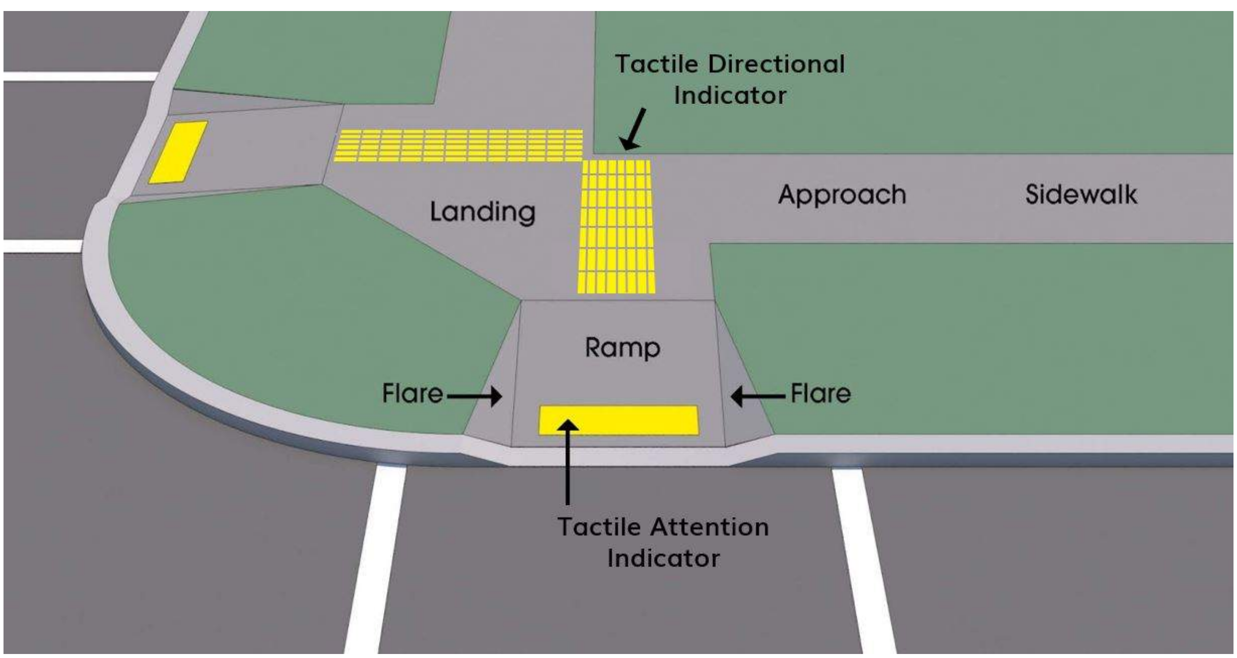


Figure 3.53 *Parts of the Curb Ramp*

Curb ramp design is dependent on the adjoining sidewalk design and crosswalk location and width. To ensure a Universal Design accessibility, the curb ramp and adjoining sidewalk shall adhere to the design criteria in ***Table 3.33.***

Table 3.33 *Curb Ramp Design Requirements*[1]

Design Criteria		*Design Requirement*
Approach/Sidewalk	Cross Grade	≤ 2%
	Longitudinal Grade	≤ 5%
Curb ramp	Provision	At every corner and mid-block crossing
	Grade	≤ 6.0%; maximum grade of 1:12 (8.33%)
	Curb Ramp Flare	400 mm (separated sidewalk)/1700 mm (monowalk/plaza) - See detail 5510.
	Width (exclusive of flared sides)	1.8 m min.; should match sidewalk width up to 3.0m
	Length	Based on grade
	Tactile Device	**Tool Grooved Concrete** Tool Grooved Concrete at minimum at each curb ramp along or crossings all freeway/expressway, arterial, and collector, and local streets and off-street shared pathways (e.g., paths along utility corridors) crossings with these street classifications. **Tactile Attention Indicators (i.e., Truncated Domes)** Truncated domes shall be utilized at locations with high pedestrian volumes, including pedestrian priority areas and street oriented developments, as well as at schools, transit centres, libraries, and recreation centres. If using truncated domes with mid-block crossings, guidance should also be provided to direct users to the crossing, a physical element perpendicular should also be considered. Example details 5520, 5521, 5522, 5523, 5524, 5530 and 5531 provide guidance around the use of truncated domes for curb ramps. 5530 and 5531 provide pilot examples of directionality using truncated domes and detectable guidance surface indicators.
Landing	Width	Match curb ramp
	Length	1.8 m min. and up to 2.25 m to accommodate most wheelchair types

[1] Based on:Transportation Association of Canada (TAC). 2017. Geometric Design Guide for Canadian Roads . Ottawa: Transportation Association of Canada; Canadian Standards Association (CSA), 2023. Accessible Design for the Built Environment. Mississauga: CSA Group, formerly Canadian Standards Association.

The following general guidance applies to curb ramps at crosswalks:

- Curb ramps should optimally be centred in the crosswalk (i.e., the curb ramp should meet a crosswalk roughly at its centreline) so they do not project people walking and wheeling into the vehicle traffic lanes, parking spaces, or parking access aisles.
- A2 type (bidirectional) curb ramps should in general be avoided unless in constrained areas in retrofit situations or other geometric requirements.
- Curb ramps should be equipped with Tactile Attention Indicators, whether they are located at an intersection or mid-block, to make the person walking and wheeling aware they are entering a hazard area and to direct their travel through the area.
- Perpendicular curb ramps are preferred as they enhance safety and mobility for people walking and wheeling. They mitigate crowding through separation of users travelling in different directions and reduce ambiguity for drivers about which crosswalk people walking and wheeling intend to use. These ramps allow wheelchair users and people with vision loss to directly enter the crosswalk rather than entering the street at an angle. They also reduce encroachment by turning motor vehicle traffic compared to a fully depressed corner.

- Where desirable, a bend out configuration or curb extensions can be used to provide space for separated curb ramps.
- Perpendicular curb ramps will not provide a straight path of travel on large radius corners. At intersections with narrow sidewalks and large corner radii, unidirectional curb ramps or a fully depressed curb ramp should be considered. For typical arterial/arterial intersections, this threshold occurs at a 11.0 m radius. For typical arterial/collector intersections, this threshold occurs at a 6.5 m radius.
- Provide adequate distance between the curb ramps to allow for development of the full curb height between the curb ramps on the corner. A minimum distance of 3 m should be provided for the tapers down to the curb ramps. A minimum of 0.5 m between the ends of two adjacent perpendicular curb ramp flares is needed to develop the full curb height. Refer to ***Figure 3.54*** and ***3.55***.
- Where increased separation exists between the crosswalk and adjacent turning lanes, additional consideration must be given to ensuring adequate sight lines for people crossing and people turning. This may necessitate "bend-in" configurations for sidewalks, or the use of depressed or parallel curb ramps.
- Catch basins/drainage facilities should be placed outside of the curb ramp and crosswalks to the greatest extent possible.

Curb ramp standard details for the City of Edmonton are shown on the standard detail drawings in Chapter 3. More information on curb ramps can be found in TAC GDG Section 6.4.6 and 6.5.2.

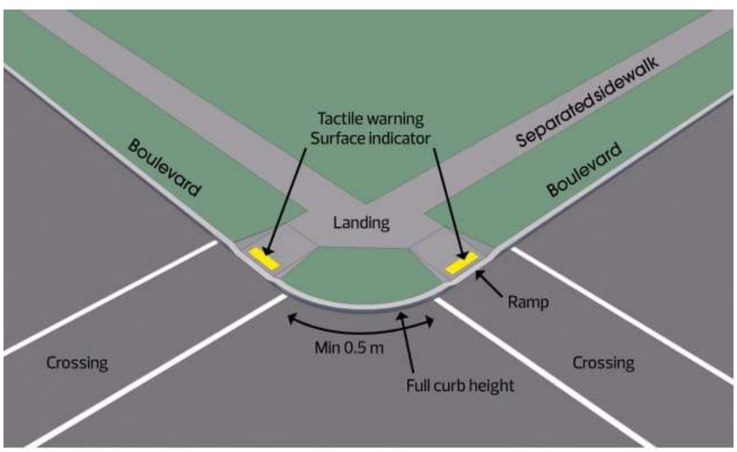


Figure 3.54 *Perpendicular Curb Ramps Boulevard Separated Sidewalk*

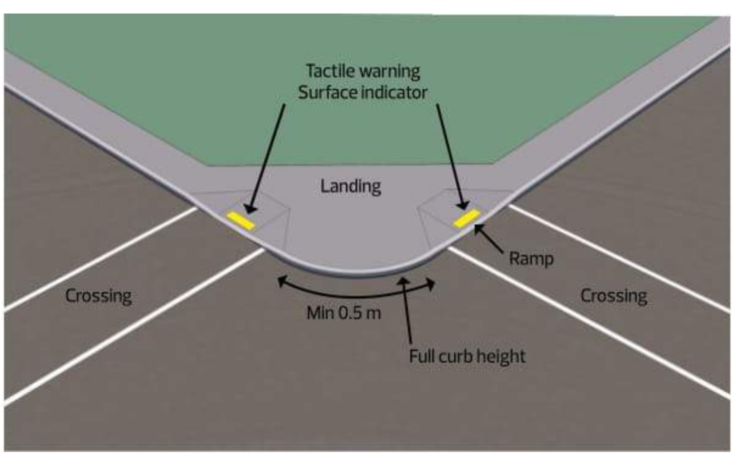


Figure 3.55 *Perpendicular Curb Ramps Monolithic Sidewalk*

3.6.4.Crossings for People Walking and Wheeling

A crossing for people walking and wheeling occurs when facilities for walking intersect with the Travelled Way or bicycle facilities, creating conflict points between people walking and wheeling and those driving and/or cycling. These conflict points occur:

- On the street, at intersection and mid-block crossing locations (e.g., crosswalks);
- On the sidewalk (i.e., Pedestrian Through Zone), where driveways and alleys cross the sidewalk;
- On bicycle facilities such as protected bike lanes at intersection and mid-block crossing locations; and
- At bus stops.

Since people walking and wheeling are the most vulnerable street users, their design needs should promote safety and comfort by managing motor vehicle speeds, improving visibility, inter-visibility, and sightlines, reducing street crossing distance, increasing crossing directness, and providing accessible spaces.

Design principles for safe and attractive crossings for people walking and wheeling include the following:

- Desire lines represent the shortest or most easily accessible route between the person and the attraction/destination. Crossing opportunities should be available at appropriate intervals to match the demand to cross the street along direct desire lines;
- Crossings should be clear and visible. The location along with possible markings, materials, and illumination of the crossing should make it easily identifiable and allow people walking and wheeling to see and be seen by traffic, both while waiting to cross and while crossing;
- Crossings should be direct and accessible to people of all ages and abilities; and
- Crossings should be as short as possible.

3.6.4.1.Crosswalks

Intersection Crosswalks

All intersections are legal crossing points, regardless of whether there is signage, pavement markings, or active devices indicating a crosswalk, unless the crossing is specifically prohibited by signage or as per the Traffic Safety Act. People driving should therefore expect to encounter people walking and wheeling at every intersection. Traffic controls (e.g., signs, pavement markings, signals) indicate to people driving a higher level of walking activity, and encourage people walking and wheeling to cross at designated locations. People walking and wheeling must still exercise due caution and care when crossing any street.

At signalized intersections, all crosswalks should be marked. At unsignalized intersections, crosswalk markings and signage, such as zebra and/or twin parallel line pavement markings, and warning measures such as overhead pedestrian flashers, may be used in accordance with the MUTCD-C and the TAC Pedestrian Crossing Control Guide.[6] Warrants to install traffic controls for crossings consider factors that include, but are not limited to, activity of people walking and wheeling and motor vehicle volumes, vehicle speed, street width, sightline restrictions, proximity to schools and seniors' facilities, proximity to transit stops and transit centres or stations, latent demand of people walking and wheeling, safety and operational history, and distance to the nearest alternative crossing. Decorative pavement marking treatments can also be applied to enhance crosswalk visibility and add vibrancy to the streetscape. Additional guidance on decorative crosswalks is provided in ***Section 3.6.9***.

The components of different types of crosswalks are provided in Tables 3A through 3F of the TAC Pedestrian Crossing Control Guide. Prohibiting crossing for people walking and wheeling at an intersection leg is sometimes implemented for safety or operational reasons. This practice should only be justified based on the needs of all intersection users, and should consider negative impacts on the crossing distance and delay for people walking and wheeling. Non-compliance can be a problem when crossings are prohibited. Justification for prohibiting a crossing should be in the form of a Design Exception (see ***Section 2.2***).

[6] Transportation Association of Canada (TAC). 2012. Pedestrian Crossing Control Guide, Second Edition . Ottawa: Transportation Association of Canada.

Location for Intersection Crosswalks. The location of crosswalk markings at intersections is impacted by corner radii (***Section 3.6.2***) and the width of the crosswalk which affects the type and placement of curb ramps (***Section 3.6.3***). ***Figure 3.56*** illustrates the effect of corner radius on the crossing distance and location of the crosswalk. For larger corner radii, implementation of a crossing setback would reduce the crossing distance. However, this approach should be avoided as it reduces the visibility of people crossing on the side street to the people travelling along the major street. The larger corner radii allow for higher turning speed, and combined with poor sightlines, creates an unfavourable condition for people crossing the side street.

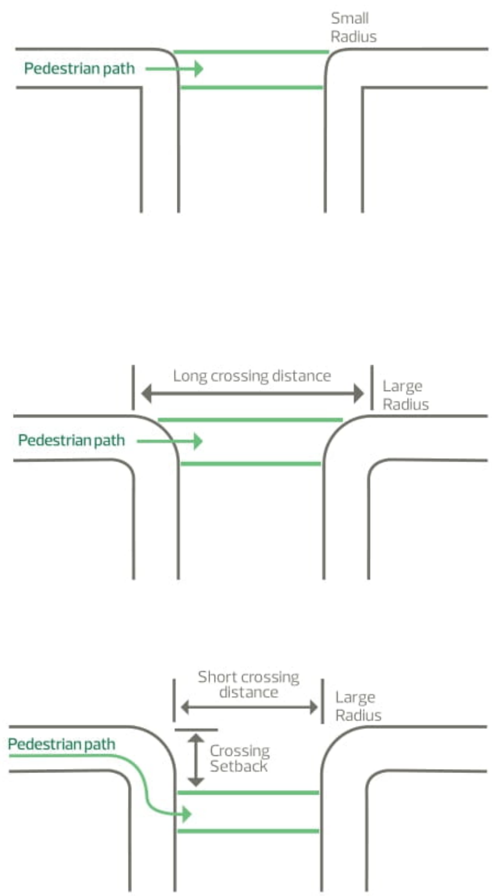


Figure 3.56: *Effect of Corner Radius on Crossing Distance and Directness for People Walking*

The following are design considerations when determining where to locate the crosswalk. More information can be found in TAC GDG Section 6.4.5.

- Smaller corner radii decrease the crossing distance for people walking and wheeling. Larger corner radii increase the crossing distance for people walking and wheeling unless the crosswalk location is set back further from the intersection, which affects crossing directness and visibility;
- The intersection side of a typical crosswalk should initially be offset a minimum of 0.6 m from the face of the parallel street curbline. The crosswalk can then be moved around the curb return as necessary to achieve a balance of crossing distance and directness;
- The curb ramps should be centred in the crosswalk;
- If within the crosswalk, a raised island shall have a level area in the middle to accommodate refuge based on Universal Design or the median can be ended prior to the crosswalk and have a median tip to protect the refuge area. See ***Section 3.6.4.2*** for guidance on refuge area size requirements; and
- Median refuge areas and curb extensions can be used to improve sightlines, reduce crossing distances, and reduce the need for active controls.

Mid-block Crosswalks

Mid-block crosswalks legally establish right of way for people walking and wheeling at a mid-block location and are often associated with connecting a shared pathway across a street or in street oriented commercial contexts. Other locations where mid-block crossings may be considered include arterials streets with block lengths of more than 200 m with key destinations on either side of the street, access points to major community destinations, where there is a history of collisions for people walking and wheeling, and locations with heavy volumes of people walking and wheeling (e.g., adjacent to mid-block transit stops). At the discretion of the City, mid-block crossings on collector and local streets may occur at closer intervals than arterial streets.

An engineering study should be completed on arterial streets to determine if a mid-block crossing is warranted. Factors to consider include vehicular volumes and speeds, street width and number of lanes, stopping sight distance and sightlines, distance to the next controlled crossing, night-time visibility, grade, origin-destination of trips, volume of people walking and wheeling, and latent demand for people walking and wheeling.

The engineering study will indicate whether signage and pavement markings are sufficient or if active traffic control is required (e.g., traffic signals or amber flashing beacons) and should consider Vision Zero as a primary objective. Details on conducting a crosswalk engineering study are found in the TAC Pedestrian Crossing Control Guide.

3.6.4.2. Median Refuge Areas

Median Refuge Areas provide a protected space for people walking and cycling to cross one direction of traffic at a time. This reduces their exposure to vehicle traffic and can be implemented at both intersections and mid-block crossing locations. Additionally, median refuge areas act as a form of horizontal traffic calming by narrowing the width of the travelled way and partially restricting the left turning movements of vehicles.

Dimensions

The absolute minimum depth of the refuge area (i.e. the dimension between the opposing roadway lanes) is 2.5 m. The recommended depth of the median refuge area is 4.1 m, which allows for Tactile Attention Indicators to be placed on either side of the refuge area and sufficient dwelling space for bicycles and other mobility devices.

The minimum width of the refuge area should match the width of the crosswalk or incoming walking and/or cycling facilities, with an absolute minimum width of 2.5 m.

Median refuge areas should be considered under the following circumstances:

- On two-way roadways with two or more lanes in each direction.
- For mid-block crossings along first stage arterial streets.
- For active transportation crossings of two lane roads to allow cyclists to safely cross both directions of traffic.
- In areas with high pedestrian or cyclist activity, particularly amongst seniors, children, or other vulnerable users (such as schools, community centres, religious assemblies, recreation centres).
- At both signalized and unsignalized intersections.
- As part of crossing improvements or traffic calming.

Even with the presence of median refuge areas, pedestrian crossings at signalized intersections should be timed to allow pedestrians to cross the entire width of the roadway in one signal phase.

Median refuge areas are an integral part of two-staged crossings which are utilized for traffic calming. Design Guidance on two-staged crossings can be found in ***Section 3.6.4.4***, with additional discussion on their traffic calming benefits found in ***Section 3.8***.

Materials & Accessibility

Materials for the surface of the refuge may be either concrete or asphalt or a combination of the two. The selection of material depends on the primary usage of the refuge. For crosswalks linking two sidewalks and primarily serving people walking, the surface of the refuge should be concrete to visually indicate the pedestrian area and match the rest of the median. However, asphalt may be used in cases of heavier cycling use, such as within crosswalks linking shared pathways. In this case, the asphalt should be uniform across the entire length of the crosswalk.

Median refuge areas require Tactile Attention Indicators on either side of the refuge area to alert pedestrians that they are entering a street crossing.

3.6.4.3.Raised Crossings

Introduction

Raised crosswalks are a vertical deflection consisting of two ramps and a flat crossing surface. The elevation of the raised crosswalk matches the walking or cycling approaches on either side of the roadway, creating a continuous level surface for people walking, wheeling or cycling.

Raised crossings may be used to achieve any of the following objectives:

- Indicate priority of people walking and cycling;
- Indicate entrances/exits to residential areas;
- Reduce speeds at conflict locations such as marked crosswalks, school crosswalks and pathway crossings;
- Reduce speeds in conjunction with an overall traffic calming strategy for a corridor or neighbourhood; and/or;
- Increase crossing accessibility and comfort by eliminating ramps and reducing accumulation of water, slush and snow in crossings.

Raised crossings improve safety for people walking, rolling and cycling by increasing driver awareness of people crossing and decreasing driver speeds. This gives drivers the benefit of a longer reaction time and reduces collision severity, should a collision occur.

Application

This section provides guidance on selection of appropriate raised crossings and evaluation of suitability of the use of raised crossings. The following conditions should be reviewed when considering the suitability of a site for a raised crossing:

Street Characteristics

- **Land Use** – Near residential, mixed-use, or commercial development, post-secondary institutions, schools, transit hubs, or other areas with high pedestrian or cyclist activity, especially seniors and other vulnerable users.
- **Number of Lanes** – 2 or fewer through lanes in each direction along the roadway for raised crosswalks, one lane in each direction for raised intersections.
- **Speed** – Posted Speed is 50 km/hr or less, with priority at transitions between speed zones.
- **Volume** – Daily motor vehicle traffic volumes are less than 20,000 vehicles per day.
- **Heavy Vehicles** – The proportion of motor vehicle traffic has a mix of 5% or less heavy vehicles including buses.
- **Transit** – Routes where articulated buses are used should be avoided to reduce the risk of decoupling. Bus stops should be located at least 25 m in advance of raised crossings to minimize potential stability problems.
- **Grade** – The longitudinal grade of the roadway is 8% or less.
- **Spacing -** Spacing of raised crosswalks should follow the guidance specified in ***Section 3.8*** for spacing of raised features along roadways.

Functional Classification

- **Arterial** - Along Downtown arterials, arterials with speeds 50 km/h or less, or arterials with low heavy vehicle volumes. Raised crossings are not typically appropriate across arterials.
- **Collector & Local** – along or across Mixed-Use and Residential Collector or Local Roadways.
- **Alleys/Driveways, Reverse Housing Alleys and Car Free Streets & Shared Spaces.**

Modal Priority

- **Pedestrian and Cyclist Priority** - Where people walking and cycling have higher modal priority, such as around, but not limited, to Nodes and Corridors in the *City Plan*, in Pedestrian Priority areas in the applicable *District Plans*, and along District Connector bike routes in the *Bike Plan.*
- **Safety** - Where a pattern of low compliance or collisions between drivers and people walking or cycling exist or is expected to occur.

Selection

Raised Mid-Block Crossings

Raised mid-block crossings can be used to reduce the approach speed of people driving at a specific conflict location between intersections and increase awareness of a mid-block crossing. They may also be applied as part of a larger traffic calming strategy along a corridor.

Figure 3.57: *Raised Mid-block Crossing*[7]

- **Street Context** – At mid-block crossings across Local and Collector roadways, Reverse Housing Alleys and Shared Roadways. Across other roadways with design speeds less than 50 km/h where context is appropriate.
- **Crossings for People Cycling** - mid-block pathway crossings, particularly where paths are located in their own right of way.
- **Crossings for People Walking and Wheeling** - mid-block school or playground crosswalks, or other locations where higher volumes of children, seniors or other vulnerable users are present.
- **Traffic Calming** – Apply as part of an overall traffic calming strategy to lower speeds along a corridor or neighbourhood, or as an entry treatment to a lower speed zone such as a playground zone.

[7] Source: NACTO Urban Street Design Guide

Raised Crossings at Intersections

Raised crosswalks may be used at intersections where a set-back crossing is used, where pedestrians and/or cyclists have priority at an intersection, where the intersecting roads have equal priority (i.e. similar traffic function), where a typical continuous crossing is not feasible, or as part of a larger traffic calming strategy. Additionally, raised crossings may be used as gateway treatments across roadways leading into areas where lower speeds are desired, such as residential and mixed use developments.

Figure 3.58: *Raised Crossing at Intersection*[7]

- **Street Context** – Residential Local and Collector roadways, Reverse Housing Alleys and Shared Roadways. Along arterial and collector roadways with bike facilities, or where residential local and collector roads meet the major roadway. When used as a gateway treatment, a target setback of 5 to 6 m should be used.
- **Crossings for People Cycling -** Setback crossings are preferable for two-way cycle facilities, including shared pathways and two-way bike paths. A target setback of 5 to 6 m should be used. For one-way bike facilities, setback raised crosswalks may be used when continuous crossings are not feasible.
- **Crossings for People Walking and Wheeling** - at school or playground crosswalks, or other locations where higher volumes of children, seniors or other vulnerable users are present.
- **Traffic Calming** – Apply as part of an overall traffic calming strategy to lower speeds along a corridor or within a neighbourhood, or as an entry treatment to a lower speed zone such as a playground zone or residential area.

Continuous Crossings

Continuous Crossings should be used along a corridor as a gateway treatment into a residential area and to clearly emphasize pedestrian and cyclist priority along a corridor through materials and grading. Continuous crossings minimize conflict between road users by encouraging better yielding behaviour and slower speeds entering and exiting a side street across a walking and or cycling facility.

Set-back continuous crossings are built using the same detail as raised crossings, but should use materials to visually communicate pedestrian and cyclist priority.

Figure 3.59: *Continuous Crossing*

- **Street Context** - Along Downtown Arterial Streets and Mixed-use and Residential Collector Streets where residential local and collector roads meet the major roadway. When used as a gateway treatment, a target setback of 5 to 6 m should be used.

- **Crossings for People Cycling -** For raised cycle facilities where cyclists have clear priority over the side street and the side street is controlled by a stop or yield condition. Continuous crossings are preferred for one-way bike facilities, and only used for two-way bike facilities when setback raised crossings are not feasible.

- **Crossings for People Walking and Wheeling** - Along corridors with higher walking priority, such as along Downtown arterial streets, at school or playground crosswalks, or other locations where higher volumes of children, seniors or other vulnerable users are present.

Raised Intersections

In locations that are suitable for raised crossings both along and across a corridor or where intersection operations are more complex, a raised intersection may be considered. This may include:

- As traffic calming, where roadways of equal priority meet;

- Where multiple legs of an intersection would benefit from from a raised crossing, such as where the primary pedestrian movement is across multiple legs of the intersection; and

- Where intersection operations and more caution is desirable, such as where a bike facility transitions into another facility.

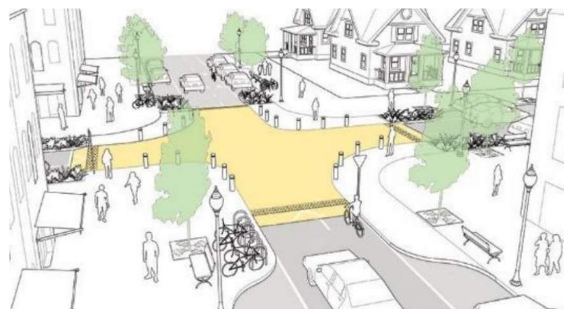


Figure 3.60: *Raised Intersection*[7]

[7] Source: NACTO Urban Street Design Guide

Design Elements

Crossing Width

The table top width has an impact on the effectiveness of the raised crossing as a speed control measure and the impact to larger vehicles such as buses and fire trucks. The shorter the table top, the more impact it has on a vehicle and its passengers.

The target table top width is 4.0m for most crossings to match the standard crosswalk width and reduce the impact on large vehicles. When the width of the incoming walking and/or cycling facilities are wider than 4.0m, the width of the flat crossing surface should be increased to match the combined width of the walking & cycling facilities. In constrained conditions, the absolute minimum crossing width is 2.5m.

Vehicle Ramps

Vehicle ramp design is one of the most challenging and critical elements in implementing an effective raised element. Ramp grades are influenced by the design speed, traffic control, surrounding curb height and incoming grades. The target grade breaks between the roadway, table-top and ramp are found in ***Table 3.34*** and ***Table 3.35***. The grade breaks and ramp length have been chosen to achieve an equivalent height of 80-125 mm. These are a starting point for the designer and the overall interaction between crossing width, slope of approaches, context of the area, and desired operational characteristics of all users need to be considered.

Effective Radius

For raised crossings at intersections, the design radius should match the design radii and design vehicles in ***Section 3.6.2.2***. For continuous crossings, the standard detail accommodates the Design and Control vehicles for a Local Street intersection. The extent of the reinforced area and pan may need to be adjusted to accommodate larger design vehicles and should be confirmed using swept path analysis.

Table 3.34 *Design Domain: Raised Crosswalks and Intersections - Ramp Length and Grade Break for Vehicles*

Parameter:	*Design Domain Recommended Range*[1]		
	Lower Limit	*Upper Limit*	*Target*[2]
Ramp Length (m)	1.75	2.75	1.75
Grade Break	4.0%	7.5%	6.25%

Notes:

1. On frequent transit routes or where high volumes of truck traffic are present, a 5.75% grade break is recommended with a maximum grade break of 6.25%.

2. Target design speed is 40 km/h. If a higher design speed is selected, increasing the ramp length and/or reducing the grade break is required.

Table 3.35 *Design Domain: Continuous Crossings - Ramp Length and Grade Break for Vehicles*

Parameter:	*Design Domain Recommended Range*		
	Lower Limit	*Upper Limit*	*Target*[1]
Ramp Length (m)	0.8	1.0	0.8
Grade Break	10%	16.5%	12.5%

Notes:

1. Target design speed is 5 km/h, which is consistent with a stop or yield control. If a higher design speed is selected, increasing the ramp length and/or reducing the grade break is required.

Accessibility

The crossing surface of the raised crossing is considered part of the sidewalk and/or cycling facility and should meet the horizontal and vertical grade design standards for pedestrian and cycling facilities provided in ***Section 3.5.7***.

Tactile Walking Surface Indicators (TWSI)

A tactile warning to alert people walking and wheeling that they are entering a street crossing is required at all raised crossings. See the *City of Edmonton Access Design Guide* for more information.

Pavement Marking & Signage

Raised crossings that are not controlled by a stop or yield sign must be marked by a WA-50 bump sign installed adjacent to the raised crosswalk to alert drivers of the vertical deflection. If a sign or raised crosswalk is visually obstructed, a WA-50 sign with a distance tab may be considered for installation in advance of the raised crosswalk. Additional signage to indicate crossings for pedestrians and/or cyclists (pedestrian crossing, bicycle crossing, pedestrian and bicycle crossing, etc.) may supplement the crossing location.

Crosswalk and crossride markings are not required at all raised crossings but may be installed in accordance with the MUTCD-C and the TAC Pedestrian Crossing Control Guide.

Warning markings ('shark's teeth') are placed on the ramps at all asphalt raised crossings, and concrete crossings with a posted speed greater than 40 km/h. Due to the poor adhesion of pavement markings on concrete, pavement markings may be placed on the asphalt in advance of the raised crossing.

Drainage

Generally raised crossings require new drainage infrastructure on one or both sides of the crossing depending on incoming road grades. Proximity to drainage tie-ins should be considered to avoid excessive drainage costs.

Where applicable, water may be directed across the side-street along continuous crossings, with a single catch basin located on the up-stream side. Catch basins should also be located outside of the perpendicular curb ramps and flares.

Drainage surface infrastructure should be all the way in or all the way out of any raised crossing (not in ramps).

Materials

Materials for raised crossings may be either concrete or asphalt or a combination of the two. For continuous crossings, the crossing materials should match the intersecting walking or cycling facilities to visually indicate priority of active modes over the side street.

For decorative crossings, the crosswalk materials may consist of stamped asphalt, and/or coloured asphalt, or coloured concrete. Use of stamped concrete or pavers for crossings is not permitted. These crossings must include white parallel lines to mark the legal crossing location.

Additional Considerations

Raised crossings delay the response speeds of Emergency Services. Use of raised crossings near hospitals and fire stations should involve consultation with Emergency Medical Services and Fire Rescue Services. Removing raised crossings or adjusting to have gentler ramp grades and/or longer table tops may be considered.

Raised crossings should be avoided on longitudinal grades over 8%. Special consideration should also be given to the proximity of or on a horizontal (minimum horizontal radius of 100 m for locating on a horizontal curve) and vertical curves and availability of good sightlines.

On higher speed roadways, high traffic volume roadways, or roadways with high volumes of right turning vehicles, consideration should be given to traffic operations and overall safety resulting from the reduced turning speed of vehicles from the primary roadway onto the secondary roadway.

3.6.4.4.Two-Stage Crossings

Introduction

Two-stage crossings allow people, walking, wheeling, and cycling to cross the roadway one lane at a time. The benefits of this include:

- Reduced crossing distance;
- Slower driving speeds due to horizontal deflection; and
- A higher number of crossing opportunities.

Two-stage crossings include a median refuge space and can be implemented using either temporary or permanent infrastructure. Examples of both temporary and permanent two-stage crossings are shown in ***Figure 3.61A*** and ***Figure 3.61B***:

Figure 3.61A: *Two-Stage Crossings (Temporary)*

Figure 3.61B: *Two-Stage Crossing (Permanent)*

Application

Two-stage crossings can be applied for pedestrian, shared pathway or bike crossings on two-lane collector or arterial roadways. For crossings along bike routes, traffic volume criteria should be considered as per the following:

- When peak hour vehicle volumes are less than 800 veh/hr, the use of two-stage crossings is encouraged, but not required.
- When peak hour volumes fall between 800 and 1600 veh/hr, the use of two-stage crossings is strongly recommended.

When volumes in the peak hour exceed 800 vehicles, the safety risk for cyclists increases due to minimal gaps in vehicle traffic required to cross the road after yielding. This increases the likelihood of cyclists undertaking risky manoeuvres and, therefore, should be addressed by implementing a two-stage crossing.

Design Elements

Minimum Lane Width

The minimum travel lane width adjacent to a two-stage crossing should be maintained at 3.7 m to allow sufficient space for snow and ice clearance.

Pedestrian and Cyclist Refuge Area

The following dimensions shall apply to the width of the refuge area, defined as the space between the travel lanes on either side:

- Minimum width: 2.5 m
- Target width: 4.1 m
- Maximum width: No maximum width as long as the minimum travel lane width is maintained. Specific considerations include the length of the taper, how it impacts accesses, and whether the median is continuous or requires a taper.

For more details on the refuge space, refer to ***Section 3.6.4.2***.

Other Dimensions

- Taper rate from edge of median to centreline: 5:1
- Centreline lead: 6.0 m from taper
- Crosswalk width: 4.0 m
- Minimum length of two-stage crossing: 6.0 m (between median noses)

3.6.5.Crossings for People Cycling

Intersections are areas of potential conflict and can be challenging to navigate by bicycle. Designing intersections requires careful consideration of the inter-visibility of people cycling and driving, isolating and managing conflicts upstream of the intersection area, and clearly assigning yield priority (i.e., there should not be signs that contradict or perceive to contradict each other). The following sections identify intersection treatments for bicycle crossings based on the type of bicycle facility provided on the street. In some cases, the bicycle facility may change at the intersection (i.e., to provide more separation) to manage conflicts and improve safety. The following principles shall be considered in the design of crossings for people cycling:

- Designs should be consistent with cyclist behaviour;
- Create a forgiving environment that enables safe decisions;
- Clear right of way;
- No dismounting; and
- Provide a direct and predictable path.

Accommodation of bicycle facilities at intersections requires specific consideration for addressing conflict points between bicycle traffic and vehicle traffic. The main conflict points between people cycling and people driving at a typical intersection of two streets are:

- Through bicycle traffic with right turning motor vehicle traffic;
- Through bicycle traffic with left turning motor vehicle traffic;
- Bicycle traffic turning into and out of bike facilities; and
- Left turning bicycle traffic with through motor vehicle traffic.

Where conflicts with motor vehicles are more significant due to high traffic volumes, high speed vehicle turns, or at locations with limited sight distance, steps should be taken to reduce or eliminate conflicts with other strategies such as restricting turn movements, providing traffic signal phasing that allows for fully protected cycling movements, providing physically separated operating space for people cycling (i.e., protected intersection), or providing grade separation. In any case, minimum sight triangles must be checked and provided to ensure adequate sightlines to cyclists crossing intersections. Refer to ***Section 3.6.1.4*** for minimum sightline distances for cyclists.

Painted bike lanes are generally suitable only on lower speed and lower motor vehicle volume streets, where conventional intersection designs such as pavement markings, bike boxes, and two-stage turn queue boxes may be adequate. Larger or more complex intersections and intersections along streets with higher motor vehicle volumes or those operating at higher speeds typically coincide with protected bike lanes or shared pathways. These locations require a greater degree of physical protection for people cycling and can include protected intersections, bend-out configurations, separate signal phasing of multimodal movements, and/or two-stage turn queue boxes.

The guidance on how to design for these conflict points should be matched with the bicycle facility type determined based on ***Section 3.2.3***. The following sections provide a summary of common treatments, but the treatments shown are not exhaustive. Variations of the treatments may be required to address site specific context that considers space constraints, intersection of different facility types, etc.

Additional reference information to support design decisions are available in TAC GDG Section 5.6, the NACTO Urban Bikeway Design Guide, and the CROW Manual.

3.6.5.1.Protected Bike Lanes at Intersections

Intersections and driveway crossings with protected bike lanes must be carefully designed to promote safety and facilitate turns from the protected bike lane. In addition to TAC GDG, FHWA also provides useful information specifically on protected bike lanes at intersections.[4] Bidirectional protected bike lanes, shared pathways, and contraflow bike lanes require additional considerations at intersections and driveways because they create unusual or unexpected conflict points.

The approaches outlined in ***Section 3.6.6*** can also be applied for bidirectional protected bike lane intersection treatments.

The following provides information on designing common intersection treatments for protected bike lanes. For other intersection treatments refer to TAC GDG, TAC Bikeway Traffic Control Guidelines for Canada, CROW Manual, and FHWA Separated Bike Lane Planning and Design Guide.

Protected Bicycle Signal Phase

A protected bike lane with bicycle signal phase (***Figure 3.62***) allows people cycling to reach the intersection within a bike lane separated from motor vehicle traffic. The bicycle signal phase then provides temporal separation of bicycle and motor vehicle traffic rather than spatial separation. This eliminates conflicts with right turning motor vehicle traffic and the signal phasing can also be designed to mitigate conflicts between motor vehicle traffic and people walking and wheeling. Left turns for people cycling are typically carried out in a two-stage left turn to eliminate conflicts with through motor vehicles. Another option is to use an all-bicycle signal phase (similar to an all-pedestrian phase referred to as a “pedestrian scramble”) to remove conflicts between people cycling and those driving vehicles.

(All Red Phase)

(Vehicle Phase with Protected Right Turn)

(Bike Phase, Prohibited Vehicle Right Turn)

Figure 3.62: *Protected Bicycle Signal Phase (No Lateral Shift) (Source: City of Vancouver[8])*

[8] *Federal Highway Administration (FHWA). 2015. Separated Bike Lane Planning and Design Guide. Report FHWA-HEP-15-025. McLean, Virginia: Federal Highway Administration.*

Horizontal Offset: Bend-out and Queuing Area

The offset distance between a protected bike lane and the adjacent travel lanes is an important consideration and has been shown to impact safety performance. Research indicates a horizontal offset of the protected bike lane between 2 m and 5 m at all types of intersections, including signalized and unsignalized intersections, can have safety performance benefits. In some cases, this will require the protected bike lane to bend-out at the intersection approach and in other cases the protected bike lane or bike path may need to bend-in.[9]

This horizontal offset creates a queuing area for drivers. The space reduces driver workload by allowing drivers to first yield for and cross the bicycle facility crossride and crosswalk, and then allowing the drivers to focus attention on the intersection with the roadway. Without this queuing area, drivers need to scan multiple directions and multiple facilities at the same time. This is even more important at crossings of bidirectional bikeways including bidirectional protected bike lanes, shared pathways, and bike paths. The queuing area also provides queuing space for people cycling who are turning left from the bike facility.

A protected bike lane that is a “bend-in” at the intersection refers to shifting the horizontal alignment of the protected bike lane toward the centre line of the street and toward the adjacent travel lanes as illustrated in ***Figure 3.63***.

A protected bike lane that is a “bend-out” at the intersection refers to shifting the horizontal alignment of the protected bike lane away from the centre line of the street. This is typically required to support protected intersection designs and create the horizontal offset and queuing space at both signalized and unsignalized interactions (measured from the edge of the through lane continuing extending through the intersection). The bend-out is illustrated in ***Figure 3.64***.

The bicycle crossings can also be supplemented by being raised, similar to a raised crosswalk, to provide further safety benefits.[10]

[9] de Groot, R. editor (CROW). 2016. Design Manual for Bicycle Traffic . The Netherlands: CROW.
[10] Martinson, R & Golly, T. 2017. Protected Bikeways Practitioners Guide . Washington, DC: Institute of Transportation Engineers

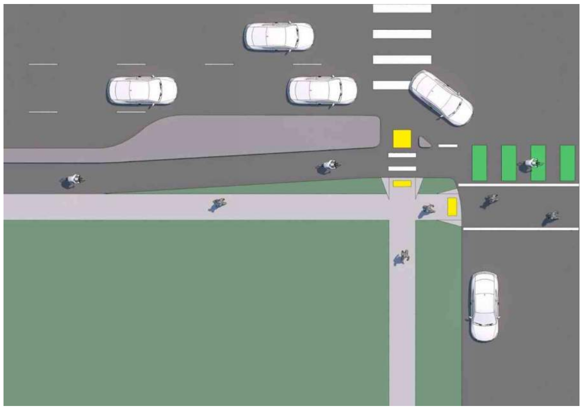


Figure 3.63: *Protected Bike Lane with Bend-In*

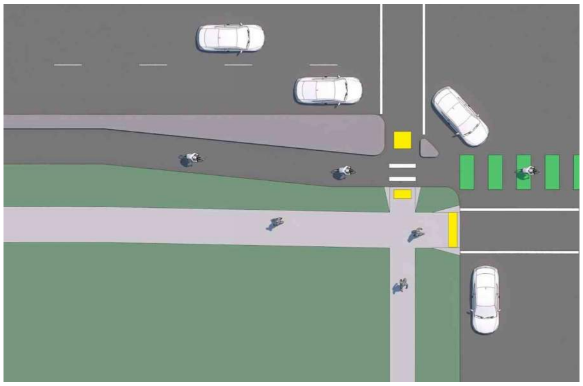


Figure 3.64: *Protected Bike Lane with Bend-Out*

Due to the larger size of vehicles in Edmonton as compared to where the research was conducted, the target dimension for the horizontal offset from the protected bike lanes to the adjacent general purpose travel lanes is 6 m, although a reduced offset of 2 m may be suitable in specific applications. When establishing the horizontal offset, designers should consider the following:

- At signalized and unsignalized intersections along arterial streets, streets without right-turn lanes, or higher speed streets (posted speed 60 km/h or greater), the recommended horizontal offset is 6 m to allow drivers to make a right-turn movement and have the queuing area to stop for people cycling and walking without blocking the arterial or higher speed street. For drivers turning onto these busier streets, the recommended horizontal offset also provides the queuing area between the crossride and the street.

- Due to the bidirectional operations, a 6 m horizontal offset should be provided for bidirectional protected bike lanes as well as shared pathways and bike paths (See ***Section 3.6.6***) at all signalized and unsignalized intersections;

- At fully signalized arterial street or collector street intersections, the horizontal offset for bidirectional facilities can be reduced to 2 m if the motor vehicle turn movements (left-turn and right-turns) are time-separated from through bicycle movements by traffic signal phasing;

- Along corridors with unidirectional protected bike lanes, the horizontal offset can be reduced below 6 m to a minimum of 2 m, although designers should endeavour to provide 6 m, if possible;

- At all-way stop intersections, the horizontal offset should be reduced to 0.6 to 1 m (and use a bend-in configuration). This maintains the physical protection of the protected bike lane but allows for the use of a common stop bar location for motor vehicle and bicycle traffic.

In most locations, the bend-out configuration is likely required to achieve the recommended offset and the safety performance. For both bend-out and bend-in configurations, see ***Section 3.2.6.3*** for minimum radius and lateral shift criteria for bicycle facilities.

Two-Stage Left Turns

For a person cycling to make a normal left turn on multilane streets, a manoeuvre is required across one or more lanes of through traffic. In situations where traffic speeds may reach or exceed 50 km/h, or where there are few gaps in traffic, such a manoeuvre can be difficult to execute. In such situations, the preferred approach is to provide a protected intersection. In select constrained circumstances, this may not be possible and designers may need to provide a two-stage turn queue box. Two-stage turn queue boxes can be used in conjunction with one-way and two-way bikeways (i.e., bidirectional protected bike lanes, shared pathways, bike paths).

A two-stage turn queue box is a marked space for people cycling to wait outside of the Travelled Way portion of the street parallel to the bike lane. The preferred minimum dimensions of a two-stage turn queue box are 2.0 m by 2.0 m although sizes should be based on anticipated bicycle traffic volumes and site conditions. Common configurations place the two-stage turn queue box in line with the adjacent on-street parking lane or between the bike lane and the crosswalk as illustrated in ***Figure 3.65***.

While two-stage turns may increase comfort for people cycling in many locations, this configuration will typically result in higher average signal delay for people cycling due to the need to receive two separate green signal indications before proceeding (one for the through street, followed by one for the cross street). Right turn on red restriction is also necessary for the cross street motor vehicle traffic to provide a conflict-free space for a person on a bicycle to enter and wait in the queue box during the red signal period.

Figure 3.65 *Two-Stage Left Turn Queue Boxes*

Protected Intersections

Protected intersections provide a high level of comfort and safety for people cycling, especially at large intersections with multiple lanes and complex signal phasing. Protected intersections should be provided at arterial street-arterial street intersections, arterial street-collector street intersections, and collector street-collector street intersections where protected bike lanes exist, are being added, or may be added in the future. For intersection crossings for shared pathways or bike paths, the principles and design approach for protected intersections should be used typically through a bend-out design (see ***Section 3.6.6***).

As illustrated in ***Figure 3.66***, they provide dedicated space for people cycling that extends into the intersection and, as such, can accommodate through, left turn, and right turn bicycle movements in a safe and low stress manner, consistent with the Design User group requirements.

A protected intersection accommodates bicycle left turn movements in two stages. However, relative to a two-stage turn queue box, a protected intersection provides greater physical protection for people cycling that are waiting for the second movement, even at large intersections. A protected intersection also functions more intuitively because it replicates walking movements around the perimeter of the intersection. It is particularly beneficial where two streets with protected bike lanes intersect or where a wide buffer or parking lane separates a protected bike lane.

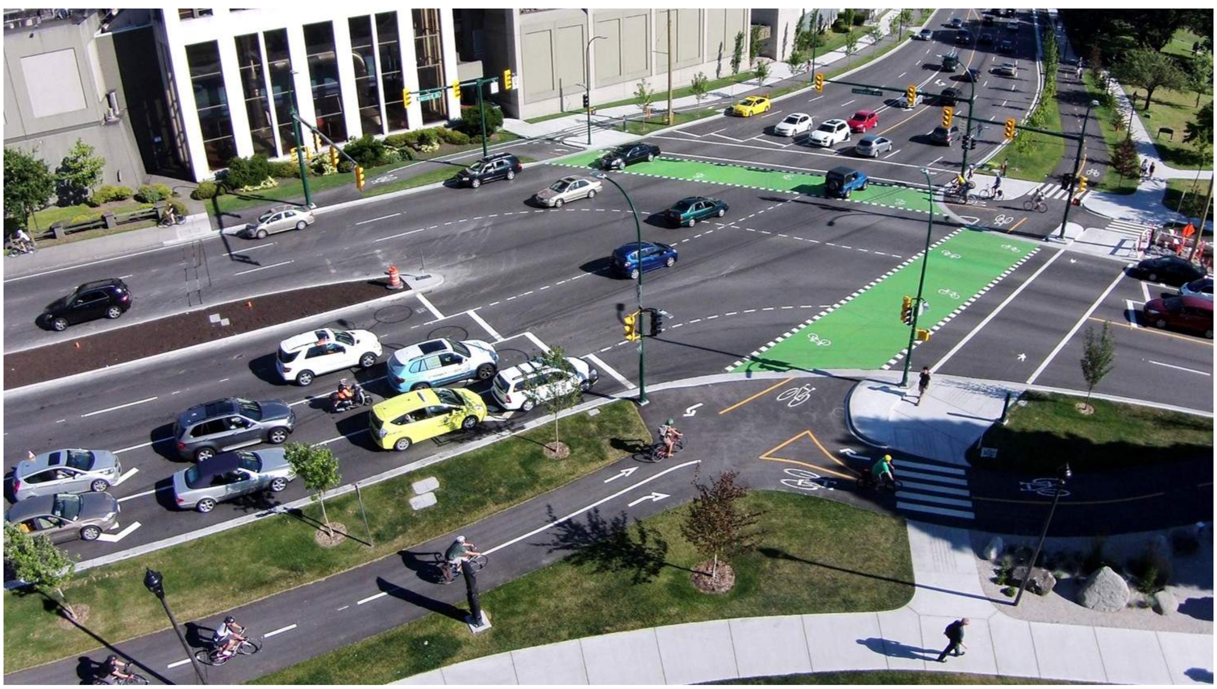


Figure 3.66 *Protected Intersection (Source: City of Vancouver)*

Protected Intersection Design Elements and Design Guidance

A protected intersection has the following design elements (see ***Figure 3.67***):

1. Corner Safety Island (and Corner Radius)
2. Crossride and Crossride Setback
3. Bikeway Approach Tapers and Radii
4. Intersection Approach Clear Space
5. Bicycle Turning Radii and Diagonal Area
6. Bicycle Queuing Area (and Bicycle Advanced Stop Bar)
7. Sidewalk Widths
8. Pedestrian Refuge Areas
9. Crosswalks
10. Accessibility Features (including TWSIs)
11. Corner Truck Aprons
12. Centre Median
13. Elevations and Drainage
14. Traffic Controls

For more information on Protected Intersection design, refer to the City of Ottawa Protected Intersection Design Guide and the BC Active Transportation Design Guide.

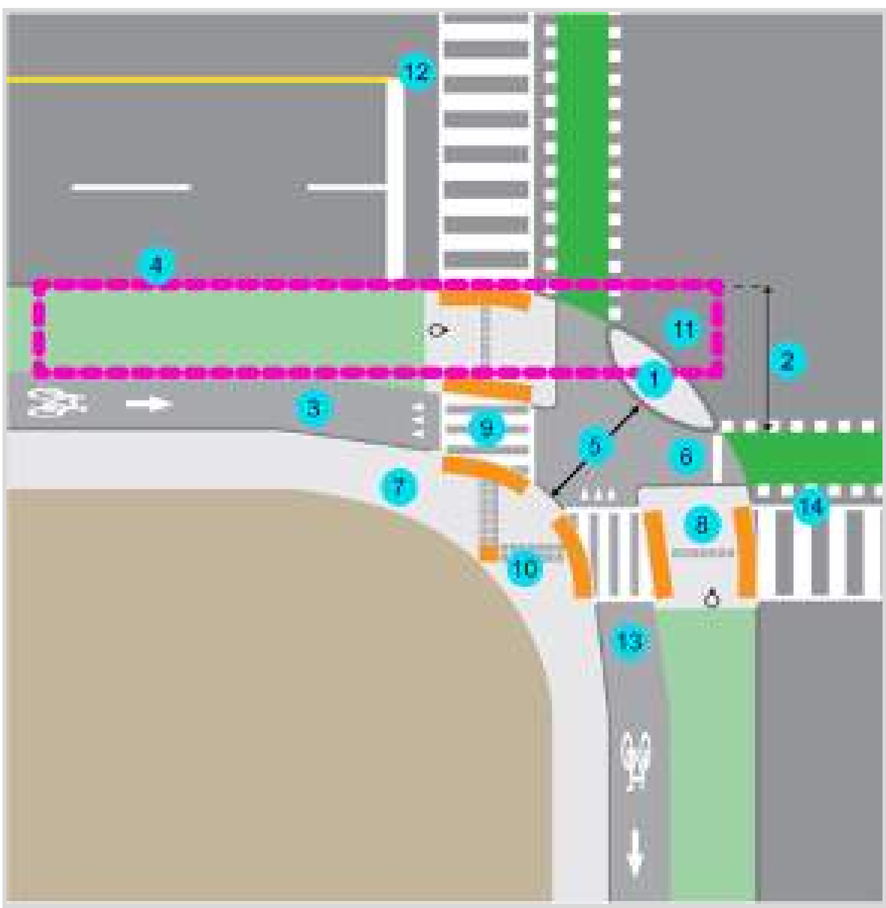


Figure 3.67 *Protected Intersection Elements (adapted from City of Ottawa Protected Intersection Design Guide)*

Corner Safety Island (and Corner Radius)

The conflict area between right turning vehicle traffic and through bicycle traffic at the intersection approach, and the associated higher speed motor vehicle turns, is mitigated by introducing a corner safety island. The corner safety island orients a turning motor vehicle traffic to between 45 and 90 degrees to the bicycle crossing, so that eye contact can be established between the person driving and people cycling which improves yielding behaviour. The corner safety island at the far side of the intersection functions like a two-stage turn queue box.

The corner safety island should be built as a raised curb median in an “almond” or “eyebrow” shape. The curb height on the Travelled Way side of the corner safety island should be a 150 mm straight face curb. The outer corner radius should be established based on the turning radius for the Design Vehicle (see also Corner Truck Apron, below).

The inner radius adjacent to the protected bike lane should be based on the minimum turning radii for a bicycle (see ***Section 3.2.6.3***) which can result in a minimum radius of 4.0 m for the curb. The radius can be lower, but a lower value may make the turn more difficult for people riding cargo bikes or riding bicycles and pulling trailers. The target inner radius is 5.0 m.

The width of the corner safety island will vary and can be a minimum of 1.0 m (most commonly when an eyebrow shaped island is provided). See Bicycle Queuing Area (below) for more information on queuing space which may lead to a different geometry of the corner safety island adjacent to the protected bike lane.

Crossride and Crossride Setback

Within the protected intersection, the target setback for the protected bike lane crossing (i.e., Crossride) from the parallel travel lanes is 6.0 m. The recommended range for the Crossride Setback is 2.0 to 6.0 m; however, the Crossride Setback for bidirectional protected bike lanes should be 6.0 m, while the Crossride Setback for unidirectional protected bike lanes may be as low as 2.0 m (see guidance in *Horizontal Offset: Bend-out and Queuing Area*, above).

The target Crossride Setback provides a queuing area for adequate space for a single motor vehicle to queue outside the path of both through vehicle traffic and crossing bicycle traffic. A Crossride should be marked to indicate the bicycle crossing. The presence of Corner Safety Islands and Crossrides means that the person cycling is more visible to the person driving. (See also Crosswalks, below.)

Bikeway Approach Tapers and Radii

On the approach to a protected intersection, the protected bike lane may have to bend-in or bend-out to provide sufficient space for the Pedestrian Refuge Areas, the Bicycle Queuing Area, and the Crossride Setback. The lateral shift tapers and any associated radii should meet the guidance in ***Section 3.2.6.3***. A target of 5:1 (longitudinal to horizontal) should be used to help slow bicycle traffic prior to the crosswalks. If used in conjunction with a taper, the target radii for curves to start and end the taper should be 12.0 m. For a bidirectional protected bike lane, the taper may be reduced to 3:1 to aid in slowing bicycle traffic within the wider bikeway.

Intersection Approach Clear Space

Approach Clear Space at intersections for bikeways is provided in ***Section 3.6.1.4***. Motor vehicle parking, loading, and stopping must be restricted within the Intersection Approach Clear Space.

Bicycle Turning Radii and Diagonal Area

The inner corner radii between the protected bike lane and the sidewalk should be based on the minimum Bicycle Turning Radii outlined in ***Section 3.2.6.3***. The target radius for the curb is 5.0 m to support larger bicycles and bicycle turns at speeds that will maintain bicycle rider stability.

The outer curb between the protected bike lane and the sidewalk should be a half- or full-height curb to allow for detectability by people with vision loss. The curb could be straight-faced or bevelled.

The Diagonal Area, measured from the sidewalk-protected bike lane curb line to the Corner Safety Island (see ***Figure 3.67*** above), has a target dimension of 3.0 m for a unidirectional protected bike lane and 4.0 m for a bidirectional protected bike lane. If bicycle volumes are higher, this dimension should increase to allow space for bicycle traffic to flow through the intersection for left, right, and through bicycle movements. If a separate lane for left turning bicycle traffic is required, this lane should be a minimum of 1.2 m wide and can be created by reducing the width of the Corner Safety Island.

Bicycle Queuing Area

The Bicycle Queuing Area provides a dedicated space for people on bicycles to wait to cross the intersection without blocking other bicycle traffic travelling through the protected intersection. Bicycle traffic signal detection equipment is typically located in this area (such as bike loops).

The target depth of the Bicycle Queuing Area is 3.6 m to accommodate cargo bikes or bicycles pulling trailers. In constrained locations, this may not be possible and a minimum depth of 2.0 m may be acceptable. The target width of the Bicycle Queuing Area is equal to or greater than the width of the incoming bikeway. See ***Table 3.8*** for Design Domain for protected bike lane widths.

The total area of the Bicycle Queuing Area should be based on the volume of bicycle traffic flowing through with a target area of 6.0 m2 or greater. When bicycle volumes exceed 300 bicycles per peak hour using a single crossride, the Bicycle Queuing Area may warrant a larger space.

The Bicycle Stop Bar is also marked within the Bicycle Queuing Area and denotes the extents of the Bicycle Queuing Area in terms of its depth. The advanced bicycle stop bar increases the visibility of bicycle traffic for right and left turning drivers.

Sidewalk Widths

Sidewalk widths may require narrowing and shifting the alignment of the sidewalks at the intersection. The minimum width of the sidewalks is 1.8 m, and they should lead to curb ramps that are oriented perpendicular to the protected bike lane and Travelled Way. Wider sidewalks should be provided, if possible, that are consistent with the sidewalk widths prior to the intersection. If the sidewalk needs to bend-in or bend-out on the approach to the intersection, the recommended taper angle should be between 3:1 and 5:1 (longitudinal to horizontal).

Pedestrian Refuge Areas

Pedestrian Refuge Areas provide dedicated waiting areas for people walking and wheeling to wait to cross the street. People walking and wheeling can cross the crosswalk over the protected bike lane to access the Pedestrian Refuge Area. Pedestrian Refuge Areas may also be provided in a centre median refuge in some designs.

The size of the Pedestrian Refuge Area should be sufficient for people using mobility aids and those with service animals, strollers, or other devices to manoeuvre comfortably. The minimum width of the Pedestrian Refuge Area should match the width of the sidewalks that connect on either side of the crossing. The minimum depth of the pedestrian refuge area is 2.5 m, while the target refuge area depth is 3.0 m (this also aligns with the target depth for the Bicycle Queuing Area, see above). Increased depths should be used when the target speed of the Travelled Way is above 50 km/h.

In some cases, there may not be sufficient space to provide enough waiting area for people walking and wheeling within the Pedestrian Refuge Area. In these cases, providing additional area within the Pedestrian Through Zone and Furnishing Zone can be used. This will also affect the design and traffic controls for crosswalks and traffic signals (See Crosswalks, below).

Accessible Pedestrian Signals should be provided within the Pedestrian Refuge Area (See Traffic Controls, below). The Pedestrian Refuge Area should also include Tactile Attention Indicators and Tactile Direction Indicators (See Accessibility Features, below).

Crosswalks

Crosswalks across the protected bike lanes provide designated crossing locations for people walking and wheeling and communicate the requirements for yielding by people cycling. Traffic signal-controlled crosswalks across the bikeway may be beneficial for high-volume crosswalks, crosswalks in areas with higher volumes of people with vision loss, for crosswalks that are also used to access floating bus stops, and in constrained locations where Pedestrian Refuge Areas (see above) cannot be provided, which will require people walking to queue on the sidewalk.

Crosswalks over the Travelled Way can also be raised at unsignalized protected crossings, in conjunction with raised Crossrides (see above), to further alert drivers to the crossing. This has been shown to increase yielding compliance and reduce motor vehicle speeds across the crossride/crosswalk.

Accessibility Features

Supporting the navigation of protected intersections for people with vision loss and those with mobility challenges requires special features. Curb ramps are required at all crosswalks and they should be separated ramps rather than combined ramps. The design of the curb ramps, including grades, should meet the requirements outlined in ***Section 3.6.3***.

The use of intermediate- or street-level protected bike lanes allows for a detectable curb edge between the sidewalk and the bikeway for people using long white canes or service animals.

At Crosswalks and Pedestrian Refuge Areas (see above), tactile walking surface indicators (TWSIs) should be used as follows:

- Tactile Attention Indicators (truncated domes) that are 600 mm deep, and as wide as the Crosswalk, curb ramp, or Pedestrian Refuge Area should be placed prior to all crossings of the bikeway and Travelled Way.
- Tactile Direction Indicators (elongated bars) that are contrasting in colour to the adjacent surface (and not yellow), 600 mm wide, and placed perpendicularly across the sidewalk and onto the curb ramp to the edge of the Tactile Attention Indicators should be placed prior to the crosswalks over the bikeway (or roadway if a Pedestrian Refuge Area is not provided).
- Tactile Direction Indicators that are 300 mm wide and placed between Tactile Attention Indicators should be placed within the Pedestrian Refuge Areas.

TWSIs should also be used within two-stage crossings, if provided. If the protected bike lane is raised to curb height (i.e., sidewalk-level), a trapezoidal Tactile Edge Indicator can be used to delineate the sidewalk from the protected bike lane. See ***Section 3.6.3*** for more information on TWSIs.

If signalized, Accessible Pedestrian Signals (APS) should be placed in all Pedestrian Refuge Areas (or at all corners if refuge areas are not provided). If a centre median refuge is provided, APS should be placed there as well if crossing in two movements may be required.

Corner Truck Aprons

The corner radius of the Corner Safety Island should be as small as feasible to accommodate the Design Vehicle while encouraging slow motor vehicle traffic turning speeds and appropriate yielding behaviour. To accommodate Control Vehicles, the Corner Safety Island can include a mountable apron to allow access and provide smaller corner radii. If the corner radius is greater than 12.0 m, a truck apron should be used to support a non-apron corner radius of between 5.0 and 8.0 m.

Centre Median

Centre medians at intersections designed as protected intersections should be designed to slow left turning motor vehicle traffic across the Crossride. Centre medians can include a drop nose design on the intersection side of the Crossride and Crosswalk. At some locations, this median may also act as a centre median refuge and should be wide enough to accommodate people walking and/or cycling.

Elevations and Drainage

The preferred configuration of a protected intersection is to include a half-height raised protected bike lane. This allows for curb ramps to be placed on both the sidewalk side and the Pedestrian Refuge Area side of the protected bike lane and a detectable curb edge to be provided between the protected bike lane and sidewalk.

The protected bike lane should be 50 to 60 mm below the elevation of the sidewalk and the preferred curb is bevelled.

The target grade for the ramp for the protected bike lane between street- and intermediate-level should be 5% and up to a maximum of 8.33%.

The drainage should include:

- Target cross fall of 2% across the sidewalk (Maximum 4% in constrained situations)
- Target cross fall of 2% across the protected bike lane (Maximum 4% in constrained situations)
- A target longitudinal slope of 1% should be applied within the protected corner area with grading to flow water away from the crosswalks and protected corner area

3.6.5.2.Painted Bike Lanes at Intersections

Painted bike lanes are not permitted at intersections except for the approaches of Local Street Bikeways to an intersection. For all other locations, painted bike lanes should transition to protected facilities at intersections. This could include protected bike lanes, shared pathways, or bike paths. Guidance on the design of painted bike lanes at intersections can be found in the TAC GDG.

Bike Ramps

Bike ramps typically connect between on-street and off-street bikeways such as painted bike lanes connecting to shared pathways or bike paths. They may also be provided to enable bypass movements around a roundabout or complex intersection, as shown in ***Figure 3.68.***

Bikeway ramps should generally be constructed at an angle of no greater than 30°, with a maximum slope of 6%.

Figure 3.68: *Bike Ramp from On-Street Bike Lane to Off-Street Bike Path or shared pathway*

3.6.6.Bike Path & Shared Pathway Crossings

This section provides guidance on the treatment of bike paths and shared pathways at intersections and mid-block crossings. Generally, the design treatments for these two types of bikeways are similar at intersections, since bike paths are frequently paired with a sidewalk. When marked with pavement markings and signs, street crossings for bike paths and shared pathways are called crossrides.

3.6.6.1.Intersection Crossings

At street intersections, additional accommodation is required to inform people driving that the crossing is not only for people walking and wheeling, but for multiple types of off-street path users. These treatments may include, but are not limited to:

- Including a crossride along with the crosswalk at the path crossing to accommodate a larger variety of users;
- Incorporating design treatments such as a material change to the street surface;
- Using vertical deflection, such as a raised crossing to increase awareness of the crossing for people driving; and
- Adding a protected signal phase to the intersection crossing, either an advance bike/walk phase or a restricted right/left turn phase, to eliminate many potential conflicts.

Details of crosswalk and crossride markings within the intersection are described in the MUTCD-C and TAC Bikeway Traffic Control Guidelines for Canada.

Bend-Out and Bend-In Configurations

The distance of the shared pathway or bike path crossing from the parallel and adjacent general purpose travel lanes should be 6 m due to the bidirectional operation of most paths. If bike paths are provided and are unidirectional, a reduced offset may be provided. See guidance in for *Horizontal Offset: Bend-out and Queuing Area in* ***Section 3.6.5.1*** on protected bike lanes at intersections for more information related to this offset to the intersection crossings.

Designing a bike path or shared pathway alignment to curve or bend prior to an intersection that parallels a street (bend-in or bend-out) improves visibility of path users, moderates path user speeds, and alerts path users to the presence of an intersection. These bends may also be required to provide the necessary horizontal offset to and create a queuing space for turning motor vehicle traffic.

The bend-out configuration for a shared pathway is illustrated in ***Figure 3.69***. For a bike path combined with a sidewalk, the design is similar, except that the cycling and walking and wheeling areas are separate, and at the intersection crossing, there is a crosswalk for the walking/wheeling path and a crossride on the side closer to the intersection for the bike path.

The bend-out option provides a setback from the parallel street which:

- Provides additional reaction time to drivers turning across the path;
- Allows drivers to orient their vehicles perpendicular to the path before crossing it, facilitating two-way sightlines between drivers and path users;
- Enables a turning driver to avoid blocking through motor vehicle traffic while waiting for path users to clear; and
- Provides space for people walking and wheeling queuing between the path and the curb ramp.

The bend-in option brings shared pathway users closer to the street edge, which tends to require less space.

Bending the path out is preferred. The bend-out option provides generous queuing space in comparison with the bend-in option which provides little to no queuing space for people walking and wheeling perpendicularly across the path. For intersections with high volumes of crossing walking/wheeling traffic, the bend-out option provides more queuing space.

In conditions where the shared pathways extend across an intersecting sidewalk, additional markings can be placed on the pathway to indicate to all users that they are entering a shared-use space. Additional signage can also be used for pathway users to require them to yield to the intersecting sidewalk users.

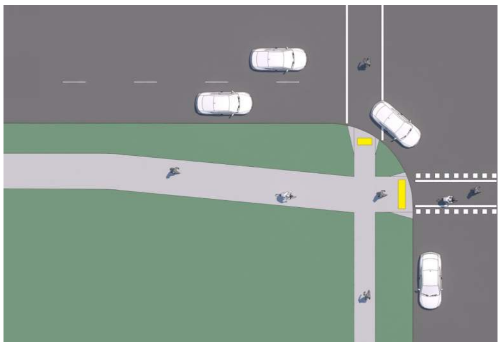


Figure 3.69: *Intersection Shared Pathways Crossing (Bend-Out)*

3.6.6.2.Mid-Block Crossings

At the approach to mid-block crossings, the shared pathway should be designed with speed-reducing elements such as alignment curvature or an uphill grade change in advance of the crossing. Other measures that may be applied include signage to clarify right of way, textural surface contrast and pavement markings, such as zebra crossings for people walking and wheeling and crossrides for people cycling, and flashers or hybrid beacons in order to alert all users of the crossing and to advise which street user has the legal right of way. Mid-block crossings, their approach and the crossing, also require lighting of the crossing to ensure people walking, wheeling, and cycling can be seen by people driving.

A typical treatment is shown in ***Figure 3.70***.

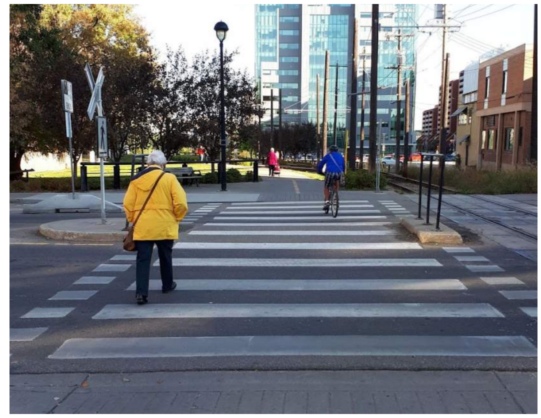


Figure 3.70: *Mid-Block Shared Pathway Crossing*

Adequate sight distances for both shared pathway users and people driving are required to provide adequate reaction time for all users at the crossing and on the approach.

TAC 5.6.3.1 provides guidance on sight distances. ***Figure 3.71*** illustrates the sight distance required at mid-block crossings and includes a formula that can be used to calculate the necessary sight distance. For Two-Stage Crossings, the sight distance calculation should be completed for each phase of the crossing, which will result in shorter sight distance requirements.

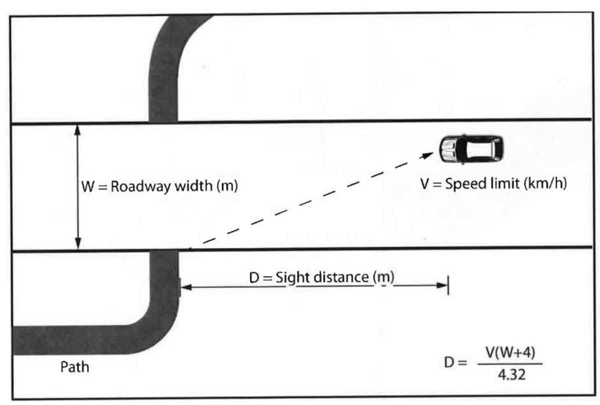


Figure 3.71: *Mid-Block Pathway Crossing Sight Distance (Source: TAC GDG Figure 5.6.12)*

3.6.7.Roundabouts

3.6.7.1.Basic Roundabout Features

A ***roundabout*** is a type of circular intersection in which vehicles travel counter-clockwise where vehicles entering the roundabout must yield to circulating traffic. Roundabouts have specific geometric design and traffic control features, including:

- ***Central Island*** – The raised area in the centre of the roundabout;
- ***Splitter Island*** – Raised or painted areas provided between the entry and exit lanes of an intersection leg to separate traffic, deflect and slow entering traffic. When raised and sufficiently wide, they allow for a two-stage crossing for people walking and wheeling;
- ***Circulatory Roadway*** – The curved Travelled Way used by vehicles to travel counter-clockwise around the Central Island;
- ***Walking & Cycling Facilities*** – Sidewalks, shared pathways, local street bikeways, bike lanes, bike paths, and protected bike lanes that are used by people walking, wheeling, and cycling to travel around the roundabout. For low volume streets with mini-roundabouts, shared lanes may be suitable. Roundabouts on higher volume streets should have bicycle facilities located outside the Circulatory Roadway;
- ***Truck Apron*** – A truck apron is a traversable, hard surfaced area with semi-mountable curb to accommodate the off-tracking of large vehicles. Truck Aprons are usually provided around the central island of single-lane roundabouts, but may also be provided on the outside of the Circulatory Roadway at entrances and exits. Truck aprons should be 60 mm high to minimize instances of load shifting. Truck aprons shall not be used to accommodate transit movements under normal operating conditions;
- ***Entrance Line*** – A dashed line that marks the point of entry into the Circulatory Roadway. In some instances, the Entrance Line functions as the yield line, if no separate line is present;
- ***Walking & Cycling Crossings*** – Crossings for people walking, wheeling and/or cycling are located upstream of the roundabout Entrance Line and downstream of the exit. The Splitter Island is cut at the crossing, approximately one car length (6 m), or a multiple thereof, from the Entrance Line, to allow people walking, wheeling, and/or cycling of all abilities to pass through;
- ***Landscape Buffer*** – Landscape Buffers separate vehicular, walking and wheeling, and cycling traffic and assist with guiding them to the designated crossing locations. The Landscape Buffer, which forms part of the Furnishing Zone, can also help to enhance the aesthetics and appearance of the roundabout; and
- ***Inscribed Circle Diameter (ICD)*** – While not a geometric design or traffic control feature, the ICD is a critical design dimension that influences the operational and safety performance of a roundabout. The ICD is defined as the diameter of the largest circle that can be fit into the roundabout outline.

Figure 3.72 illustrates the geometric design features of a roundabout.

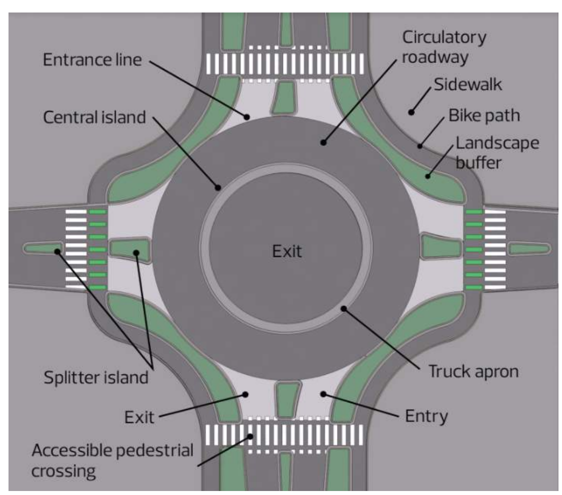


Figure 3.72: *Basic Geometric Design Features of a Roundabout*

There are three main safety benefits of roundabouts:

- Conflict Points – The number of conflict points for motor vehicles in a roundabout is greatly reduced as motor vehicle travel is in the same direction, eliminating right-angle and left-turn conflicts;
- Entering and Circulating Speed – The design of a roundabout places high priority on speed control, which is achieved through geometric features. Drivers entering a roundabout are usually doing so at lower speeds compared to a signal which results in lower collision severity if drivers fail to yield and collide. This reduced speed also reduces the severity of collisions with people walking and wheeling. Speed differential between people cycling and driving is an important consideration of where to locate bicycle facilities; and
- Deflection Angle – Roundabout entries provide deflections for motor vehicle traffic, decreasing the angle of impact during a collision and reducing entry speeds. This results in a significant reduction or elimination of typically more serious right-angle and head-on collisions.

Roundabouts have a distinct set of advantages and disadvantages compared to stop and traffic signal control. Advantages include:

- Traffic Management – The geometric design of a roundabout influences drivers to moderate vehicle speeds in a more natural way compared to abrupt stopping and starting caused by other traffic control devices, and they are especially effective as gateway treatments because they convey a change in environment and encourage drivers to slow down, such as between urban and rural areas.
- Access – Roundabouts provide U-turn opportunities at safer locations, eliminating the need for more difficult mid-block left-turns, and reducing the number of full movement access points along a roadway corridor.
- Environment and Sustainability – Roundabouts reduce fuel consumption and vehicle emissions by reducing delays and idling time, they consume less energy than traffic signals, they require little maintenance, and they work efficiently during power failures.
- Aesthetics – Roundabouts can provide an opportunity to create an aesthetically pleasing focal point within or adjacent to a community by providing an opportunity for additional landscaping to enhance the streetscape.
- Economic – Roundabouts require less maintenance than traffic control signals, offer time and fuel savings to users, provide societal cost savings through less severe and fewer collisions, alleviate the need for auxiliary turn lanes, and create the possibility for narrower roadways and shorter or narrower bridge structures.

Disadvantages include:

- Spatial Requirements – roundabouts may require more property beyond the limits of a typical road allowance (because of their shape) compared to a conventional stop-controlled or signalized intersection.
- Construction Costs and Constructability – roundabouts usually have higher initial construction costs due to a larger intersection footprint, complexity in traffic management, the need to build the ultimate configuration (because of the challenges with interim staging), greater property acquisition and degree of landscaping. Costs tend to be higher for retrofit construction due to the greater complexity involved, but more comparable for “greenfield” installations, especially in an urban environment where lighting, curbing, drainage, etc. are required regardless. Retrofitting to install a roundabout may require a longer construction period and present greater complexity for traffic management and construction staging.
- Traffic Operations – Roundabouts may not be as efficient if approach volumes are highly unequal, they can interrupt traffic signal progression along a corridor, they are not as effective in handling large changes in traffic demand or transit priority, and they cannot be used to prohibit certain movements.
- Accessibility – Roundabouts may be more challenging for seniors, children, and pedestrians with vision loss or mobility challenges to navigate, and large roundabouts can also create discomfort for cyclists.
- Public Education – In communities where roundabouts are not common, new installations may require public education and outreach prior to implementation.

3.6.7.2.Roundabout Design Principles

In general, roundabout design should strive to achieve the same principles as other types of intersections. Specifically, for roundabouts, these principles include:

- For motor vehicle traffic, provide low entry speeds and consistent speeds through the roundabout. This is achieved through the use of horizontal curvature to create deflection;
- Provide adequate entry width and circulating width with an appropriate number and assignment of lanes for the roundabout to provide the required traffic capacity;
- Include proper channelization, providing people driving with adequate guidance as to appropriate speed and path, and smooth transitions for entry and exit movements;
- Include facilities and provisions adequate for all intended roundabout users including people walking and wheeling, cycling, driving and delivering goods. Some roundabouts may not be suitable for people cycling on the street and a separated circulating path for people cycling will be required which may be unidirectional or bidirectional;
- Ensure that roundabouts can accommodate movements for the appropriate design vehicle, swept path analysis may be required to confirm manoeuvres during design.
- Ensure that adequate stopping and sight distance and inter-visibility between users is provided for all intended users;
- Include landscaping where possible and where sight distance is maintained. See Chapter 9 of the TAC Canadian Roundabout Design Guide for more direction on landscaping;
- Include adequate lighting of the roundabout, crossings, and public realm. See Chapter 8 of the TAC Canadian Roundabout Design Guide for more direction on illumination; and
- Design the landscape and roundabout elements to support winter operations. See Chapter 10 of the TAC Canadian Roundabout Design Guide for direction on winter control maintenance.

3.6.7.3.Categories of Roundabouts

Three categories of roundabouts are most commonly used in North America: mini-roundabouts, single-lane roundabouts, and multi-lane roundabouts. These roundabout types are described below and illustrated in ***Figures 3.73***, ***3.74***, and ***3.75***. More information on roundabouts can be found in the TAC Canadian Roundabout Design Guide.

Mini-Roundabouts

Mini-roundabouts are small and characterized by a semi-mountable central island and mountable or semi-mountable splitter islands to allow trucks to manoeuvre through the intersection without travelling around the island. Distinct from neighbourhood traffic circles because of the splitter islands and semi-mountable central island, mini-roundabouts are commonly used in low-speed urban environments and locations where right of way constraints cannot accommodate a typical single-lane roundabout.

Single-Lane Roundabouts

Single-lane roundabouts are characterized by deflection on the entry approach, single-lane entries, and one circulatory lane. When compared to a mini-roundabout, the central island diameter is much larger and the overall size is dependent on the Design Vehicle. The geometric design usually includes a non-mountable central island and splitter islands, semi-mountable truck apron (to accommodate off-tracking of large vehicles), and crosswalks/crossrides.

Multi-Lane Roundabouts

Multi-lane roundabouts are characterized by at least one entry with two or more lanes. Typical configurations are a two-lane roundabout (all entries and exits are two lanes), and a partial two-lane roundabout (entries and exits on opposite directions are two lanes, and the others are single-lane). The circulatory roadway is wider to accommodate vehicles operating side-by-side and a multi-lane roundabout will have higher entry, circulating, and exit speeds than a single-lane roundabout.

The geometric design typically includes a non-mountable central island and splitter islands, and crosswalks/crossrides, and may include a semi-mountable truck apron (to accommodate the off-tracking of large vehicles making left turns), The circulatory roadway and exits are striped to accommodate each turning movement of the exit lane configuration in such a way as to require no lane changes for any movement through the roundabout.

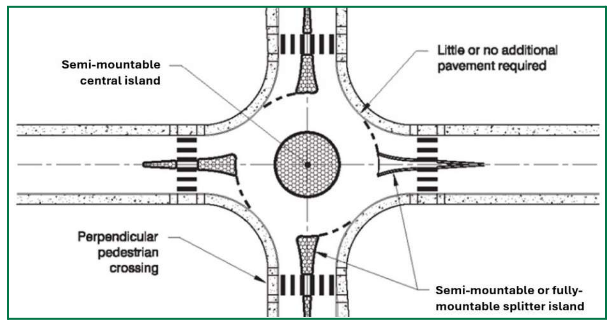


Figure 3.73: *Features of a Typical Mini-Roundabout (Source: TAC Canadian Roundabout Design Guide Figure 9.21.1)*

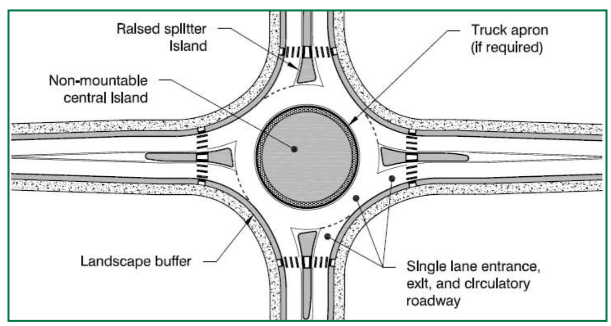


Figure 3.74: *Features of a Typical Single-Lane Roundabout (Source: TAC Canadian Roundabout Design Guide Figure 9.21.2*

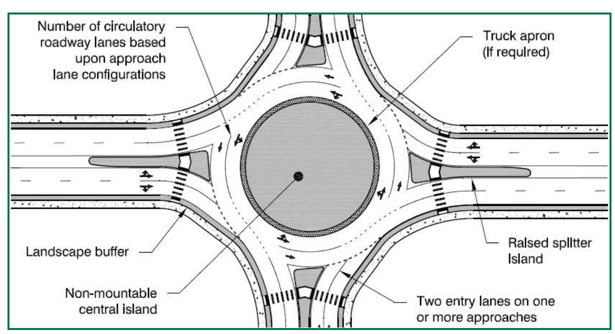


Figure 3.74: *Features of a Typical Multi-Lane Roundabout (Source: TAC Canadian Roundabout Design Guide Figure 9.21.3)*

Key distinguishing features between each of these three roundabout treatments are summarized in ***Table 3.36***. Daily service volumes noted represent the total daily motor vehicle traffic volumes travelling through the roundabout.

Neighbourhood Traffic Circles

Neighbourhood traffic circles are typically constructed in residential areas for traffic calming and/or aesthetic reasons. In many locations, a neighbourhood traffic circle can be installed within the footprint of the existing intersection without impacting the curb lines. The intersection typically does not include splitter islands to guide the approaching driver into the circulatory roadway. ***Figure 3.76*** shows a typical neighbourhood traffic circle.

Neighbourhood traffic circles should only be used at intersections between local roads and should not be used in conjunction with bike infrastructure. While they do not necessarily enhance intersection control or capacity, they can aid in slowing approaching vehicles to improve multimodal safety. The central island is sized based on typical vehicle dimensions with the expectation that large vehicles, which are usually very infrequent, may need to turn left in front of the circle due to limited turn radius.

Figure 3.76: *Neighbourhood Traffic Circle*

***Table 3.36** Roundabout Category Comparison*

Design Element	Mini-Roundabout	Single-Lane Roundabout	Multi-lane Roundabout
Appropriate Fastest Path Entry Speeds[1]	NA	30-50 km/h	45-70 km/h
Typical Free-Flow Vehicle Speeds[2]	15-25 km/h	20-30 km/h	25-35 km/h
Typical inscribed circle diameter	20 - 30 m	30 - 50 m	45 - 70 m
Central island treatment	Semi-mountable	Non-mountable (but usually includes truck apron)	Non-Mountable (but may include maintenance apron)
Splitter Islands	Painted, mountable	Non-mountable, min. 2.0 m wide at pedestrian crossing	Non-mountable, min. 2.0 m wide at pedestrian crossing
Design Vehicle(s) Accommodated	WB-19 off-tracking over the splitter islands and central island Transit bus (if on bus route) avoiding the splitter islands and central island	WB-19 off-tracking over the central island truck apron, and transit bus avoiding the truck apron	WB-21, typically by off-tracking into the adjacent lane as it enters, circulates and exits
Typical daily service volumes on 4-leg roundabout (veh/day)	Up to approximately 15,000 vpd	Up to approximately 25,000 vpd	Up to approximately 45,000 vpd
Closest Access (Right-in/Right-out), Measured From Edge of Circulatory Roadway (Arterials and Collectors)	80 m	80 m	80 m
Closest Access (Right-in/Right-out), Measured From Edge of Circulatory Roadway (Locals)	15 m	25 m	N/A

[1]A fastest-path speed is a theoretical attainable or "worst-case" speed and is used in the roundabout design process as a proxy for yield potential. It assumes no other traffic in the roundabout and that a driver will ignore all pavement markings (including lane lines in a multi-lane roundabout).

[2]A typical speed is an estimate of average vehicle speed through the roundabout and includes left and right turns.

3.6.7.4. Roundabout Design Methodology and Guidelines

Roundabout design methodology will vary on a case-by-case basis. Most often, the goal of roundabout design is to optimize intersection operations while maximizing safety for all users of the intersection. The design process must consider the unique aspects of the individual intersection and the design parameters. The schematic presented in ***Figure 3.43*** of this document outlines a typical intersection design process which must be tailored to meet the needs of the individual project and applies to roundabouts as well.

Roundabouts in New Developments

Roundabouts in new developments shall conform to the City of Edmonton standard drawings for mini-roundabouts on local roads and single-lane roundabouts on collector roads. Prior justification must be provided if another diameter of mini-roundabout or roundabout is planned. A roundabout Design Checks Package shall be provided for each mini-roundabout or roundabout being proposed at the concept design stage. The package should be approved by the City before proceeding to further stages of roundabout design.

A Design Checks Package should consist of:

- Drawings showing design vehicle accommodation and entry angles.
- A drawing showing path radii (fastest-path speeds) through the entries and exits.
- For a multi-lane roundabout it should additionally include a drawing showing path overlap tangents through the entries and exits.

Path radii at roundabouts must be drawn for all directions using splines. Splines must be drawn with 1.5 m offsets from face of curb (truck apron and outer curbs) and 1.0 m offsets from roadway centrelines. No offsets shall be assumed from any other pavement markings. Entry path radii should be converted to fastest-path speeds assuming 2% outward cross fall using Equation 3.2.1 and Table 3.2.2 of the TAC Geometric Design Guide for Canadian Roads.

Retrofit Roundabouts

Roundabouts at existing intersections will need to be more flexible in terms of diameter, to best accommodate existing site constraints. An example two-lane roundabout is in Standard Drawing 3720. A Design Checks Package is required at the preliminary design. The package shall be approved by the City before proceeding to further stages of roundabout design.

A neighbourhood traffic circle may be acceptable at an existing local road intersection, in which case the design should conform to Standard Drawing 3700.

Additional Guidance

In general, roundabouts shall be designed in accordance with the TAC Canadian Roundabout Design Guide (2017) and good engineering design principles, with additional guidance taken from the National Cooperative Highway Research Program (NCHRP) Research Report 1043, Guide for Roundabouts (2023) where necessary.

3.6.8.Turn Lanes

3.6.8.1.Right Turn Lanes

Right turn lanes are typically used on divided arterial streets, streets with Posted Speeds above 50 km/h, and streets with high right turn traffic volumes which represent 10% or greater of the approach volume (or more than 100 vehicles per hour), and no downstream bus stops. The presence of right turn lanes can reduce the severity of conflicts between people driving through intersections and people turning right by separating slower turning movements from the faster through traffic. Right turn lanes can assist people who drive larger vehicles in negotiating turns and provides vehicle storage at intersections. However, right turn lanes have a negative effect on people who walk and cycle by increasing crossing distances (and exposure) and increasing mixing areas between through bicycle traffic and right turning motor vehicle traffic. Right turn lanes can also lead to auxiliary lanes (i.e., merge lane or free-flow lane) on the intersecting street.

The provision of right turn bays should consider the following:

- Existing and future road volumes, access volumes, and access operations;
- Transit stop locations and current transit operations (eg. Curb-side vs. layby); and
- Corridor design including existing or future active transportation facilities, existing and future context, and roadway classification.

More information on selection criteria for right turn bays can be found in the City's Access Management Guidelines.

Figure 3.77 illustrates the typical layout for right turn designs. The form of traffic control should be selected to suit the design and minimize conflicts between right turning, left turning, and through vehicles, as well as people walking, wheeling, and cycling.

The length of a right turn bay is determined by the storage requirements and required deceleration lengths. The length of a right burn bay is measured from the end of the taper radius to the stop bar or one metre back from the edge of the crosswalk for channelized right turns. Storage length is equal to the bay length plus half the taper length for arterial streets.

A right turn lane taper is used to introduce the right turn lane. It is measured from the edge of the through lane at the start of the taper radius to the beginning of a full width right turn lane bay at the end of the taper radius. Right turn lane taper designs are a function of Design Speed, the width of the right turn lane, and the horizontal curvature.

More information on right turn lanes can be found in TAC GDG Sections 9.14.3 and 9.14.4, while information on right turn lane design with bicycle facilities can be found in ***Section 3.6.6*** of this document. More information on corner radii is included in ***Section 3.6.2***. Appendix D of this document includes design matrices for guidance on the type of right turn treatments to use for both retrofit and new construction.

Standard detail drawings for right turn lane treatments are contained in Chapter 3.

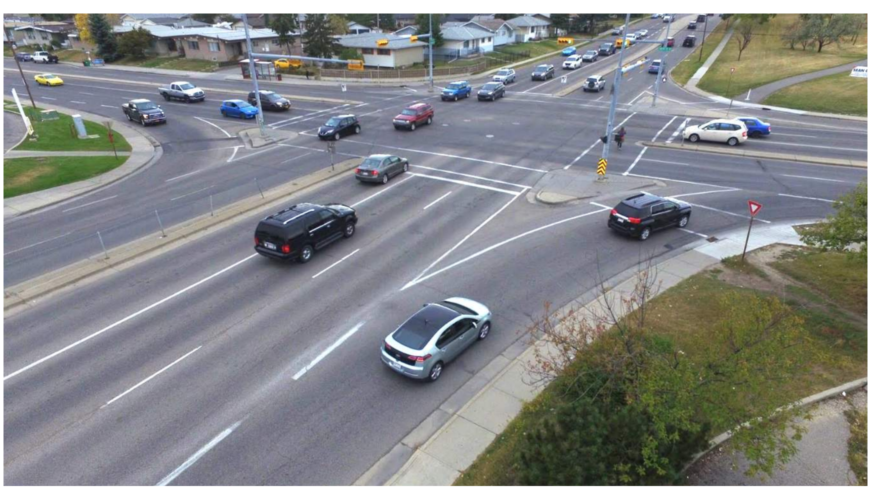


Figure 3.77: *Typical Layout for Right Turn Designs*

Channelization

Channelization at an intersection can be used for one or more of the following functions:

- Provide protected storage areas for turning vehicles, which enable people driving to decelerate and make the manoeuvres necessary for the turn outside of the path of the higher speed through vehicles;
- Provide a refuge area for people walking and wheeling between the various traffic streams;
- Reduce large areas of unused pavement, created by large corner radii or by skewed or flared intersection designs;
- Separate and reduce areas of potential conflict and decision to ensure the driver is required to make only one decision at a time;
- Control the angle of merging traffic streams;
- Segregate traffic movements into left turning, right turning, and through traffic streams;
- Control the speed of motor vehicle traffic;
- Physically prevent or discourage undesired, unsafe, or wrong-way movements at an intersection;
- Restrict access to adjacent land uses;
- Effectively locate and protect traffic control and safety devices, including traffic signs, signals, and street lighting; and
- Reduce conflicts with right turning vehicles.

Channelization is not recommended for intersections with high walking volumes in the following areas because it creates more points of conflict and reduces the comfort, convenience, and safety for people walking and wheeling.

Due to safety and operational consideration, channelization shall not be utilized in the following:

- Downtown area;
- On-street bike routes;
- Street oriented contexts; and
- Transit Oriented Development areas.

Channelization can be achieved using a combination of pavement markings and raised concrete islands/medians. These are supplemented with traffic control devices (i.e., signs and signals), and appropriate geometric design of pavement tapers and transitions, corner radii, and approach and departure geometry.

When designing channelization, drainage must be considered. Standard curb and gutter should be used and must include a means of collecting island and street drainage. For minor street islands not at intersections and with low traffic volumes reverse gutter may be considered.

For the urban environment where a simple or compound radius is not possible, the “High Entry Angle” right turn channelization, shown in ***Figure 3.78***, should be used. “High Entry Angle”, also known as “Aussie Rights” and “Smart Channel” treatments, are designed to increase the street entry angle and decrease the turning speed to be more consistent with the yield condition for people driving. “High Entry Angle” also reduces the viewing angle for the right turn manoeuvre (especially important for older people with poor head and neck rotational mobility) and improves the visibility of people walking, wheeling, and cycling to people driving. This design for right turn channelization is friendlier to people walking/wheeling/cycling, supports improved traffic operations, and decreases the workload for people driving. Standard designs for channelized right turn treatments in the City of Edmonton are contained in Chapter 3.

3.6.8.2.High Entry Angle

Based on intersection geometry, angles of approach, turning movements or other extenuating design factors, additional tracking for larger vehicles such as WB-21 or WB-36 may be required to be accommodated. In order to maintain as many of the benefits described above, a concrete apron can be used to supplement the High Entry Angle design and a detail is provided for reference on drawing #3130. The City of Edmonton has been piloting coloured concrete aprons using egyptian red and a pinwheel brick pattern to delineate the raised apron. Other jurisdictions within Alberta have been using similar colours in between dark red and brown earth tones.

Figure 3.78: *Right Turn Channelization “High Entry Angle”*

3.6.8.3.Low Entry Angle / Free Flow

Low Entry Angle or Free Flow channelization currently exists at many intersections within Edmonton. However, this design is no longer being used and is not a preferred design.

3.6.8.4.Left Turn Bays

Left turn lanes at intersections should be considered when the left turning motor vehicle traffic volumes create a hazard and significantly reduce motor vehicle capacity of the intersection. The left turn lane requirements for two lane and four lane divided streets and undivided streets are based on volume, operational, and collision warrants found in the TAC Geometric Design Guidelines Section 9.17. There may also be other instances where left turn bays are warranted. Left turn warrants should be confirmed based on traffic analysis.

Left turn lanes are composed of a taper and bay and may include a median to separate the bay from other travel lanes in the Travelled Way. The median width at the intersection can vary and may include a refuge area for two-stage crossings for people walking, wheeling, and cycling as discussed in ***Section 3.6.4.2***.

On divided streets, the left turn lane taper is used to introduce the left turn lane into the median. As with right turn lanes, the taper is measured from the edge of the through lane at the start of the taper radius to the beginning of a full width left turn lane bay at the end of the taper radius. This is different from the approach taper for streets without a centre median, which is used to shift the through lanes laterally to the right to provide width for a left turn lane. Left turn lane taper designs are a function of Design Speed, the width of the left turn lane, and the street curvature.

The storage length for a left turn lane is provided by the left turn bay and is normally designed to accommodate left turning vehicle queues as determined by traffic analysis. The length of a left turn bay is measured from the end of the taper radius to the stop bar. Storage length is equal to the bay length plus half the taper length for arterial streets and collector streets at the intersections with arterial streets.

More information on the design of different types of left turn bays can be found in TAC GDG Section 9.17. Left turn lane design for bicycle facilities are discussed in ***Section 3.6.6*** of this document. Information on median design for left turn lanes can be found in ***Section 3.2.5***. Standard detail drawings for left turn lane treatments can be found in Chapter 3.

Slotted Left Turn

Slotted left turn bays include a divisional island between the left turn lane and the adjacent through lanes. Slotted left turns are typically provided at intersections along major arterial streets or expressways wherever the median is wider than 10.8 m, where required to accommodate sightlines due to horizontal curvature, or where dual left turning lanes are proposed to minimize left turn interlock. Typical designs for slotted left turns are shown on the standard detail drawings in Chapter 3.

The advantages of slotted left turns include:

- Turning paths are clearly defined within an expansive median opening;
- Increased safety resulting from improved visibility for left turning drivers and the fact that simultaneous opposing left turns are offset from one another;
- When signalized, increased capacity of the left turn lane movement due to reduced distance and time involved in making the manoeuvre; and
- Improved safety as lane changes from left to through, and vice versa, are not possible in the immediate area of the intersection because of the divisional island.

However, slotted left turns also significantly increase the crossing distance for people walking and wheeling, resulting in larger, less friendly intersections. Providing median refuge areas for people walking and wheeling can reduce this impact.

3.6.9. Pavement Markings, Signs & Signals at Intersections

The latest pavement marking guidelines for the City of Edmonton can be found in the City's Design & Construction Standards Volume 8. This document should be referenced for all standard longitudinal markings (lane lines, pavement edge lines, guidelines, etc.), lateral markings (crosswalks, stop bars), merging/diverging markings, and pavement symbols.

For more information on pavement markings, signage, and signals, refer to the MUTCD-C.

For additional information on the application of MUTCD-C bicycle-specific pavement markings and signage, see the TAC Bikeway Traffic Control Guidelines for Canada.

Specific details pertaining to the design and application of decorative crosswalks can be accessed through the City's Decorative Crosswalk Guidelines and in consultation with the City.

Further information regarding bicycle traffic signals can be found in the MUTCD-C and TAC Traffic Signal Guidelines for Bicycles. Considerations and other aspects of walk signals can be found in the TAC Pedestrian Crossing Control Guide.

3.6.10. Intersection Spacing, Driveways, & Access Management

For design guidance on intersection spacing, driveways, and access management, refer to the City's Access Management Guidelines. The Access Management Guidelines are intended to assist in the planning of vehicular access for development or redevelopment of land parcels within Edmonton. Guidance is provided on the location, type, and configuration of accesses in context with a variety of factors such as safety, convenience, adjacent land use, traffic/transit operation, adjoining street classification, and street character.

3.6.11.Emergency Access

Secondary emergency accesses shall be provided whenever the length of a cul-de-sac exceeds 120 m (as measured from the centre of the cul-de-sac to the centre of the intersection), or whenever the bottle neck length of any portion of roadway exceeds 120 m (as measured from the centre of one intersection to the centre of the second intersection), as shown in ***Figure 3.80***. The secondary emergency access may take the form of an emergency access connection via an off-street path, as exemplified in ***Figure 3.79***. Alleys will not be considered for emergency access in a permanent capacity, except for reverse housing lanes. Use of alleys for temporary emergency access may be permitted at the discretion of the City.

The off-street path shall be centred on the right of way (straight alignment, requiring minimal turning manoeuvres) and constructed to the satisfaction of the City. The off-street path width shall be determined by an authenticated swept path analysis as per the Edmonton Fire Rescue Services Swept Path Analysis requirements, with the emergency vehicle remaining on hard surface at all times, and having a minimum clearance of 0.3 m on all sides of the vehicle from any obstructions.

A swept path analysis for a City of Edmonton fire apparatus shall be provided in support of all off-street paths to be designated for emergency access. Any off-street paths must have the load-bearing capacity to support the Fire Rescue Services Ladder Apparatus, which is 81,500 lbs.

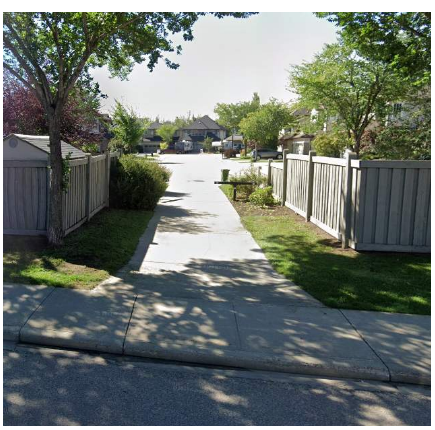


Figure 3.79: *Off-Street Path Emergency Connection*

The swept path analysis shall take into consideration on-street parking along the adjacent streets. Where the swept path cannot be accommodated without the need for parking restrictions, approval will be required. Parking restrictions in excess of 15 m will not be permitted.

Signage shall be installed at all emergency accesses and off-street path connections to restrict vehicular access to emergency and maintenance vehicles. At the discretion of the City, bollards may be required at each end of the off-street path access, as shown on the standard detail drawings in Chapter 3. The posts shall prevent non-emergency vehicle access while allowing access for maintenance equipment and emergency vehicles. Rolled face curbs at the approaches to the off-street paths are adequate.

The normal gradient for emergency access off-street paths shall be 0.7% and the minimum gradient shall be 0.5%. The maximum gradient shall not exceed 8.0%.

Where off-street paths provide access to utility corridors and natural areas, fire hydrants shall be provided at the nearest property line or where the trail ties into the street network to accommodate firefighting access.

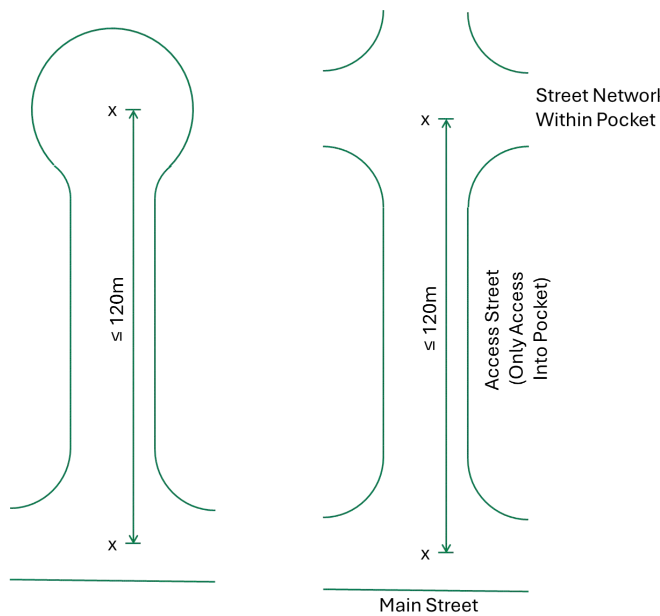


Figure 3.80: *Measurement of Street Lengths for Secondary Emergency Access*

3.7. OFFSETS AND UTILITY ALIGNMENT

Utilities can include sewer, water, gas, telecommunications, and power for street lights/traffic signals and auxiliary power for signs, transit shelters, and other street furniture elements. Within the public realm in urban areas, underground utilities may be located in all the design zones – Curbside Zone, Furnishing Zone, Pedestrian Through Zone, and Frontage Zone.

Utilities are provided to service the buildings along urban streets, the infrastructure along these streets, and the adjacent communities. In many cases, utilities are located along existing urban streets, either underground or overhead. Deep utilities usually run under the street Travelled Way or Curbside Zone and shallow utilities usually run under the Furnishing Zone or Pedestrian Through Zone, though they may also be located in the Frontage Zone or easement on private property within the Adjacent Lands.

The offset of utilities, street furniture, and landscaping from other elements in the street right of way is an important factor related to traffic safety, street user behaviour, and constructability. The offset between some elements (e.g., water mains, storm sewer, and sanitary sewer) are Provincially legislated.

Based on TAC guidance, the use of the Clear Zone design concept for higher speed streets is not applicable, practical, or desirable for arterial, collector, and local streets. This is due to the typical conditions along urban streets with lower target operating speeds, denser development, limited right of way, closely spaced intersections, and multimodal street users. In these urban environments, lateral clearance (i.e., horizontal offsets) is typically provided to improve operations rather than shielding obstacles.

The Design Domain for offsets between utilities, poles, cabinets, trees, sidewalk/path, and face of curb are provided in Volume 1: Table of Offsets. The Volume 1 Table of Offsets is available at: City of Edmonton Design and Construction Standards. In all cases, underground utilities running parallel to the roadway must maintain a minimum 1.15 m offset to the face of curb except at traffic calming installations.

For more information on offsets to intersections and driveways as related to sightlines and clear sight triangles, refer to ***Section 3.6*** of this document.

Other utility requirements for street design include:

- Utility fixtures and appurtenances shall not be placed within the Pedestrian Through Zone.
- Auxiliary power should be provided along all street oriented commercial streets which requires coordination with Business Improvement Associations (BIAs). Power receptacles are to be attached to trees (at a minimum height of 2 m above ground level) and/or street lighting poles and should be readily accessible to support outdoor lighting, festivals, and other events. See Design and Construction Standards Volume 6 for street lighting requirements;
- The City has developed a multi-party shallow utility trench arrangement and detailed standards which are to be used for all new construction. This allows for a number of shallow utility providers to locate their services within a common trench making efficient use of available right of way. The multi-party trenching Standard Details can be found in Chapter 3;
- Installation of hydrants in rural areas will require the construction of an access pad. Hydrants are typically placed at 1.5 m off of the edge of asphalt, with a pad extending from 1.5 m behind the hydrant to the Travelled Way surface and 1.5 m either side. The pad sides are to be sloped to match the ditch grading and no steeper than 4:1 (adding culverts as required) and are to be sodded. The pad shall be surfaced with road crush or asphalt on the top. Protection posts are required on the hydrant pads; and
- The lighting design and other utilities must be shown on the construction plan submitted for City approval.

3.8. TRAFFIC CALMING

This section draws upon the TAC Canadian Guide to Traffic Calming. Furthermore, the City has adopted a Safe Mobility Strategy to guide how the City will work with communities to address traffic concerns in their neighbourhoods.

Traffic calming is the installation of mainly physical modifications to a roadway and its roadside environment in such a way that motorists will drive slower, exercise caution, and make the street far friendlier to people regardless of how they choose to move around. These modifications can both bring the street closer to its intended use while limiting the negative effects on emergency response agencies and operational costs. It can also involve traffic management, or changing traffic routes or flows within a neighbourhood.

Traffic calming usually involves the installation of one or a combination of the following roadway design characteristics or features:

- Installation of visual treatments that visually narrow the road and add side-friction. These may include gateway features at entrances (such as roundabouts, curb extensions, raised crossings, or other traffic calming features) and/or roadside trees;
- Changes to the roadways surface texture and/or colour;
- Changes to the vertical and/or horizontal alignment of the roadway;
- Changes to the travelled portion of the roadway through pavement markings and/or lane narrowing; and
- Restricting directional flows of traffic.

3.8.1.Objectives & Principles

The objective of traffic calming is to determine the best combination of measures that result in an improvement, both real and perceived, in the quality of life in a neighbourhood.

Traffic calming is intended to achieve one or more of the following objectives:

- ***Reduce vehicular speeds.*** Speeding increases the risk to all street users, and especially people walking, wheeling, and cycling, creates more noise, and detracts from a neighbourhood's livability;
- ***Discourage through traffic.*** High volume non-local traffic increases noise, congestion, and delays while reducing safety for all street users within a neighbourhood;
- ***Minimize conflicts between street users.*** Though physical separation of street users is effective, reducing vehicular speeds and volumes, correcting geometric deficiencies and improving sightlines all can help to reduce conflicts; and,
- ***Improve the neighbourhood environment.*** In addition to providing an opportunity for aesthetic enhancements through landscaping and design features, traffic calming installations have the potential to improve the feeling of safety and security for residents, improve the sense of community identity, reduce noise and air pollution, and increase the level of comfort for vulnerable users.

There are a number of principles which are the foundation of any traffic calming strategy. These include:

- ***Identifying the real problem.*** Perceived issues from residents may not be the real issue(s);
- ***Quantifying the problem.*** Determine if data should be collected to evaluate the problem. Data is collected under the following circumstances;
    - On existing streets;
    - On local streets;
    - To evaluate shortcutting; and,
    - To compare traffic speeds before and after implementation to gauge effectiveness.
- ***Defining the Design Speed.*** The design speed should be clearly defined for each roadway targeted for traffic calming to determine which measures are most appropriate;
- ***Identifying Volume Thresholds.*** Many traffic calming measures are only appropriate within a specific range of traffic volumes. These thresholds should be defined and understood prior to selecting measures to implement;
- ***Considering improvements to the arterial street network.*** Motorists may short-cut because there is a congestion issue on a nearby arterial. Consideration must be given to managing congestion on the arterial streets via signal optimization or changes in signalization, if it can be effectively addressed;
- ***Applying traffic calming measures on an area-wide basis.*** Consider adjacent streets and the larger area. All neighbourhood streets (local and collector) within the selected area should incorporate traffic calming elements to encourage vehicles to travel at the posted speed. Otherwise traffic calming to solve issues on one street might deflect the problem to an adjacent street. Guidance on applying traffic calming on a neighbourhood scale is found in ***Section 2.4***;
- ***Balancing access and egress restrictions.*** Restricting access is useful when addressing concerns of vehicles shortcutting through a community or along bike routes to promote active transportation. However, this measure may not be received well by some community residents or may impact the provision of emergency services. Special care should be taken towards achieving a balance between these competing interests if access restriction is considered for implementation;
- ***Using self-enforcing measures.*** Physical measures are more effective than signage alone, (for example, turn prohibition signs) which requires enforcement;
- ***Considering adaptable measures.*** Many issues can be addressed through the use of adaptable measures, especially within existing neighbourhoods where roadway renewal work is not planned for some time. These temporary installations can be used to provide a quick and targeted response in problematic areas under a reduced cost. However, impacts on snow clearing and winter maintenance should be considered during the design process;
- ***Considering all services.*** Consider transit, police, fire, ambulance, waste collection, and snow clearing to help minimize delays and impacts to these services; and
- ***Education and Enforcement.*** Education of street users can improve compliance and understanding of the measures deployed in a community. Enforcement can further improve compliance with traffic calming measures, however, consideration should be given to the installation of measures that decrease the need for enforcement, and are self-explanatory to street users.

3.8.2.Types of Traffic Calming

Traffic calming measures can be grouped into 5 general categories: vertical deflection, horizontal deflection, access restrictions, intersection treatments, and signing.

Vertical deflection describes those physical measures that cause a vertical upward movement of the vehicle. This movement generally results in lowered vehicle speeds because motorists slow to avoid unpleasant sensations when traversing the traffic calming measure. In Edmonton, these include raised crosswalks, raised intersections, continuous crossings, speed humps, speed cushions, and speed tables. ***Figure 3.81*** illustrates an example of vertical deflection - a raised crosswalk. See ***Section 3.6.4.3*** for more information.

Figure 3.81 *Raised Crosswalk*

Horizontal deflection describes those physical measures that cause a lateral shift and/or narrowing in the travel pattern of vehicles. This forces a motorist to slow the vehicle in order to comfortably navigate the measure. In Edmonton, these include chicanes, curb radius reductions, on-street parking, curb extensions, raised median islands, traffic circles, lateral shift, speed kidneys, lane narrowing, and road 'right-sizing'. ***Figure 3.82*** illustrates an example of horizontal deflection - a chicane.

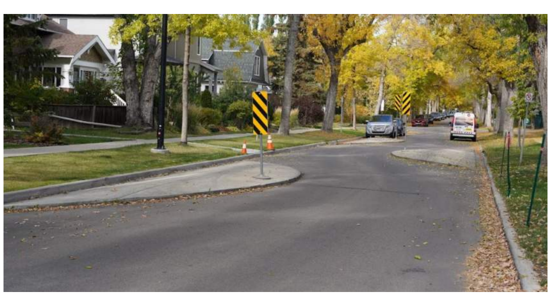


Figure 3.82 *Chicane*

Access Restrictions are physical measures that alter access to/from a street that is being traffic calmed. In Edmonton, these include directional closures, diverters, full closures, intersectional channelization, raised median through the intersection and right-in/right-out islands. ***Figure 3.83*** illustrates examples of access restrictions - a directional closure and a full closure.

Intersection Treatments are measures that may slow vehicular traffic through the intersection and improve safety for all roadway users. These may include raised crosswalks, two-stage crossings, curb extensions, roundabouts, etc.

Signing can include regulatory signs that regulate traffic movements (e.g. no left turn restriction), though these have limited effectiveness without enforcement. There are also signs that identify other traffic calming measures (at their location, and/or in advance).

Figure 3.83A *Directional Closure*

Figure 3.83B *Full Closure*

3.8.3.General Design Considerations

General design considerations that apply to the design of traffic calming measures include:

Grades. Minimum and maximum grade guidelines apply to many traffic calming measures. Vertical deflection measures, for example, should not be installed on a street exceeding 8% gradient due to potential adverse effects on vehicle control.

Surface Drainage. Drainage design to avoid ponding and ice build-up is critical, and should consider inflow to the drainage system. For example, catch basins should be located on the uphill side of traffic calming devices and away from the inside of tight curves. Alternatives to installing additional CBs, such as LID, could be used to hold and route surface drainage.

Underground Utilities. Traffic calming plans need to consider the need for access to underground utilities and the potential effect of roots on underground utilities from heavily landscaped measures. Catch Basin and Maintenance Hole access should be considered when placing traffic calming measures.

Construction Materials. Materials used for traffic calming must be capable of withstanding heavy vehicle loads, drainage, snow clearing operations, and freeze-thaw action. Thick paint or other materials that would make the Travelled Way surface slippery when wet should be avoided.

Signs. Traffic calming features typically require signs to advise street users of their location. In the interest of community aesthetics, efforts should be made to avoid installation of advance warning of these features.

Streetscaping. The introduction of landscaping and the presence of mature trees can enhance a traffic calming measure visually, and increase driver's awareness and reduce their travel speeds. Care must be taken to ensure that landscaping does not obscure sightlines.

Maintenance. There are three major maintenance considerations – repairing damage to vertical deflection measures being struck by snow clearing equipment, damage to snow clearing equipment itself, and removal of the accumulation of leaves, debris, and snow. Measures should be clearly signed and equipment operators made aware of these types of measures. Additional consideration is necessary to ensure that landscaping is maintained to eliminate obstructions of sightlines.

New Construction vs. Retrofit. Streets in new areas should be built in a manner which integrates traffic calming elements to reinforce operating speeds, improve safety, and reduce shortcutting. The integration of traffic calming in neighbourhood design is outlined in ***Section 2.4***.

User Considerations

For more details on these considerations, refer to Section 4.1 of the TAC Canadian Guide to Neighbourhood Traffic Calming. General user considerations that apply to the application of traffic calming measures include:

Emergency Services. There is a need to balance between the benefit of decreased frequency and severity of collisions due to the installation of traffic calming devices with the disbenefit (e.g. increased response time) to emergency services. Emergency Services should be consulted during the development of a community traffic calming plan to effectively strike this balance.

Transit Services. Due to their dimensions, transit buses are affected in a similar way to emergency vehicles for vertical and horizontal deflections. Acceptable vertical deflection measures along transit routes include speed tables and raised crosswalks, as these provide speed management for passenger vehicles while accommodating transit and emergency vehicles. Horizontal measures, meanwhile, are also acceptable provided that their dimensions allow adequate space for safe passage of transit vehicles.

Another consideration related to transit service when designing traffic calming measures is to coordinate their location with any existing transit stops to ensure that they do not impede and remain easily accessible by pedestrians.

Therefore, to maximize the benefits of a traffic calming plan and minimize the effects on transit services, several sources suggested to take the following items into consideration:

- The proposed traffic calming plan (number of measures and location) should avoid a substantial increase in travel time.
- A recommended operational speed of 25 kilometres per hour or less for transit vehicles crossing traffic calming measures such as speed tables and raised crosswalks;
- The proposed traffic calming plan should not include more than five (5) vertical deflection measures per the length of a single transit route through the neighbourhood; and
- The flat surface of speed tables and raised crosswalks should be a minimum of 4 metres long, particularly along transit routes. A reduction to 3 metres may be possible in constrained locations.

Long Vehicles. Knowledge of truck, bus, and emergency routes within a community is necessary when developing a traffic calming plan. Horizontal deflection measures such as curb radius reductions, traffic circles, and directional closures shall accommodate the appropriate design vehicle for the roadway. Measures which are restrictive to large turning radius vehicles should only be located in neighbourhoods where truck and bus volumes are low and emergency access into an area can still be accommodated via other routes, if necessary.

People Walking, Wheeling & Cycling. Implementation of traffic calming measures should ensure access for people walking and wheeling, and should minimize impacts on active modes, with the following considerations:

- Traffic calming should be used to enhance safety at both marked and unmarked crossings;
- Traffic calming should not negatively impact the safety of people walking, wheeling, and cycling;
- Where there is a dedicated bike facility (painted or protected) or a bikeway facility is located on a local roadway with parking banned on both sides, avoid extending speed humps across the entire Travelled Way so that bicycles can travel beside the measure without having to travel up and over the hump. This space should be protected by concrete barriers and/or vertical flexpost which physically separate vehicles from cyclists; and
- Horizontal measures should be clearly marked to enable people cycling to identify and anticipate them.

For more details on user considerations, refer to the TAC Canadian Guide to Traffic Calming.

3.8.4.Detailed Design Guidelines

Additional details on traffic calming measures (including design drawings), are provided in Chapter 4 of the TAC CGNTC. The specific section for detailed design guidance on each traffic calming measure type in TAC CGNTC is provided below:

- Vertical deflection measures: Section 4.2;
- Horizontal deflection measures: Section 4.3;
- Roadway narrowing measures: Section 4.4; and,
- Access Restriction: Section 4.7.

3.8.4.1. Intersection and Crossing Treatments

Detailed geometric and design guidance specific to intersection and crossing treatments in Edmonton can be found in the following sections of this document:

- Curb Extensions: ***Section 3.3.1.5***
- Raised Crossings, Raised Intersections, & Continuous Crossings: ***Section 3.6.4.3***
- Roundabouts: ***Section 3.6.7***
- Two-Staged Crossings: ***Section 3.6.4.4***

3.8.4.2. Vertical Deflections

This section provides detailed guidance on the selection and design of speed humps and speed tables as vertical deflections, as these measures can be used between intersections to address problems of excessive vehicle speeds. However, proper placement of these measures must consider conflicts with existing infrastructure along with transit and emergency services.

Description

Speed humps and speed tables are raised traffic calming features which are placed between intersections to encourage slower vehicle travel. However, while both generally extend across the width of the travelled way and contain a similar height, speed humps differ from speed tables in having a shorter length, meaning a more abrupt change in elevation for passing vehicles.

Consequently, speed humps are not used along roads with transit service or frequent use by emergency vehicles, and are therefore generally only appropriate for use along local roads in residential areas.

Meanwhile, speed tables can be used along collector roads within residential areas as the rate of change in elevation is low enough to a degree that permits safe and mostly uninhibited passage of transit and emergency vehicles while still being an effective measure to lower speeds amongst other vehicles. Depending on local context, other two-lane roads, such as enhanced locals, may also be appropriate for speed table placement. However, speed tables can only be implemented as a permanent or semi-permanent measure.

Examples of Speed Humps and Speed Tables within Edmonton are shown below.

Figure 3.84: Speed Hump

Figure 3.85: Speed Table

Application

The following considerations are used when selecting locations for vertical deflection between intersections:

- **Intent:** Vertical deflections can be used to address the following:
  - Speeding and/or shortcutting through neighbourhoods;
  - Road Run-Off Collisions along curves; and
  - Yielding Behaviour at Crosswalks and/or Intersections.
- **Transit Service:** Speed humps are appropriate for use along roads without transit service or potential for transit service in the future. Therefore, they are generally only applied on local roads. Collector or enhanced local roads with transit service, however, must use speed tables only.
- **Placement:**
  - When used to address concerns regarding speeding and shortcutting, speed humps and speed tables shall be placed in a series and spaced 50-150 m and 100-150 m apart, respectively. For both measures, a minimum of two placements should be made per corridor.
  - Speed humps and speed tables should be placed a minimum of 10 m away from crosswalks and intersections when used to improve yielding behaviour.
  - When used to address trends of run-off-road collisions along curved roads, either measure shall be placed on both sides of the curve.
  - In any case, speed humps and speed tables must be situated a minimum of 75 m away from signalized intersections.
- **Sightlines:** Speed humps and speed tables should be easily detectable by drivers and not obscured by trees, parked vehicles, or roadway curvature.
- **Utilities:** Speed humps and speed tables shall not be placed overtop water valves, chambers, maintenance holes, power cables, or gas mains.
- **Residential Proximity:** Avoid placing vertical deflections directly in front of driveways and walkways. Additionally, placement should allow for a single parking spot in front of residential walkways wherever feasible and should not interfere with disabled parking. Vertical deflections should also be avoided directly in front of windows and flanking residential properties where headlights could shine into the dwelling when vehicles traverse the vertical deflection.
- **Roadway Conditions:** Avoid placing vertical deflections in areas with cracked pavement or excessive vertical grade.
- **Bike Infrastructure:** Installation of vertical deflections as per the standard details can be applied along bike routes through the entire width of the carriageway. Where protected separate bike lanes are present, vertical deflections should not be obstructed within the protected bike lanes.

3.8.5.Selection & Implementation

Benefits/Disbenefits

Using the four traffic calming measure types, ***Table 3.37*** provides a summary of the potential benefits of these and other common traffic calming measures in terms of speed reduction, volume reduction, conflict reduction, and environment as well as the potential disbenefits associated with each measure in terms of local access, emergency response, other travel modes, enforcement, maintenance, and replacement costs.

***Table 3.37A** Horizontal Deflection Measures – Potential Benefits and Disbenefits*

Measure	Example	Applicable to Interim Implementation	Potential Benefits				Potential Disbenefits					
			Speed Reduction	Volume Reduction	Conflict Reduction	Environment	Local Access	Emergency Response	Active Transportation	Enforcement	Parking	Maintenance
Chicane	Raised concrete structure within the carriageway which requires drivers to maneuver around 	■	■	■	■	▣	□	▣	▣	□	■	▣
Curb Radius Reduction	Reduction in the radii of curb corners to encourage slower and tighter turns by drivers 	■	▣	□	□	▣	□	□	▣	□	□	▣
Mini Roundabouts and Neighbourhood Traffic Circles	Small roundabouts used in low-speed urban environments with right of way constraints 		■	▣	■	■	□	▣	▣	□	▣	▣
Traffic Diversion	Access restrictions which prevent vehicles from travelling straight through a section of roadway while permitting bicycle and pedestrian travel 	■	□	■	□	□	■	■	□	□	□	▣

Measure	Example	Applicable to Interim Implementation	Potential Benefits				Potential Disbenefits					
			Speed Reduction	Volume Reduction	Conflict Reduction	Environment	Local Access	Emergency Response	Active Transportation	Enforcement	Parking	Maintenance
Two-Stage Crossing	Enlarged medians which provide refuge space and allow pedestrians and cyclists to cross one direction of roadway at a time 	■	▣	☐	▣	☐	☐	▣	☐	☐	■	▣

Legend:

■ = substantial (dis)benefits
▣ = minor (dis)benefits
☐ = no (dis)benefit

Notes:

1. Less effective if implemented with pavement markings only.
2. More effective on single-lane roads.

***Table 3.37B** Vertical Deflection Measures – Potential Benefits and Disbenefits*

Measure	Example	Applicable to Interim Implementation	Potential Benefits				Potential Disbenefits					
			Speed Reduction	Volume Reduction	Conflict Reduction	Environment	Local Access	Emergency Response	Active Transportation	Enforcement	Parking	Maintenance
Raised Intersection	Intersection surface which is raised slightly to encourage slower travel 		▣	□	▣	□	□	□	□	□	□	▣
Speed Cushion	Small vertical deflections which encourage slower travel by passenger vehicles while more easily allowing emergency and transit vehicles to pass unimpeded 	■	■	▣	■	▣	□	▣	▣	□	▣	▣
Speed Hump/Table	Similar to speed cushions besides spanning the entire width of the roadway and having a smaller width 	■	■	▣	■	▣	□	▣	▣	□	▣	▣

Measure	Example	Applicable to Interim Implementation	Potential Benefits				Potential Disbenefits					
			Speed Reduction	Volume Reduction	Conflict Reduction	Environment	Local Access	Emergency Response	Active Transportation	Enforcement	Parking	Maintenance
Raised Crossing	Pedestrian crossing which is raised above the surface of the roadway to encourage slower travel and greater awareness of the crossing 	■	▣	□	▣	□	□	□	□	□	□	▣
Continuous Crossing	Similar to raised crossings, except the height of the crossing matches the sidewalk/pathway elevation and is the same material 		▣	□	▣	□	□	□	□	□	□	▣

Legend:

■ = substantial (dis)benefits
▣ = minor (dis)benefits
□ = no (dis)benefit

Notes:

1. Less effective if implemented with pavement markings only.

2. More effective on single-lane roads.

***Table 3.37C** Roadway Narrowing Measures – Potential Benefits and Disbenefits*

Measure	Example	Applicable to Interim Implementation	Potential Benefits				Potential Disbenefits					
			Speed Reduction	Volume Reduction	Conflict Reduction	Environment	Local Access	Emergency Response	Active Transportation	Enforcement	Parking	Maintenance
Curb Extension	Extensions of the curb outwards into the driving surface to reduce the roadway width, particularly around pedestrian crossings and intersections 		▣	□	□	■	□	□	▣	□	■	▣
Lane Narrowing [1]	Narrowing of the roadway's drivable area through temporary or permanent measures designed to reduce vehicle speeds 	■	▣	□	□	□	□	□	▣	□	▣	□
Addition or Removal of On-Street Parking	Addition of parking space to add side friction to roadways, or removal of parking spaces to accommodate another form of traffic calming or bike+pedestrian infrastructure 	■	▣	□	□	▣	□	▣	▣	□	□	▣

Measure	Example	Applicable to Interim Implementation	Potential Benefits				Potential Disbenefits					
			Speed Reduction	Volume Reduction	Conflict Reduction	Environment	Local Access	Emergency Response	Active Transportation	Enforcement	Parking	Maintenance
Raised Median Island/Centre Median	Raised medians which can both narrow the roadway and/or supplement a horizontal deflection 	■	▣	□	▣	□	▣	□	□	□	▣	▣
Road Diet	Various methods or measures to reduce driving space and encourage lower speeds along extended stretches of roadway, including lane removal and narrowing through traffic calming 		■	■	■	■	▣	□	□	□	■	▣
Vertical Centreline Treatment	Temporary or permanent fixtures which reinforce the presence of the roadway centreline and prevent vehicle intrusions into the opposite lane 	■	▣	□	□	□	□	□	□	□	□	▣

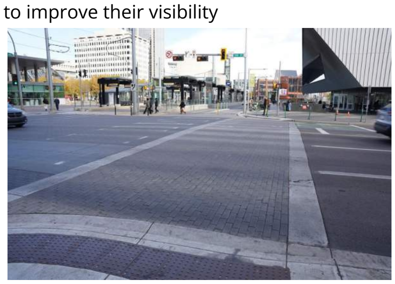
Legend:

■ = substantial (dis)benefits
▣ = minor (dis)benefits
□ = no (dis)benefit

Notes:

1. Less effective if implemented with pavement markings only.
2. More effective on single-lane roads.

***Table 3.37D** Surface Treatment Measures – Potential Benefits and Disbenefits*

Measure	Example	Applicable to Interim Implementation	Potential Benefits				Potential Disbenefits					
			Speed Reduction	Volume Reduction	Conflict Reduction	Environment	Local Access	Emergency Response	Active Transportation	Enforcement	Parking	Maintenance
Textured Crosswalk	Crosswalks which are supplemented with textured material to improve their visibility 		▣	□	▣	▣	□	□	▣	□	□	■
Textured Pavement	Sections of pavement which are supplemented with textured material to encourage slower driving speeds 		▣	□	□	▣	□	□	▣	□	□	■

Legend:

■ = substantial (dis)benefits
▣ = minor (dis)benefits
□ = no (dis)benefit

Notes:

1. Less effective if implemented with pavement markings only.

2. More effective on single-lane roads.

***Table 3.37E** Education & Enforcement Measures – Potential Benefits and Disbenefits*

Measure	Example	Applicable to Interim Implementation	Potential Benefits				Potential Disbenefits					
			Speed Reduction	Volume Reduction	Conflict Reduction	Environment	Local Access	Emergency Response	Active Transportation	Enforcement	Parking	Maintenance
Speed Display Devices [2]	Digital signs which record and display driver's speeds and flash if the speed is above the posted speed limit 	■	■	□	□	□	□	□	□	▣	□	■
Lawn Signs Encouraging Slower Driving	Temporary lawn signs displayed in residents front yards along residential streets to encourage slower vehicle speeds 	■	□	□	□	□	□	□	□	□	□	□
Mobile Changeable Message Signs with Road Safety Messaging	Mobile signs displaying digital safety messages on the side of roadways 	■	■	□	▣	□	□	□	□	□	□	■

Legend:

■ = substantial (dis)benefits
▣ = minor (dis)benefits
□ = no (dis)benefit

Notes:

1. Less effective if implemented with pavement markings only.
2. More effective on single-lane roads.

3.9. SHARED STREETS, REVERSE HOUSING LANES AND ALLEYS

Alleys and Shared Streets are low volume, low speed streets where the Travelled Way is a shared space between all users and functions as part of the public realm on these streets. Alleys and Shared Streets - in both residential and commercial settings - serve distinct purposes; an Alley is a low volume street that primarily serves those driving to access a residence or business, a Shared Street provides similar access but is specifically designed to prioritize those walking and wheeling, functioning foremost as a public space for recreation, socializing, shopping, and leisure.

The design speed limit for Alleys and Shared Streets are identified in ***Section 3.2***.

3.9.1.Shared Streets

An example of a Shared Street is shown in ***Figure 3.86***. In a Shared Street, walking and wheeling is accommodated and encouraged within the Travelled Way, therefore, the planning, design and implementation of a Shared Street must take into account motor vehicle traffic operations (Circulation Zone), public realm needs and opportunities (Activity Zones), a safe pedestrian space, particularly for those users with mobility challenges (Pedestrian Through Zones), crossings for people cycling, walking, and wheeling, and the combined operational characteristics of all travel modes including walking and cycling.

These types of streets and/or spaces may not always be the best solution and are not necessarily appropriate to be implemented in all locations and situations. Clear consideration needs to be given to proper place-making and the need to accommodate the movement of all modes of travel including pedestrians, cyclists and vehicles within the same space as well as snow clearing operations.

A Shared Street environment should be considered in places where there are a lot of people walking and vehicle volumes are either low or discouraged. Each shared street is unique and needs to be designed to be context-sensitive by taking into account the surrounding land-use and the complementary street functions. Shared Streets are designed to create a public space predominantly for pedestrian activity, and to deliberately reduce the dominance of vehicles in these spaces.

The following volume thresholds should be considered when designing Shared Streets:

- **Residential Shared Streets:** Consistent with Local Street Bikeways, 500 to 1,000 vehicles per day and peak hour motor vehicles volumes of less than 100;
- **Commercial Shared Streets:** Up to 2,500 vehicles per day and 100 vehicles per hour. It is desirable to have higher volumes of people walking to reinforce the pedestrian priority of the street (e.g., 1,000 people per hour, or 4 people per motor vehicle).

The planning and design of these spaces shall include the considerations outlined in this section.

3.9.1.1.Configuration

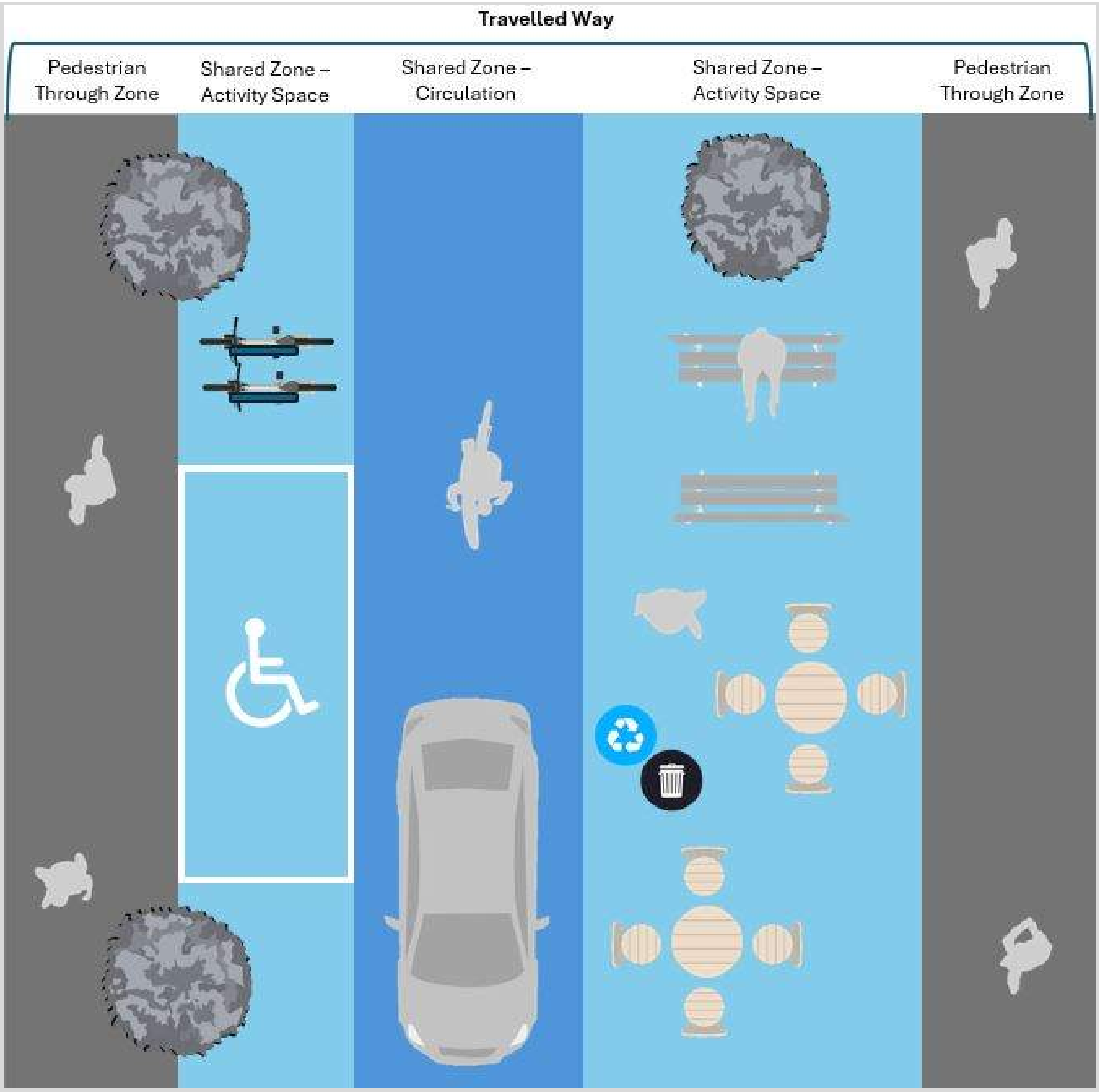


***Figure 3.86** Shared Street Components*

Typically there are public realm elements located within the Activity Zones, such as landscaping, seating areas, site furnishings, etc., provided outside of the Circulation Zone (but still within the Travelled Way). There may also be parking and loading areas. The specific type and location of elements outside of the Circulation Zone will reflect the adjacent land use.

On wider Shared Streets, staggered blocks of landscaping, parking, and loading spaces can be used to create a chicane effect. In some cases, parking may be permitted directly adjacent to properties in a residential environment.

Deliveries to businesses are typically restricted to certain hours of the day, usually in the morning. Paving materials, landscaping, street furniture, curbs, and bollards can be utilized to help define parking spaces and to delineate the different zones.

Shared streets must include a Pedestrian Through Zone which provides a safe, vehicle free area on either side of the Travelled Way that is clear of obstacles and street furniture and provides a minimum width of 1.8 m. The Pedestrian Through Zone should be defined using detectable warning strips (textured pavers) or tactile walking surface indicators (TWSI's). Additional delineation may be achieved through the use of planters, street furniture, bollards and curbs.

On longer Shared Streets (in excess of 100 m), consideration should be given to identifying designated crossing locations to enhance safety for people walking and wheeling and to support universal design. Where necessary, traffic volumes can be decreased through network design and traffic calming as part of a conversion. Shared Streets may also be closed to through traffic for specific portions of the day. Movable planters and time-of-day restrictions can be utilized to further regulate the shared space.

3.9.1.2. Pavement, Surfacing and Drainage

There should be minimal elevation change between the Travelled Way and the adjacent public realm (i.e. v-gutters or rolled face curbs should be utilized to be nearly flush with adjacent pavements) to reinforce the pedestrian priority within the Shared Street.

Textured pavements that are flush with the curb reinforce to users that a Shared Street prioritizes those walking. Selection of snow plow-compatible materials is required.

Tactile Walking Surface Indicators (TWSIs) should be provided at the entrance to all Shared Streets to assist in alerting users, particularly those with low vision, of a potential hazard for people people walking and to indicate the location of, and direct users to, the Pedestrian Through Zone within the Shared Street.

Tactile Delineator Strips (TDS) with a minimum width of 600 mm are required along the full length of the Shared Street to delineate the Pedestrian Through Zone from other zones. Street furniture, landscaping, bicycle parking, and, where necessary, bollards may be included within the design to prevent vehicle entry into the Pedestrian Through Zone.

Designated loading and unloading areas can be provided within the Activity Zones and may be defined through differences in pavement pattern or use of striping and signage.

Drainage channels should be provided along the flush curb, depending on the underground utilities and other existing conditions.

3.9.1.3. Signage

A Shared Street sign and Speed Limit sign should be used at the entrance to a Shared Street. In some cases, a modified YIELD TO PEDESTRIANS sign (MUTCD-C RB-38) may be added to educate and reinforce the conversion in early stages. However, Shared Streets should generally be designed to operate intuitively as shared spaces without the need for signage. Residential Shared Street signage often depicts children playing to make people driving aware they are entering a low speed area.

3.9.1.4. Snow Clearing and Maintenance

A snow clearing and maintenance plan shall be submitted in support of all shared streets to be accepted by the City. The City will not provide enhanced snow and ice control on shared streets.

3.9.2. Car Free Streets

Car Free Streets provide opportunities to improve overall network mobility for people walking, but also to create lively public spaces that can be used for public events, markets and festivals. Bicycles may be permitted, but people cycling should be encouraged to move at walking speeds.

Car Free Streets should be designed to accommodate emergency services, though other traffic should be restricted either through clear signage or removable bollards.

3.9.3.Alleys and Reverse Housing Lanes

Alleys are low speed residential or commercial streets whose primary function is to facilitate access to adjacent properties. Alleys in urban areas do not typically have defined travel lanes as they are intended to be lower speed streets. Local conditions and practices related to provision of on-street parking, emergency access, waste and recycling collection, and snow storage need to be considered in determining the width of the Travelled Way.

The City has two alley classifications, one for residential alleys and one for commercial alleys. Residential alleys are further divided into typical residential alleys and reverse housing lanes.

The standard detail drawings for all alleys and lanes can be found in Chapter 3.

Commercial alleys require paving of the entire alley right of way to a thicker pavement structure to accommodate loading and delivery vehicle operations. Residential lanes utilize a thinner pavement structure, and typically require a pavement width of 4.0 m, unless there is perpendicular parking immediately adjacent to, and accessed from, the lane. In this case paving of the entire alley right of way may be necessary, at the discretion of the City. An example of a Commercial Shared Alley is shown in ***Figure 3.87***:

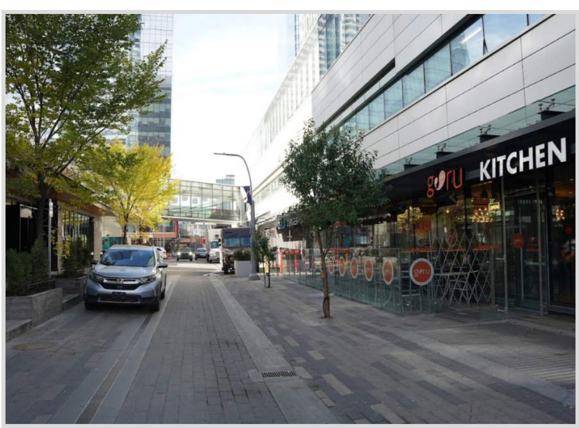


Figure 3.87 *Commercial Shared Alley*

Typical residential alleys must be designed to accommodate waste collection vehicles, while reverse housing lanes must accommodate both waste collection vehicles and fire trucks. With the growth of garden and garage suites, there is increasing residential development along alleys and it is expected that alleys will continue to evolve to become even more of a shared resource.

Another development trend within the City is the construction of Reverse Housing, which fronts onto a linear or traditional park space, with access provided from an enhanced alley. The alley for these developments provides not only vehicular access to each lot, but also serves to facilitate emergency access, utility connections, walking/cycling connectivity, and in some cases visitor parking.

Reverse housing lanes utilize a wider right of way compared to a typical residential lane, with a minimum 7.5 m pavement width to accommodate emergency access routing and staging as well as utility installations, and always include street lighting. Additional right of way is also required whenever dedicated, separated Pedestrian Through Zones are provided in reverse housing lanes, or where on-lane visitor parking is proposed.

A separate 1.8 m sidewalk must also be provided for reverse housing, with necessary lighting, and located within a road ROW. The sidewalk ROW can be located in between the lane and houses (i.e., lane with sidewalk and lighting), or on the open space side between the houses and open space (i.e., dedicated right of way with sidewalk and lighting). The open space may take the form of a park, pipeline, stormwater management facility, or greenway (as shown in ***Figure 3.88***).

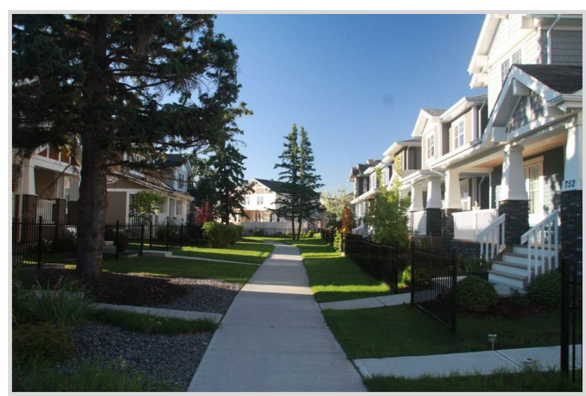


Figure 3.88 *Reverse Housing*

3.9.3.1.Activating Alleys

Alleys take up a lot of space in the urban environment, and this space provides opportunities for placemaking. In the appropriate land use context, making an alley part of a green network, bicycle corridor, or art installation can transform a forgotten alley into a vibrant, safe and sustainable urban destination.

Activating an alley should first and foremost complement adjacent land uses. For example, alleys in the downtown core can provide spill out space for businesses, whereas in a low density residential neighbourhood, alleys may provide needed public space for alley or backyard housing.

As shown in ***FIgure 3.89***, design considerations which can improve and activate alleys include:

- Paving – combination of brick pavers with higher quality material to accommodate heavy trucks;
- Lighting - including pedestrian-scaled luminaires;
- Tree and shrub planting - including Low Impact Development;
- Artwork (temporary and permanent);
- Concealing or fencing off waste collection areas;
- Street furniture; and/or
- Considerations for snow clearing and drainage.

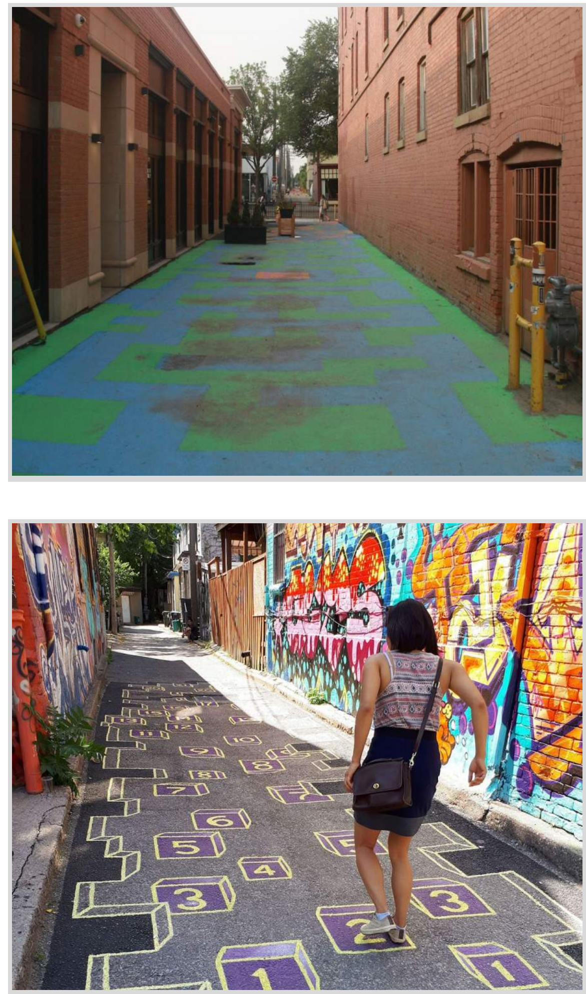


Figure 3.89 *Activated Alley Examples*

3.9.3.2. Width

In addition to shared alleys, the City of Edmonton has developed four alley classifications, which can be found in Chapter 3:

- 4.0 m Wide Residential Alley;
- 6.0 m Wide Commercial Alley;
- 7.5 m Wide Reverse Housing Alley; and
- 9.5 m Wide Reverse Housing Alley with Parking.

3.9.3.3. Turnarounds

A turnaround is required to terminate an alley, as shown on the standard detail drawings in Chapter 3. Alley turnarounds in new developments are not permitted without specific authorization from the City.

3.9.3.4. Horizontal Alignment

Alleys shall be centred on the alley right of way wherever possible. A 5 m fillet shall be constructed at the corners of all alley to alley intersections. The total length of an alley from the nearest street access cannot exceed 120 m. Where lengths exceed 120 m, a secondary access must be provided.

Alley connections to the intersecting street should provide adequate sightlines as per ***Section 3.6.1.4***.

3.9.3.5. Vertical Alignment

The vertical alignment of an alley adjacent and parallel to Collector or Arterial streets shall be designed in conjunction with the grades on the adjacent streets and abutting lots. The minimum longitudinal grade for new alley construction is 0.7%. Though this may not be achievable in retrofit situations, efforts to maximize longitudinal grades while respecting adjacent property lot grading shall be made.

3.9.3.6. Cross Fall

Shared alleys and shared spaces should be cross-falled to a gutter using either a parabolic crown or consistent cross fall to one side of the right of way.

Residential, commercial, and reverse housing alleys may be cross-falled to the centre in a “V” configuration.

3.9.3.7. Drainage

Lateral drainage should be provided using a v-gutter or rolled face curb. Catch basins should be located to collect stormwater runoff and prevent flooding of the Pedestrian Through Zone or adjacent properties during rainfall events.

3.10. TEMPORARY ROADS, TURNAROUNDS AND STAGING

3.10.1. Temporary Roads and Turnarounds

A Temporary Road may be required for a number of reasons. For example, a temporary access may be required in a partially built community before a permanent, approved access is constructed. Temporary turnarounds are also necessary to enable large vehicles and buses to egress when there is no through connection due to staging or construction. A Temporary Road may also be required as a detour during a major infrastructure construction project (e.g. interchange), and should be designed to accommodate displaced traffic while ensuring safety for all street users.

When it has been determined by the City that a Temporary Road is required in a new subdivision, the road shall be built in accordance with plans approved by the City in accordance with the standard detail drawing in Chapter 3, with all costs thereof borne by the Developer.

A Temporary Road between a proposed subdivision and an existing Local or Collector street which is required as a point of access shall be constructed to one of the following standards:

- The road shall be gravel surfaced or constructed to the completed paving stage, and may require lighting at the discretion of the City and as specified as the subdivision approval stage. A Temporary Road constructed through or flanking a single family lot shall have screen fencing provided to buffer the adjacent development, and a sign indicating the temporary nature of the road shall be erected.
- When the Temporary Road will be used only by construction traffic and will be taken out of service before residential occupancy of the subdivision following the construction of permanent access points, the road shall be constructed to the interim gravel stage without curbs and gutters. When the Temporary Road crosses the curbs, gutters, and sidewalks/shared pathways of adjoining streets, provision shall be made to permit regular vehicle movement across the curbs;
- Where a Temporary Road will be used only for emergency access, and will not ultimately be required with completion of the development, the road shall be constructed to the interim gravel stage without curb and gutters. Signage shall be installed at either end of the temporary road to restrict use to emergency vehicles; and
- Where a street terminates at mid-block more than one lot from the nearest intersection and has no provision for egress, a temporary circular turnaround shall be constructed to the same structure as the abutting street and shall be designed with a minimum 12 m radius on a local/collector (without transit) or a 17 m radius on a collector/arterial (with transit). All temporary turnarounds are required to be constructed at a gravel stage prior to opening the road to public access. If the turnaround is to be used by transit it may be required to be paved to an asphalt hard surface standard prior to opening the roadway at the discretion of the City. A temporary turnaround is not required where the roadway termination is easily visible from the adjacent intersection (a two lot maximum distance).
- Where temporary roads connect to existing infrastructure, impacts on existing trees shall be minimized. Where trees cannot be avoided, removal must occur in accordance with the City's live tree removal guidelines.

Temporary Roads shall be shown on detailed engineering drawings, and must include vertical and horizontal alignments, drainage details, and typical cross sections.

3.10.2. Road Staging

Collector and local road cross sections, complete with sidewalks and shared pathways, must be constructed in their entirety with no temporary infrastructure. Arterial roadways, however, may be constructed in stages depending on anticipated traffic volumes and planned growth pattern of the surrounding greenfield area. The staging plan, however, must be approved by the City prior to implementation.

3.11. VEHICULAR BARRIERS

Vehicular barriers are permanent protective devices that are placed between traffic and off-roadway areas to reduce the severity of a collision when an errant vehicle leaves the travelled portion of the roadway. These devices may be one of the following:

- Flexible (i.e. High Tension Cable Barrier);
- Semi-Rigid (i.e. Guardrail), or
- Rigid (i.e. Concrete).

In some situations, vehicle barriers may be required between the Travelled Way and urban area public realm or non-urban area roadside to protect against crashes between motor vehicle traffic and adjacent buildings, people walking, wheeling, and cycling, and elements located within the public realm/roadside. Examples of such cases could include:

- A barrier adjacent to a school boundary or property to minimize potential vehicle contact;
- Shielding businesses or residences near the right of way where there is a history of road run-off collisions, particularly along streets with low radius curves; and,
- Where provisions for a shared pathway are included so that people biking do not have to ride on high speed streets, but horizontal separation to the Travelled Way is limited due to right of way constraints (examples include River Valley Road and Groat Road).

In these cases and others, conventional criteria will not serve to provide warrants for barriers, and the designer must be aware of the needs and circumstances of the individual situation when deciding on appropriate action.

Barriers are also appropriate for the protection and separation of people walking, wheeling, and cycling along streets with high motor vehicle traffic speeds and/or volumes. Specific design guidance is provided in the following TAC GDG Sections:

- Section 5.3.1 – Protected Bike Lanes;
- Section 5.4 – Bikeway Facility Selection;
- Section 5.7.5 – Protected Bike Lane Delineators;
- Section 6.5.5 – Pedestrian Safety Fencing and Barriers; and
- Section 7.6.4.3 – Multimodal Configurations (of Bridges.

3.11.1. Barrier Posts

Vehicular barriers (barrier posts) are to be constructed as shown on Drawings 6200/6220 or as approved by the City and are required at the following locations:

- Across the end of off-street paths/trails which terminate in an Alley;
- Across the end of an Alley cul-de-sac which abuts a street;
- Along the length of an Alley which parallels an adjacent street;
- Along the length of an Alley which parallels a park area, public utility lot, utility corridor, or stormwater management facility;
- To prevent vehicular access at shared pathways leading into open spaces;
- Along the length of an open space or utility corridor which parallels a road to prevent vehicular access;
- To delineate pedestrian only spaces from shared spaces on shared streets and alleys as per ***Section 3.9***; and,
- To prevent vehicular access at wide curb ramps.

Steel bollards shall align with the *Downtown and the Quarters Streetscape Design Manual*, and shall be surface mounted with a base plate cover over concrete (or in case of pavers, anchors going through pavers into the concrete base), and shall be either:

- Black powder coated, 990 mm height, Reliance Foundry, R-7691 (***Figure 3.90***)
- NPS Schedule 40, type 316 stainless steel pipe, 114 mm diameter Base-165 mm diameter, 19 mm thick, type 316 stainless steel base plate with (4) 21 mm diameter holes for anchor bolts, satin finished, Reliance Foundry R-7183 (***Figure 3.91***).

Figure 3.90 *Black Bollard, Reliance Foundry R-7691*

Figure 3.91 *Stainless Steel Bollard, Reliance Foundry R-7183*

Placement of barrier posts should not obstruct accessibility.

3.11.2. Roadside & Median Barriers

For guidance on roadside barriers, median barriers, bridge railings, and end treatments, for non-urban, higher-speed roadways refer to TAC GDG Section 7.6: Traffic Barriers and ATEC Roadside Design Guide Section H4: Grading and Drainage. Barriers as they relate to roadside in non-urban areas are discussed in ***Section 3.4.2*** of this document. Selected barrier products must be included on the approved product list published by ATEC.

3.12. CUL-DE-SAC

The use of culs-de-sac within Edmonton is discouraged during land use planning and design of new neighbourhoods. Culs-de-sac may only be used in areas in which the planning and engineering of extending continuous streets are limited by constraints, such as:

- Adjacent Land Uses;
- Public Utility Lots;
- Topographical Constraints;
- Municipal Reserve Lots;
- Utility Corridors (Power line Rights of Way, Pipeline Rights of Way);
- Environmental Reserve and Ravines;
- In existing infill development in which roads terminate at adjacent property lines the cul-de-sac can be used as an option at the end of the roadway;
- Where public roads transition to private roads. The use of a cul-de-sac will be required. When neighbourhood plans project permanent road infrastructure with future development, temporary turnarounds would be utilized as the interim solution until such time entire road networks would be completed; and
- Ownership constraints in which ownership of lands creates limited options to deliver neighbourhood plans in ultimate configuration.

When culs-de-sac are used in the limited exceptions above, the following design criteria shall be met:

- Sidewalks will be required on both sides of a cul-de sac for the full length of the cul-de-sac, regardless of the number of lots.
- A Shared Pathway or walkway connection will be provided within the cul-de-sac bulb to provide pedestrian and active mode permeability from the cul-de-sac to existing or planned shared pathways or walkways in adjacent spaces.
- Secondary emergency access shall be provided based on criteria in ***Section 3.6.11***.
- The design shall comply with the cul-de-sac standard detail drawings in Chapter 3.

Proposed culs-de-sac planning and design that are not in the situations identified above must have a design exception request done prior to or concurrent with planning or engineering submissions. The design exceptions must provide the following information but not be limited to:

- Detailed information and plot plan layouts showing that the use of culs-de-sac provide an efficient use on more traditional lot layouts and include the additional benefit from a social impact.
- Engineering and planning rationale.

Islands in culs-de-sac shall be designed to allow minimum turning movements of passenger vehicles and waste collection vehicles, plus sufficient width for parallel parking. Minimum Travelled Way widths must comply with the standard detail drawings in Chapter 3.

Cul-de-sac islands should be landscaped to accommodate winter snow storage. The islands may be permitted to use straight face curb and reverse gutter with a 500 mm monolithic concrete header, and a standard street cross fall of 0.025 m/m.

3.13. INDUSTRIAL STREETS

The following provides guidance for the design of streets in Industrial Areas. While it incorporates the Complete Streets Principles and considerations from ***Section 1***, the design process outlined in ***Section 2***, and the Design Users and Human Factors in ***Section 3.1***, the industrial area context necessitates additional considerations.

3.13.1.Industrial Area Context

Industrial areas are districts which can reflect highly varied land use characteristics, including office parks, retail uses, small manufacturing establishments, warehouses, large manufacturing establishments, and intensive industrial plants. Although the Zoning Bylaw includes distinctions between typical industrial zones (that may result in different types of business) and their associated transportation needs, many different types of end users can be found in each land use zone. This variety in business type and transportation requirements makes it difficult to predict the precise character and resulting streetscape which should be associated with any given industrial zone. The fact that industrial areas, particularly older districts, show highly fragmented zoning patterns, increases the variation of building type and associated end user to be found on any given street or block. Over time, the type of businesses and their associated transportation needs may change, which requires industrial area streets to be designed to accommodate a wide range of transportation access and mobility needs.

The transportation needs for industrial areas vary based on the business operations. Some businesses will require access for large vehicles while other businesses, such as office parks, may be more focused on employee and client multi-modal personal access. In many cases, industrial areas are developed with non-street oriented buildings, which is a consideration when designing the transportation system. In general, the following transportation requirements need to be considered for streets in industrial areas:

- Business-related movements including the movement of heavy vehicles for businesses such as shipping and manufacturing;
- Employee access including all modes and consideration of equity and accessibility; and
- Customer access, which may include a variety of motorized and non-motorized modes and can include heavy vehicles.

3.13.2.Industrial Area Modal Priority & Design Users

Streets in industrial areas are High Priority Goods Movement corridors. This means streets in industrial areas are designed based on the access requirements for heavy vehicles and large trucks. Design vehicles are described in more detail in ***Section 3.1.3***.

However, designing streets to accommodate multimodal connectivity on a network level, including access for walking and cycling, is still a requirement for industrial areas. Demand and all-day use of walking and cycling infrastructure, including walking/cycling connections to transit, may vary between industrial areas, but providing walk/bike/transit access to industrial area businesses provides employees of all abilities and incomes with an affordable and safe option to get to and from work and encourages greater mode shift towards sustainable modes of transportation. This approach also considers industrial parcels which have transitioned into commercial land uses, thus generating more demand for safe multimodal access.

Design Users for walking/wheeling, cycling, and transit are also outlined in ***Section 3.1.3***. Facilities for walking and cycling should be separated from motor vehicle travel lanes by a Furnishing Zone in industrial areas. Use of monolithic facilities is discouraged.

3.13.3. Industrial Area Cross Section Types

For non-street oriented industrial areas, there are three types of street cross sections that can be used:

- Urban: curb and gutter, underground drainage;
- Rural: over land drainage with ditches, may include centre median with curb and gutter; and
- Urban-Rural Hybrid: one side of the street is urban and the other is rural.

Considerations for which type of cross section is most appropriate will include:

- Number of accesses: rural or hybrid cross sections will require culverts at driveways/accesses and intersections;
- On-street parking: rural and hybrid cross sections (the rural side) will not support on-street parking due to lack of sidewalk access and the presence of side slopes;
- Developable land restrictions: rural and hybrid cross sections (the rural side) may require easements on private land to reduce the public right of way, or alternatively will require wider right of way compared to urban cross sections. These easements restrict development within them or use of the area for parking or signage;
- Access to bus stops: rural and hybrid cross sections (the rural side) will require culverts for transit passengers at bus stops and shall include connections to the sidewalk or shared pathway beyond the backslope, where one is provided, or to the nearest adjacent intersection;
- Active transportation facilities: rural and hybrid cross sections (the rural side) will require sidewalks or shared pathways beyond the back slope to support all-seasons operation of the street and active transportation infrastructure; and
- Lighting: rural and hybrid cross sections (the rural side) may require additional lighting to illuminate both the Travelled Way and off-street public realm where the active transportation facilities are located away from the street.

Industrial areas may also be street oriented depending on the land uses fronting the street, such as schools or commercial businesses. This includes transitionary areas which are in the process of being converted into more commercial uses. While industrial traffic should not be discounted, street oriented industrial areas require greater consideration towards multimodal access, as the businesses in these areas generate more trips from people walking, cycling, and using transit.

3.13.4. Industrial Area Design Requirements

Table 3.38 summarizes the design requirements for streets in industrial areas. Design should be completed in accordance with the requirements set out in this document and the requirements outlined in the City's Design and Construction Standards Volumes 3, 4, 5, 6, and 7 on Drainage, Water, Landscaping, Street Lighting, and Power, respectively.

Standard details for urban and rural industrial streets can be found in Chapter 3.

Table 3.38: *Industrial Area Street Design Requirements*

Cross Section Element	*Industrial Arterial*	*Industrial Collector*	*Industrial Local*
Shoulder	Yes - for rural and hybrid cross sections	Yes - for rural cross sections	Yes - for rural cross sections
Travelled Way & Intersection Geometry	Based on Design Vehicle (***Section 3.1.3***)	Based on Design Vehicle (***Section 3.1.3***)	Based on Design Vehicle (***Section 3.1.3***)
On-street Parking	No	Yes - for urban cross sections[1] No - for rural cross sections	Yes - for urban cross sections[1] No - for rural cross sections
Active Transportation Infrastructure	Shared pathway both sides Located beyond back slope for rural and hybrid cross sections Crossings and sidewalk connections provided to all bus stops	Shared pathway one side or separated bike facility Located beyond back slope for rural cross sections Crossings and sidewalk connections provided to all bus stops (including on the side of street without shared pathway)	Boulevard sidewalk one side Located beyond back slope for rural cross sections
Transit Stops	Stops provided with amenities determined by Edmonton Transit (e.g., shelters, benches)	Stops provided with amenities determined by Edmonton Transit (e.g., shelters, benches)	Stops typically not provided on Local streets
Landscaping	Per landscaping standards	Per landscaping standards	Per landscaping standards
Utilities	All utilities underground	All utilities underground	All utilities underground

Notes:

1. Parking restrictions may be required for turning movements. Where unused, parking areas provide additional space for truck turning movements at accesses in industrial areas.

3.14. WILDLIFE PASSAGES

The two primary objectives of wildlife passages are:

1. To maintain habitat connectivity and reduce genetic isolation among Edmonton's wildlife populations so that these communities continue to fulfill their ecological, social and economic functions; and,

2. To aid in the reduction of human wildlife conflict and improving awareness, safety, and reducing collisions.

The design of any street must take into consideration potential wildlife passage requirements to reduce conflicts between street users and wildlife, and to improve wildlife habitat. Wherever feasible, the location of wildlife passages requiring curb drops should be coordinated and consolidated with adjacent marked crosswalks.

The City is currently updating the Wildlife Passage Engineering Design Guidelines, which will be made available on the City's website when complete.

SECTION 4.0: REFERENCES

References that provide guidance for the CSDCS are noted throughout the document within the text and as footnotes as and where relevant. In addition, the latest editions of the following documents are important supplementary references for designing Edmonton streets and transportation facilities:

- Access Management Guidelines (AMG), City of Edmonton
- Accessible Design for the Built Environment, CSA
- Bikeway Traffic Control Guidelines for Canada, TAC
- Canadian Guide to Neighbourhood Traffic Calming, TAC
- Canadian Roundabout Design Guide, TAC
- City Plan, City of Edmonton
- Design Manual for Bicycle Traffic, CROW,
- Design and Construction Standards, City of Edmonton
  - Volume 1: General
  - Volume 3: Drainage
  - Volume 4: Water
  - Volume 5: Landscaping
  - Volume 6: Street LIghting
  - Volume 7: Power
  - Volume 8: Pavement Marking
- Designing for All Ages & Abilities - Contextual Guidance for High-Comfort Bicycle Facilities, NACTO, 2017
- Geometric Design Guide for Canadian Roads, TAC
- Guide for the Design of Roadway Lighting, TAC
- Highway Geometric Design Guide, Alberta Transportation and Economic Corridors
- Manual for Uniform Traffic Control Devices for Canada (MUTCD-C), TAC
- Transit Oriented Development Guidelines, City of Edmonton
- Transportation System for the City of Edmonton Bylaw, City of Edmonton
- Winter Design Guidelines, City of Edmonton

SECTION 5.0: ABBREVIATIONS

AASHTO	American Association of State and Highway Transportation Officials
ARP	Area Redevelopment Plan
ASP	Area Structure Plan
Austroads	Association of Australian and New Zealand Road Transport and Traffic Authorities
BIA	Business Improvement Area
CGNTC	Canadian Guide for Neighbourhood Traffic Calming (TAC)
City	City of Edmonton
CSA	Canadian Standards Association
CSDCS	Complete Streets Design and Construction Standards (City of Edmonton)
DSD	Decision Sight Distance
FHWA	Federal Highway Administration
GDG	Geometric Design Guide for Canadian Roads (TAC)
h	Hour
ICD	Inscribed Circle Diameter
km	Kilometres
km/h	Kilometres per hour
LID	Low Impact Development
LRT	Light Rail Transit
m	Meters
mm	Millimeters
MTO	Ministry of Transportation Ontario
MUTCD-C	Manual of Uniform Traffic Control Devices for Canada (TAC)
N/A	Not Applicable
NACTO	National Association of City Transportation Officials
NCHRP	National Cooperative Highway Research Program
NSP	Neighbourhood Structure Plan
Province	Province of Alberta
PUL	Public Utility Lot
SSD	Stopping Sight Distance
SUP	shared pathway
SWMF	Stormwater Management Facility
TAC	Transportation Association of Canada
TOD	Transit Oriented Development
TWSI	Tactile Walking Surface Indicator
veh/day	Vehicles per Day
WDG	Winter Design Guidelines (City of Edmonton)

APPENDICES

APPENDIX A: COMPLETE STREETS PRINCIPLES

The Complete Streets Principles are listed below, along with several bullets providing additional guidance on how each of the Principles can improve the completeness of streets in Edmonton. These represent design ideas that are not mandatory, but help to illustrate what implementation of the Principles could look like.

A network of streets, transitways, and of-street pathways together accommodate all users and allow for efficient and high quality travel experiences. Implementation of this principle will generally improve completeness of streets by:

- Reflecting the character, scale and needs of the neighbourhood and surrounding area. That is, not all complete streets will look identical; some streets may need to accommodate all modes, while others may accommodate a more limited range of modes.
- Considering and evaluating the trade-offs between efficiency and quality of journey for each mode
- Including all streets: new streets and streets that require rehabilitation/renewal, repair/ maintenance, or operational review
- Including all streets in locations (residential, commercial / mixed use, industrial, and institutional) and for all functional types (freeways, arterials, collectors, locals, alleys)

The mobility system provides travel options for users of all ages and abilities that are safe, universally designed, context sensitive, and operable in all seasons (including winter). Implementation of this principle will generally improve completeness of streets by:

- Allowing safe travel by all modes (pedestrian, bicyclists, transit, goods movement, automobiles) to connect destinations (homes, community gathering places, businesses, shopping, schools, work places, parks, recreation, and transit)
- Supporting active lifestyles for people of all ages and abilities (including barrier-free, age-friendly, and universal design).
- Providing appropriate access for waste removal, emergency vehicles, trucks and snow and ice control equipment that recognizes the need to balance the many users of a road.
- Considering the maintenance and operational requirements in all seasons based on the context and users.

Streets are adaptable by accommodating the needs of the present and future. Implementation of this principle will generally improve completeness of streets by:

- Anticipating implementation over a period of time, based on a clear framework for street design elements that guides how and where to achieve the most progress
- Considering the appropriate amount of street right of way required today and in the future to support the adjacent communities
- Considering flexibility to incorporate innovative and progressive design features
- Providing places for basic elements in the street such as transit stop pads, utilities, fire hydrants, on-street parking, technology such as Intelligent Transportation Systems, and lighting.

Streets contribute to the environmental sustainability and resiliency of the city. Implementation of this principle will generally improve completeness of streets by:

- Encouraging and facilitating a shift towards sustainable modes of transportation
- Enabling reduced stormwater runoff, greenhouse gas emissions, other pollution, and energy consumption

Consider both direct and indirect costs, as well as the value of the public right of way and the adjacent real estate.
Implementation of this principle will generally improve completeness of streets by:

- Being cost effective to build, maintain and operate by considering the costs and trade-offs to taxpayers, developers, home buyers, the City, and utility companies.
- Being mindful of health, safety, collision, emission, and urban design costs
- Recognizing the appropriate cost of urban design elements and requirements for on-street parking will vary depending on the context.
- Supporting streets as destinations; for example, vibrant shopping areas
- Accommodating trucks in industrial areas and on key goods movement routes.

Streets are vibrant and attractive people places in all seasons to contribute to an improved quality of life.
Implementation of this principle will generally improve completeness of streets by:

- Creating spaces that encourage citizens to interact with each other and their surroundings in all seasons through provisions such as wider sidewalks in the appropriate context.
- Considering attractive urban design elements, public art, street trees, street furniture and decorative lighting while reducing visual clutter in the appropriate context.
- Contributing to a sense of personal security

APPENDIX B: SAMPLE DESIGN EXCEPTION FORM

The latest consolidated design exception form can be found here: https://docs.google.com/spreadsheets/d/1buRFww8LYYuogGAJs2wgXi2RIMsfepf6SzzMBy_ltuk/edit?usp=sharing

APPENDIX C: SUMMARY OF GEOMETRIC DESIGN STANDARDS

Classification	*Suggested Design speed (km/h)*	*Minimum centreline curve radii [1, 8]*	*Super elevation*	*Minimum horizontal curve lengths*	*Maximum gradient [2,6]*	*Minimum gradient [3,6]*	*Minimum tangent section lengths*	*Minimum Intersection spacing*
Local								
Residential Local	40	90 m	No	60 m	8%	0.6%	30 m	20 m[7]
Industrial Local	50	90 m	No	60 m	8%	0.6%	60 m	20 m[7]
Residential Service Road	40	90 m	No	60 m	8%	0.6%	30 m	20 m[7]
Industrial Service Road	50	90 m	No	60 m	8%	0.6%	30 m	20 m[7]
Collector								
Residential Collector (One Lane Each Direction)	40	120 m	No	60 m	8%	0.6%	60 m	60 m[7]
Residential Collector (Two or More Lanes Each Direction)	40	120 m [4]	Optional	60 m	8%	0.6%	60 m	60 m[7]
Industrial Collector	50	130 m [4]	Optional	60 m	8%	0.6%	60 m	60 m[7]
Arterial								
5-Lane Undivided Arterial	50 or 70	190 m [4]	Yes [5]	TAC GDG	6%	0.6%	TAC GDG	200 m
4-Lane Divided Arterial	50 or 70	190 m [4]	Yes [5]	TAC GDG	6%	0.6%	TAC GDG	200 m
6-Lane Divided Arterial	50 or 70	190 m [4]	Yes [5]	TAC GDG	6%	0.6%	TAC GDG	400 m
Walkways & Bikeways								
Walkways	N/A	N/A	N/A	N/A	5%	0.6%	N/A	N/A
Shared Pathways (or Bike Path)	30	24 m	N/A	N/A	5%	0.6%	N/A	N/A
Alleys								
Residential Alleys	N/A	N/A	N/A	N/A	10%	0.7%	N/A	N/A
Commercial Alleys	N/A	N/A	N/A	N/A	10%	0.7%	N/A	N/A
Rural Roads								
Rural Local or Collector	80	250 m	Yes[5]	TAC GDG	6%	N/A	TAC GDG	200 m
Temporary Roads								
Access/Detour Road	N/A	90 m	No	60 m	8%	N/A	30 m	N/A

See notes on next page.

Notes:

1. Larger curve radii should be used wherever possible

2. Dependent on topography and access locations may restrict sightlines accordingly.
   Wherever possible, maximum gradients should be kept to under 5% to provide accessibility to the widest range of street users.

3. Minimum gradient on curb radii < 20 m shall be 0.8%

4. Preferred curve radius is 500 m

5. For Superelevation, refer to ***Section 3.2.6.2***

6. Please see ***Section 3.2.7.1*** for details on target maximum gradients.

7. Minimum spacing applies to distance between alleys, local roads, and collector roads intersecting with the roadway being assessed. Refer to the City's Access Management Guidelines for minimum spacing requirements for principal or arterial roadways.

8. For undivided roadways, the centreline is defined as the painted yellow line which separates opposing directions of traffic or the centre of the parabolic crown on unpainted or one-way streets. For divided roadways, the centreline is defined as the centre of the median.

APPENDIX D: RIGHT TURN DESIGN MATRIX

Factors for Consideration	*Design Options*					*Additional Data*
	No-Island		*High Entry Angle (Aussie)*		*Low Entry Angle -free Flow*	
	No-Encroachment	*With Some Encroachment*	*No-Encroachment*	*With Some Encroachment*		
ROAD CHARACTERISTICS						
Upstream Conditions						
Far side bus stop	Yes	Possibly [1.5]	Yes	Possibly [1.5]	No	
Upstream Access	Yes	Yes	Possibly [1.5]	Possibly [1.5]	No	
Receiving Street Standard						
Freeway	No	No	No	No	Yes	
Arterial	Yes	Possibly [1.5]	Yes	Possibly [1.5]	Yes	
Collector	Yes	Yes	Yes	Yes	No	
TRAFFIC CHARACTERISTICS						
Right Turn/Cross Street Volume						
High/High (>300 per lane/>600 per Lane)	Possibly [3]	No	Possibly [4]	No	Yes	Turning movement counts
High/Low (>300 per lane/<600 per lane)	Yes	Possibly [1]	Yes	Possibly [1]	Possibly [6]	Turning movement counts
Low/High (<300 per lane/>600 per lane)	Yes	No	Yes	No	Possibly [6]	Turning movement counts
Low/Low (<300 per lane/<600 per lane)	Yes	Yes	Yes	Yes	Possibly [6]	Turning movement counts
Traffic Composition						
Designated Truck Route or High Volume of Turning Trucks (>20 turns in the peak hour)	Possibly [7]	No	Possibly [7]	No	Yes	Truck volumes
Low Volume of Turning Trucks (<20 turns in the peak Hour)	Possibly [7]	Possibly [1]	Possibly [7]	Possibly [1]	Yes	Truck volumes

Factors for Consideration	*Design Options*					*Additional Data*
	No-Island		*High Entry Angle (Aussie)*		*Low Entry Angle -free No- Flow*	
	No-Encroachment	*With Some Encroachment*	*No-Encroachment*	*With Some Encroachment*		
Impact on Traffic Signal Operation						
The increased crossing distance for people walking / wheeling results in Intersection capacity breakdown with 1.5M horizon volumes	Possibly [8]	Possibly [8]	Yes	Yes	Yes	1.5M Volumes, Signal data
The increased crossing distance for people walking/ wheeling does not have significant impact on intersection capacity with 1.5M horizon volumes	Yes	Yes	Yes	Yes	Yes	1.5M Volumes, Signal data
PEDESTRIAN/VULNERABLE ROAD USER CHARACTERISTICS						
Pedestrian Activity						
Low Crossing Volume (< 20 peds/peak hour on two crosswalks meeting at the corner considered)	Yes	Yes	Yes	Yes	Yes	Pedestrian Volumes
Moderate Crossing Volume (20-40 peds/ peak hour on two crosswalks meeting at the corner considered)	Possibly [8]	Possibly [8]	Yes	Yes	Possibly [10]	Pedestrian Volumes
High Crossing Volume (>40 peds/peak hour on two crosswalks meeting at the corner considered)	Yes	Yes	Yes	Yes	Possibly [10]	Pedestrian Volumes

Factors for Consideration	*Design Options*					*Additional Data*
	No-Island		*High Entry Angle (Aussie)*		*Low Entry Angle -free No- Flow*	
	No-Encroachment	*With Some Encroachment*	*No-Encroachment*	*With Some Encroachment*		
Land Uses near Intersection						
Schools, senior residences	Possibly [9]	Possibly [9]	Yes	Yes	Possibly [10]	
Shopping Centres, Commercial Stores	Yes	Yes	Yes	Yes	Possibly [10]	
Industrial (Low walking/ wheeling activity)	Yes	Possibly [5]	Yes	Possibly [5]	Yes	
Office	Yes	Yes	Yes	Yes	Possibly [10]	

Possibly [1] - If truck volumes are significantly low, some encroachment may be allowed

Possibly [2] - Complying with the City's access management policy

Possibly [3] - May need to consider dual right turn lanes; this may require banning right turn on red. Impact of these changes on overall signal operation and capacity should be considered.

Possibly [4] - May be possible with dual right turn lanes.

Possibly [5] - Depending on the cross street volumes, allowing some encroachment may be possible.

Possibly [6] - This option should only be considered if the other options are not feasible

Possibly [7] - No encroachment design may result in undesirably wide lanes that may encourage passenger cars to use the facility as if it had two lanes; to discourage this behavior, mountable curbs or other effective physical measures should always be used to delineate the desired path to a reasonable width at the merge point.

Possibly [8] - Increase crossing time may result in capacity breakdown

Possibly [9] - No Island design would increase the crossing distance for people walking and wheeling and thereby exposure to traffic. However, it results in lower speed for turning vehicles compared to other two design options. These conditions need to be taken into account when a decision is made to implement no-Island design.

Possibly [10] - Consider mitigating measures to improve safety for people walking and wheeling (e.g., moving crosswalk to the upstream half of the island to improve visibility and the location where vehicle speed is minimal).

APPENDIX E: SIDEWALK, WALKWAY, AND PATHWAY REQUIREMENTS

Facility	*Location*	*Monolithic or Separate*	*Material*	*Width*
Sidewalk	Local	Monolithic	Concrete	1.8 m
Sidewalk/Walkway	Local/Collector/Arterial or Walkway Lot	Separate	Concrete	1.8 m
Sidewalk	Adjacent to School Site	Monolithic	Concrete	2.5 m
Sidewalk	Arterial	Monolithic [1]	Concrete	2.3 m
Shared Pathway	Emergency Access, Utility Lot, Walkway Lot (10 m in width)	Separate	Asphalt	3.0 m
Shared Pathway	SWMF or Utility Lot (other than 10 m in width)	Separate	Asphalt	3.0 m
Shared Pathway	Arterial	Separate	Asphalt	3.0 m
Granular Walkway	Top of Bank & SWMF (where identified in NSP and NAMP)	N/A	N/A	1.8 m
Granular Walkway	TUC	N/A	N/A	3.0 m

Notes:

1. Monolithic sidewalks along arterial streets are permitted only as a last resort in constrained situations where no other measures are possible to construct a separate walk and require approval from the City.

APPENDIX F: LIST OF DESIGN TABLES

Table 3.1 *Design Domain for People Walking and Wheeling (in m)*

Parameter: Operating Envelope	Recommended Values	
	Horizontal Operating Envelope	Vertical Operating Envelope
Person Walking	0.75	2.10
Manual Wheelchair or Scooter	0.90	2.10
Person Walking with Child / Person Walking with Service Animal / Two People Walking / Two Wheelchair Users Passing	1.80	2.10

Table 3.2 *Design Domain for People Cycling (in m)*

Parameter: Operating Envelope	Recommended Values		
	Recommended Lower Limit	Recommende d Upper Limit	Targe t Value
Horizontal Operating Envelope	1.2	1.5	1.5
Lengthwise Operating Envelope	2.5	4.1	2.5
Vertical Operating Envelope	2.5	N/A	2.5

Table 3.3 *Design Vehicles by Context*

Street Classification	Design Vehicle	Control Vehicle [2]	Control Vehicle Allowable Encroachments
Car Free Streets & Shared Streets	Bicycle	FT	FT must manoeuvre within hard surfaced areas with 0.3 m clearance to hard surface edge and any obstacles.
Reverse Housing Lane	P	WT, FT	WT, FT must manoeuvre within hard surfaced areas with 0.5 m clearance to any property line.
Alley	P	WT	WT must manoeuvre within hard surfaced areas with 0.3 m clearance to pavement edge and any obstacles.
Local (Non-Industrial)	P	WT, FT, MSU	Manoeuvre within hard surfaced areas with 0.3 m clearance to pavement edge and any obstacles.
Collector (Non-Industrial)	COE Bus	WT, FT	Manoeuvre within hard surfaced areas with 0.3 m clearance to pavement edge and any obstacles.
Arterial[1] (Non-Truck Route[3] or Downtown[1] Truck Route[3])	COE Bus	WB-21	Encroachment into adjacent lanes in same direction at major intersections (opposing lanes at minor intersections)
Industrial Local	WB-21	WB-36	Encroachment into opposing lanes permitted at intersections (local/collector)
Industrial Collector	WB-21	WB-36	Encroachment into opposing lanes permitted at intersections (local/collector)
Arterial (Truck Route[3])	WB-21	WB-36	Encroachment into adjacent lanes in same direction permitted at major intersections (opposing lanes at minor intersections)
Freeways/Expressways	WB-21	WB-36	Encroachment into adjacent lanes in the same direction at ramp intersections only.

See Notes on Next Page.

Legend (Design, Control Vehicles):

P = Passenger Car;
MSU = Medium Single Unit Truck;
FT = City of Edmonton Fire Truck;
WT = City of Edmonton Waste Collection Truck;
COE Bus = City of Edmonton Modified Standard Single Unit Bus (Xcelsior Model);
WB-21 = Semi-Trailer (Alberta Transportation); and
WB-36 = Turnpike Double (Alberta Transportation).

Notes:

1. As defined in the Centre City - Downtown, Centre City - North Edge, Centre City - Wihkwentowin, 124 Street, and Centre City - Quarters areas of the Central District Plan.

2. A minimum 6.0 m clear width and 5.0 m clear height is required to accommodate FT operations. This must be provided where FT is a control vehicle and can be accommodated by including the width of opposing lanes, as well as parking lanes on local streets.

3. For Truck Routes refer to the latest City of Edmonton Truck Route Map.

4. For detailed information on swept path analysis requirements, refer to ***Section 3.6.2.2***.

5. Straight Face (SF) curbs are considered obstacles for all vehicle types. Semi-mountable (SM) and Rolled Face (RF) curbs may be mounted by FT vehicles for short distances. However, this does not apply to WT vehicles.

Table 3.4 *Design Domain for Design Speeds & Posted Speeds (in km/h)*

Contextual Street Classification (building relationship to the street, land use, and functional classification)	*Design Domain Recommended Range*		*City of Edmonton Target Value*	
	Recommended Lower Limit	*Recommended Upper Limit*	*Design Speed*	*Posted Speed*
Alleys, Reverse Housing Lanes, Shared Streets, Shared Alleys, and Car Free Street (all contexts)	5	20	20	20
Local Streets (all contexts except Industrial)	30	40	40	40
Local Industrial Streets	30	50	50	50
Collector Streets (except Industrial Areas) 40 km/h posted speed	30	50	40	40
Collector Streets (except Industrial Areas) 50 km/h posted speed[3]	40	50	50	50
Industrial Collector Streets	50	50	50	50
Downtown Core Roadways (all classifications)	40	40	40	40
Street Oriented Arterial Streets (all land use Contexts, except downtown)	40	50	50[1]	50
Non-Street Oriented Arterial Streets (all land use contexts, except downtown)	50	70	70	60
Freeways/Expressways	70	120	90+	80+

Notes:

1. Use 60 km/h Design Speed for horizontal alignment, vertical alignment, and intersection sightlines for street oriented arterial streets.

2. Where a road falls into more than one classification, the lowest recommended design and posted speed shall apply.

3. 50 km/h Collectors only apply to legacy collector roads and shall not be used in greenfield development

Table 3.5 *Design Domain for Design Speed of Pathways & Bikeways (in km/h)*

Parameter: Design Speed	*Design Domain Recommended Range*		City of Edmonton Target Value
	Recommended Lower Limit	*Recommended Upper Limit*	
Where: ✚ ***Pathways are shared with people walking, wheeling, and cycling*** ✚ ***Uneven pathways*** ✚ ***Pathways with low coefficients of friction or not concrete or asphalt surfaces*** ✚ ***Protected bike lanes or pathways with multiple conflict points and insufficient sightlines*** ✚ ***High usage by vulnerable users (e.g. schools, parks etc.)*** ✚ ***Geometric constraints***	10	30	20
Neighbourhood Route	20	40	20
District Connector Route	20	40	30[1]
Approaching Intersections	20	50	20[2]

Notes:

1. Where the downgrade exceeds 5% for more than 60 m, or strong tailwinds are likely due to prevailing wind conditions, design speed should be increased to ≥ 40 km/h. See ***Section 3.2.7.2*** and TAC GDG Chapter 5 for additional direction.
2. Careful consideration needs to be given to continuous crossings to provide safe crossings at a higher speeds for cyclists given limitations on sightlines. Where possible, a 30 km/h design speed should be targeted to support increased sight distances.

***Table 3.6A** Design Domain for Lane Widths (in m): Design Speed 50 km/h or Less*

Parameter: Lane Widths [1,2]	*Design Domain Recommended Range*		*City of Edmonton Target Value*
	Recommended Lower Limit	*Recommended Upper Limit*	
Standard Travel Curbside Lane (non-transit, non-truck route)[3]	3.25	3.75	3.25
Standard Travel Lane (non-transit, non-truck route)	3.00	3.50	3.00
Transit Route Curbside Lane	3.55	3.75	3.55
Transit Route Lane	3.30	3.50	3.30
Truck Route Curbside Lane	3.55	3.95	3.65
Truck Route Lane	3.30	3.70	3.40
Parking Lane	2.35	2.65	2.45[4]

Notes:

1. Dimensions are for through and turning lanes. Turning lanes are typically at the lower end of the recommended ranges as these movements are completed at lower Operating Speeds.

2. Dimensions are measured to face of curb for curbside lanes.

3. For local streets, local street bikeways, alleys, shared streets, and car free streets, a combined single drive lane with yield operation for both directions can be provided. This shared lane must be a minimum of 4.1 metres wide. For local streets, the minimum Travelled Way width shall be 8.0 m to accommodate required offsets for underground utilities and emergency response access, which may require parking restrictions. Where they already exist, service roads have a minimum Travelled Way width of 6.0 m due to the presence of an adjacent street. The designer must also consider the impacts of underground utilities, as well as winter design and operations when selecting Travelled Way widths.

4. Parking lanes for large trucks in industrial areas shall be 3.10 m to face of curb for collector and local roadways.

5. For local streets, local street bikeways, alleys, shared streets, and car free streets, a combined single drive lane with yield operation for both directions can be provided. For streets designated as local street bikeways, the shared lane must be a minimum of 4.1 metres wide. For local streets and shared streets, the desired shared lane should be 4.1 metres wide, which may be reduced to a minimum of 3.3 metres wide through an approved design exception. For local streets, the minimum Travelled Way width shall be 8.0 m to accommodate required offsets for underground utilities and emergency response access, which may require parking restrictions. Where they already exist, service roads have a minimum Travelled Way width of 6.0 m due to the presence of an adjacent street. The designer must also consider the impacts of underground utilities, as well as winter design and operations when selecting Travelled Way widths.

Table 3.6B *Design Domain for Lane Widths (in m): Design Speed Over 50 km/h*

Parameter: Lane Widths [1,2]	*Design Domain Recommended Range*		*City of Edmonton Target Value*
	Recommended Lower Limit	*Recommended Upper Limit*	
Standard Travel Curbside Lane (non-transit, non-truck route)[3]	3.55	3.95	3.75
Standard Travel Lane (non-transit, non-truck route)	3.30	3.70	3.50
Transit Route Curbside Lane	3.65	3.95	3.75
Transit Route Lane	3.40	3.70	3.50
Truck Route Curbside Lane	3.65	3.95	3.95
Truck Route Lane	3.40	3.70	3.70

Notes:

1. Dimensions are for through and turning lanes. Turning lanes are typically at the lower end of the recommended ranges as these movements are completed at lower Operating Speeds.
2. Dimensions are measured to face of curb for curbside lanes.

Table 3.7 *Framework for Consideration of Bike Facilities* omitted for conciseness. Refer to ***Section 3.2.3.1***.

Table 3.8 *Design Domain: Protected Bike Lanes (in m)*

Parameter	*Design Domain Recommended Range*		
	Lower Limit	*Upper Limit*	*Target*
Bike Lane Component[1]			
Unidirectional Bike Lane (District Connector)	2.1[2]	3.0	2.5
Unidirectional Bike Lane (Neighbourhood Route)	2.1[2]	2.5	2.1
Bidirectional Bike Lane (District Connector)	3.0	4.5	4.0
Bidirectional Bike Lane (Neighbourhood Route)	3.0	4.0	3.0
Buffer Component[3,4]			
Unidirectional Bike Lane Buffer Width, Bike to Street	0.6	5.0	1.5[5]
Bidirectional Bike Lane Buffer Width, Bike to Street	0.6	5.0	1.5[5]
Buffer Width, Bike to Walk	0.6[6]	N/A	1.0

Notes:

1. The width of the bike lane component is measured to/from the face of the curb and accommodates the horizontal operating envelope, horizontal offset to curbs, 0.25 m gutters, and considerations for all seasons maintenance. For gutters wider than 0.25 m, additional width is required due to the longitudinal hazard caused by the joint between the gutter and pavement.

2. The recommended minimum width of unidirectional protected bike lanes is based on the bike lane being located between two vertical curbs. If the bike lane is raised to sidewalk level, the minimum width can be 1.8 m for Neighbourhood Routes. In this situation, concrete must be used.

3. Where the posted speed exceeds 60 km/h, a separated bike path or shared pathway is preferred and the path should be located outside of the clear zone. If a bike lane is used, an appropriate roadside barrier is required.

4. Wider buffers are preferred when practical within available right of way.

5. The width of the street buffer for protected bike lanes should also consider the intersection and driveway crossing offset requirements from the parallel traffic lane. The recommended crossing offsets from the parallel travel lane for unidirectional protected bike lanes are 2 to 5 m. The recommended offset for a bidirectional protected bike lane is 5 m. The protected bike lane should bend-out prior to intersections and crossings. See ***Section 3.6.5.1*** for additional guidance on intersection design for protected bike lanes.

6. The minimum width of the sidewalk buffer at 0.6 m accommodates installation of signage.

Table 3.9 *Design Domain: Shared Pathways and Bike Paths (in m)*

Parameter	*Design Domain Recommended Range[1]*		*Target*
	Lower Limit	*Upper Limit*	
Path Component[1]			
Unidirectional Bike Path (District Connector)	2.1	3.0	2.5
Unidirectional Bike Path (Neighbourhood Route)	1.8	2.5	2.1
Bidirectional Bike Path (District Connector)	3.0	4.5	4.0
Bidirectional Bike Path (Neighbourhood Route)	3.0	4.0	3.0
Shared Pathway (District Connector)	3.0[2]	6.0	3.0
Shared Pathway (Neighbourhood Route)	3.0[2]	4.0	3.0
Buffer Component[3,4]			
Buffer Width, Bike to Street	0.6	N/A	1.5[4]
Buffer Width, Bike to Walk	0.3	N/A	1.0

Notes:

1. Widths measured from edge of path to edge of path. If paths are located adjacent to a curb (i.e., curbline or monolithic path), an additional minimum 0.6 m width is required.
2. The Design Domain for shared pathway recommended lower limit along an Industrial Local Street can be 2.5 m if the path is not a District Connector Route within the larger bicycle network at the discretion of the City.
3. Wider buffers are preferred when practical within available right of way and, when parallel to higher speed streets where posted speeds exceed 60 km/h, the pathways should be located outside the clear zone.
4. The width of the street buffer for bike paths and shared pathways should consider intersection and driveway crossing offset requirements from the parallel traffic lane. The recommended offsets from the parallel travel lane for unidirectional bike paths are 2 to 5 m, while the offset for shared pathways and bidirectional bike paths is 5 m. This dimension can be used continuously along the corridor, or a bend-out design can be used at intersections and crossings. See ***Section 3.6.6*** for additional guidance on intersection design for pathways.

Table 3.10 *Design Domain: Painted Unidirectional Bike Lanes (in m)*

Parameter	*Design Domain Recommended Range*		
	Lower Limit	*Upper Limit*	*Target*
Bike Lane Component[1]			
Unidirectional Bike Lane (District Connector)	1.8	2.5	2.1
Unidirectional Bike Lane (Neighbourhood Route)	1.8	2.1	1.8
Buffer Component[2]			
Buffer Width, Bike/Street	0.3	N/A	0.9

Notes:

1. The width of the bike lane component is measured from face of curb and accommodates the horizontal operating envelope, horizontal offset to curbs, 0.25 m gutters, and considerations for all seasons maintenance. For gutters wider than 0.25 m, additional width is required due to the longitudinal hazard caused by the joint between the gutter and pavement.

Table 3.11 *Design Domain: Median Widths (in m)*

Parameter: Median Width	*Design Domain Recommended Range*[1]	
	Recommended Lower Limit	*Recommended Upper Limit*
Freeway Median, Depressed	13.0	30.0
Freeway Median, Raised	5.5	N/A
Non-Freeway, No Left Turn Bay[1]	1.2[2,3]	N/A
Non-Freeway, With Left Turn Bay[1]	4.5	N/A
Non-Freeway, Walking/ Cycling Refuge[1]	3.6[3]	N/A

Notes:

1. Non-freeway median widths are measured from face of curb to face of curb.

2. Minimum median width of 1.8 m is required for a raised landscaped median. Median widths under 1.8 m shall be hard surfaced.

3. Walking/Wheeling/Cycling Refuge areas should have a target width of 4.1 m and an absolute minimum width of 2.5 m. The minimum area of the refuge shall be 10 m^2 to provide sufficient room for all users. Median refuge areas should include a median tip when a street crossing of more than 2 lanes per direction is required and the crosswalk/crossride passes through the median at street level.

***Table 3.12A** Minimum Radii for Paved Bikeways (Source: TAC GDG Table 5.5.2)*

Design Speed (km/h)	Coefficient of Lateral Friction	Minimum Radius for Design (m)	
		e = 0.02 m/m	e = 0.05 m/m
20	0.30	10	9
25	0.30	15	14
30	0.28	24	21
35	0.27	33	30
40	0.25	47	42
45	0.23	64	57
50	0.22	82	73

***Table 3.12B** Design Domain: Recommended Minimum Radii for Paved Bikeways (in m)*

Network Context	Minimum Centreline Radius (m)
Protected Bike Lane	20
Shared Pathway	15
Major Intersection Approach	10
Minor Intersection Approach or Driveway	6

***Table 3.12C** Design Domain: Bikeway Tapers*

Parameter: Bikeway Tapers	Design Domain Recommended Range		Target
	Recommended Lower Limit	Recommended Upper Limit	
Taper[1]	5:1	12:1	10:1-12:1
Degrees[2]	11.31°	4.76°	5.71°-4.76°

Notes:

1. The absolute minimum taper is 3:1 and should only be used where slowing people cycling is required for traffic calming or in very constrained situations.
2. The absolute minimum is 18.43°.

***Table 3.13** Design Domain: Gradients (in %)*

Parameter: Gradient	Design Domain Recommended Range		Target Value [3]
	Lower Limit	Upper Limit	
Local & Collector	0.6%	8.0%[1]	6.0%
Arterial	0.6%	6.0%[1]	4.0%
Freeway / Expressway	0.6%	5.0%[2]	4.0%

Notes:

1. Maximum grades of up to 12% may be utilized in exceptional circumstances where necessary due to Topography.
2. Higher maximum grades may be necessary in exceptional circumstances due to topography. Design consideration should be given to truck deceleration/ acceleration where grades in excess of 5.0% are used on high speed roads.
3. Maximum grades of 4.0% are recommended for Arterials and other major transportation facilities that are planned to include significant transit and/or goods movement, wherever feasible.

***Table 3.14** Design Domain: Cycle and Walking Gradients (in %)*

Parameter: Gradient	Design Domain Recommended Range	
	Recommended Lower Limit	Recommended Upper Limit
Dedicated Cycle Facility	0.6%[1]	6.0%
Walking and Wheeling Facility (Sidewalk, Walking Trail)	0.6%[1]	5.0%[2]
Shared Pathway	0.6%[1]	5.0%[2]

Notes:

1. Minimum gradient may be reduced to 0.0% provided adequate cross fall and lateral slope is provided. Care should be given in designs where slopes are reduced. The recommended lower limit is also the target value for the City of Edmonton.
2. Maximum 8% slope is permissible for walkways located adjacent to Storm Water Management Facilities

(SWMF).

Table 3.15 *Grade Impacts for People Cycling*

Grade	Impacts
< 4%	✚ Ideal grade for cycling ✚ Uphill speed is 10 km/h ✚ Downhill coasting speeds can reach 25 km/h
4% - 6%	✚ Downhill coasting speeds can reach 40 km/h ✚ Desirable to have a relatively flat area (3% or less) every 100 m to allow people cycling to rest for uphill
6% - 8%	✚ Not recommended ✚ Considered steep ✚ Should be paved ✚ Will reduce uphill speeds ✚ Downhill coasting speeds can reach 60 km/h ✚ Higher design speeds should be used ✚ Warning signs should be posted

Table 3.16 *Design Domain: Roadway Cross Falls*

Roadway	Crown Height	Effective Cross Fall	Equation
8.0m Local	110mm*	3.0%	$y = 0.007822x^2$
9.0m Local	130mm*	3.0%	$y = 0.007197x^2$
11.5m Collector	150mm*	2.5%	$y = 0.004959x^2$
14.5m Collector	180mm*	2.5%	$y = 0.003673x^2$
All Other Urban		2.5%	n/a
Hard Surfaced Rural		2.5%	n/a
Gravel Surfaced Rural		3.0%	

Notes:

* Measured from lip of gutter

"x" is measured relative to the centreline of the roadway crown

"y" is the corresponding drop relative to roadway crown

Table 3.17 *Design Domain: Curbside Zone (in m)*

Parameter	Recommended Lower Limit	Recommended Upper Limit
Width*, Curbside Zone	2.1	2.5

* Measured from face of curb.

Table 3.18 *Design Domain: Furnishing Zone (in m)*

Parameter	Recommended Lower Limit	Recommended Upper Limit
Width*, Furnishing Zone	1.7	5.0

* Measured from face of curb.

Table 3.19: Design Domain: Pedestrian Through Zone (in m)

Parameter: Width, Pedestrian Through Zone		*Recommended Lower Limit*
Local Street	Monolithic or separated sidewalk	1.8[1]
Industrial Local Street	Monolithic sidewalk	2.3
	Separated sidewalk	1.8
School Zone	Monolithic sidewalk	2.5
Collector Street	Monolithic sidewalk	2.3[4]
	Separated sidewalk	1.8[1]
	Sidewalks with or anticipated higher use	2.25[5]
Industrial Collector Street	Monolithic sidewalk	2.3[4]
	Separated sidewalk	1.8
Street Oriented Arterial Street[3]	Separated sidewalk[2]	2.5
Non-Street Oriented Arterial Street[3]	Separated sidewalk	1.8
	Sidewalks with higher use	2.25[5]
Primary or Secondary Corridor/High Activity Area[3]	Separated sidewalk	3.0

Notes:

1. In constrained retrofit locations, the minimum width of the Pedestrian Through Zone can be reduced to 1.6 m measured from face of curb to back of sidewalk for monolithic sidewalk or edge to edge for separated sidewalks.
2. Monolithic sidewalks are not recommended along arterial streets. Where monolithic sidewalks cannot be avoided due to site constraints at the discretion of the City, the sidewalk width must be increased by a minimum of 0.5 metres.
3. The use of sidewalks along arterial streets will require alternate bicycle accommodation where shared pathways are not currently being provided.
4. Monolithic sidewalks along Collector or Industrial Collector Streets are not recommended; however, in retrofit locations, reconstruction or replacement of existing monolithic sidewalks may be required and the dimension noted should be used as the minimum width of the Pedestrian Through Zone.
5. Areas with more walking and wheeling activity require wider minimum sidewalk widths to provide sufficient space for users of all ages and abilities to comfortably use the space. Areas that are or will be along recreational running or walking routes and locations with street oriented commercial uses are examples of locations requiring sidewalks with larger minimum widths. See ***Section 3.2.3.2*** for user volume considerations when separating shared pathways into a separate sidewalk and bicycle facility.

***Table 3.20** Design Domain: Frontage Zone (in m)*

Parameter	Recommended Lower Limit	Recommended Upper Limit
Width, Frontage Zone	0.3[1]	4.5

Note:

1. Frontage zone may be reduced to 0.0 metres where there is constrained right of way, at the discretion of the City.

***Table 3.21** Roadside Accommodation for People Walking, Wheeling, and Cycling on Streets in Cross Sections (i.e., Non-Urban Areas)*

Speed Limit	Walking/Wheeling & Cycling Facilities
≥ 60 km/h	Off-street bicycle facilities such as shared pathways or bike lanes located outside the clear zone and on the backslope side of the drainage channel
40 km/h to < 60 km/h	Off-street bicycle facilities such as shared pathways or bike lanes located off the Travelled Way
< 40 km/h	Sidewalks off the Travelled Way and on-street bicycle facilities.

***Table 3.22** Sidewalk/Walkway/Shared Pathway/Trail Grading Requirements*

Maximum Slope	Maximum Length	Maximum Height	Landings
≤2%	None	None	Not required
>2% to ≤5%	None	None	Note 1
>5% to ≤6.25%	12 m	750 mm	Every 12 m
>6.25% to ≤8.30%	9 m	750 mm	Every 9 m
>8.30% to ≤10%	1.5 m	150 mm	Note 2

Notes:

1. Landings at 750 mm elevation difference are desirable.

2. It is recognized that the gradient and building layout on some streets may make the provision of landings impractical.

3. Maximum 8% slope is permissible for walkways located adjacent to Storm Water Management Facilities (SWMF).

***Table 3.23A** Stopping Sight Distance for Passenger Cars*

Design Speed (km/h)	*Stopping Sight Distance by Grade (m)*						
	-9%	*-6%*	*-3%*	*0*	*3%*	*6%*	*9%*
20	20	20	20	20	19	18	18
30	35	35	32	32	31	30	29
40	53	50	50	50	45	44	43
50	74	70	66	65	61	59	58
60	97	92	87	85	80	77	75
70	124	116	110	105	100	97	93
80	154	144	136	130	123	118	114

(Adapted from TAC GDG Tables 2.5.2 and 2.5.3, for brake reaction time of 2.5 s, deceleration rate of 3.4 m/s2, and a passenger car. NOTE: SSD for trucks are longer than those provided below and should be calculated based on guidance from TAC GDG Section 2.5.3.)

***Table 3.23B** Stopping Sight Distance for Bicycles*

Design Speed (km/h)	*Stopping Sight Distance by Grade (m)*						
	-8%	*-6%*	*-4%*	*0*	*4%*	*6%*	*8%*
20	23	22	21	20	19	19	19
30	42	39	38	35	33	32	32

(Adapted from TAC GDG Tables 5.5.1 for a bicycle with paved surface, wet conditions, coefficient of friction of 0.25, and perception-reaction time of 2.5 s.)

***Table 3.24** Minimum Sightline Distance for Approach Clear Sight Triangle*

Design Speed (km/h)	Minimum Sightline Distance, b (m)	Minimum Stopping Sight Distance, a1 (m)
≤ 20	45	20
30	70	35
40	90	50
50	115	65
60	135	85
70	160	105
80	180	130

(Adapted from TAC GDG Table 9.9.10, for intersection approach grades ≤ 3% based on passenger car making a left or right turn at a yield-controlled intersection)

***Table 3.25** Minimum Sightline Distance for Departure Clear Sight Triangle*

Design Speed (km/h)	Minimum Sightline Distance, b (m)
20	45
30	65
40	85
50	105
60	130
70	150
80	170

(Adapted from TAC GDG Table 9.9.4, for intersection approach grades ≤ 3% and based on passenger car)

***Table 3.26** Sightline Distance for Two Off-Street Facilities*

Facility Design Speed (km/h)	Minimum Sightline Distance, b (m)
20	20
30	35

***Table 3.27** Sightline Distance for Vehicle Priority Crossings*

Roadway Design Speed (km/h)	Road Crossing (approximate distance)	Minimum Sightline Distance, b (m)
30	Single Lane (3-4 m) Two Lanes (6-8 m) Local Street (9.0 m) Collector with Parking (10-14 m)	45 55 60 70
40	Single Lane (3-4 m) Two Lanes (6-8 m) Local Street (9.0 m) Collector with Parking (10-14 m)	75 90 95 105
50	Single Lane (3-4 m) Two Lanes (6-8 m) Local Street (9.0 m) Collector with Parking (10-14 m)	105 120 130 140

***Table 3.28** Sightline Distance for Cyclist Priority Crossings*

Width of Cycling Facility to be Crossed (m)	Intersection Sight Distance, b (m) At Bicycle Approach Speed	
	20 km/h	30 km/h
2	25	37
3	26	39
4	28	41

***Table 3.29** Vehicle Turning Speeds*

Vehicle Type	Turning Speed (km/h)
Passenger Vehicle	5 - 10
Large Trucks (WB-21, WB-36)	5
Fire Truck	10 - 15
Transit Bus	10 - 15
All Other Design Vehicles	5 - 10
All Other Design Vehicles	5 - 10

Note:

1. Lower vehicle speeds may be used for constrained conditions at the discretion of the City.

Table 3.30 *Permissible Encroachments by Approach and Receiving Street Type*

Approach Street / Receiving Street	*Design Vehicle*	*Allowable Encroachment*		*Control Vehicle*	*Allowable Encroachment*	
		Approach	*Receiving*[1]		*Approach*	*Receiving*[1]
Arterial Truck Route / Arterial Truck Route	WB-21	None	Two receiving lanes	WB-36	Adjacent lane	All receiving lanes in same direction, mountable aprons
Arterial Truck Route / Arterial Non-Truck Route	COE Bus	None	Two receiving lanes	WB-21	Adjacent lane	All receiving lanes in same direction, mountable aprons
Arterial Truck Route / Collector	COE Bus	None	Two receiving lanes	WT, FT	Adjacent lane	All receiving lanes in same direction, mountable aprons
Arterial Non-Truck Route / Arterial Truck Route	COE Bus	None	Two receiving lanes	WB-21	Adjacent lane	All receiving lanes in same direction, mountable aprons
Arterial Non-Truck Route / Arterial Non-Truck Route	COE Bus	None	Two receiving lanes	WB-21	Adjacent lane	All receiving lanes in same direction, mountable aprons
Arterial Non-Truck Route / Collector	COE Bus	None	Up to two receiving lanes	WT, FT	None	All receiving lanes in same direction, mountable aprons
Collector / Arterial Truck Route	COE Bus	None	Up to two receiving lanes	WT, FT	None	All receiving lanes in same direction, mountable aprons
Collector / Arterial Non-Truck Route	COE Bus	None	Up to two receiving lanes	WT, FT	None	All receiving lanes in same direction, mountable aprons
Collector / Collector	COE Bus	None	Up to two receiving lanes	WT, FT	None	All receiving lanes in same direction, mountable aprons
Arterial / Local	P	None	N/A[2]	WT, FT, MSU	None	Full width of roadway, mountable aprons
Local / Arterial	P	N/A[2]	None	WT, FT, MSU	Full width of roadway	All receiving lanes in same direction, mountable aprons
Collector / Local	P	None	N/A[2]	WT, FT, MSU	All departing lanes in same direction	Full width of roadway, mountable aprons
Local / Collector	P	N/A[2]	None	WT, FT, MSU	Full width of roadway	Up to 3 m beyond centreline
Local / Local	P	N/A[2]	N/A[2]	WT, FT, MSU	Full width of roadway	Full width of roadway

Note:

1. Encroachment into receiving lanes is permitted for the same direction of travel only.
2. N/A identifies local streets where shared two- way operations are expected and permitted.

Table 3.31 *Design Domain: Intersection Corner Radii (in m)*

Parameter: Intersection Corner Radii (Departing Street/Receiving Street)	*Design Vehicle*	*Control Vehicle*	*Design Domain Recommended Range*[1]		*Design Target Value*[2,4]
			Recommended Lower Limit	*Recommended Upper Limit*	
Arterial Truck Route/Arterial Truck Route[3]	WB-21	WB-36	Use High Entry Angle channelized right turn design		
Arterial Truck Route/Arterial Non-Truck Route[3,5]	COE Bus	WB-21	7.5	15.0	12.0
Arterial Truck Route/Collector	COE Bus	WT, FT	10.0	15.0	10.0
Arterial Non-Truck Route/Arterial Truck Route[3,5]	COE Bus	WB-21	7.5	15.0	12.0
Arterial Non-Truck Route/Arterial Non-Truck Route[3,5]	COE Bus	WB-21	7.5	15.0	8.0
Arterial Non-Truck Route/Collector	COE Bus	WT, FT	10.0	15.0	10.0
Collector/Arterial Truck Route[3]	COE Bus	WT, FT	7.5	12.5	8.0
Collector/Arterial Non-Truck Route[3]	COE Bus	WT, FT	6.5	12.5	7.0
Collector/Collector	COE Bus	WT, FT	7.5	12.5	8.0
Primary or Secondary Corridor/Any Street,[6, 7] ***OR Any Street/Primary or Secondary Corridor***	MSU	COE Bus	4.5	12.5	6.0
Local/Any Street OR Any Street/Local	P	WT, FT, MSU	4.0	9.0	5.0

Notes:

1. Designers should use corner radii toward the lower end of the Design Domain if the design target value is not used, however, turning manoeuvres must be confirmed using swept path analysis for the Design and Control Vehicle

2. Target value is based on typical street cross sections as shown in the Standard Details. Swept path analysis is required to confirm corner radius based on the Design Principles. Where a corner is utilized by a bus, and the total width of the receiving lanes is less than 6.0 m (in the same direction), a two centred R9 + R70 curve shall be used.

3. All arterial street receiving lane scenarios are based on two receiving lanes along the arterial street and a median. If more than two lanes are provided, a corner radius lower than the Design Domain recommended lower limit is possible, but must be confirmed using swept path analysis. For first stage arterials where only a single receiving lane is provided, the simple radius may not be applicable, a compound curve radius, channelization, stop box, or additional receiving lanes may be required to accommodate turning movements.

4. When along a Primary or Secondary Corridor, or inside a Major or District Node or Pedestrian Priority Area, review simple or multi-centred radius curves with the objective to minimize crossing distances for people walking.

5. Where there is a raised or depressed centre median, a simple radius may not accommodate the Control Vehicle. Complete swept path analysis to confirm vehicle turning movements. The use of a High Entry Angle channelized right turn may be required.

6. A COE Bus design vehicle should be utilized where bus movements are expected and may require adjustment to curb radii depending on the number of receiving lanes.

7. Where the receiving street has a single lane and encroachment into oncoming lanes is not desirable for the MSU design vehicle, a R7.5 + R50 two-centred curve may be used.

Table 3.32 *Design Domain: Intersection Corner Radii – Industrial Areas (in m)*

Parameter: Intersection Corner Radii (Departing Street/Receiving Street)[1]	*Design Vehicle*	*Control Vehicle*	*Design Domain Recommended Range[2]*		*Design Target Value[3]*
			Recommended Lower Limit	*Recommended Upper Limit*	
Arterial Truck Route/Industrial Area Collector	WB-21	WB-36	Use High Entry Angle channelized right turn design		
Arterial Truck Route/Industrial Area Local	WB-21	WB-36	Use High Entry Angle channelized right turn design		
Industrial Area Collector/Arterial Truck Route[4]	WB-21	WB-36	Use High Entry Angle channelized right turn design		
Industrial Area Collector/Industrial Area Collector	WB-21	WB-36	11.5	15.0	13.0
Industrial Area Collector/Industrial Area Local	WB-21	WB-36	14.0	15.0	15.0
Industrial Area Local/Arterial Truck Route[4]	WB-21	WB-36	Use High Entry Angle channelized right turn design		
Industrial Area Local/Industrial Area Collector	WB-21	WB-36	12.5	15.0	13.0
Industrial Area Local/Industrial Area Local	WB-21	WB-36	15.0	15.0	15.0

Notes:

1. Arterial street/arterial street intersection Design Domain is provided in ***Table 3.27***.

2. Designers should use corner radii toward the lower end of the Design Domain if the design target value is not used, however, turning manoeuvres must be confirmed using swept path analysis for the Design and Control Vehicle.

3. Target value is based on typical street cross sections as shown in the Standard Details. Swept path analysis is required to confirm corner radius based on the Design Principles.

4. All arterial street receiving lane scenarios based on two receiving lanes along the arterial street and a median. If more than two lanes are provided, a corner radius lower than the Design Domain recommended lower limit is possible, but must be confirmed using swept path analysis.

Table 3.33 *Curb Ramp Design Requirements*[1]

Design Criteria		Design Requirement
Approach/ Sidewalk	Cross Grade	≤ 2%
	Longitudinal Grade	≤ 5%
Curb ramp	Provision	At every corner and mid-block crossing
	Grade	≤ 6.0%; maximum grade of 1:12 (8.33%)
	Curb Ramp Flare	400 mm (separated sidewalk)/1700 mm (monowalk/plaza) - See detail 5510.
	Width (exclusive of flared sides)	1.8 m min.; should match sidewalk width up to 3.0m
	Length	Based on grade
	Tactile Device	**Tool Grooved Concrete** Tool Grooved Concrete at minimum at each curb ramp along or crossings all freeway/expressway, arterial, and collector, and local streets and off-street shared pathways (e.g., paths along utility corridors) crossings with these street classifications. **Tactile Attention Indicators (i.e., Truncated Domes)** Truncated domes shall be utilized at locations with high pedestrian volumes, including pedestrian priority areas and street oriented developments, as well as at schools, transit centres, libraries, and recreation centres. If using truncated domes with mid-block crossings, guidance should also be provided to direct users to the crossing, a physical element perpendicular should also be considered. Example details 5520, 5521, 5522, 5523, 5524, 5530 and 5531 provide guidance around the use of truncated domes for curb ramps. 5530 and 5531 provide pilot examples of directionality using truncated domes and detectable guidance surface indicators.
Landing	Width	Match curb ramp
	Length	1.8 m min. and up to 2.25 m to accommodate most wheelchair types

[1] Based on:Transportation Association of Canada (TAC). 2017. Geometric Design Guide for Canadian Roads . Ottawa: Transportation Association of Canada; Canadian Standards Association (CSA), 2023. Accessible Design for the Built Environment. Mississauga: CSA Group, formerly Canadian Standards Association.

Table 3.34 *Design Domain: Raised Crosswalks and Intersections - Ramp Length and Grade Break for Vehicles*

Parameter:	Design Domain Recommended Range[1]		
	Lower Limit	Upper Limit	Target[2]
Ramp Length (m)	1.75	2.75	1.75
Grade Break	4.0%	7.5%	6.25%

Notes:

1. On frequent transit routes or where high volumes of truck traffic are present, a 5.75% grade break is recommended with a maximum grade break of 6.25%.

2. Target design speed is 40 km/h. If a higher design speed is selected, increasing the ramp length and/or reducing the grade break is required.

Table 3.35 *Design Domain: Continuous Crossings - Ramp Length and Grade Break for Vehicles*

Parameter:	Design Domain Recommended Range		
	Lower Limit	Upper Limit	Target[1]
Ramp Length (m)	0.8	1.0	0.8
Grade Break	10%	16.5%	12.5%

Notes:

1. Target design speed is 5 km/h, which is consistent with a stop or yield control. If a higher design speed is selected, increasing the ramp length and/or reducing the grade break is required.

Table 3.36 *Roundabout Category Comparison*

Design Element	*Mini-Roundabout*	*Single-Lane Roundabout*	*Multi-lane Roundabout*
Appropriate Fastest Path Entry Speeds[1]	NA	30-50 km/h	45-70 km/h
Typical Free-Flow Vehicle Speeds[2]	15-25 km/h	20-30 km/h	25-35 km/h
Typical inscribed circle diameter	20 - 30 m	30 - 50 m	45 - 70 m
Central island treatment	Semi-mountable	Non-mountable (but usually includes truck apron)	Non-Mountable (but may include maintenance apron)
Splitter Islands	Painted, mountable	Non-mountable, min. 2.0 m wide at pedestrian crossing	Non-mountable, min. 2.0 m wide at pedestrian crossing
Design Vehicle(s) Accommodated	WB-19 off-tracking over the splitter islands and central island Transit bus (if on bus route) avoiding the splitter islands and central island	WB-19 off-tracking over the central island truck apron, and transit bus avoiding the truck apron	WB-21, typically by off-tracking into the adjacent lane as it enters, circulates and exits
Typical daily service volumes on 4-leg roundabout (veh/day)	Up to approximately 15,000 vpd	Up to approximately 25,000 vpd	Up to approximately 45,000 vpd
Closest Access (Right-in/Right-out), Measured From Edge of Circulatory Roadway (Arterials and Collectors)	80 m	80 m	80 m
Closest Access (Right-in/Right-out), Measured From Edge of Circulatory Roadway (Locals)	15 m	25 m	N/A

[1]A fastest-path speed is a theoretical attainable or “worst-case” speed and is used in the roundabout design process as a proxy for yield potential. It assumes no other traffic in the roundabout and that a driver will ignore all pavement markings (including lane lines in a multi-lane roundabout).

[2]A typical speed is an estimate of average vehicle speed through the roundabout and includes left and right turns.

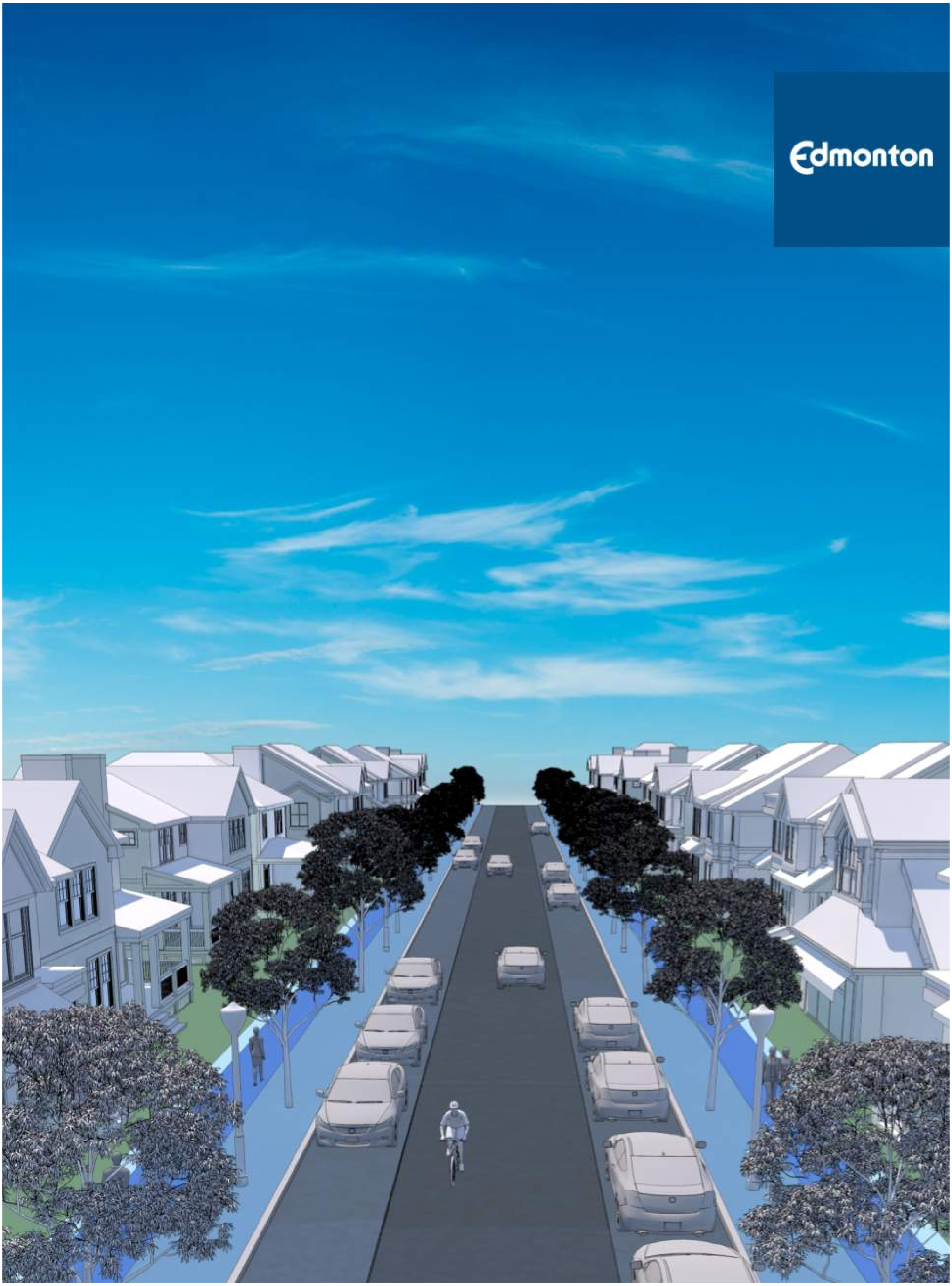
Table 3.37 (A/B/C/D/E) *Traffic Calming Benefits and Disbenefits* omitted for conciseness. Refer to ***Section 3.8.5***.

Table 3.38: *Industrial Area Street Design Requirements*

Cross Section Element	*Industrial Arterial*	*Industrial Collector*	*Industrial Local*
Shoulder	Yes - for rural and hybrid cross sections	Yes - for rural cross sections	Yes - for rural cross sections
Travelled Way & Intersection Geometry	Based on Design Vehicle (***Section 3.1.3***)	Based on Design Vehicle (***Section 3.1.3***)	Based on Design Vehicle (***Section 3.1.3***)
On-street Parking	No	Yes - for urban cross sections[1] No - for rural cross sections	Yes - for urban cross sections[1] No - for rural cross sections
Active Transportation Infrastructure	Shared pathway both sides Located beyond back slope for rural and hybrid cross sections Crossings and sidewalk connections provided to all bus stops	Shared pathway one side or separated bike facility Located beyond back slope for rural cross sections Crossings and sidewalk connections provided to all bus stops (including on the side of street without shared pathway)	Boulevard sidewalk one side Located beyond back slope for rural cross sections
Transit Stops	Stops provided with amenities determined by Edmonton Transit (e.g., shelters, benches)	Stops provided with amenities determined by Edmonton Transit (e.g., shelters, benches)	Stops typically not provided on Local streets
Landscaping	Per landscaping standards	Per landscaping standards	Per landscaping standards
Utilities	All utilities underground	All utilities underground	All utilities underground

Notes:

1. Parking restrictions may be required for turning movements. Where unused, parking areas provide additional space for truck turning movements at accesses in industrial areas.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