LET'S CONNECT

ACTIVE TRANSPORTATION MASTER PLAN

City of Brampton

DESIGN COMPENDIUM

JULY 2019

Prepared by IBI Group

Table of Contents

List of Exhibits

This page is intentionally left blank.

1

Design
Users and Safety

1.1 INTRODUCTION

The provision of safe, high quality and connected active transportation infrastructure is essential to encourage the use of active modes and to build sustainable and livable communities. This design compendium identifies recommended practices for the design of active transportation facilities and provides examples of emerging design practices.

The compendium is not intended to be a comprehensive design standard, instead providing reference materials and examples to draw on.

1.2 THE IMPACT OF SPEED ON VULNERABLE ROAD USER SAFETY AND COMFORT

Roadway design speeds and subsequent vehicular operating speeds have a significant impact on driver perception and reaction, driver behaviour, and overall safety of vulnerable road users.

At higher operating speeds, a driver's field of view tends to narrow, which reduces their ability to detect pedestrians entering the roadway (refer to Exhibit 1.1).

The operating speed of a motorist also has a significant affect on collision severity when it comes to pedestrians and people on bikes. When traveling above 50 km/h, the probability of a motor vehicle collision with a pedestrian or cyclists resulting in a fatality is more than 80%, and even higher for older adults. The probability of a fatality does not drop below 10% until impact speeds of 30 km/h or lower are reached.

Exhibit 1.1: Driver field of vision at various operating speeds

Operating Speed15-25 km/h

Operating Speed 30-40 km/h

Operating Speed 50-55 km/h

Operating Speed >65 km/h

Source: NACTO Urban Street Design Guide

1.2.1 Design Speed

According to the TAC Geometric Design Guide, the design speed of a particular roadway is "a speed selected as the basis to establish appropriate geometric design elements for a particular section of road." As a result, the design speed is one of the most critical elements related to safety, as it influences every aspect of corridor design such as corner radii, lane widths, parking accommodation, and the clear zone.

Traditionally, designers attempted to improve safety for drivers by providing roadways that were more forgiving. This meant using a design speed higher than operating and posted speeds. However, as the understanding of safety has evolved to consider the implications of higher speeds in urban areas, designers are encouraged to **"design streets using target speed, the speed you intend for drivers to go, rather than operating speed."** (NACTO Urban Streets Design Guideline).

Exhibit 1.2: Design speed relationship with operating, target and posted speed

Conventional Highway Design:

Design Speed > Operating Speed > Posted Speed

Proactive Urban Street Design:

Target Speed = Design Speed = Posted Speed

Source: NACTO Urban Street Design Guide

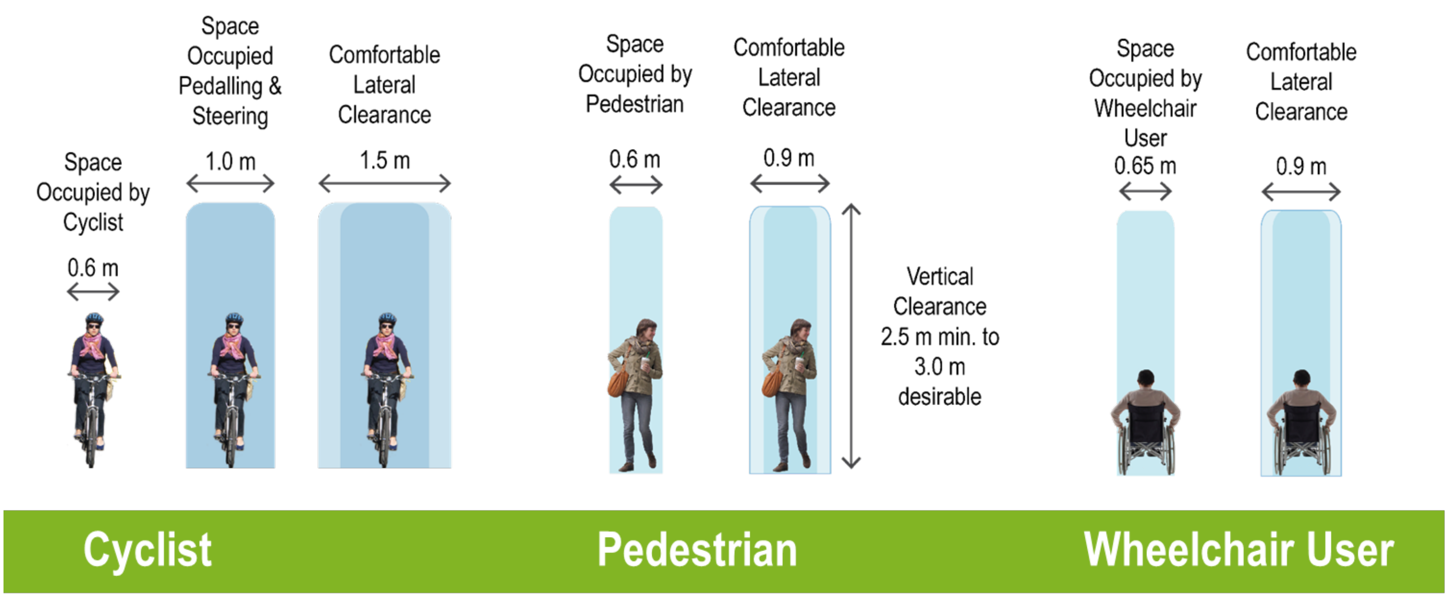
This proactive approach is consistent with the approach in **Brampton's Complete Street Guidelines**.

1.3 VULNERABLE ROAD USER CHARACTERISTICS

The design of pedestrian and cycling facilities must account for the operating space and lateral clearance of these users, as illustrated in Exhibit 1.4, just as roadway designs consider operating space for motor vehicles.

Design of sidewalk, pathway and cycling facilities for vulnerable users are discussed in more detail in Sections 2, 3 and 4 of this design compendium.

Exhibit 1.4: Operating space and lateral clearance required by vulnerable users



Source: IBI Group

2

Pedestrian Facilities

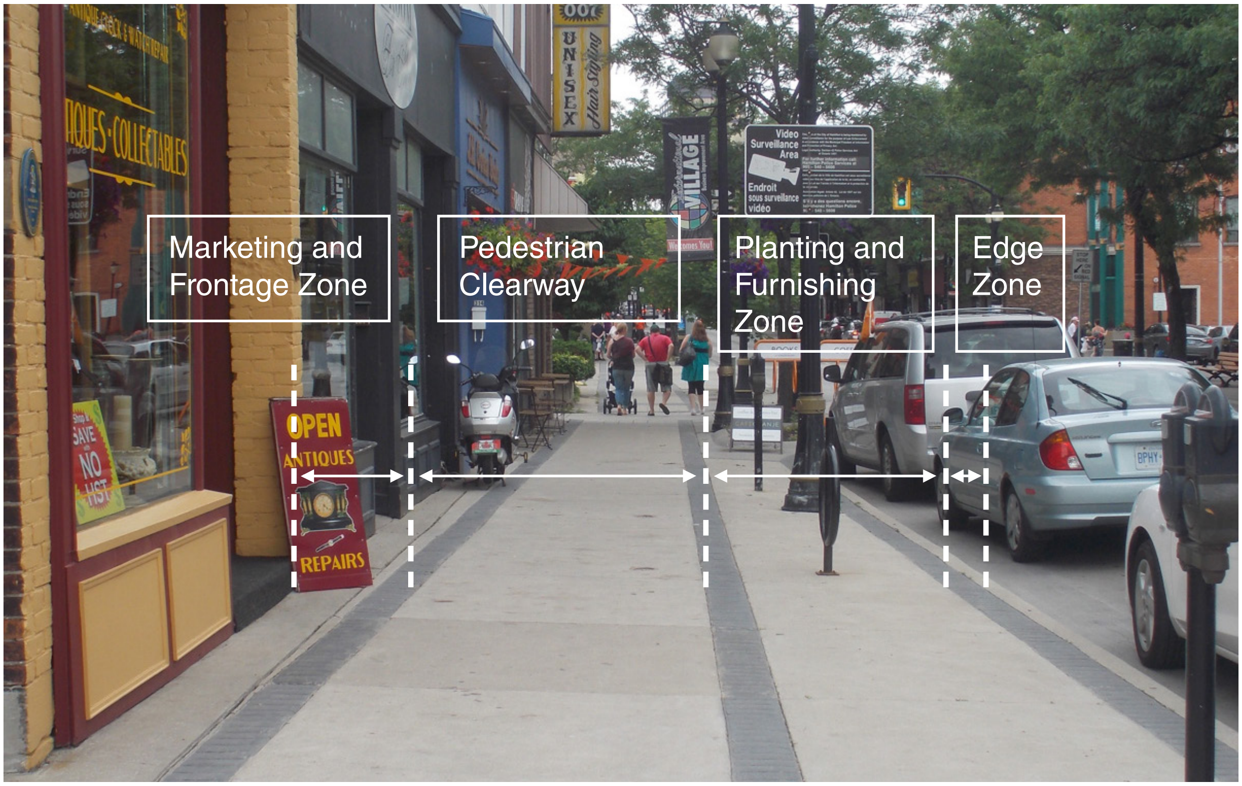
2.1 SIDEWALKS

Sidewalks provide the necessary operating space and surface to enable people to walk comfortably. The sidewalk is also a place of social interaction and provides access to businesses in an urban environment.

Sidewalks are generally made up of multiple distinct zones, as summarized below and illustrated in Exhibit 2.1:

- **Edge Zone** – The edge zone consists of the roadway curb and any hard surface behind the curb required for maintenance or buffering (typically a kill strip or maintenance strip).
- **Planting & Furnishing Zone** – In some locations (although not all), a defined planting and furnishing is provided to hold streetscaping elements such as trees, planters, benches as well as utility poles or other accoutrements. This space is not readily traversable, and cannot be considered part of the pedestrian clearway (see below). It is desirable, wherever a planting and furnishing zone is provided, that it is located between the edge zone and the clearway, so as to provide a buffer between pedestrians and the adjacent roadway.
- **Pedestrian Clearway** – Pedestrian clearway is the portion of the pedestrian zone or sidewalk specifically intended for travel. This is an area free of encroachments. It may be more difficult to distinguish the clearway within a hardscaped boulevard compared to a sidewalk that is bordered by grass. However, designs that respect this area are essential to maintaining an accessible area free of hazards and obstructions for pedestrians of all ages and abilities. A pedestrian clearway can be distinguished within a hardscaped boulevard by tonal colour or surface texture, to clearly distinguish the planting & furnishing zone and marketing/frontage zone.
- **Marketing / Frontage Zone** – This is the space on the sidewalk allocated to a variety of uses such as “A-frames” and other advertising boards, space for queuing (such as outside of a movie theatre), or even restaurant patios. A marketing/frontage zone is most applicable in setting with adjacent commercial land uses.

Exhibit 2.1: Elements of a sidewalk



Source: IBI Group

Recommended design criteria for each of these components of a sidewalk are shown in Exhibit 2.2.

Exhibit 2.2: Components of a sidewalk

Edge/Curb Zone	1.8m desirable 0.5m min. (0.9m at intersections) with no vertical obstructions in urban conditions. Wider dimensions may be required informed by context, user profile and available space within the ROW
Planting and Furnishing Zone	1.0 to 2.2m wide 1.8 metres where street trees are included No less than 1.2 metres
Pedestrian Clearway Zone	2.1m general 1.8m min. 1.5m min. in constrained conditions
Frontage and Marketing Zone	0.9 m width for advertising boards: + 1.2m for lineup areas + 1.2m for display + 1.75 fm for restaurant tables

These suggested dimensions help to support comfortable pedestrian facilities, but also exceed minimum requirements set out in the Accessibility for Ontarians with Disabilities Act (AODA) Regulations for the Design of Public Spaces Standards (see following Section 2.1.1).

2.1.1 Accessibility Requirements

The Province of Ontario passed the Accessibility for Ontarians with Disabilities Act (AODA) in 2005. The purpose of this legislation is to improve accessibility across Ontario by creating and enforcing standards that address key areas of daily living. The legislation identifies standards (ON. Reg. 413/12) pertaining to both transportation and the design of public spaces (built environment).

Ontario's public sector, including the City of Brampton, is required to comply with the regulations governing these Standards, by updating existing infrastructure assets that are non-compliant. Acknowledging that this may require significant investment in infrastructure for some municipalities, a horizon year of 2025 has been set to address the standards required by AODA legislation.

A summary of some of the key accessibility requirements for sidewalks and curb ramps is provided in Exhibit 2.1. Note that this list focuses solely on sidewalks and is not inclusive of all AODA requirements.

> The provision of accessible infrastructure helps people with disabilities and benefits families travelling with young children using strollers or wagons. About **1.85 million people in Ontario have a disability or 1 in 7 Ontarians.** As the population ages, it is projected the number of Ontarians with a disability will increase to 1 in 5. The number of seniors aged 65 and over in Ontario is projected to more than double from 1.7 million in 2008 to 4.1 million by 2036. For the first time in 2017, seniors accounted for a larger share of the Ontario population than children aged 14 and under.

Exhibit 2.1: Summary of basic AODA requirements for sidewalks and curb ramps

DESIGN ELEMENT	STANDARD	NOTES / CONSIDERATIONS
Exterior Path of Travel (Sidewalk, walkway etc.)		
Clear width	1500 mm MIN	
Clear width – level landing adjacent curb ramp	1200 mm MIN	
Clear width – entrance to exterior path of travel	850 mm MIN	Where bollards or other features create an entry way
Running slope	1:20 MAX (5%), or slope of adjacent roadway	Sidewalk slope cannot be steeper than the slope of the adjacent roadway when slope > 1:20 (5%)
Cross slope	1:20 MAX (5%)	Assuming asphalt, concrete or other hard surface, otherwise 1:10 MAX for all other surfaces
Openings	20 mm DIA. MAX	Elongated openings must be oriented approximately perpendicular to the direction of travel
Curb Ramp		
Clear width	1200 mm MIN	Exclusive of any flared sides
Running slope (Elevation <75 mm)	1:8 MAX (12.5%)	
Running slope (Elevation 75-200 mm)	1:10 MAX (10%)	Barrier curb height
Cross slope	1:50 MAX (2%)	
Flared Side Maximum Slope	1:10 MAX (10%)	
Curb Ramp Running Slope	1:10 MAX (10%)	

DESIGN ELEMENT	STANDARD	NOTES / CONSIDERATIONS
Alignment	Must align with direction of travel	
Depressed Curbs		
Running slope	1:20 MAX (5%)	
Tactile Walking Surface Indicators		
Placement on curb ramp	150 mm to 200 mm from curb edge	Locate at the bottom of the curb ramp
Depth	610 mm MIN	
Other criteria: Tactile Walking Surface Indicators must have: Raised tactile profiles High tonal contrast with the adjacent surface Extend the full width of the curb ramp		

Source: Adapted from the Integrated Accessibility Standards Regulations Guidelines, Part 4.1 – Design of Public Spaces (April 2014)

2.2 PEDESTRIAN SAFETY

The ATMP builds on the City of Brampton's Pedestrian Safety Plan, a planning tool for city staff to implement improvements to the pedestrian network. The plan establishes the context for pedestrian safety in Brampton through a review of key statistics relating to collisions and the variables that cause collisions. From this, several best practices and provisions for improving pedestrian safety are outlined. These practices include:

- Pedestrian related traffic control (Pedestrian Crossover, traffic control signals, mid-block pedestrian signals, school crossing guards, and stop sign controlled intersections)
- Pedestrian warning signs
- Pedestrian related initiatives

The Pedestrian Safety Plan provides useful guidance on pedestrian initiatives, road design, and traffic control measures that can be used by planners and engineers to develop a safer environment for pedestrians. Since the plan was developed, there have been other guidelines developed, such as Ontario Traffic Manual Book 15 Pedestrian Crossing Treatments (OTM Book 15), on pedestrian facility design. The initiatives of the pedestrian safety plan have been evaluated and compared to the additional guidance provided by OTM Book 15.

2.3 SURFACE TYPES AND OPERATIONAL CONSIDERATIONS

Safety can be enhanced by maintaining high-quality walking facilities. Surfaces with cracks or pot holes are potential hazards for people walking and cycling that can be mitigated with a surface maintenance program that is mindful to the needs of these users.

When a trail or path is being constructed, the cost to maintain the facility over the course of its life should be considered. Although the initial capital cost to build an asphalt surface trail is higher than stone dust, asphalt trails require less surface maintenance once constructed. The provision of a hard-packed stone dust trail may require ongoing investments to address drainage and erosion issues.

The provision of hard-packed stone dust recreational trails may be acceptable for some lower volume connections, although when scoping a new trail, asphalt should be identified as the default option. If there is a strong reason not to provide an asphalt surface, it is important from both a cycling and accessibility perspective that the uppermost surface be stone dust, and not larger types of gravel. The less fine the aggregate, the more traction issues people walking and cycling may encounter. Wood chip should not be used for any surface that is meant to be accessible. Aside from issues with the surface being uneven, wood chip paths may incur a significant operational cost, due to seasonal re-chipping.

Asphalt-surface trails do not require the annual reapplication of their surface material. Their hard surface is also desirable from the standpoint of sweeping, plowing and snow removal operations, as hard surface trails provide the option of being maintained for year-round use. Asphalt pavement for trails should be designed to carry maintenance vehicles. Their life-cycle is typically 15 to 20 years before rehabilitation is required.

3

Cycling Facilities

This section provides an overview of various types of cycling facilities (Section 3.1) and when they should be implemented. Design considerations for each of these types of facilities are provided in Sections 3.2 to 3.5.

3.1 CYCLING FACILITY SELECTION

Cycling facilities provide varying degrees of separation from traffic. Some roads require a higher degree of separation in order to provide a comfortable riding experience, while other roadways are perfectly comfortable as shared facilities. An overview of various classes and types of cycling facilities is shown in Exhibit 3.1.

Exhibit 3.1: Summary of Brampton cycling facility classes

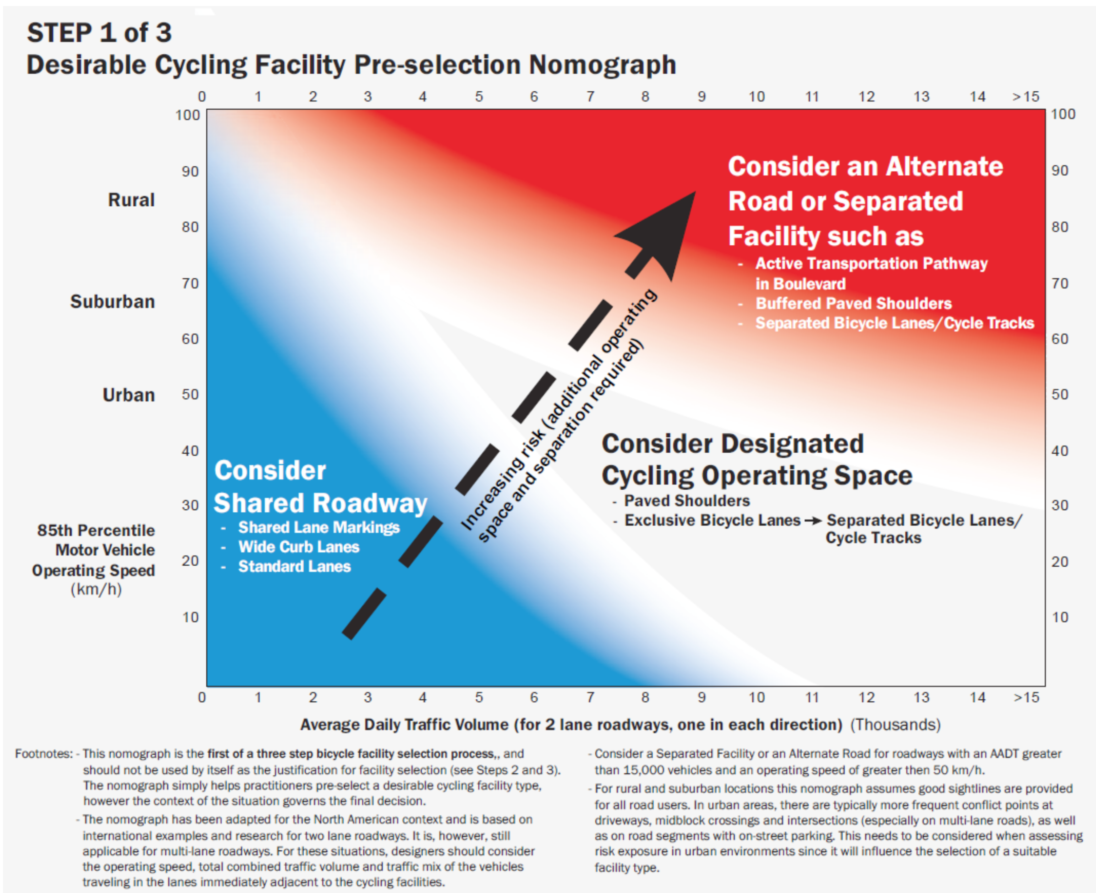
Shared Space	• Bicycle Boulevards • Sharrows • Super Sharrows • Signed Routes	» Volumes of < 3,000 AADT » Operating speeds < 40km/hr » Local roads
Designated Space	• Bike Lanes • Buffered Bike Lanes • Paved Shoulders • Buffered Paved Shoulders	» Volumes of 3,000 to 15,000 AADT » Operating speeds of 40 to 50 km/hour » Collector Road/Minor Arterial Roads
Separated Space	• Boulevard Multi-use Paths • Separated Bike Lanes or Cycle Tracks	» Volumes of > 10,000 to > 15,000 AADT » Operating speeds of equal to or greater than 50 km/hour » Minor Arterial Roads/Major Arterial Roads

The Ontario Traffic Manuals (OTM) are a series of guidelines directed at transportation practitioners to ensure uniformity across the province in the design, application, and operation of traffic control devices and systems. The guidelines are consistent with the intent of the Highway Traffic Act and provide a basis for road authorities to create their own guidelines and standards based on their professional judgment.

OTM Book 18 provides guidance on the selection of a shared, designated or separated cycling facility based on a variety of factors.

OTM Book 18 provides guidance on the selection of appropriate cycling facilities for various road contexts. The selection of an appropriate cycling facility is critical to encouraging cycling amongst a wider audience. Cycling facilities that do not reflect their surroundings will be, at best, underutilized, and at worst, dangerous. By contrast, an appropriate cycling facility can attract new cyclists, improve the pedestrian realm by either slowing or separating traffic, and improve safety for drivers in addition to vulnerable users.

Exhibit 3.2: OTM Book 18 cycling facility pre-selection nomograph



Source: OTM Book 18

Applying the pre-selection nomograph in Exhibit 3.2 is the first step in the process, helping designers to identify the general category of cycling facility. It takes into account the volume and speed of traffic, two major factors that affect the comfort and safety of cyclists. The second step in the process is a more detailed review of six primary criteria and seven secondary criteria provided in Exhibit 3.3.

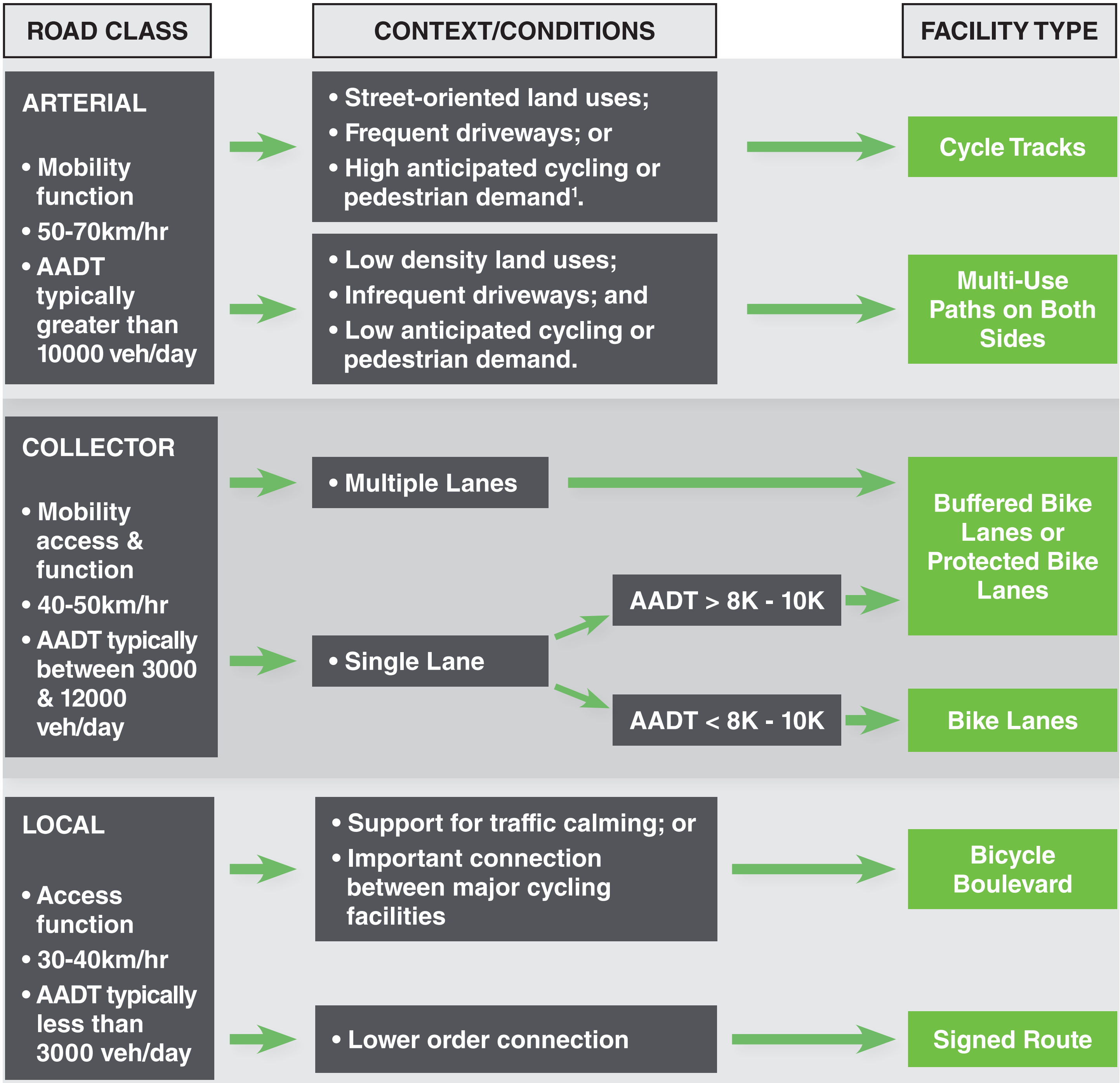
Exhibit 3.3: OTM Book 18 criteria for selecting type of cycling facility

PRIMARY DETERMINING CRITERIA	SECONDARY CRITERIA
➤ 85th percentile motor vehicle operating speeds ➤ Motor vehicle volumes ➤ Function of street, road or highway ➤ Vehicle mix ➤ Collision history ➤ Available space	➤ Costs ➤ Anticipated users in terms of skill and trip purpose ➤ Level of bicycle use ➤ Function of route within bicycle facility network ➤ Type of roadway improvement project ➤ On-street parking ➤ Frequency of intersections

Source: Adapted from OTM Book 18

As a Brampton-specific supplement to guidance in OTM Book 18, a specific facility selection tool has been prepared for the City of Brampton, as shown in Exhibit 3.4

Exhibit 3.4: Range of treatments for shared cycling roadways

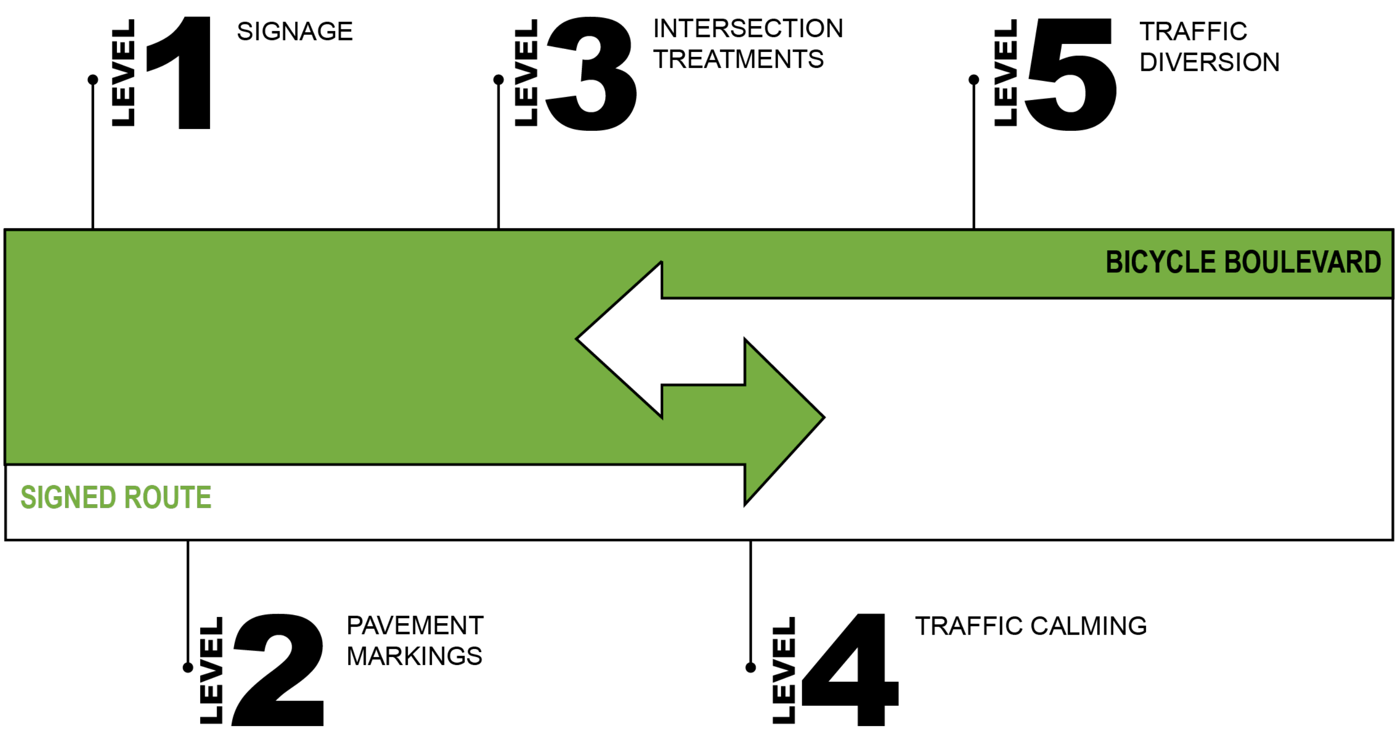


3.2 SHARED ROADWAYS

Along shared cycling facilities, cars and cyclists share the same travelled way, so this type of facility is appropriate only on low-speed, low-volume roadways.

Within the category of shared roadways there are a number of treatment levels (refer to Exhibit 3.5), ranging from signed bike routes to “bicycle boulevards” or neighborhood greenways that may incorporate a wide variety of traffic calming, and traffic diversion features to provide an overall pleasant environment for cyclists of all abilities. These greenways may also include streetscape and natural enhancements such as trees, vegetation, natural systems for stormwater management, etc.

Exhibit 3.5: Range of treatments for shared cycling roadways



3.2.1 Signed Routes

Signed routes are the most basic type of shared roadway infrastructure. Signage can include route signage, which indicates to a cyclist that they are on a defined cycling route within the cycling network, and wayfinding signage, to help cyclist navigate to key destinations using the cycling network.

Cycling Route Signage

Wayfinding Destination Signage

Source: City of Toronto

Wayfinding Directional Signage with Distance

Sharrow Pavement Markings

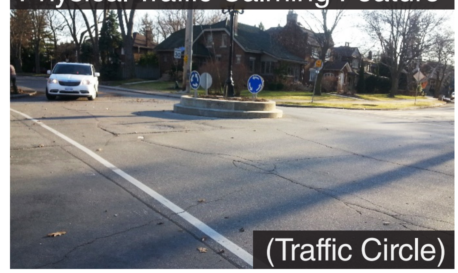
Signage may be supplemented by pavement markings including sharrows as needed. The use of linear sharrows is generally discouraged. Instead, sharrows are most useful for spot applications, or to guide cyclists to and from connecting signed routes and bicycle boulevards.

3.2.2 Bicycle Boulevards

Bicycle boulevards are streets that incorporate a variety of pavement markings, signage and traffic calming measures to create a comfortable cycling route. Bicycle boulevards are typically implemented as part of a network of connected streets to provide connectivity through a neighbourhood.

Traffic calming is often a key component of bicycle boulevards. The City's Neighbourhood Traffic Management Guide is currently used to implement traffic calming measures and includes tools such as speed humps, raised crosswalks, curb radius reduction, and pedestrian refuge.

Physical Traffic Calming Feature



(Traffic Circle)

Urban shoulders do not provide a dedicated space for cycling (motorists are permitted to park in them), but may be understood as a traffic calming measure that can delineate a cycling travel area outside the travelled way. On streets where urban shoulders have been installed, the introduction of a signed route may be appropriate. As cycling increases, parking can be prohibited and the urban shoulder can become a designated bike lane.

Traffic Diverters

Beyond traffic calming measures to reduce vehicle speed, it may be desirable to install traffic diverters to reduce vehicle volumes. Traffic diverters may result in lower motor vehicle volumes, with some jurisdictions targeting volumes as low as 500 vehicles per day. Some examples of physical interventions that are in use to create quiet street cycling routes in North American cities are described below.

Exhibit 3.5: Physical traffic diversion measures

Source: NACTO Urban Bikeway Design Guide

Right-in / Right-out island – This type of measure restricts movements at an intersection to prevent left turns and through vehicles from accessing the other side of the intersection. This measure can help to reduce short cutting and through traffic along a street segment.

Source: NACTO Urban Bikeway Design Guide

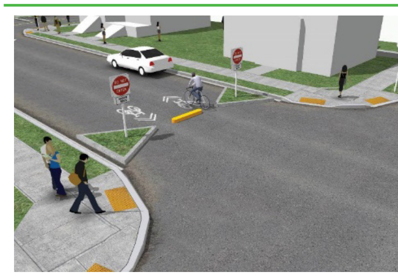
Diagonal Diverter – This measure restricts through movements at an intersection to limit through traffic. The diverter can be designed to permit pedestrian, cycling and emergency vehicle access

Source: IBI Group

Raised Median through Intersection – This measure prevents left and through movements at an intersection, however special "cut-throughs" can be provided to facilitate these movements for cyclists, pedestrians and emergency vehicles. This measure can reduce short cutting and through traffic along a street segment, as well as reduce crossing distances for pedestrians.

Source: NACTO Urban Bikeway Design Guide

Partial / Directional Closure – This measure involves a curb extension that extends to the centreline of a roadway, restricting one direction of traffic from entering the roadway. Bicycle and pedestrian access are maintained.



Source: NACTO Urban Bikeway Design Guide

Full Closure – This intervention restricts all vehicular movements at an intersection or midblock while permitting bicycle and pedestrian access.

3.3 DESIGNATED FACILITIES

Designated facilities provide space outside of vehicular lanes but are not delineated other than through pavement markings and signage. A sampling of designated cycling facilities is shown in Exhibit 3.6.

Bike lanes are lanes dedicated exclusively for use by cyclists through a combination of pavement markings and signage. Buffered bike lanes are similar to conventional bike lanes but incorporate a painted buffer area to provide additional clearance and comfort between cyclists and vehicles.

Although they are not considered a designated cycling facility, the City of Brampton has installed urban shoulders on residential streets and signed them as bike routes. They are similar to bike lanes, however, parking is currently permitted in them for short durations (3 hours). The City intends to transition these to designated bike lanes over time as demand warrants.

Exhibit 3.6: Sampling of designated cycling facilities

Design criteria for bike lanes and buffered bike lanes are shown in Exhibit 3.7. Design criteria for paved shoulders will vary significantly depending on roadway speed, volume, available base and anticipated ridership.

Exhibit 3.7: Design criteria for unidirectional bike lanes

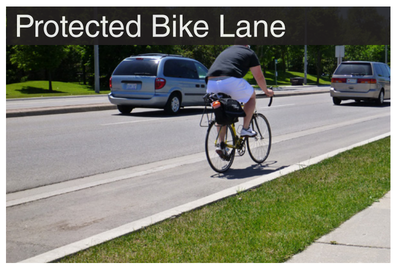
ELEMENT	WIDTH (m)	
	Recommended	Minimum
Bike Lane	1.8-2.0m	1.5m; 1.6m adjacent parking 1.2m for constrained corridors
Buffer	0.8-1.2m	0.5m

3.4 SEPARATED CYCLING FACILITIES

3.4.1 Overview

Separated facilities provide physical separation between cyclists and motorists by some vertical element. These facilities are appropriate along high speed or high volume roadways as they help to create more comfortable facilities that are buffered from the noise and motion generated by heavy or fast traffic. Examples of various types of separated facilities are shown in Exhibit 3.8.

Exhibit 3.8: Sampling of separated cycling facilities



3.4.2 Selecting an Appropriate Separated Facility

Once it is determined that a roadway warrants a facility that separates people cycling from motor vehicles, the appropriateness of each facility type can largely be attributed to three main criteria:

- **Centres of activity.** Along a given corridor, activity can be either fairly evenly distributed along both sides of a street, i.e. a typical main street or commercial centres, or it can be largely concentrated on one side, i.e. a suburban connector with houses on one side only. In the later condition, multi-use paths on one side of the street are sufficient, but not ideal. Otherwise, adequate opportunities to cross safely and easily at desired locations must be provided.

- **Length of blocks.** Depending on land-use characteristics, block lengths can vary significantly. Shorter, densely spaced blocks provide more crossing opportunities, which is attractive from a routing perspective. However, each intersection will require design treatments so that cyclists (and pedestrians for multi-use paths) can easily travel through and cross at intersections. Longer blocks provide more continuous spans of uninterrupted travel and are typically associated with heavier traffic volumes and higher speeds of travel. As a result, in-boulevard facilities are likely to be more comfortable.

- **Expected volumes of cyclists and pedestrians.** As the current or expected numbers of pedestrians and cyclists grows, it becomes more critical to separate the two modes in order to provide a more comfortable and convenient environment for both pedestrians and cyclists.

From a practical perspective, another major consideration when implementing these facilities is feasibility. Often, boulevards and roadways have limited width available for the implementation of cycling facilities. Designers are required to make trade-offs and should consider the following issues when developing a proposed facility:

- **Connectivity.** Transitions between bi-directional facilities and uni-directional facilities, or facilities on opposite sides of the street can be very tedious or intimidating for cyclists unless properly designed, and it is recommended that transitions be minimized.
- **On-road Impacts.** Finding room for protected bike lanes on an existing road will challenge the road space available, typically requiring trading off parking or a travel lane.

The follow sections address the ideal applications of multi-use paths, protected bike lanes and cycle tracks.

Multi-Use Paths

A multi-use path can be defined as a shared pedestrian and cycling facility that accommodates two-way travel within a road right-of-way. Multi-use paths can present safety challenges at intersections, so they are most appropriate on corridors with long blocks and fewer intersections. Cyclists traveling at higher speeds on the path, particularly in the direction opposite adjacent traffic, are not expected by motorists turning at intersections. Intersection design treatments should be used to mitigate this safety issue.

Both pedestrians and cyclists can use these facilities, and pavement markings and signage can help to clarify how users should share the path.

Multi-use paths are typically bi-directional facilities, and crossing treatments where they intersect with roadways must take this into account. As multi-use facilities are used by both persons cycling and pedestrians, crossings should be in compliance with AODA legislation, including but not limited to the provision of curb cuts and use of tactile plates. Typical design criteria for multi-use paths are shown in Exhibit 3.9.

Exhibit 3.9: Typical design criteria for multi-use paths

MULTI-USE PATH WIDTH (m)*	
Recommended	Minimum
4.0 – 5.0m	3.0m 2.4m over short, constrained sections such as bridge decks

*Excludes street buffer width, ideally 1.8m measured to face of curb

Multi-use paths are most appropriate along corridors with:

- long blocks with few driveways
- lighter current and anticipated pedestrian and cycling volumes
- back-lotted land uses
- activity on one side of the street (where path is provided only on one side)

Source: City of Brampton

Protected Bike Lanes (On-road)

Protected bike lanes are bike lanes protected by some form of vertical element or separation. The type and spacing of various forms of separation can vary substantially but may include: flexible posts, mountable, semi-mountable and barrier curbs, planters, parked cars, jersey barriers, and rubber or concrete stops. These facilities can be bi-directional (typically on one-way streets) or uni-directional (preferred) and can accommodate driveways and shorter blocks. Typical design criteria for protected bike lanes are shown in Exhibit 3.10 & Exhibit 3.11.

Protected bike lanes are most appropriate along corridors with:

- short – medium blocks with driveways
- heavier current and anticipated pedestrian and cycling volumes
- activity on both sides of the street
- roadways without significant truck or transit traffic

Alternate names: separated bike lanes, on-road cycle tracks, green lanes

Source: IBI Group

Cycle Track (In-boulevard)

Similar to protected bike lanes, cycle tracks are physically separated from the travelled portion of the roadway by a vertical element. The key difference is the placement of the cycling facilities. These facilities are located in the boulevard beyond the travelled way. These facilities may be set back behind street furniture such as transit stops, garbage recepticles, benches and lighting. The increased level of separation results in different operating conditions for cyclists, and usually requires the introduction of specialized treatments at intersections to ensure that cyclists are highly visible to drivers.

In-boulevard cycle tracks typically operate in one direction so are required in the boulevards on both sides of the roadway.

Alternate names: in-boulevard separated bike lanes, in-boulevard protected bike lanes

Source: Adam Coppola Photography

In-boulevard cycle tracks are most appropriate along corridors with:

- short – medium blocks with driveways
- heavier current and anticipated pedestrian and cycling volumes
- activity on both sides of the street
- roadways with significant truck or transit traffic

Cycle tracks operate differently than traditional on-road painted bike lanes, since they are physically constrained by a vertical element. Therefore, operating space requirements are critical to provide a comfortable facility. Exhibit 3.10 and Exhibit 3.11 illustrate recommended and minimum design criteria for unidirectional and bidirectional protected bike lanes or cycle tracks.

Exhibit 3.10: Design criteria for unidirectional protected bike lanes

BICYCLISTS / PEAK HOUR (ONE-DIRECTION)	BIKE LANE / CYCLE TRACK WIDTH (m)	
	Recommended	Minimum*
<150**	1.8m	1.5m
150-750***	2.4m	2.0m

Exhibit 3.11: Design criteria for bidirectional protected bike lanes

BICYCLISTS / PEAK HOUR (BOTH-DIRECTIONS)	BIKE LANE / CYCLE TRACK WIDTH (m)	
	Recommended	Minimum*
<150**	3.0m	2.4m
150-400***	3.4m	3.0m

***A design exception would typically be required for widths below the minimum**

**** <150 source: OTM Book 18**

*****150-750 source: MassDOT's Separated Bike Lane Planning & Design Guide**

In addition to the widths of the bike lanes noted above, it is important to consider clearance to fixed objects for facilities adjacent to fixed objects such as street furniture, utility poles, street trees or vertical bike lane separators (i.e. “elbow-room”). A minimum clearance of 0.25m with a preferred clearance of 0.6m should be provided adjacent objects.

3.4.3 Delineating Cycling and Pedestrian Zones

For in-boulevard cycle tracks, the delineation of bicycle and pedestrian space, or the “sidewalk buffer zone”, is an important operational and safety consideration. A key consideration for the sidewalk buffer zone is the issue of maintenance. In some cases providing a flush buffer zone may improve the ease of maintenance. However, operational considerations should not outweigh the need for strong delineation where heavy cycling and pedestrian volumes may be expected within the same corridor. Current guidance suggests that a variety of applications may be used to accomplish this delineation.

> “Physical separation with street furniture, landscaping or other objects is recommended for the sidewalk buffer provided that an accessible path of travel and sufficient sidewalk width is maintained for unobstructed pedestrian flow. In constrained locations where physical separation is desirable because of moderate to high pedestrian or cycling demand, for example town centres and urban areas, curb separation is preferable to ensure pedestrians do not walk in the cycle track, and bicyclists do not ride on the sidewalk. However it is also possible to achieve the desired separation when the sidewalk and cycle track are at the same elevation and are directly adjacent to each other by providing a high degree of visual contrast between the two. This can be accomplished through the utilization of different materials for each zone, stained surfaces, or applied surface colorization materials.” (MassDOT Separated Bike Lane Planning & Design Guide, p. 39)

With respect to the separation of cycle track and an adjacent sidewalk, industry best practice recommends a tactile surface separating the two types of facilities. The dual purpose is to ensure cane detection, so that vision impaired pedestrians do not walk into the cycle track, while also ensuring that the texture alerts people cycling that they are riding out of the cycle track, and onto the sidewalk. Depending on the context and local preference of users, either landscaping pavers or tactile plates may be suitable to provide these tactile cues.

Transit Stop Treatments

As multi-use paths or cycle tracks approach transit stops, the facilities should be aligned to avoid conflicts with transit passengers that are waiting for, boarding or alighting a vehicle by passing on the outside of the transit stop. This is exemplified on Bovaird Drive in Brampton, as seen in the image below. In cases where the right-of-way width is narrow, and this cannot be achieved, tactile walking hazard indicator strips can be used to warn passengers where they cross over the cycle track to / from the sidewalk. They are also used across the cycle track at either end of the transit stop to warn pedestrians that they are in the cycle track and not the sidewalk. This treatment is exemplified on Sherbourne Street in Toronto in the image below.

Exhibit 3.12: Examples of transit stop treatments for separated cycling facilities

Source: Google Streetview

4

Intersections & Crossings

The design of intersections and crossings is a balancing act between the safety and convenience of users of different modes. Key factors that affect the safety and operations of a crossing are summarized in Exhibit 4.1.

Exhibit 4.1: Factors including safety & operations at a crossing

FACTOR	CRITERION
Exposure to Conflicts	➤ Number of conflict points ➤ Level of activity (Auto, truck, pedestrian and bicyclist volume) ➤ Distance of crossing (longer width of crossing has higher exposure to vehicles) ➤ Type, frequency and complexity of conflict points ➤ Separation between road users (e.g. presence of sidewalk or bikeway)
Geometric Configuration	➤ Consistency in design ➤ Roadside safety ➤ Speed (operating speed, design speed and posted speed) ➤ Lateral separation from motor vehicle traffic ➤ Lane width
Driver Awareness	➤ Visibility and illumination ➤ Sight distance ➤ Yielding right-of-way and understanding the rules of the road ➤ Positive guidance ➤ Wrong-way driving
Other Human Factors	➤ Pedestrian and cyclist behaviour ➤ Pedestrian and cyclist ability ➤ Driver / cyclist expectation and driver / cyclist workload (Cyclists work load navigating through a series of conflict points and number of conflict points within the stopping sight distance). ➤ Driver visual scanning practices and turning

Fundamentally, crossings may be one of two types, they are either:

1. A **protected crossing** where vehicles must yield to pedestrians.

2. An **unprotected crossing** where pedestrians must yield to vehicles.

Intersections and crossings for pedestrians and cyclists will be designed in accordance with the City's own standards and the following guidelines:

- Ontario Traffic Manual (OTM) Book 12 Traffic Signals
- OTM Book 12A Bicycle Signals
- OTM Book 15 Pedestrian Crossing Treatments
- OTM Book 18 Bicycle Facilities

This section describes a variety of conditions, including both protected and unprotected crossings.

4.1 ROADWAY INTERSECTION DESIGN ELEMENTS INFLUENCING ACTIVE TRANSPORTATION USERS

4.1.1 Corner Radii

A common issue with urban intersections is the interaction between turning vehicles and crossing pedestrians or cyclists. These conflicts are magnified by large radii in urban settings that increase the speed of drivers completing the turn and reduce visibility of waiting pedestrians and cyclists. As a result, it is desirable to provide a tighter radius that can still accommodate the control vehicle.

Brampton's Complete Street Guidelines recommend an approach to corner radii that disassociate corner radius from turning radius, uses minimum vehicle turning path to determine the max. turning radii, and limits turning speed to 15 km/h. This approach also recommends considering "effective turn radii" and permitting turns to encroach into other receiving lanes.

"Smaller curb-return radii shorten the distance that pedestrians must cross at intersections. The occasional turn made by large trucks can be accommodated with slower speeds and some encroachment into the opposing traffic lanes."

(ITE Designing Walkable Urban Thoroughfares, 2010)

4.1.2 Slip Lanes / Channelized Right-Turn Lanes

Channelized right-turn lanes can increase the ease and speed with which vehicles make right turns, which in turn can reduce the comfort and safety of crossing pedestrians or cyclists. Moreover, channelized right-turn lanes rely on yield control, which can be harder to negotiate for people with visual impairments.

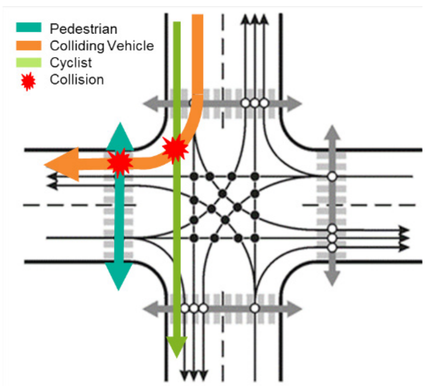
Accordingly, **Brampton's Complete Streets Guidelines** recommends the use of righ-turn channels only at signalized intersections, with high right-turning volumes. Where these slip lanes are justified, a series of mitigating measure are recommended to improve comfort and safety of vulnerable users including interventions such as: adding raised accessible islands; pedestrian signals; crosswalk striping; material changes to restrict path of travel; and illumination.

4.2 COLLISIONS AT SIGNALIZED INTERSECTIONS

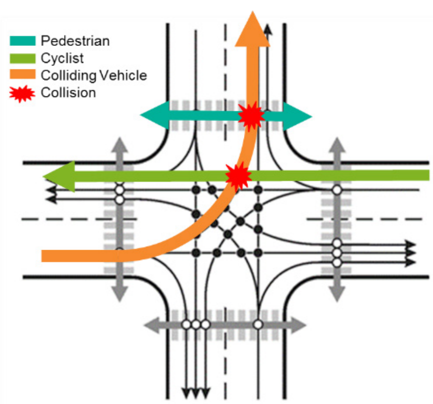
4.2.1 Common Types of Collisions

Understanding the types of collisions that occur most frequently allows a designer to target specific interventions and address common conflicts. The following diagrams (refer to Exhibit 1.7) illustrate common collision types, between pedestrians or cyclists and motorized traffic.

Exhibit 4.2: Common collision types between vehicles and pedestrians



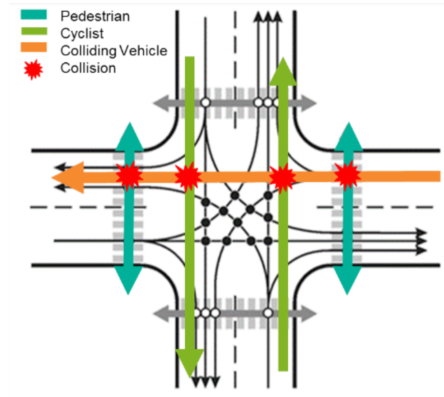
Right-turn collisions. Driver does not see the on-coming pedestrian or cyclist just entering the intersection coming from the same direction. Pedestrians crossing outside of the crosswalk may be less visible to turning vehicles. This particular collision involving a cyclist is also commonly referred to as a “right-hook.” This can also occur when a cyclist is riding on the sidewalk, then crosses the intersection and the turning driver does not expect the cyclist. Drivers are typically looking to their left at traffic so they often do not notice pedestrians crossing to their right.



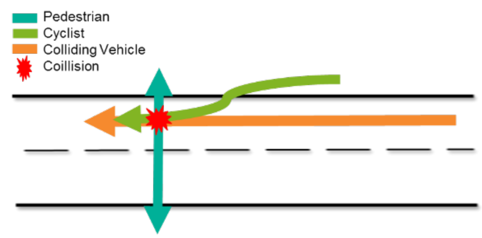
Left-turn collisions. Driver focus is on selecting a gap in on-coming traffic so they often do not notice pedestrians or cyclists crossing to their left.

This can also occur if a cyclist is riding on a sidewalk or multi-use path, then crosses the intersection and the turning driver does not expect the cyclist. This type of collision is more likely where motorists do not expect two-way cycling, and so may be applicable where multi-use trails or bi-directional cycle tracks cross a roadway. Where bi-directional cycling facilities are installed, separate signal phases can help avoid this collision.

Red-light running/Jay-walking collisions. Driver, pedestrian, or cyclist enters the intersection against the traffic controls and there is insufficient time or space for the driver, pedestrian or cyclist to take evasive action.



Midblock collisions. Pedestrian or cyclist enters the roadway midblock where there is no controlled crossing providing right-of-way over approaching vehicles and there is insufficient time or space for the driver to take evasive action.



4.2.2 Potential Contributing Factors

With these various types of collisions, it is important to assess how elements of the roadway environment and human factors can influence the associated risks. Some basic examples of diagnostic questions are provided below.

Driver

- Can drivers see pedestrians and cyclists if riding in the boulevard before they reach the edge of the road?
- Does the roadway design help motorists to spot pedestrians or cyclists waiting to cross?
- Is this an area where pedestrians or cyclists are expected?
- Is this an area where a specific population of pedestrians is expected (e.g., school zone, retirement home area, hospital, bars, etc.)?
- Will drivers be focused on some other hazard?

Pedestrian and / or Cyclist

- Will pedestrians and cyclists be able to easily use safety features?
- Is this an area where driving speeds are high or highly variable?
- Are there gaps in the traffic stream to allow pedestrian and / or cyclist crossings?
- Can pedestrians and cyclists see approaching vehicles?

4.3 CURB DEPRESSIONS AT CROSSINGS

As stated in OTM Book 15, “Curb depressions improve accessibility for crossing activity for all pedestrians. They are typically provided in urban areas where pedestrian activity exists. Curb depressions are not intended to imply right-of-way, but rather improve accessibility and safety where pedestrian activity has been demonstrated.”
Curb depressions are applied to sidewalks, multi-use paths and in-boulevard cycle tracks where they cross roadways mid-block or at intersections.

4.4 DRIVEWAYS

The simplest type of intersection is the point at which a cycling facility or sidewalk crosses a driveway. As noted in the **Brampton Complete Streets Guidelines**, it is important maintain the elevation of sidewalks or cycling facilities across driveways. It is also important to maintain the appearance (concrete) of the sidewalk and applying pavement markings along cycling facilities crossing a driveway. A summary of recommended and optional pavement markings for cycling facilities through driveways are shown in Exhibit 4.3.

Exhibit 4.3: Driveway crossing - Dixie Road

Source: Google Streetview

Exhibit 4.4: Suggested driveway pavement markings treatment types

FACILITY TYPE	BASIC DRIVEWAY TREATMENT	ENHANCED DRIVEWAY TREATMENT
MULTI-USE PATH	➤ Elephant's feet pavement markings	➤ Mixed crossride
ON-ROAD BICYCLE LANE	➤ Dashed Guidelines	➤ Green conflict zone markings ➤ Bicycle stencil + arrow
SEPARATED BIKE LANE / CYCLE TRACK	➤ Elephant's feet pavement markings	➤ Green conflict zone markings ➤ Bicycle stencil + arrow

Source: IBI Group

4.5 BICYCLE SIGNALS

Separate signal heads for cyclists are provided for some cycling facilities, depending on the location and phasing requirements of cyclists. The signals are recognizable from other traffic signals by the bike symbol indication that replaces the typical solid ball.

At intersections where bicycle facilities are provided, cyclists may simply be considered in the timing of the regular traffic signal cycle and placement of traffic detection devices. Where a cycling facility is separate from the adjacent traffic lanes, or has its own signal phase a bicycle traffic signal may be necessary. Examples of facility types that may require bicycle signal heads include multi-use trails and boulevard cycle tracks. Contra-flow bicycle lanes (in the opposite direction of travel on one-way streets for motorists) require bicycle signal heads, as this type of bicycle lane allows for a travel movement that is prohibited for motorists so signals facing the cyclists are required. Additional guidance on locations where protected bike signal phases should be considered is provided in OTM Book 12A.

4.6 CROSSRIDES

Crossrides are intersection treatments that allow cyclists to legally ride through an intersection without dismounting. Crossrides consist of pavement markings with elephant's feet (white square markings) and bicycle symbols.

Multi-use path crossings can be accommodated with the provision of crossrides. OTM Book 18 suggests that "where a crossride is provided in place of a crosswalk, a cyclist may ride their bicycle within the crossing without dismounting" (p. 121).

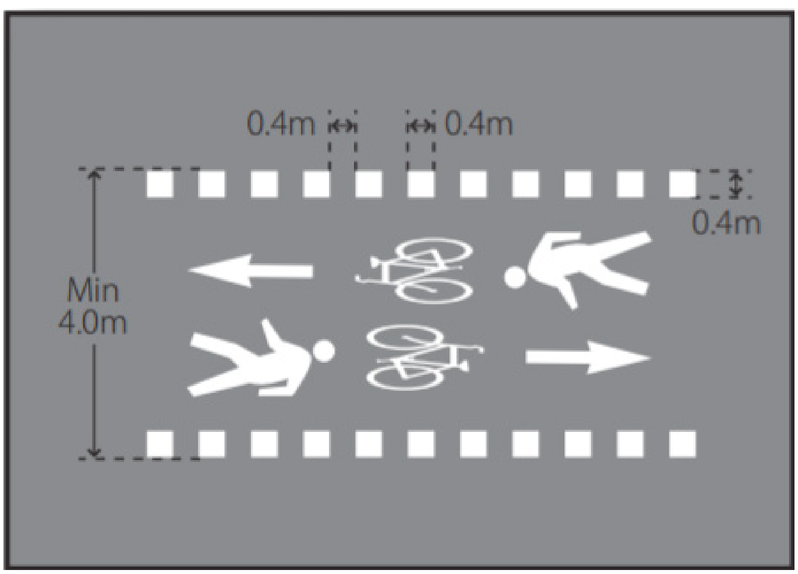
There are three basic crossride options:

- Mixed crossride
- Combined crossride
- Separated crossride

4.6.1 MIXED CROSSRIDE

The mixed crossride consists of "elephant's feet" markings on the outside with bicycle, pedestrian and arrow symbols between them. Cyclists and pedestrians are expected to share the crossing. The mixed crossride is not legal within a roadway application. The Highway Traffic Act permits a bicyclist to ride along side of a crosswalk, however continues to prohibit a bicyclist from riding within a crosswalk. This change was made to support the introduction of the crossride. Since the cyclist and pedestrians are not separated within the mixed crossride then the cyclist would be in contravention of the HTA by riding within the crosswalk. This treatment however is appropriate for driveways (not defined as public road allowance).

Exhibit 4.5: Mixed Crossride



Source: OTM Book 18

4.6.2 Combined Crossride

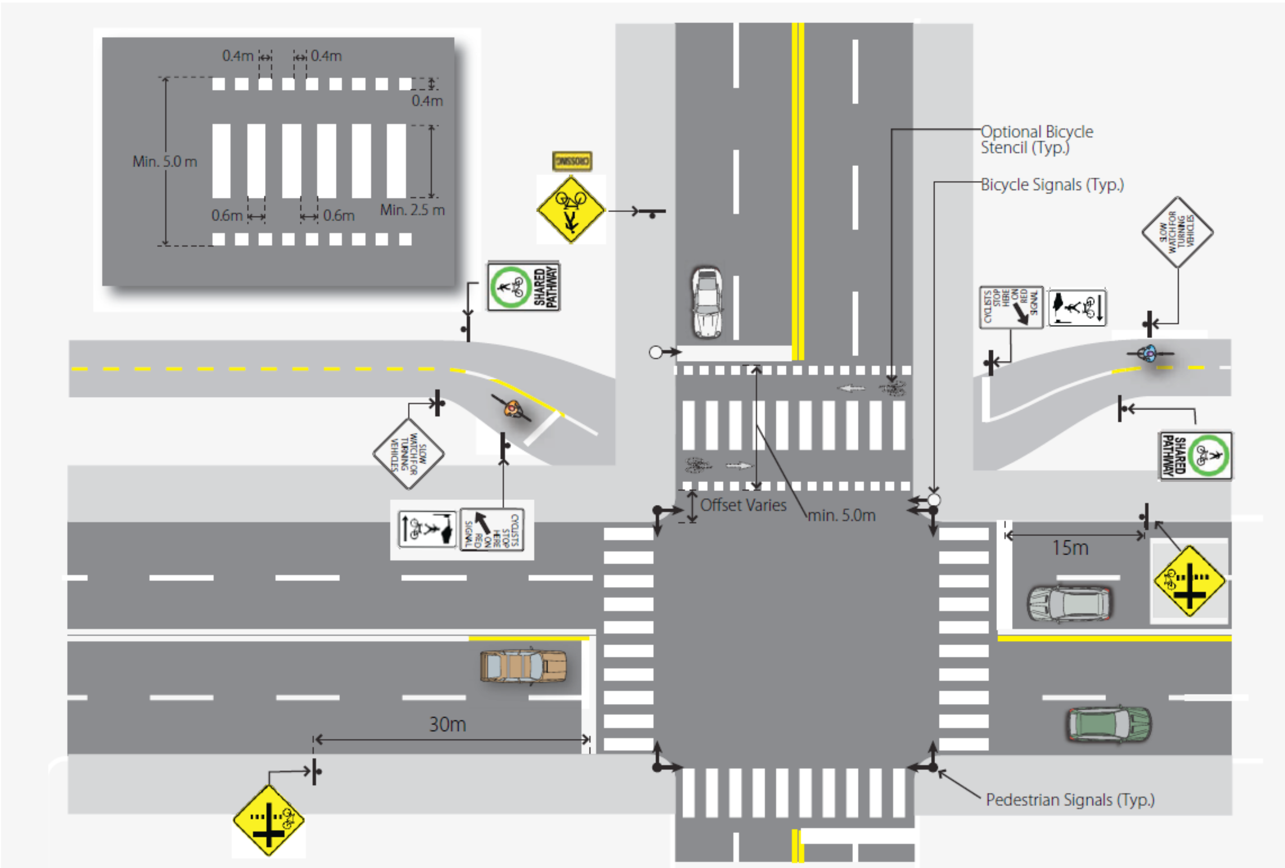
A combined crossride is comprised of "elephant's feet" markings, with "zebra stripe" markings inside. Pedestrians are intended to make use of the central area, and cyclists to use the outer parts.

- More visible than a mixed crossride
- Provides delineation between persons cycling and persons walking
- May be suitable for MUPs where pedestrian volumes significantly exceed cycling volumes, as the marking suggests that cyclists should ride around the centrally positioned zebra stripes
- Recommended for medium volume/speed roadways, where the use of elephant's feet will be sufficient to delineate the cycling travel area to motorists
- Most appropriate at signalized intersections where sidewalk and trail users mix and where user volumes are low

Exhibit 4.6: Combined crossride

Source: IBI Group

Exhibit 4.7: Combined Pedestrian & Cyclist Crossride



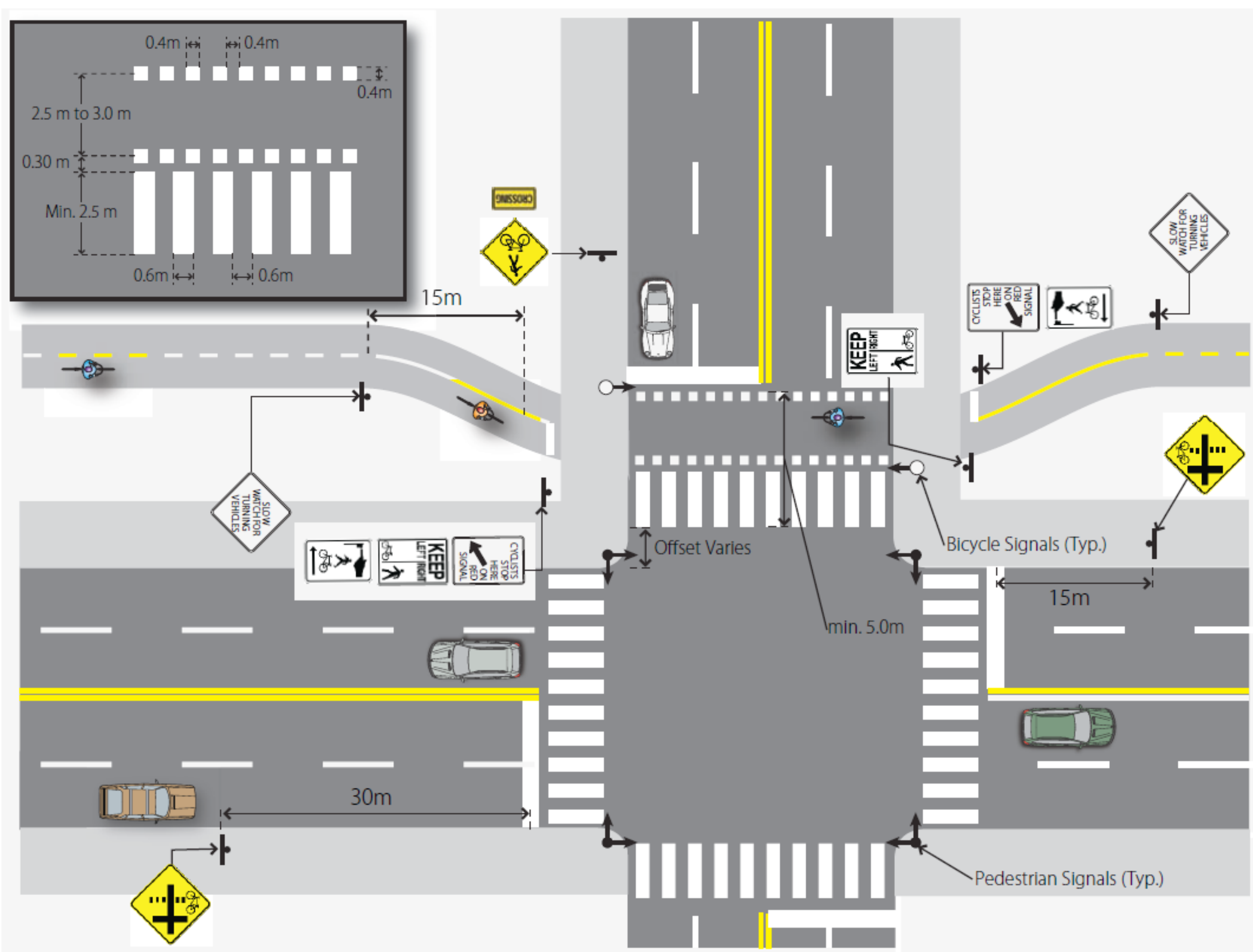
Source: OTM Book 18

4.6.3 Separate Pedestrian & Cyclist Crossride

This crossride consists of "elephant's feet" markings on one side, and "zebra stripe marking" on the other. The zebra stripes and elephant's feed should be aligned with appropriate cycling facilities, sidewalks or MUPs.

- Generally more visible than a mixed crossride
- Provides delineation between persons cycling and persons walking
- Recommended for medium volume/speed roadways, where the use of elephant's feet will be sufficient to delineate the cycling travel area to motorists
- Most appropriate where sidewalks are present in addition to a multi-use path, and at signalized intersection crossings

Exhibit 4.8: Separated Pedestrian Crosswalk and Cyclist Crossride



Source: OTM Book 18

4.7 ADVANCED AND TWO-STAGE LEFT-TURN BIKE BOXES

Advanced bike boxes and two-stage left-turn bike boxes can be installed to enhance intersections for cycling turning movements. They are typically installed at locations where cyclists are turning out of a dedicated cycling facility.

A bike box is a designated area that provides bicyclists with a safe and visible way to get ahead of queuing traffic. They also help cyclists make left turns. Bike box pavement markings may increase the visibility of cyclists at an intersection. When used in conjunction with a “no right turn on red” prohibition for motor vehicles, bike boxes can prevent “right-hook” conflicts with motor vehicles. Cyclists have generally reported that bike boxes are most comfortable to use when a leading signal phase allows for persons standing in the box to begin cycling ahead of when motorists begin to drive.

Advanced bike boxes (refer to Exhibit 4.9) are typically most appropriate at signalized intersections where motor vehicle right turns are high, and in conflict with high cyclist through or left turn movements. They may be placed in advance of the right-most traffic lane stop bar to reduce the right-turn conflict. They may also be placed in advance of the through and left-turn lane stop bar to allow cyclists to move to the left on the red signal to position themselves to make a left turn when the signal turns green. However, if traffic volumes are high, a two-stage left-turn bike box is more appropriate to facilitate cyclist left turns. Advanced bike boxes should not span more than two lanes of traffic to avoid the cyclist moving to the left during a red signal and getting caught in a middle lane during the change to green.

Exhibit 4.9: Advanced Bike Box

Source: IBI Group

Two-stage left-turn bike boxes provide a marked area where cyclists can wait to make a left turn in two stages. First they cross through the intersection to the far-side and wait in the bike box for the cross street green signal (or a gap in traffic is at at a stop controlled intersection), and then complete the second stage of their crossing to make the left turn. Multiple positions may be designed for, depending on the intersection configuration.

Exhibit 4.10: Two-stage left-turn bike box inset into the boulevard

Source: IBI Group

The NACTO Guide for Urban Bikeway Design provides the following guidance regarding bike boxes.

"Cycle track design often prevents bicyclists from merging into traffic to turn. This makes the provision of two-stage turns critical for basic transportation function. The same principles for two-stage turns apply to bike lanes as well. While two stage turns may increase bicyclist comfort in many locations, this configuration typically results in increased delay for bicyclists. Bicyclists now need to receive two separate green signal indications (one for the through street, followed by one for the cross street) to turn. At unsignalized intersections this configuration may also increase delay for bicyclists due to the need to wait for appropriate gaps in crossing motor vehicle traffic."

4.8 UNSIGNALIZED CROSSINGS & PEDESTRIAN CROSSOVERS

Mid-block crossings may be signalized or uncontrolled. The installation of a signalized crossing should be justified through OTM Book 12 – Justification 6, which is based on a combination of minimum pedestrian volume and minimum pedestrian delay criteria for an 8-hour period.

In cases where a signal is not warranted, there are several types of unsignalized pedestrian crossovers (PXOs) that should be considered. These new crossovers are marked by specific signs and pavement markings. In some cases, but not always, they may also have pedestrian-activated flashing lights. The crossovers will alert drivers that they must stop and yield to pedestrians intending to cross the road, and wait for them to complete their crossing before proceeding. In 2018, Brampton City council endorsed these new Level 2 PXOs and an accompanying implementation strategy.

The criteria for determining if a PXO is warranted, is identified in Figure 2, the Decision Support Tool – Preliminary Assessment, of OTM Book 15.

It considers the following:

- 8-hour or 4-hour pedestrian volume
- Connectivity
- Distance from a signalized crossing

If a PXO is warranted, there are 4 different configurations that can be selected: Type A, B, C or D. A detailed description can be found in Section 6.3.2. of OTM Book 15. Type D consists of signs and pavement markings for two-lane roadways; Type B and C add the use of rapid flashing beacons for two- to four-lane roadways; and Type A has overhead yellow flashing signals for higher speed and volume roadways.

The decision making criteria for the type of PXO identified in Table 7: Pedestrian Crossover Selection Matrix in OTM Book 15. The decision matrix is based on:

- 8-hour or 4-hour vehicle volume
- Posted speed limit
- Total number of roadway lanes in the roadway cross-section

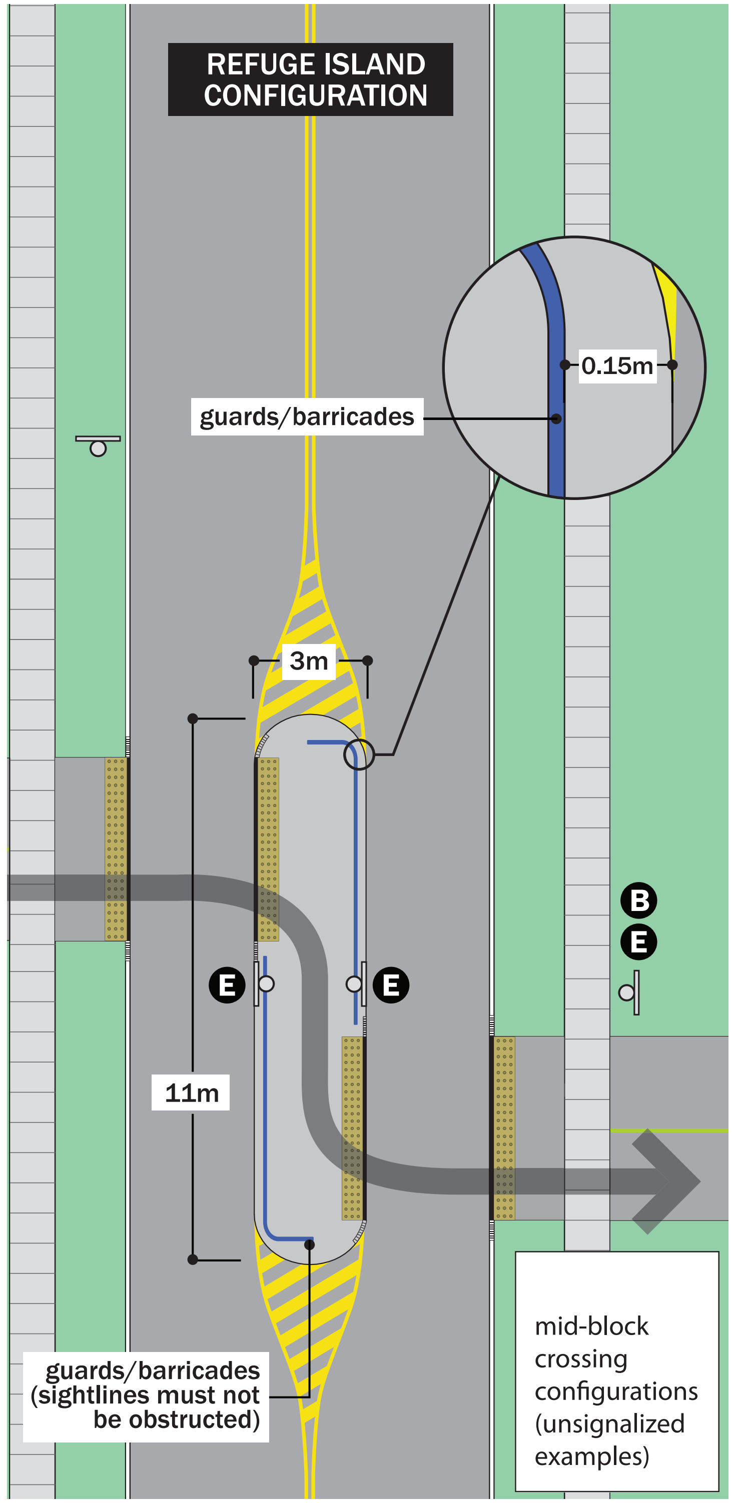
Cyclists are currently required to dismount to cross at PXOs. The revision to OTM Book 18 (currently underway) is anticipated to consider amendments to the Highway Traffic Act to permit the use of crossride applications at PXOs.

4.9 REFUGE ISLANDS

Where the crossing distance is greater and speeds or volumes are elevated, but a signal is not warranted, a refuge island may be appropriate. Refuge islands used for multi-use paths should be sufficiently wide to allow for easy bicycle access and egress, without having to dismount. A width of 3m and a length of 11m is recommended for this purpose. Refugee islands may also be used in conjunction with PXOs.

See section 4.8 for additional information regarding PXOs.

Exhibit 4.11: Median refuge island



Source: City of Toronto Mult-use Path Design Guidelines

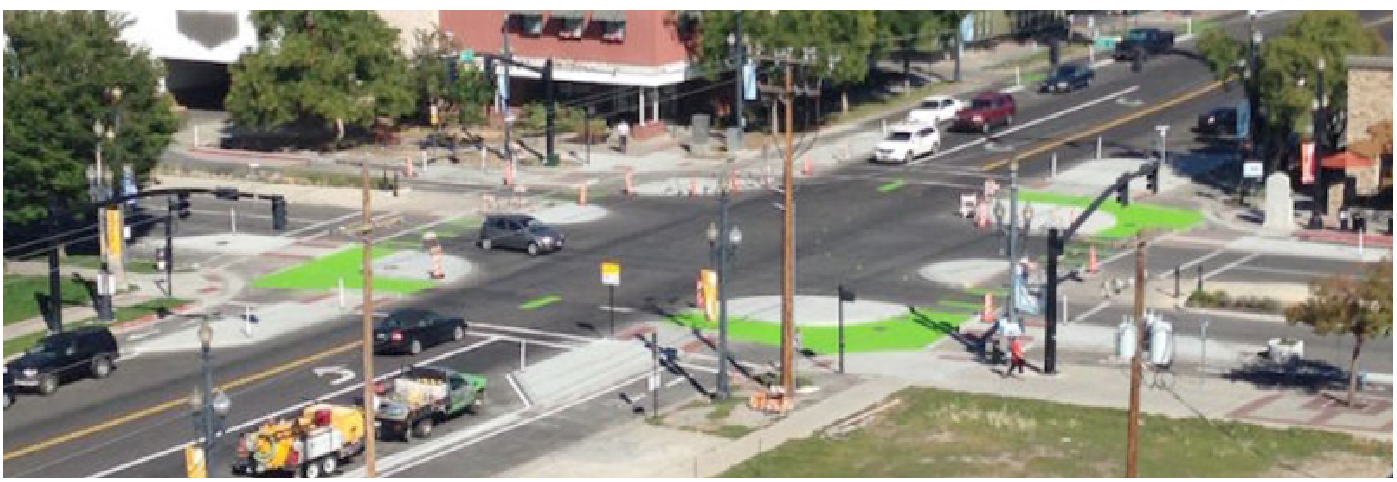
4.10 PROTECTED INTERSECTIONS

As the application of cycling facilities expands to include protected facilities, providing high quality crossings becomes even more essential to ensuring that the facility continues to attract and encourage all types of cyclists.

One of the emerging design options for cycle tracks and protected bike lanes in North America is the application of protected intersection design concepts from the Netherlands. There are a growing number of examples of protected intersections in North America, including Vancouver, Ottawa, Chicago, Salt Lake City and Boulder. The general concept of the protected intersection is to provide a physically protected space for cyclists to wait to cross any leg of the intersection and to facilitate two-stage left-turns.

The key elements of a protected intersection include a corner refuge island and a motorist yield zone that is outside the path of the adjacent through traffic. The design also includes accessible pedestrian crossing features and separation of pedestrian / cyclist crossing areas from queuing areas.

Exhibit 4.12: Protected intersection constructed in Salt Lake City



Source: Salt Lake City Transportation Division

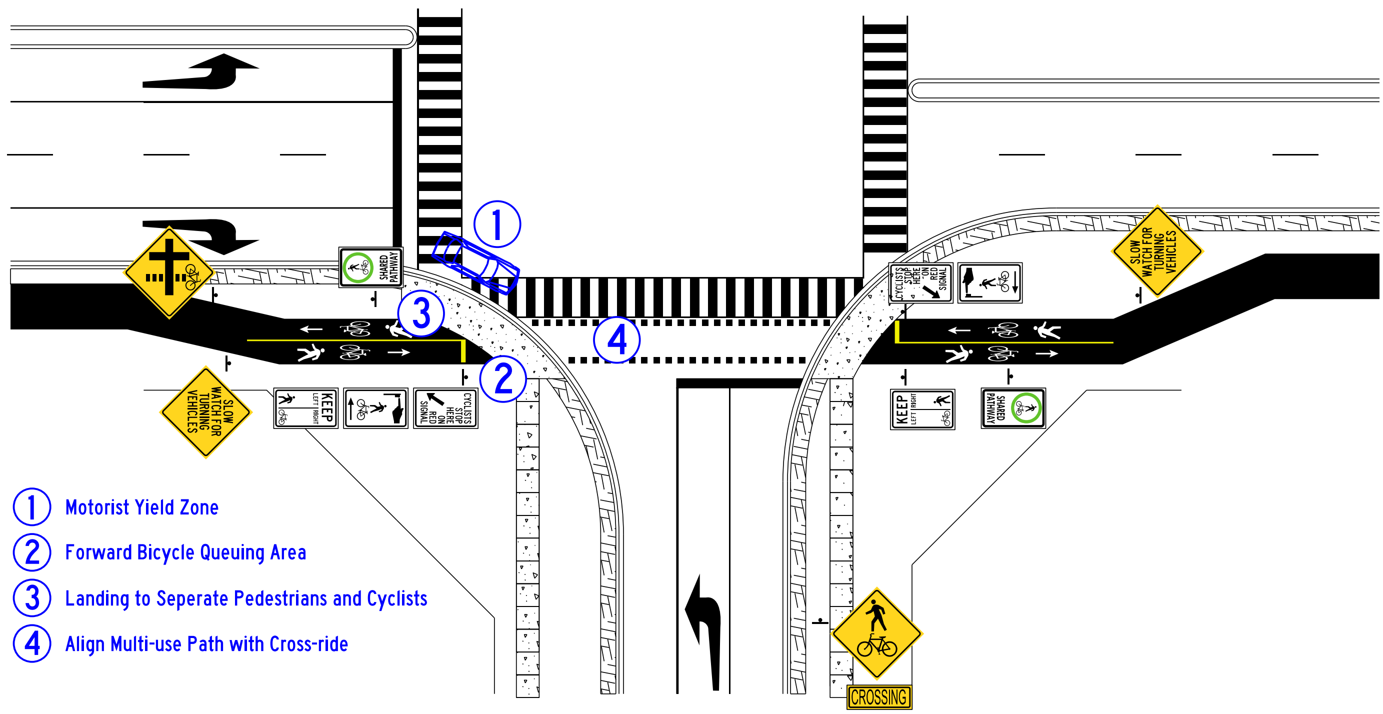
A key challenge of adopting protected intersection designs is the consideration for a leading or dedicated cycling signal phase. These sorts of signal design provisions are not yet common in North America, and there are concerns about impacts to vehicular level of services and overall cycle lengths for intersections. Further experimentation with protected signal phase may be considered in the City of Brampton.

Exhibit 4.13: Close-up of a protected intersection corner in the City of Chicago

Source: NACTO

Elements of protected intersections can also be applied to improve the safety of multi-use paths at intersections. A concept that adopts elements of the protected intersection and applies it to improve the crossing of a multi-use path at an intersections is shown in Exhibit 4.14.

Exhibit 4.14: Elements of a protected intersection applied to a multi-use path at an intersection



4.11 BEND-IN AND BEND-OUT DESIGNS

Although there is currently limited adoption of the protected intersection on a wider scale, the on-going inclusion of separated facilities has included some of the design concepts behind the protected intersection. Both bend-in and bend-out concepts (refer to Exhibit 4.15 and Exhibit 4.16) have been used within the North American context and the bend-in concept is recommended in several of the separated bike lane planning & design guidelines.

Guidance from the CROW manual is more explicit in its recommendation of bend-in designs within urban areas:

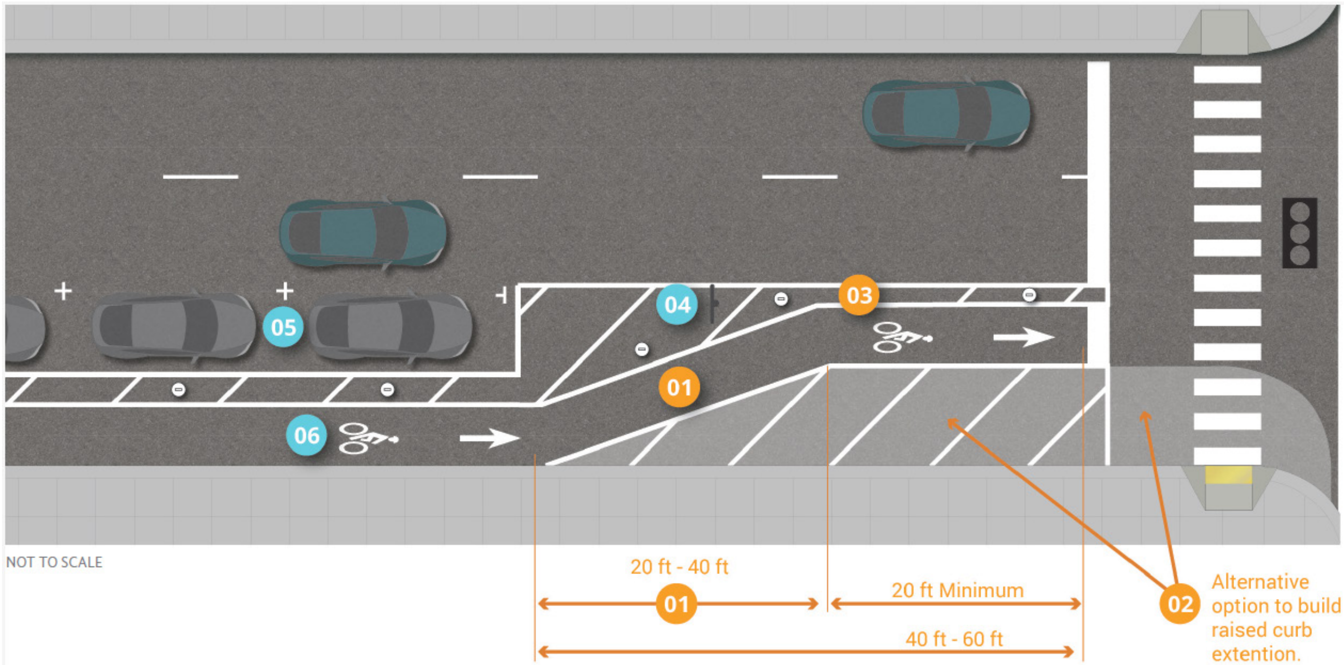
> For the safety of cyclists on an intersection it is extremely important that they are noticed by the other traffic. For this reason it is recommended that on roads within built-up areas and estate access roads outside built-up areas separate cycle tracks are bent in 20 to 30 metres before an intersecting road (bending-in is defined as bending a separate cycle track toward the carriageway, with the distance between the cycle track and the side of the main carriageway measuring between 0 and 2m.) If a separate cycle track is next to or a short distance from a main carriageway, this creates optimal conditions for a good view of the cyclists. On district access roads outside of the built-up area, bending-in is not recommended. This is not because visibility is not so important there, but because, as a result of bending-in, traffic turning off does not have stacking space between the carriageway and the cycle track. On roads where cars drive at speeds in excess of 60 km/hr, this could lead to serious conflicts, given the larger differences in speed between through traffic and vehicles turning off. (***CROW Manual***, p. 188)

It is important to note that operating speeds on many suburban roads are closer to 60 km/hr+ so the applications of bend-out designs are more appropriate in these instances.

The NACTO guidelines identify the following recommendations for bend-out designs:

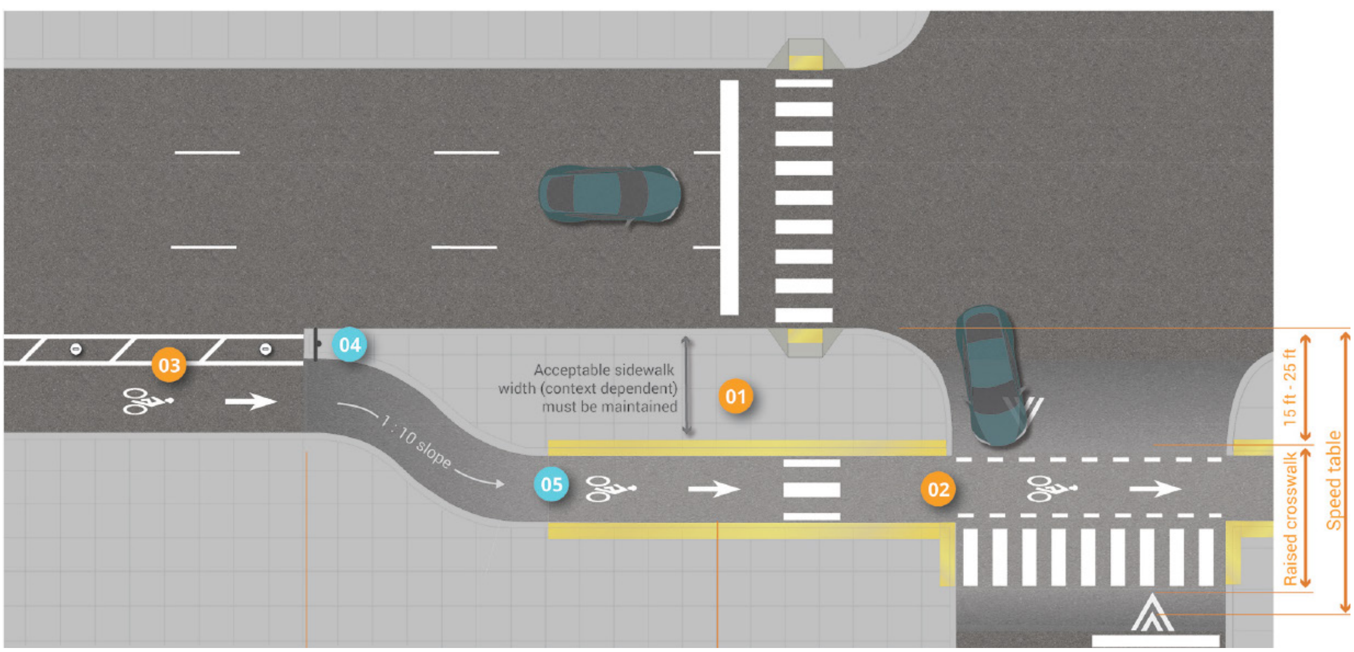
> A less intuitive solution, this “bend out” design is the opposite design from a “bend in.” This design shifts the cycle track away from the main roadway in order to separate conflicts into an area outside of the main intersection. Car drivers first turn right around the corner, then they stop for bicyclists in a space large enough to be outside of the flow of traffic. Dutch design manual recommend this on high-speed roads in less developed areas, where more space may be available. This is less likely to be an appropriate solution in the middle of a city.

Exhibit 4.15: Bend-in cycle track design concept



Source: FHWA's Separated Bike Lane Planning and Design Guide, p. 110

Exhibit 4.16: Bend-out cycle track design concept



Source: FHWA's Separated Bike Lane Planning and Design Guide, p. 111

4.12 HIGHWAY RAMP CROSSINGS

Freeflow highway ramp crossings can be particularly uninviting, and dangerous for vulnerable road users. Ramps leading to 400-series highways are generally under the jurisdiction of the Ontario Ministry of Transportation, and so coordination will often be necessary in order to achieve facilities for cyclists and pedestrians at these locations.

Where free-flow interchange ramps are provided there are several strategies for accommodating pedestrian and cyclist crossings:

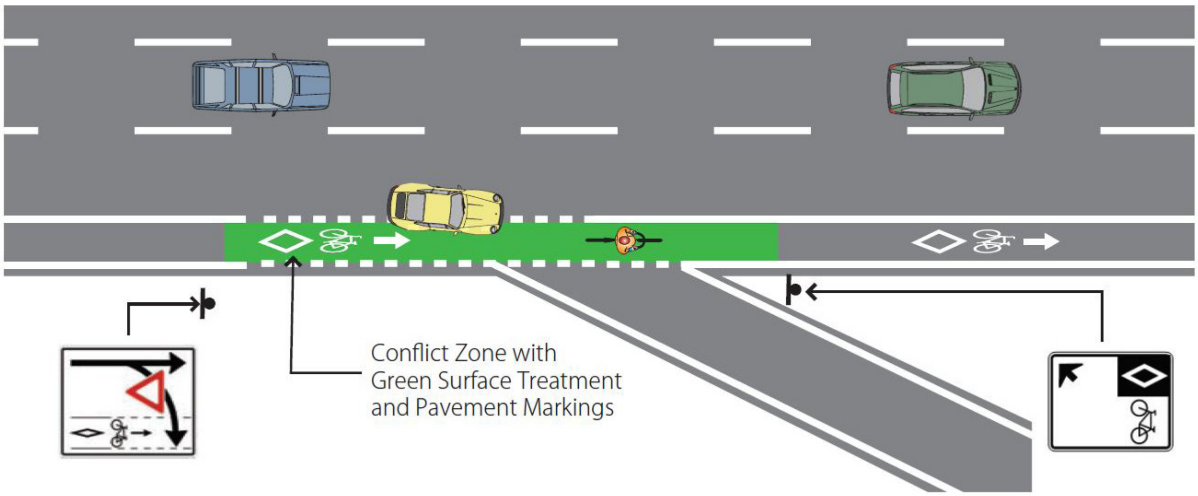
1. Provide grade separation of vulnerable users. This approach is most desirable, however it is also the most expensive alternative, and may not be feasible in all cases. An example of a grade separation across interchange ramps is shown in Exhibit 4.17 below.

Exhibit 4.17: Example of a proposed cycleway connection in Sydney

Source: NSW Government - Sydney Harbour Bridge

2. Provide conflict zone markings and signage across lower-speed ramps. OTM Book 18 illustrates several concepts for conflict zones across ramps, including the concept shown below in Exhibit 4.18.

Exhibit 4.18: Conflict zone marking across ramp



Source: OTM Book 18

3. Across high-speeds ramps, jughandle designs can help to position cyclists in such a way that they can wait for a gap in traffic to cross the ramp. An example of this design at an off-ramp in Lyon, France, is provided in Exhibit 4.19. Further geometric details and pavement markings and signage can be found in OTM Book 18.

Exhibit 4.19: Application of jug handle design to help improve sight lines. In this example, motorists are expected to yield to pedestrians and cyclists.

Source: Google Streetview

4.13 BARRIER CROSSINGS

Significant physical barriers, such as waterways, rail corridors and highways, may necessitate lengthy detours by pedestrians and cyclists unless appropriate infrastructure is provided.

Given the high cost of building grade separated structures, it is critical that the needs of persons walking and cycling are considered at the time new structures are being planned and designed. The planning of new crossing locations should consider not only the needs of the existing road network, but the context of existing and planned land uses.

From a design and construction perspective, it is also worth noting that municipalities may face unique jurisdictional challenges when building highway or river crossings. In the province of Ontario, highways are under provincial jurisdiction. Municipal planning and design efforts must recognize the Ontario Ministry of Transportation's jurisdiction, and realize the best possible solutions collaborating with provincial stakeholders.

In circumstances where a crossing is needed over a rail corridor, it is necessary to identify the company which owns the tracks, while also considering additional rail companies that are authorized to use the tracks, to ensure the structure's clearance requirements considers the needs of all stakeholders.

The banks and lands immediate to many waterways may be under the jurisdiction of a local conservation authority. When structures are being considered at these types of locations, studies which consider environmental considerations, including effects on wildlife and sensitive aspects of naturalized areas may be required.

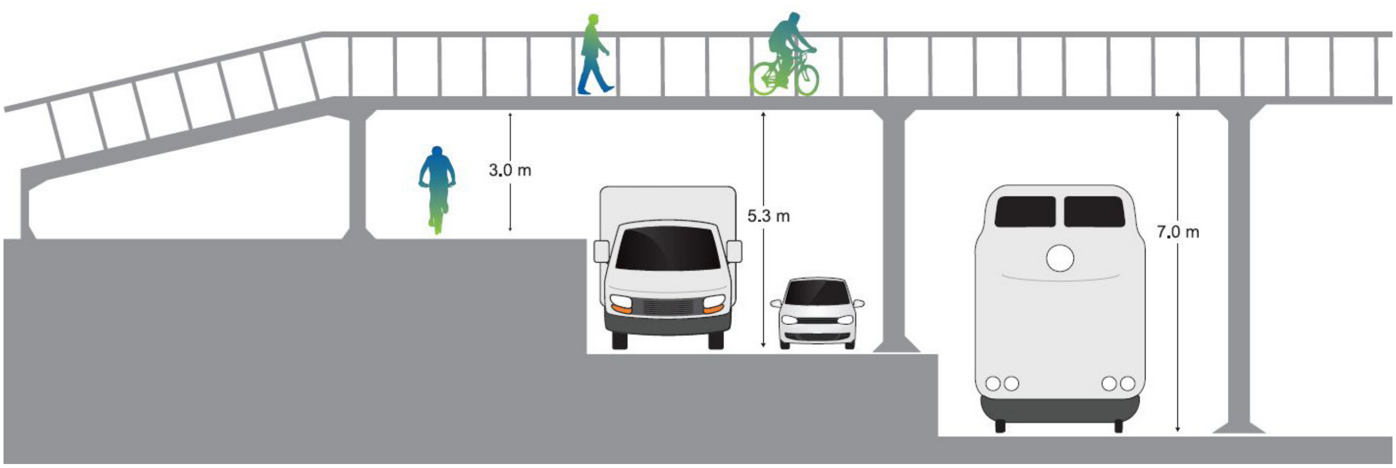
4.13.1 Bridges and Overpasses

Bridges and overpasses can provide crossings for persons walking or cycling either as stand-alone structures or they can include expansion or modification to existing structures.

Standalone Active Transportation Structures

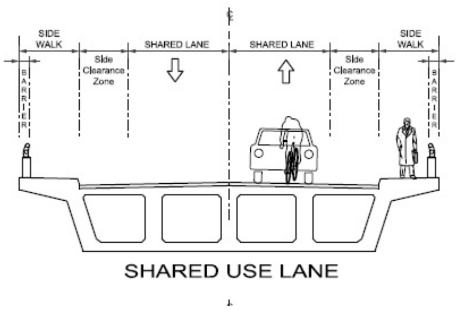
Investments in standalone structures may be needed to make important connections. Grade-separated structures may be considered where they would be more inviting than tunnels due to natural lighting, a more expansive line of sight and a potential for viewing the surrounding landscape. These factors should be considered against the overall footprint of the structure, including vertical clearance requirements and the space needed for ramps. However, as depicted in Exhibit 4.20, a minimum vertical clearance of at least 5.3 m is often required and when crossings a roadway and a minimum 7 m clearance is required when crossing a railway. The crossing design must consider the needs of all vehicles which must be accommodated.

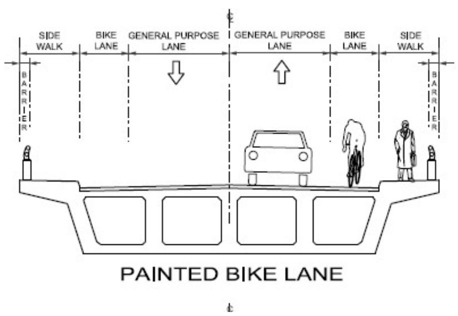
Exhibit 4.20: Vertical clearance beneath a walking/cycling bridge

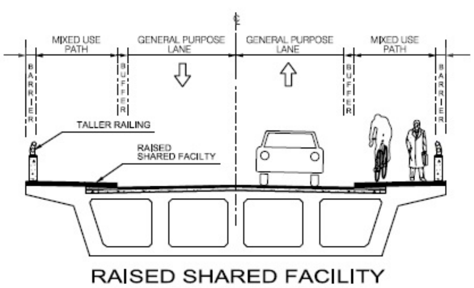


Source: Adapted from Velo Quebec Technical Guide – Planning and Design for Pedestrians and Cyclists

Exhibit 4.21: Typical Bridge Retrofit: traditional approach and two active transportation examples







Source: City of Ottawa

Retrofitting Existing Bridges

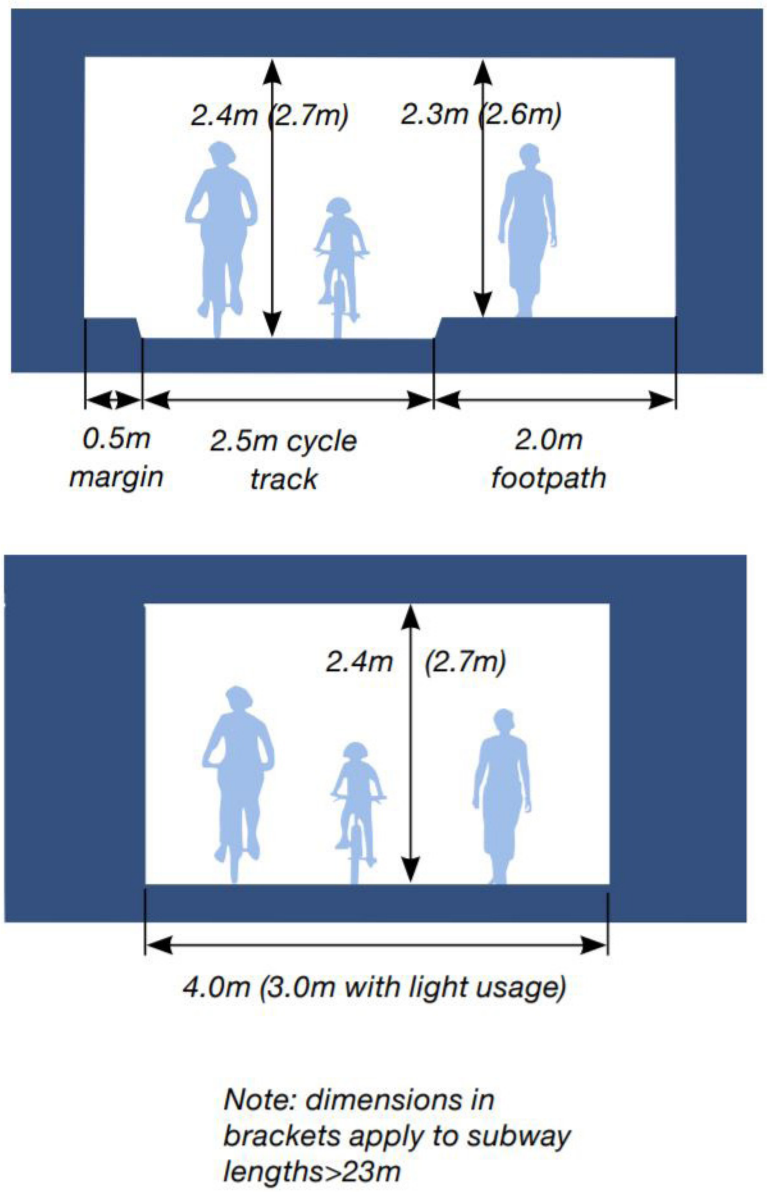
Where existing road bridges along a key cycling route can be retrofitted to create dedicated space for cyclists, this may be less costly than standalone structures. In doing so, the feasibility of introducing a dedicated facility should be assessed and comply with the standards set out in the Canadian Highway Bridge Design Code (2002) and reference should be made to Section 5.6 in OTM Book 18, which discusses the integration of bicycle facilities at grade separations. Considerations should also be made for raising cycling facilities across bridges.

A sample of how cycling facilities can be retrofit to an existing bridge is shown in Exhibit 4.21. The first cross-section shows a typical existing condition, while the following examples show retrofit improvements for active transportation.

4.13.2 Tunnels

Tunnels can provide an alternative to bridges and overpasses and may require less vertical clearance (3 m). This difference in elevation may require gentler access ramps which may be less physically demanding for persons walking and cycling across the barrier.

Exhibit 4.22: Cycling/Pedestrian Tunnel Clearance Requirements



Source: Sustrans Design Manual Chapter 8 - Bridges and other structures

5

Bike Parking

Providing bike parking (both long-term and short-term) is important for encouraging cycling for a variety of purposes. This section provides details on the quantity, types and placement of various racks. For additional guidance on policies for bike parking for new developments, candidate sites and siting recommendations, please refer to the Active Transportation Master Plan, Chapter 3.5.

5.1 RACK TYPE GUIDANCE

General Guidance

Ontario Traffic Manual (OTM) Book 18 outlines a series of guidelines for the design of bicycle parking facilities on a given site. All types of bike parking should:

- Provide two points of contact between the bicycle and the rack to provide stability and security
- Allow for the locking of the frame and one or both wheels
- Be compatible with standard locking devices — particularly the standard u-lock
- Be secured with tamper proof bolts
- Be optimized for ease of access and functionality
- Complement the surroundings

The design of a bicycle parking facility should consider the duration that bicycles will typically be parked there– whether it is a long-term place to store a bicycle (apartments), an all-day parking facility (places of work or transit stations), or whether it is a short term facility that experiences frequent turnover (retail destination). The design and location of bicycle parking on a given site, as well as weather protection, visibility and security, and space or clearance around the rack should be considered in the provision for bicycle parking.

> Convenience is one of the most important factors when considering short-term bicycle parking needs. Bike racks that are intended for short-term users must be installed in **highly visible locations**, as close as possible to the destination - 15 m or less form the entrance is a good benchmark.

5.1.1 Short-Term Bicycle Parking

Short-term parking is designed to meet the needs of people visiting businesses and institutions, and others with similar needs—typically lasting up to two hours. Short-term users may be infrequent visitors to a location, so the parking installation needs to be readily visible and self-explanatory.

Racks should allow bicycles of varying shapes and sizes to be easily attached with a U-lock. “Inverted-U” and ‘post and ring’ racks fulfill these requirements. Refer to Exhibit 5.1.

Weather protection is not critical for short-term bicycle parking, but may be achieved by placing it under a canopy, awning or building overhang. It can make bicycle transportation more viable for daily and year-round use, and can reduce the motivation for users to bring wet bicycles into buildings. If the bicycle parking rack is sheltered by a partial enclosure, it is recommended that a transparent material be used to allow passive surveillance of the bicycle parking area. Area lighting is important for any location likely to see use outside of daylight hours.

Exhibit 5.1: Examples of “Inverted-U” (left) and “Post and Ring” (right) racks

Source: IBI Group

Security

All racks must be sturdy and well-anchored, but location determines the security of short-term parking as much as any other factor. Users seek out parking that is visible to the public, and they particularly value racks that can be seen from within the destination. Areas with high incidence of bicycle theft may justify specific security features such as specialty racks, tamper-proof mounting techniques, or active surveillance.

Bike Corrals

Some cities with limited sidewalk space and strong bicycle activity place bike parking in “bike corrals” located on the street adjacent to the curb. Bike corrals can sometimes make use of on-street areas that are unsuitable for auto parking. When replacing a single auto parking space, a corral can generally fit 8 to 12 bicycles.

Temporary Bike Parking

Additional temporary bike parking (e.g. bike valet service) may be commissioned by event organizers such as outdoor concerts, festivals or sport events, if it is expected that the bike parking demand will outstrip the supply available. The provision of temporary bike parking for major events is an increasing practice in North America. The investment in these services is understood as a “Transportation Demand Management” strategy, which is often much less costly to the event organizer than the provision of car parking spaces for every attendee.

Long-term parking can take a variety of forms, including a room within a residential building or workplace, a secure enclosure within a parking garage, or a cluster of bike lockers at a transit center. Some long-term parking is open to the public—such as a staffed secure enclosure at a transit hub—and some of it is on private property with access limited to employees, residents, or other defined user groups.

5.1.2 Long-Term Bicycle Parking

Users of long-term parking generally place high value on security and weather protection. Long-term parking is designed to meet the needs of employees, residents, public transit users, and others with similar needs. These users typically park either at home or at a routine destination such as a workplace on a regular basis. They often leave their bicycles unmonitored for a period of several hours or longer, so they require security and weather protection that let them park without unreasonable concern for loss or damage.

Appropriate locations for long-term parking vary with context. Long-term parking users are typically willing to trade a degree of convenience for weather protection and increased security. Long-term installations emphasize physical security above public visibility. Signage may be needed for first-time users.

Access to parked bicycles can be limited individually (as with lockers) or in groups (as with locked bike rooms or other secure enclosures). Options for access control include user supplied locks, keys, smart cards, and other technologies.

In many ways, short-term and long-term parking function similarly and are served by the same guidelines, but long-term parking provides greater density. The need for bicycle parking to be supplied in a more compact area may arise from the competition of uses for high-security and sheltered locations. When parking needs cannot be met with standard racks, consider rack systems designed to increase parking density (refer to Exhibit 5.2).

Exhibit 5.2: Example of a high-density bike parking system

Source: Wim Mulder

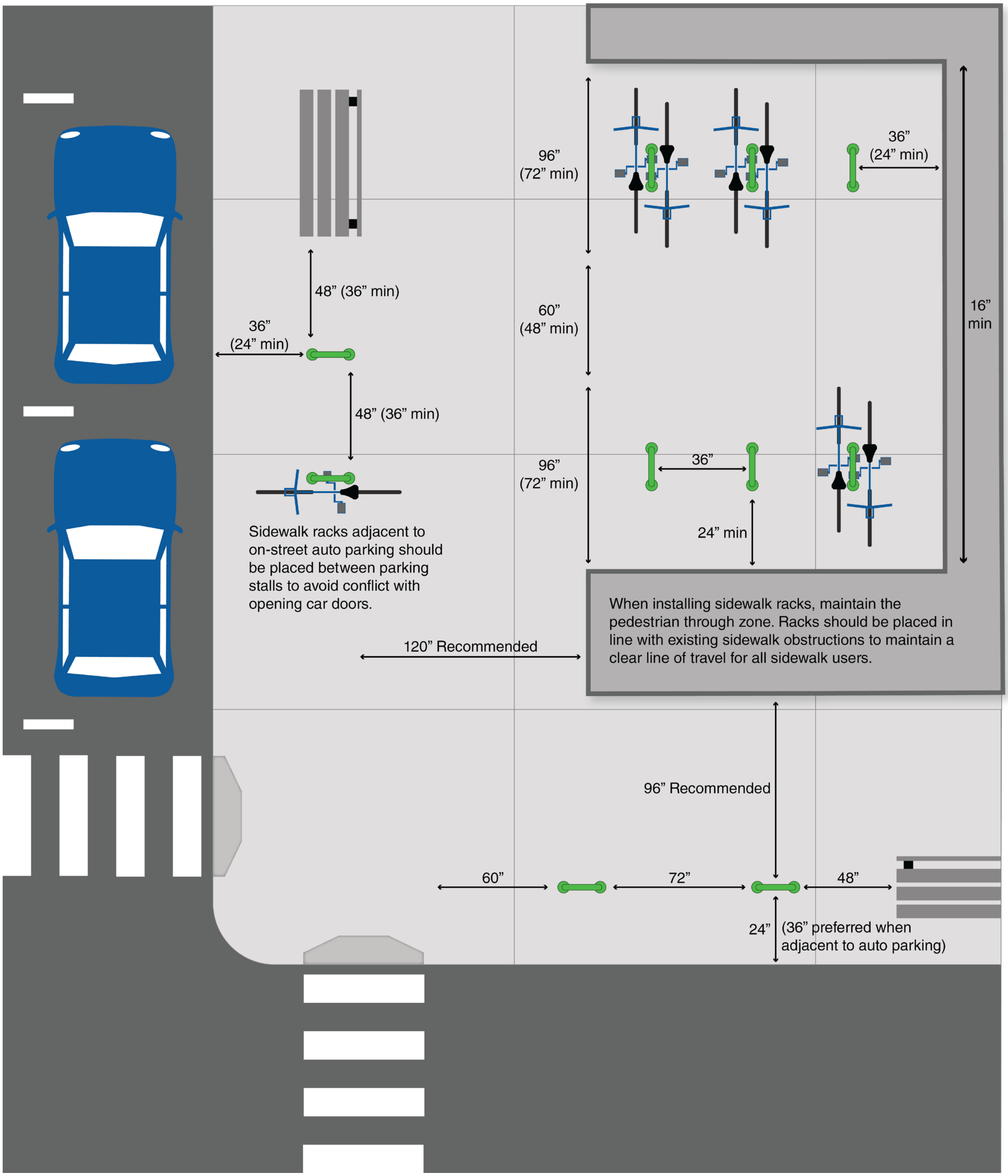
5.2 SPACE REQUIREMENTS FOR BIKE PARKING

A bicycle parking space must comply with the following:

- The minimum dimension of a bicycle parking space is 1.8m in length and 0.6m in width. The minimum vertical clearance from the ground is 1.9 m.
- The minimum dimension of a bicycle parking space if placed in a vertical position on a wall, structure or mechanical device is 1.9m in height and 0.6m in width. The minimum horizontal clearance from the wall is 1.2m.
- If a stacked bicycle parking space is provided, the minimum vertical clearance for each bicycle parking space is 1.2 m and the total vertical clearance is 2.4 m.

An illustration of clearance requirements around conventional racks is provided in Exhibit 5.3.

Exhibit 5.3: Placement of bicycle racks



Source: Adapted from APBP Essential of Bike Parking, 2015.

This page is intentionally left blank.